TRANSMOUNTAIN

CELEBRATING 60 YEARS OF SERVICE 1953 to 2013

Trans Mountain Pipeline ULC

Trans Mountain Expansion Project

An Application Pursuant to Section 52 of the National Energy Board Act

December 2013

Volume 5a ESA - Biophysical

KINDER MORGAN CANADA

NATIONAL ENERGY BOARD

IN THE MATTER OF

**the *National Energy Board Act*,
R.S.C. 1985, c. N-7, as amended, ("*NEB Act*")
and the Regulations made thereunder;**

AND IN THE MATTER OF

**the *Canadian Environmental Assessment Act*, 2012,
S.C. 2012, c. 37, as amended,
and the Regulations made thereunder;**

AND IN THE MATTER OF

**an application by Trans Mountain Pipeline ULC
as General Partner of Trans Mountain Pipeline L.P.
(collectively "Trans Mountain")
for a Certificate of Public Convenience and Necessity and
other related approvals pursuant to Part III of the *NEB Act***

APPLICATION BY TRANS MOUNTAIN FOR APPROVAL OF THE TRANS MOUNTAIN EXPANSION PROJECT

December 2013

**To: The Secretary
The National Energy Board
444 — 7th Avenue SW
Calgary, AB T2P 0X8**

Trans Mountain Expansion Project
Application Pursuant to Section 52 of the *National Energy Board Act*

Guide to the Application

Application	
Transmittal - Letter to the National Energy Board	
Volume 1	Summary
Volume 2	Project Overview, Economics and General Information
Volume 3A	Public Consultation
Volume 3B	Aboriginal Engagement
Volume 3C	Landowner Relations
Volume 4A	Project Design and Execution – Engineering
Volume 4B	Project Design and Execution – Construction
Volume 4C	Project Design and Execution – Operations and Maintenance
Volume 5A	**Environmental and Socio-Economic Assessment – Biophysical**
Volume 5B	Environmental and Socio-Economic Assessment – Socio-Economic
Volume 5C	Environmental and Socio-Economic Assessment – Biophysical Technical Reports
Volume 5D	Environmental and Socio-Economic Assessment – Socio-Economic Technical Reports
Volume 6A	Environmental Compliance
Volume 6B	Pipeline Environmental Protection Plan
Volume 6C	Facilities Environmental Protection Plan
Volume 6D	Westridge Marine Terminal Environmental Protection Plan
Volume 6E	Environmental Alignment Sheets
Volume 7	Risk Assessment and Management of Pipeline and Facility Spills
Volume 8A	Marine Transportation
Volume 8B	Marine Environmental and Socio-Economic Technical Reports
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This volume contains:

Volume 5A			
Section 1.0	Introduction	Section 6.0	Environmental Setting for Facilities
Section 2.0	Project Description	Section 7.0	Environmental Effects Assessment
Section 3.0	Public Consultation, Aboriginal Engagement and Landowner Relations	Section 8.0	Cumulative Effects Assessment
		Section 9.0	Supplemental Studies
Section 4.0	Corridor and Facility Site Selection	Section 10.0	Follow-up
Section 5.0	Environmental Setting for the Pipeline	Section 11.0	Conclusions

NEB FILING MANUAL CHECKLIST

CHAPTER 3 – COMMON INFORMATION REQUIREMENTS

Filing #	Filing Requirement	In Application? References	Not in Application? Explanation
3.1 Action Sought by Applicant			
1.	Requirements of s.15 of the Rules.	Volume 1 Section 1.1	---
3.2 Application or Project Purpose			
1.	Purpose of the proposed project.	Volume 2 Section 1.1	---
3.4 Consultation		Volumes 3A, 3B, 3C; Volumes 5A, 5B Section 3; Volume 8A Section 3	--
3.4.1 Principles and Goals of Consultation			
1.	The corporate policy or vision.	Volume 3A Section 1.2.1 Volume 3B Section 1.2.1	--
2.	The principles and goals of consultation for the project.	Volume 3A Section 1.2.2 Volume 3B Section 1.2.2 Volume 5A Section 3.2.1 Volume 5B Section 3.2.1	--
3.	A copy of the Aboriginal protocol and copies of policies and principles for collecting traditional use information, if available.	Volume 3B Section 1.3.5	--
3.4.2 Design of Consultation Program			
1.	The design of the consultation program and the factors that influenced the design.	Volume 3A Section 1.3 Volume 3B Section 1.3 Volume 5A Section 3.1.1, 3.2.2 Volume 5B Section 3.1.1, 3.2.2	--
3.4.3 Implementing a Consultation Program			
1.	The outcomes of the consultation program for the project.	Volume 3A Section 1.7 Volume 3B Section 1.5 Table 1.5.1 Volume 5A Section 3.1.5, 3.2.4 Volume 5B Section 3.1.5, 3.2.4	--
3.4.4 Justification for Not Undertaking a Consultation Program			
2.	The application provides justification for why the applicant has determined that a consultation program is not required for the project.	N/A	N/A
3.5 Notification of Commercial Third Parties			
1.	Confirm that third parties were notified.	Volume 2 Section 3.2.2	--
2.	Details regarding the concerns of third parties.	Volume 2 Section 3.2.2	--
3.	List the self-identified interested third parties and confirm they have been notified.	N/A	N/A
4.	If notification of third parties is considered unnecessary, an explanation to this effect.	N/A	N/A

CHAPTER 4 – SECTIONS 4.1 AND 4.2: COMMON REQUIREMENTS FOR PHYSICAL PROJECTS

Filing #	Filing Requirement	In Application? References	Not in Application? Explanation
4.1 Description of the Project			--
1.	The project components, activities and related undertakings.	Volume 2 Section 2.0; Volume 4A	--
2.	The project location and criteria used to determine the route or site.	Volume 2 Section 4.0; Volume 4A	--
3.	How and when the project will be carried out.	Volume 2 Section 2.3; Volume 4B Section 2.0	--
4.	Description of any facilities, to be constructed by others, required to accommodate the proposed facilities.	N/A	N/A
5.	An estimate of the total capital costs and incremental operating costs, and changes to abandonment cost estimates.	Volume 2 Section 2.9	--
6.	The expected in-service date.	Volume 2 Section 1.1; Volume 4B Section 2.1	--
4.2 Economic Feasibility, Alternatives and Justification			
4.2.1 Economic Feasibility			
1.	Describe the economic feasibility of the project.	Volume 2 Section 3.5	--
4.2.2 Alternatives			
1.	Describe the need for the project, other economically-feasible alternatives to the project examined, along with the rationale for selecting the applied for project over these other possible options.	Volume 2 Section 3.0; Volume 8A Section 2.2	--
2.	Describe and justify the selection of the proposed route and site including a comparison of the options evaluated using appropriate selection criteria.	Volume 2 Section 4.0; Volume 8A Section 2.2	--
3.	Describe the rationale for the chosen design and construction methods. Where appropriate, describe any alternative designs and methods evaluated and explain why these other options were eliminated.	Volume 2 Section 4.0; Volume 8A Section 2.2	--
4.2.3 Justification			
1.	Provide a justification for the proposed project	Volume 2 Section 3.4	--

GUIDE A – A.1 ENGINEERING

Filing #	Filing Requirement	In Application? References	Not in Application? Explanation
A.1.1 Engineering Design Details			
1.	Fluid type and chemical composition.	Volume 4A Section 3.1.1	--
2.	Line pipe specifications.	Volume 4A Section 3.2.8	--
3.	Pigging facilities specifications.	Volume 4A Section 3.3.1, 3.3.2	--
4.	Compressor or pump facilities specifications.	Volume 4A Section 3.4	--
5.	Pressure regulating or metering facilities specifications.	Volume 4A Section 3.5	--
6.	Liquid tank specifications, or other commodity storage facilities.	Volume 4A Section 3.4	--
7.	New control system facilities specifications.	Volume 4A Section 3.3	--
8.	Gas processing, sulphur or LNG plant facilities specifications.	N/A	N/A
9.	Technical description of other facilities not mentioned above.	N/A	N/A
10.	Building dimensions and uses.	Volume 4A Section 3.3, 3.4, 3.5	--
11.	If project is a new system that is a critical source of energy supply, a description of the impact to the new system capabilities following loss of critical component.	N/A	N/A
A.1.2 Engineering Design Principles			
1.	Confirmation project activities will follow the requirements of the latest version of CSA Z662.	Volume 4A Section 2.2	--
2.	Provide a statement indicating which Annex is being used and for what purpose	Volume 4A Section 2.3	--
3.	Statement confirming compliance with OPR or PPR.	Volume 4A Section 2.1	--
4.	Listing of all primary codes and standards, including version and date of issue.	Volume 4A Section 2, Table 5.1.1	--
5.	Confirmation that the project will comply with company manuals and confirm manuals comply with OPR/PPR and codes and standards.	Volume 4A Section 2.6, Table 5.1.2	--
6.	Any portion of the project a non-hydrocarbon commodity pipeline system? Provide a QA program to ensure the materials are appropriate for their intended service.	N/A – all hydrocarbons	N/A
7.	If facility subject to conditions not addressed in CSA Z662: • Written statement by qualified professional engineer • Description of the designs and measures required to safeguard the pipeline	Volume 4A Section 2.9	--
8.	If directional drilling involved: • Preliminary feasibility report • Description of the contingency plan	Volume 4A Section 2.12	--
9.	If the proposed project involves the reuse of materials, provide an engineering assessment in accordance with CSA Z662 that indicates its suitability for the intended service.	Volume 4A, Section 2.7	--
10.	If new materials are involved, provide material supply chain information, in tabular format.	Volume 4A Section 2.7	
11.	If reuse of material is involved, provide an engineering assessment in accordance with CSA Z662 that indicates its suitability for the intended service.	Volume 4A, Section 2.7	--
A.1.3 Onshore Pipeline Regulations			
1.	Designs, specifications programs, manuals, procedures, measures or plans for which no standard is set out in the OPR or PPR.	--	Existing standards will be followed
2.	A quality assurance program if project non-routine or incorporates unique challenges due to geographical location.	--	No unique challenges
3.	If welding performed on a liquid-filled pipeline that has a carbon equivalent of 0.50% or greater and is a permanent installation: • Welding specifications and procedures • Results of procedure qualification tests	--	Welding on liquid filled pipe will not be conducted

GUIDE A – A.2 ENVIRONMENTAL AND SOCIO-ECONOMIC ASSESSMENT

The following table identifies where information requested in the National Energy Board (NEB) Filing Manual Guide A – A.2 Environmental and Socio-economic Assessment checklist may be found in the various volumes of the Application for the Trans Mountain Expansion Project.

Filing #	Filing Requirement	In Application? References	Applicable Marine Transportation Elements	Not in Application? Explanation
A.2.5 Description of the Environmental and Socio-Economic Setting				
1.	Identify and describe the current biophysical and socio-economic setting of each element (*i.e.*, baseline information) in the area where the project is to be carried out.	Volume 5A: ESA - Biophysical • Sections 5.0 and 6.0 Volume 5B: ESA - Socio-Economic • Sections 5.0 and 6.0 Volume 5C: ESA - Biophysical Technical Reports Volume 5D: ESA - Socio-Economic Technical Reports	Volume 8A: Marine Transportation • Section 4.2 Volume 8B: Technical Reports	---
2.	Describe which biophysical or socio-economic elements in the study area are of ecological, economic, or human importance and require more detailed analysis taking into account the results of consultation (see Table A-1 for examples). Where circumstances require more detailed information in an ESA see: i. Table A-2 – Filing Requirements for Biophysical Elements; or ii. Table A-3 – Filing Requirements for Socio-economic Elements.	Volume 5A: ESA - Biophysical • Sections 5.0 and 6.0 Volume 5B: ESA - Socio-Economic • Sections 5.0 and 6.0 Volume 5C: ESA - Biophysical Technical Reports Volume 5D: ESA - Socio-Economic Technical Reports	Volume 8A: Marine Transportation • Section 4.2 Volume 8B: Technical Reports	---
3.	Provide supporting evidence (*e.g.*, references to scientific literature, field studies, local and traditional knowledge, previous environmental assessment and monitoring reports) for: • information and data collected; • analysis completed; • conclusions reached; and • the extent of professional judgment or experience relied upon in meeting these information requirements, and the rationale for that extent of reliance.	Volume 5A: ESA - Biophysical • Sections 5.0 and 6.0 Volume 5B: ESA - Socio-Economic • Sections 5.0 and 6.0 Volume 5C: ESA - Biophysical Technical Reports Volume 5D: ESA - Socio-Economic Technical Reports	Volume 8A: Marine Transportation • Section 4.2 Volume 8B: Technical Reports	---
4.	Describe and substantiate the methods used for any surveys, such as those pertaining to wildlife, fisheries, plants, species at risk or species of special status, soils, heritage resources or traditional land use, and for establishing the baseline setting for the atmospheric and acoustic environment.	Volume 5A: ESA - Biophysical • Sections 5.0 and 6.0 Volume 5B: ESA - Socio-Economic • Sections 5.0 and 6.0 Volume 5C: ESA - Biophysical Technical Reports Volume 5D: ESA - Socio-Economic Technical Reports	Volume 8A: Marine Transportation • Section 4.2 Volume 8B: Technical Reports	---
5.	Applicants must consult with other expert federal, provincial or territorial departments and other relevant authorities on requirements for baseline information and methods.	Volume 5A: ESA - Biophysical • Sections 3.0, 5.0 and 6.0 Volume 5B: ESA - Socio-Economic • Sections 3.0, 5.0 and 6.0 Volume 5C: ESA - Biophysical Technical Reports Volume 5D: ESA - Socio-Economic Technical Reports	Volume 8A: Marine Transportation • Sections 3.0 and 4.2 Volume 8B: Technical Reports	---

Filing #	Filing Requirement	In Application? References	Applicable Marine Transportation Elements	Not in Application? Explanation
A.2.6 Effects Assessment				
Identification and Analysis of Effects				
1.	Describe the methods used to predict the effects of the project on the biophysical and socio-economic elements, and the effects of the environment on the project (*i.e.*, changes to the Project caused by the environment).	Volume 5A: ESA - Biophysical • Section 7.0 Volume 5B: ESA - Socio-Economic • Section 7.0 Volume 7: Risk Assessment and Management of Pipeline and Facility Spills • Sections 6.0, 7.0 and 8.0 • Technical Reports	Volume 8A: Marine Transportation • Sections 4.3, 5.5 and 5.6	---
2.	Predict the effects associated with the proposed project, including those that could be caused by construction, operations, decommissioning or abandonment, as well as accidents and malfunctions. Also include effects the environment could have on the project. For those biophysical and socio-economic elements or their valued components that require further analysis (see Table A-1), provide the detailed information outlined in Tables A-2 and A-3.	Volume 5A: ESA - Biophysical • Section 7.0 Volume 5B: ESA - Socio-Economic • Section 7.0 Volume 5C: ESA - Biophysical Technical Reports Volume 5D: ESA - Socio-Economic Technical Reports Volume 7: Risk Assessment and Management of Pipeline and Facility Spills • Sections 6.0, 7.0 and 8.0 • Technical Reports	Volume 8A: Marine Transportation • Sections 4.3, 5.6 and 5.7 Volume 8B: Technical Reports	---
Mitigation Measures for Effects				
1.	Describe the standard and project specific mitigation measures and their adequacy for addressing the project effects, or clearly reference specific sections of company manuals that provide mitigation measures. Ensure that referenced manuals are current and filed with the NEB.	Volume 5A: ESA - Biophysical • Section 7.0 Volume 5B: ESA - Socio-Economic • Section 7.0 Volume 5C: ESA - Biophysical Technical Reports Volume 5D: ESA - Socio-Economic Technical Reports Volume 6B: Pipeline Environmental Protection Plan (EPP) Volume 6C: Facilities EPP Volume 6D: Westridge Marine Terminal EPP Volume 6E: Environmental Alignment Sheets Volume 7: Risk Assessment and Management of Pipeline and Facility Spills • Sections 2.0, 3.0, 4.0, 6.0, 7.0, and 8.0 • Technical Reports	Volume 8A: Marine Transportation • Sections 4.3, 5.1, 5.3, 5.6 and 5.7 Volume 8B: Technical Reports	---
2.	Ensure that commitments about mitigative measures will be communicated to field staff for implementation through an Environmental Protection Plan.	Volume 5A: ESA - Biophysical • Section 7.0 Volume 5B: ESA - Socio-Economic • Section 7.0 Volume 6A: Environmental Compliance Volume 6B: Pipeline EPP Volume 6C: Facilities EPP Volume 6D: Westridge Marine Terminal EPP Volume 6E: Environmental Alignment Sheets Volume 7: Risk Assessment and Management of Pipeline and Facility Spills • Sections 2.0, 3.0, 4.0, 6.0, 7.0 and 8.0	Volume 8A: Marine Transportation • Sections 4.3, 5.1, 5.3, 5.6 and 5.7	---

Filing #	Filing Requirement	In Application? References	Applicable Marine Transportation Elements	Not in Application? Explanation
3.	Describe plans and measures to address potential effects of accidents and malfunctions during construction and operation of the project.	Volume 5A: ESA - Biophysical • Section 7.0 Volume 5B: ESA - Socio-Economic • Section 7.0 Volume 6B: Pipeline EPP Volume 6C: Facilities EPP Volume 6D: Westridge Marine Terminal EPP Volume 7: Risk Assessment and Management of Pipeline and Facility Spills • Sections 2.0, 4.0, 6.0, 7.0 and 8.0	Volume 8A: Marine Transportation • Sections 4.3, 5.1, 5.3, 5.6 and 5.7	---
Evaluation of Significance				
1.	After taking into account any appropriate mitigation measures, identify any remaining residual effects from the project.	Volume 5A: ESA - Biophysical • Section 7.0 Volume 5B: ESA - Socio-Economic • Section 7.0	Volume 8A: Marine Transportation • Section 4.3	---
2.	Describe the methods and criteria used to determine the significance of remaining adverse effects, including defining the point at which any particular effect on a valued component is considered “significant”.	Volume 5A: ESA - Biophysical • Section 7.0 Volume 5B: ESA - Socio-Economic • Section 7.0	Volume 8A: Marine Transportation • Section 4.3	---
3.	Evaluate significance of residual adverse environmental and socio-economic effects against the defined criteria.	Volume 5A: ESA - Biophysical • Section 7.0 Volume 5B: ESA - Socio-Economic • Section 7.0	Volume 8A: Marine Transportation • Section 4.3	---
4.	Evaluate the likelihood of significant, residual adverse environmental and socio-economic effects occurring and substantiate the conclusions made.	Volume 5A: ESA - Biophysical • Section 7.0 Volume 5B: ESA - Socio-Economic • Section 7.0	Volume 8A: Marine Transportation • Section 4.3	---
A.2.7 Cumulative Effects Assessment				
Scoping and Analysis of Cumulative Effects				
1.	Identify the valued components for which residual effects are predicted, and describe and justify the methods used to predict any residual results.	Volume 5A: ESA - Biophysical • Section 8.0 Volume 5B: ESA - Socio-Economic • Section 8.0	Volume 8A: Marine Transportation • Section 4.4	---
2.	For each valued component where residual effects have been identified, describe and justify the spatial and temporal boundaries used to assess the potential cumulative effects.	Volume 5A: ESA - Biophysical • Section 8.0 Volume 5B: ESA - Socio-Economic • Section 8.0	Volume 8A: Marine Transportation • Section 4.4	---
3.	Identify other physical works or activities that have been or will be carried out within the identified spatial and temporal boundaries for the cumulative effects assessment.	Volume 5A: ESA - Biophysical • Section 8.0 Volume 5B: ESA - Socio-Economic • Section 8.0	Volume 8A: Marine Transportation • Section 4.4	---
4.	Identify whether the effects of those physical works or activities that have been or will be carried out would be likely to produce effects on the valued components within the identified spatial and temporal boundaries.	Volume 5A: ESA - Biophysical • Section 8.0 Volume 5B: ESA - Socio-Economic • Section 8.0	Volume 8A: Marine Transportation • Section 4.4	---

Filing #	Filing Requirement	In Application? References	Applicable Marine Transportation Elements	Not in Application? Explanation
5.	Where other physical works or activities may affect the valued components for which residual effects from the applicant's proposed project are predicted, continue the cumulative effects assessment, as follows: • consider the various components, phases and activities associated with the applicant's project that could interact with other physical work or activities; • provide a description of the extent of the cumulative effects on valued components; and • where professional knowledge or experience is cited, explain the extent to which professional knowledge or experience was relied upon and justify how the resulting conclusions or decisions were reached.	Volume 5A: ESA - Biophysical • Section 8.0 Volume 5B: ESA - Socio-Economic • Section 8.0	Volume 8A: Marine Transportation • Section 4.4	---
Mitigation Measures for Cumulative Effects				
1.	Describe the general and specific mitigation measures, beyond project-specific mitigation already considered, that are technically and economically feasible to address any cumulative effects.	Volume 5A: ESA - Biophysical • Section 8.0 Volume 5B: ESA - Socio-Economic • Section 8.0	Volume 8A: Marine Transportation • Section 4.4	---
Applicant's Evaluation of Significance of Cumulative Effects				
1.	After taking into account any appropriate mitigation measures for cumulative effects, identify any remaining residual cumulative effects.	Volume 5A: ESA - Biophysical • Section 8.0 Volume 5B: ESA - Socio-Economic • Section 8.0	Volume 8A: Marine Transportation • Section 4.4	---
2.	Describe the methods and criteria used to determine the significance of remaining adverse cumulative effects, including defining the point at which each identified cumulative effect on a valued component is considered "significant".	Volume 5A: ESA - Biophysical • Section 8.0 Volume 5B: ESA - Socio-Economic • Section 8.0	Volume 8A: Marine Transportation • Section 4.4	---
3.	Evaluate the significance of adverse residual cumulative effects against the defined criteria.	Volume 5A: ESA - Biophysical • Section 8.0 Volume 5B: ESA - Socio-Economic • Section 8.0	Volume 8A: Marine Transportation • Section 4.4	---
4.	Evaluate the likelihood of significant, residual adverse cumulative environmental and socio-economic effects occurring and substantiate the conclusions made.	Volume 5A: ESA - Biophysical • Section 8.0 Volume 5B: ESA - Socio-Economic • Section 8.0	Volume 8A: Marine Transportation • Section 4.4	---
A.2.8 Inspection, Monitoring and Follow-up				
1.	Describe inspection plans to ensure compliance with biophysical and socio-economic commitments, consistent with Sections 48, 53 and 54 of the *NEB Onshore Pipeline Regulations (OPR).*	Volume 5A: ESA - Biophysical • Section 7.0 Volume 5B: ESA - Socio-Economic • Section 7.0 Volume 6A: Environmental Compliance Volume 6B: Pipeline EPP Volume 6C: Facilities EPP Volume 6D: Westridge Marine Terminal EPP	Volume 8A: Marine Transportation • Section 4.3	---
2.	Describe the surveillance and monitoring program for the protection of the pipeline, the public and the environment, as required by Section 39 of the *NEB OPR*.	Volume 5A: ESA - Biophysical • Section 7.0 Volume 5B: ESA - Socio-Economic • Section 7.0 Volume 6A: Environmental Compliance Volume 6B: Pipeline EPP Volume 6C: Facilities EPP Volume 6D: Westridge Marine Terminal EPP	Volume 8A: Marine Transportation • Section 4.3	---

Filing #	Filing Requirement	In Application? References	Applicable Marine Transportation Elements	Not in Application? Explanation
3.	Consider any particular elements in the Application that are of greater concern and evaluate the need for a more in-depth monitoring program for those elements.	Volume 5A: ESA - Biophysical • Sections 9.0 and 10.0 Volume 5B: ESA - Socio-Economic • Sections 9.0 and 10.0 Volume 6A: Environmental Compliance Volume 6B: Pipeline EPP (Socio-Economic Management Plan of Appendix C)	Volume 8A: Marine Transportation • Section 4.5	---
4.	For *Canadian Environmental Assessment (CEA) Act, 2012* designated projects, identify which elements and monitoring procedures would constitute follow-up under the *CEA Act, 2012*.	Volume 5A: ESA - Biophysical • Section 10.0 Volume 5B: ESA - Socio-economic • Section 10.0	N/A	---

Filing #	Filing Requirement	In Application? References	Applicable Marine Transportation Elements	Not in Application? Explanation
Table A-1 Circumstances and Interactions Requiring Detailed Biophysical and Socio-Economic Information				
Physical and meteorological environment		Volume 5A: ESA - Biophysical • Sections 5.0, 6.0 and 7.0	N/A	---
Soil and soil productivity		Volume 5A: ESA - Biophysical • Sections 5.0, 6.0, 7.0 and 8.0 Volume 5C: ESA - Biophysical Technical Reports • Soil Assessment Technical Report Volume 7: Risk Assessment and Management of Pipeline and Facility Spills • Section 5.3, 6.0 and 7.0	N/A	---
Water quality and quantity (onshore and marine)		Volume 5A: ESA - Biophysical • Sections 5.0, 6.0, 7.0 and 8.0 Volume 5C: ESA - Biophysical Technical Reports • Groundwater Technical Report • Fisheries (Alberta) Technical Report • Fisheries (British Columbia) Technical Report • Wetland Evaluation Technical Report • Marine Sediment and Water Quality – Westridge Marine Terminal Technical Report Volume 7: Risk Assessment and Management of Pipeline and Facility Spills • Section 7.0 • Quality Ecological Risk Assessment of Pipeline Spills Technical Report	Volume 8A: Marine Transportation • Sections 4.2, 4.3, 4.4, 5.6 and 5.7 Volume 8B: Technical Reports • Ecological Risk Assessment of Marine Transportation Spills Technical Report	---
Air emissions (onshore and marine)		Volume 5A: ESA - Biophysical • Sections 5.0, 6.0, 7.0 and 8.0 Volume 5C: ESA - Biophysical Technical Reports • Marine Air Quality and Greenhouse Gas – Marine Transportation Technical Report • Air Quality and Greenhouse Gas Emissions Technical Report Volume 7: Risk Assessment and Management of Pipeline and Facility Spills • Section 7.0	Volume 8A: Marine Transportation • Sections 4.2, 4.3, 4.4, 5.6 and 5.7 Volume 8B: Technical Reports • Marine Air Quality and Greenhouse Gas Emissions	---
Greenhouse gas emissions (onshore and marine)		Volume 5A: ESA - Biophysical • Sections 5.0, 6.0 and 7.0 Volume 5C: ESA - Biophysical Technical Reports • Air Quality and Greenhouse Gas Emissions Technical Report	Volume 8A: Marine Transportation • Sections 4.2 and 4.3 Volume 8B: Technical Reports • Marine Air Quality and Greenhouse Gas Emissions	---
Acoustic environment (onshore and marine)		Volume 5A: ESA - Biophysical • Sections 5.0, 6.0, 7.0, and 8.0 Volume 5C: ESA - Biophysical Technical Reports • Acoustic Environment Technical Report	Volume 8A: Marine Transportation • Sections 4.2, 4.3 and 4.4 Volume 8B: Technical Reports • Marine Noise (Atmospheric)	---
Fish and fish habitat (onshore and marine), including any fish habitat compensation required		Volume 5A: ESA - Biophysical • Sections 5.0, 6.0, 7.0 and 8.0 Volume 5C: ESA - Biophysical Technical Reports • Fisheries (Alberta) Technical Report • Fisheries (British Columbia) Technical Report • Marine Resources - Westridge Marine Terminal Technical Report Volume 7: Risk Assessment and Management of Pipeline and Facility Spills • Sections 6.0, 7.0 and 8.0 • Qualitative Ecological Risk Assessment of Pipeline Spills Technical Report	Volume 8A: Marine Transportation • Sections 4.2, 4.3, 4.4, 5.6 and 5.7 Volume 8B: Technical Reports • Marine Resources – Marine Transportation Technical Report • Ecological Risk Assessment of Westridge Marine Terminal Spills	---

Filing #	Filing Requirement	In Application? References	Applicable Marine Transportation Elements	Not in Application? Explanation
	Wetlands	Volume 5A: ESA - Biophysical • Sections 5.0, 6.0, 7.0 and 8.0 Volume 5C: ESA - Biophysical Technical Reports • Wetland Evaluation Technical Report Volume 7: Risk Assessment and Management of Pipeline and Facility Spills • Sections 7.0 and 8.0 • Qualitative Ecological Risk Assessment of Pipeline Spills Technical Report	N/A	---
	Vegetation	Volume 5A: ESA - Biophysical • Sections 5.0, 6.0, 7.0 and 8.0 Volume 5C: ESA - Biophysical Technical Reports • Vegetation Technical Report Volume 7: Risk Assessment and Management of Pipeline and Facility Spills • Sections 7.0 and 8.0 • Qualitative Ecological Risk Assessment of Pipeline Spills Technical Report	N/A	---
	Wildlife and wildlife habitat (onshore and marine)	Volume 5A: ESA - Biophysical • Sections 5.0, 6.0, 7.0 and 8.0 Volume 5C: ESA - Biophysical Technical Reports • Wildlife and Wildlife Habitat Technical Report • Wildlife Modeling and Species Accounts Report • Marine Resources –Westridge Marine Terminal Technical Report • Marine Birds – Westridge Marine Terminal Technical Report Volume 7: Risk Assessment and Management of Pipeline and Facility Spills • Sections 6.0, 7.0 and 8.0 • Qualitative Ecological Risk Assessment of Pipeline Spills Technical Report	Volume 8A: Marine Transportation • Sections 4.2. 4.3, 4.4, 5.6 and 5.7 Volume 8B: Technical Reports • Marine Resources – Marine Transportation Technical Report • Marine Birds – Marine Transportation Technical Report • Ecological Risk Assessment of Westridge Marine Terminal Spills	---
	Species at Risk or Species of Special Status and related habitat (onshore and marine)	Volume 5A: ESA - Biophysical • Sections 5.0, 6.0, 7.0 and 8.0 Volume 5C: ESA - Biophysical Technical Reports • Fisheries (Alberta) Technical Report • Fisheries (British Columbia) Technical Report • Vegetation Technical Report • Wildlife and Wildlife Habitat Technical Report • Wildlife Modeling and Species Accounts Report • Marine Resources –Westridge Marine Terminal Technical Report • Marine Birds – Westridge Marine Terminal Technical Report Volume 7: Risk Assessment and Management of Pipeline and Facility Spills • Sections 6.0, 7.0 and 8.0 • Qualitative Ecological Risk Assessment of Pipeline Spills Technical Report	Volume 8A: Marine Transportation • Sections 4.2. 4.3, 4.4, 5.6 and 5.7 Volume 8B: Technical Reports • Marine Resources – Marine Transportation Technical Report • Marine Birds – Marine Transportation Technical Report • Marine Transportation Spills Ecological Risk Assessment Technical Report	---

Filing #	Filing Requirement	In Application? References	Applicable Marine Transportation Elements	Not in Application? Explanation
	Human occupancy and resource use (onshore and marine)	Volume 5B: ESA - Socio-Economic • Sections 5.0, 6.0, 7.0 and 8.0 Volume 5D: ESA - Socio-Economic Technical Reports • Socio-Economic Technical Report • Managed Forest Areas Technical Report • Agricultural Assessment Technical Report Volume 7: Risk Assessment and Management of Pipeline and Facility Spills • Sections 6.0, 7.0 and 8.0	Volume 8A: Marine Transportation • Sections 4.2, 4.3, 4.4, 5.6 and 5.7 Volume 8B: Technical Reports • Marine Commercial, Recreational and Tourism Use – Marine Transportation Technical Report	---
	Heritage resources	Volume 5B: ESA - Socio-Economic • Sections 5.0, 6.0 and 7.0 Volume 7: Risk Assessment and Management of Pipeline and Facility Spills • Section 6.3.3	N/A	---
	Navigation and navigation safety	Volume 5B: ESA - Socio-Economic • Sections 5.0, 6.0 and 7.0 Volume 5D: ESA - Socio-Economic Technical Reports • Socio-Economic Technical Report	Volume 8A: Marine Transportation • Section 5.2	---
	Traditional land and resource use	Volume 5B: ESA - Socio-Economic • Sections 5.0, 6.0, 7.0 and 8.0 Volume 5D: ESA - Socio-Economic Technical Reports • Traditional Land and Resource Use Report • Pipeline and Facilities Human Health Risk Assessment Technical Report Volume 7: Risk Assessment and Management of Pipeline and Facility Spills • Sections 6.0, 7.0 and 8.0 • Qualitative Ecological Risk Assessment of Pipeline Spills Technical Report	Volume 8A: Marine Transportation • Sections 4.2, 4.3, 4.4, 5.6 and 5.7 Volume 8B: Technical Reports • Traditional Marine Use Report for Marine Transportation • Marine Transportation Human Health Risk Assessment Technical Report	---
	Social and cultural well-being	Volume 5B: ESA - Socio-Economic • Sections 5.0, 6.0, 7.0 and 8.0 Volume 5D: ESA - Socio-Economic Technical Reports • Socio-Economic Technical Report Volume 7: Risk Assessment and Management of Pipeline and Facility Spills • Sections 6.0, 7.0 and 8.0	N/A	---
	Human health and aesthetics	Volume 5B: ESA - Socio-Economic • Sections 5.0, 6.0, 7.0 and 8.0 Volume 5D: ESA - Socio-Economic Technical Reports • Socio-Economic Technical Report • Community Health Technical Report • Viewshed Modelling Analysis Technical Report • Pipeline and Facilities Human Health Risk Assessment Technical Report Volume 7 Risk Assessment and Management of Pipeline and Facility Spills • Sections 6.0, 7.0 and 8.0 • Qualitative Ecological Risk Assessment of Pipeline Spills Technical Report	Volume 7: Risk Assessment and Management of Pipeline and Facility Spills • Qualitative Human Health Risk Assessment of Westridge Marine Terminal Technical Report Volume 8A: Marine Transportation • Sections 4.2, 4.3, 4.4, 5.6 and 5.7 Volume 8B: Technical Reports • Marine Transportation Human Health Risk Assessment Technical Report • Marine Transportation Spills Human Health Risk Assessment Technical Report	---

Filing #	Filing Requirement	In Application? References	Applicable Marine Transportation Elements	Not in Application? Explanation
Infrastructure and services		Volume 5B: ESA - Socio-Economic • Sections 5.0, 6.0, 7.0 and 8.0 Volume 5D: ESA - Socio-Economic Technical Reports • Socio-Economic Technical Report • Community Health Technical Report Volume 7: Risk Assessment and Management of Pipeline and Facility Spills • Sections 6.0, 7.0 and 8.0	Volume 8A: Marine Transportation • Sections 4.2, 4.3, 4.4, 5.6 and 5.7 Volume 8B: Technical Reports • Marine Commercial, Recreational and Tourism Use – Marine Transportation Technical Report	---
Employment and economy		Volume 5B: ESA - Socio-Economic • Sections 5.0, 6.0, 7.0 and 8.0 Volume 5D: ESA - Socio-Economic Technical Reports • Socio-Economic Technical Report • Worker Expenditures Analysis Technical Report	N/A	---

GUIDE A – A.3 ECONOMICS

Filing #	Filing Requirement	In Application? References	Not in Application? Explanation
A.3.1 Supply			
1.	A description of each commodity.	Volume 2 Section 3.1.1	--
2.	A discussion of all potential supply sources.	Volume 2 Section 3.3.2	--
3.	Forecast of productive capacity over the economic life of the facility.	Volume 2 Sections 3.3.1, 3.4.1	
4.	For pipelines with contracted capacity, a discussion of the contractual arrangements underpinning supply.	Volume 2 Section 3.3.2	--
A.3.2 Transportation Matters			
Pipeline Capacity			
1.	In the case of expansion provide: • Pipeline capacity before and after and size of increment • Justification that size of expansion is appropriate	Volume 2 Sections 1.1, 2.1, 3.5	--
2.	In case of new pipeline, justification that size of expansion is appropriate given available supply.	N/A – expansion	N/A
Throughput			
1.	For pipelines with contracted capacity, information on contractual arrangements.	Volume 2 Section 3.2.1	--
2.	For non-contract carrier pipelines, forecast of annual throughput volumes by commodity type, receipt location and delivery destination over facility life.	N/A	N/A
3.	If project results in an increase in throughput: • theoretical and sustainable capabilities of the existing and proposed facilities versus the forecasted requirements • flow formulae and flow calculations used to determine the capabilities of the proposed facilities and the underlying assumptions and parameters	Volume 2 Section 3.1	--
4.	If more than one type of commodity transported, a discussion pertaining to segregation of commodities including potential contamination issues or cost impacts.	N/A	N/A
A.3.3 Markets			
1.	Provide an analysis of the market in which each commodity is expected to be used or consumed.	Volume 2 Section 3.4.2	--
2.	Provide a discussion of the physical capability of upstream and downstream facilities to accept the incremental volumes that would be received and delivered.	Volume 2 Section 3.4.2	--
A.3.4 Financing			
1.	Evidence that the applicant has the ability to finance the proposed facilities.	Volume 2 Section 3.2.2	--
2.	Estimated toll impact for the first full year that facilities are expected to be in service.	Volume 2 Section 3.2.1	--
3.	Confirmation that shippers have been apprised of the project and toll impact, their concerns and plans to address them.	Volume 2 Section 3.2.1	--
4.	Additional toll details for applications with significant toll impacts.	Volume 2 Section 3.2.1	
A.3.5 Non-NEB Regulatory Approvals			
1.	Confirm that all non-NEB regulatory approvals required to allow the applicant to meet its construction schedule, planned in-service date and to allow the facilities to be used and useful are or will be in place.	Volume 2 Section 1.5	--
2.	If any of the approvals referred to in #1 may be delayed, describe the status of those approval(s) and provide an estimation of when the approval is anticipated.	Volume 2 Section 1.5	--

GUIDE A – A.4 LANDS INFORMATION

Filing #	Filing Requirement	In Application? References	Not in Application? Explanation
A.4.1 Land Areas			
1.	• Width of right-of-way and locations of any changes to width • Locations and dimensions of known temporary work space and drawings of typical dimensions • Locations and dimensions of any new lands for facilities	Volume 2 Section 5.2	--
A.4.2 Land Rights			
1.	The type of lands rights proposed to be acquired for the project.	Volume 2 Section 5.3	--
2.	The relative proportions of land ownership along the route of the project.	Volume 2 Section 5.3.2	--
3.	Any existing land rights that will be required for the project.	Volume 2 Section 5.4	--
A.4.3 Lands Acquisition Process			
1.	The process for acquiring lands.	Volume 2 Section 5.4.1, 5.4.2	--
2.	The timing of acquisition and current status.	Volume 2 Section 5.4.3	--
3.	The status of service of section 87(1) notices.	Volume 2 Section 5.4.4	--
A.4.4 Land Acquisition Agreements			
1.	A sample copy of each form of agreement proposed to be used pursuant to section 86(2) of the NEB Act.	Volume 2 Section 5.4.2	--
2.	A sample copy of any proposed fee simple, work space, access or other land agreement.	Volume 2 Section 5.5.2	--
A.4.5 Section 87 Notices			
1.	A sample copy of the notice proposed to be served on all landowners pursuant to section 87(1) of the NEB Act.	Volume 2 Section 5.4.4, Appendix D	--
2.	Confirmation that all notices include a copy of Pipeline Regulation in Canada: A Guide for Landowners and the Public.	Volume 2 Section 5.4.4	--
A.4.6 Section 58 Application to Address a Complaint			
1.	The details of the complaint and describe how the proposed work will address the complaint.	N/A	N/A

CONCORDANCE TABLE WITH THE *CEA ACT, 2012*

CEA Act, 2012 Requirement	Section in *CEA Act, 2012*	Application Volume and Section
The environmental effects of the designated project, including:		
the environmental effects of malfunctions or accidents that may occur in connection with the designated project;	s.19.1(a)	Volume 5A ESA - Biophysical: • Section 7.0 Volume 5B ESA - Socio-economic: • Section 7.0 Volume 7 Risk Assessment and Management of Pipeline and Facility Spills Volume 8A Marine Transportation: • Sections 4.3 and 5.0
any cumulative environmental effects that are likely to result from the designated project in combination with other physical activities that have been or will be carried out;	s.19.1(a)	Volume 5A ESA - Biophysical: • Section 8.0 Volume 5B ESA - Socio-economic: • Section 8.0 Volume 8A Marine Transportation: • Section 4.4
the significance of the effects referred to in paragraph (a);	s.19.1(b)	Volume 5A ESA - Biophysical: • Sections 7.0 and 8.0 Volume 5B ESA - Socio-economic: • Sections 7.0 and 8.0 Volume 8A Marine Transportation: • Sections 4.3 and 4.4
comments from the public – or, with respect to a designated project that requires that a certificate be issued in accordance with an order made under section 54 of the *National Energy Board Act*, any interested party – that are received in accordance with this *act*;	s.19.1(c)	Volume 3A Public Consultation Volume 3B Aboriginal Engagement Volume 3C Landowner Relations Volume 5A ESA - Biophysical: • Section 3.0 Volume 5B ESA - Socio-economic: • Section 3.0 Volume 8A Marine Transportation: • Section 3.0
mitigation measures that are technically and economically feasible and that would mitigate any significant adverse environmental effects of the designated project;	s.19.1(d)	Volume 5A ESA - Biophysical: • Sections 7.0 and 8.0 Volume 5B ESA - Socio-economic: • Sections 7.0 and 8.0 Volume 5C ESA – Biophysical Technical Reports Volume 5D ESA - Socio-economic Technical Reports Volume 6B Pipeline Environmental Protection Plan Volume 6C Facilities Environmental Protection Plan Volume 6D Westridge Marine Terminal Environmental Protection Plan Volume 6E Environmental Alignment Sheets Volume 8A Marine Transportation: • Sections 4.3, 4.4 and 5.0 Volume 8B Technical Reports
the requirements of the follow-up program in respect of the designated project;	s.19.1(e)	Volume 5A ESA - Biophysical: • Section 10.0 Volume 5B ESA - Socio-economic: • Section 10.0
the purpose of the designated project;	s.19.1(f)	Volume 5A ESA - Biophysical: • Section 2.0 Volume 5B ESA - Socio-economic: • Section 2.0 Volume 8A Marine Transportation: • Section 1.1

CONCORDANCE TABLE WITH THE *CEA ACT, 2012*

CEA Act, 2012 Requirement	Section in *CEA Act, 2012*	Application Volume and Section
alternative means of carrying out the designated project that are technically and economically feasible and the environmental effects of any such alterative means;	s.19.1(g)	Volume 5A ESA - Biophysical: • Sections 2.0 and 4.0 Volume 5B ESA - Socio-economic: • Sections 2.0 and 4.0 Volume 8A Marine Transportation: • Section 2.2
any change to the designated project that may be caused by the environment;	s.19.1(h)	Volume 5A ESA - Biophysical: • Section 7.10 Volume 8A Marine Transportation: • Section 4.3
the results of any relevant study conducted by a committee established under section 73 or 74; and	s.19.1(i)	N/A
any other matter relevant to the environmental assessment that the responsible authority, or, – if the environmental assessment is referred to a review panel – the Minister, requires to be taken into account.	s.19.1(j)	Volume 8A Marine Transportation Volume 8B Technical Reports Volume 8C TERMPOL Reports These volumes take into consideration the *Filing Requirements Related to the Potential Environmental and Socio-Economic Effects of Increased Marine Shipping Activities, Trans Mountain Expansion Project* (September 10, 2013) (NEB 2013)
The environmental assessment of a designated project may take into account community knowledge and Aboriginal traditional knowledge.	s 19.3	Volume 5A ESA - Biophysical: • Sections 5.0, 6.0, 7.0 and 8.0 Volume 5B ESA - Socio-economic: • Sections 5.0, 6.0, 7.0 and 8.0 Volume 5C ESA - Biophysical Technical Reports Volume 5D ESA - Socio-economic Technical Reports Volume 8A Marine Transportation: • Sections 4.2, 4.3 and 4.4 Volume 8B Technical Reports
Subsection 5(1) of *CEA Act, 2012* defines environmental effects as a change that may be caused to the following components of the environment that are within the legislative authority of Parliament:		
fish as defined in section 2 of the *Fisheries Act* and fish habitat as defined in subsection 34(1) of that *Act*;	s.5(1)(a)(i)	Volume 5A ESA - Biophysical: • Sections 5.0, 6.0, 7.0 and 8.0 Volume 5C ESA - Biophysical Technical Reports Volume 8A Marine Transportation: • Sections 4.2, 4.3, 4.4 and 5.0 Volume 8B Technical Reports
aquatic species as defined in subsection 2(1) of the *Species at Risk Act;*	s.5(1)(a)(ii)	Volume 5A ESA - Biophysical: • Sections 5.0, 6.0, 7.0 and 8.0 Volume 5C ESA - Biophysical Technical Reports Volume 8A Marine Transportation: • Sections 4.2, 4.3, 4.4 and 5.0 Volume 8B Technical Reports
migratory birds as defined in subsection 2(1) of the *Migratory Birds Convention Act, 1994*, and	s.5(1)(a)(iii)	Volume 5A ESA - Biophysical: • Sections 5.0, 6.0, 7.0 and 8.0 Volume 5C ESA - Biophysical Technical Reports Volume 8A Marine Transportation: • Sections 4.2, 4.3, 4.4 and 5.0 Volume 8B Technical Reports
any other component of the environment that is set out in Schedule 2.	s.5(1)(a)(iv)	N/A
Subsection 5(1) of the *CEA Act, 2012* defines environmental effects as (b) a change that may be caused to the environment that would occur		
on federal lands,	s.5(1)(b)(i)	Volume 5A ESA - Biophysical: • Section 7.0 Volume 5B ESA - Socio-economic: • Section 7.0
in a province other than the one in which the *act* or thing is done or where the physical activity, the designated project or the project is being carried out, or	s.5(1)(b)(ii)	N/A No changes are anticipated in provinces other than Alberta and BC in relation to the ESA.
outside Canada.	s.5(1)(b)(iii)	Volume 8A Marine Transportation: • Sections 4.3, 4.4 and 5.0
Subsection 5(1) of the *CEA Act, 2012* defines environmental effects as (c) with respect to aboriginal peoples, an effect occurring in Canada of any change that may be caused to the environment on:		

CONCORDANCE TABLE WITH THE *CEA ACT, 2012*

***CEA Act, 2012* Requirement**	**Section in *CEA Act, 2012***	**Application Volume and Section**
health and socio-economic conditions;	s.5(1)(c)(i)	Volume 5B ESA - Socio-economic: • Sections 5.0, 6.0, 7.0 and 8.0 Volume 5D ESA - Socio-economic Technical Reports Volume 8A Marine Transportation: • Sections 4.3 and 4.4 Volume 8B Technical Reports
physical and cultural heritage;	s.5(1)(c)(ii)	Volume 5B ESA - Socio-economic: • Sections 5.0, 6.0 and 7.0
the current use of lands and resources for traditional purposes; or	s.5(1)(c)(iii)	Volume 5B ESA - Socio-economic: • Sections 5.0, 6.0, 7.0 and 8.0 Volume 5D ESA - Socio-economic Technical Reports Volume 8A Marine Transportation: • Sections 4.3 and 4.4 Volume 8B Technical Reports
any structure, site or thing that is of historical, archaeological, paleontological or architectural significance.	s.5(1)(c)(iv)	Volume 5B ESA - Socio-economic: • Sections 5.0, 6.0 and 7.0

ENVIRONMENTAL AND SOCIO-ECONOMIC ASSESSMENT FOR THE TRANS MOUNTAIN PIPELINE ULC TRANS MOUNTAIN EXPANSION PROJECT

VOLUME 5A: ESA – BIOPHYSICAL

December 2013

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EXECUTIVE SUMMARY

This biophysical component of the Environmental and Socio-Economic Assessment (ESA) was completed in support of the proposed Trans Mountain Expansion Project (referred to as “TMEP” or “the Project”). (The socio-economic component of the ESA is found in the companion Volume 5B.)

Application is being made by Trans Mountain Pipeline ULC (Trans Mountain), a Canadian corporation with its head office located in Calgary, Alberta, pursuant to Section 52 of the *National Energy Board Act* (*NEB Act*) for the TMEP.

The proposed expansion will, in essence, comprise the following.

- Pipeline segments that complete a twinning (or “looping”) of the pipeline in Alberta and British Columbia with about 987 km of new buried pipeline.
- New and modified facilities, including pump stations and tanks.
- Three new berths at the Westridge Marine Terminal in Burnaby, BC, each capable of handling Aframax class vessels.

The Project will require a NEB Certificate of Public Convenience and Necessity (CPCN) pursuant to Section 52 of the *NEB Act*. In addition, according to the Regulations Designating Physical Activities, the Project is a designated project under the *Canadian Environmental Assessment Act, 2012* (*CEA Act, 2012*). The ESA considers the mandatory factors listed in Section 19(1) of the *CEA Act, 2012*, the factors listed in the NEB *Filing Manual* (NEB 2013a), and pertinent issues and concerns identified through consultation and engagement with Aboriginal communities, landowners, regulatory authorities, stakeholders and the general public.

In addition, the ESA addresses the NEB’s List of Issues (July 29, 2013) for the Project (NEB 2013b) provided below. Issues 4 and 5 of this list specifically informed the ESA.

1. *The need for the proposed project.*
2. *The economic feasibility of the proposed project.*
3. *The potential commercial impacts of the proposed project.*
4. *The potential environmental and socio-economic effects of the proposed project, including any cumulative environmental effects that are likely to result from the project, including those required to be considered by the NEB’s Filing Manual.*
5. *The potential environmental and socio-economic effects of marine shipping activities that would result from the proposed project, including the potential effects of accidents or malfunctions that may occur (addressed in Volume 8A).*
6. *The appropriateness of the general route and land requirements for the proposed project.*
7. *The suitability of the design of the proposed project.*
8. *The terms and conditions to be included in any approval the Board may issue.*
9. *Potential impacts of the project on Aboriginal interests.*
10. *Potential impacts of the project on landowners and land use.*
11. *Contingency planning for spills, accidents or malfunctions, during construction and operation of the project.*
12. *Safety and security during construction of the proposed project and operation of the project, including emergency response planning and third-party damage prevention.*

The Board does not intend to consider the environmental and socio-economic effects associated with upstream activities, the development of oil sands, or the downstream use of the oil transported by the pipeline.

Project Overview

Trans Mountain Pipeline ULC (Trans Mountain) is a Canadian corporation with its head office located in Calgary, Alberta. Trans Mountain is a general partner of Trans Mountain Pipeline L.P., which is operated by Kinder Morgan Canada Inc. (KMC), and is fully owned by Kinder Morgan Energy Partners, L.P. Trans Mountain is the holder of the National Energy Board (NEB) certificates for the Trans Mountain pipeline system (TMPL system).

The TMPL system commenced operations 60 years ago and now transports a range of crude oil and petroleum products from Western Canada to locations in central and southwestern British Columbia (BC), Washington State and offshore. The TMPL system currently supplies much of the crude oil and refined products used in BC. The TMPL system is operated and maintained by staff located at Trans Mountain's regional and local offices in Alberta (Edmonton, Edson, and Jasper) and BC (Clearwater, Kamloops, Hope, Abbotsford, and Burnaby).

The TMPL system has an operating capacity of approximately 47,690 m^3/d (300,000 bbl/d) using 23 active pump stations and 40 petroleum storage tanks. The expansion will increase the capacity to 141,500 m^3/d (890,000 bbl/d).

The proposed expansion will comprise the following.

- Pipeline segments that complete a twinning (or "looping") of the pipeline in Alberta and BC with about 987 km of new buried pipeline.
- New and modified facilities, including pump stations and tanks.
- Three new berths at the Westridge Marine Terminal in Burnaby, BC, each capable of handling Aframax class vessels.

The expansion has been developed in response to requests for service from Western Canadian oil producers and West Coast refiners for increased pipeline capacity in support of growing oil production and access to growing West Coast and offshore markets. NEB decision RH-001-2012 reinforces market support for the expansion and provides Trans Mountain the necessary economic conditions to proceed with design, consultation, and regulatory applications.

Application is being made pursuant to Section 52 of the *National Energy Board Act* (*NEB Act*) for the proposed Trans Mountain Expansion Project (referred to as "TMEP" or "the Project"). The NEB will undertake a detailed review and hold a Public Hearing to determine if it is in the public interest to recommend a Certificate of Public Convenience and Necessity (CPCN) for construction and operation of the Project. Subject to the outcome of the NEB Hearing process, Trans Mountain plans to begin construction in 2016 and go into service in 2017.

Trans Mountain has embarked on an extensive program to engage Aboriginal communities and to consult with landowners, government agencies (*e.g.*, regulators and municipalities), stakeholders, and the general public. Information on the Project is also available at www.transmountain.com.

The scope of the Project will involve:

- using existing active 610 mm (NPS 24) and 762 mm (NPS 30) OD buried pipeline segments;
- constructing three new 914 mm (NPS 36) OD buried pipeline segments totalling approximately 987 km:
  - Edmonton to Hinton – 339.4 km
  - Hargreaves to Darfield – 279.4 km
  - Black Pines to Burnaby – 367.9 km;

- reactivating two 610 mm (NPS 24) OD buried pipeline segments that have been maintained in a deactivated state:
  - Hinton to Hargreaves – 150 km
  - Darfield to Black Pines – 43 km;
- constructing two, 3.6 km long 762 mm (NPS 30) OD buried delivery lines from the Burnaby Terminal to the Westridge Marine Terminal (the Westridge delivery lines);
- installing 23 new sending or receiving traps (16 on the Edmonton-Burnaby mainlines), for in-line inspection tools at nine existing sites and one new site;
- adding 35 new pumping units at 12 locations (*i.e.,* 11 existing and 1 new pump station site);
- reactivating the existing Niton Pump Station that has been maintained in a deactivated state;
- constructing 20 new tanks located at the terminals near Edmonton (5), Sumas (1) and Burnaby (14), preceded by demolition of 2 existing tanks near Edmonton (1) and Burnaby (1), for a net total of 18 tanks added to the system; and
- constructing one new dock complex, with a total of three Aframax-capable berths, as well as a utility dock (for tugs, boom deployment vessels, and emergency response vessels and equipment) at Westridge Marine Terminal, followed by the deactivation and demolition of the existing berth.

Volume 5A includes the biophysical (*i.e.*, environmental) component of the Environmental and Socio-economic Assessment (ESA) for the Project (*i.e.*, the proposed pipeline corridor and associated facilities, including the expansion of the Westridge Marine Terminal). The socio-economic component of the ESA for the Project is provided in Volume 5B. Volume 8A provides a discussion related to potential environmental and socio-economic effects of increased marine shipping activities as a result of the Project.

Public Consultation, Aboriginal Engagement and Landowner Relations

The Aboriginal engagement, stakeholder consultation, and landowner programs are designed to foster participation from the public who have an interest in the scope, activities and routing of the Project. Engagement and consultation touched on all aspects of the Project along the proposed pipeline corridor and associated facilities. Trans Mountain has reached out to community leaders, elected officials, environmental groups and the public to receive their input. Feedback was received from public open houses, workshops, one-on-one meetings, public presentations, online discussion and comment forums that have helped shape aspects of the Project. Key topics and issues were considered and incorporated into this volume where applicable.

Since April 2012, Trans Mountain has engaged with Aboriginal communities that may be affected by the Project or that may have an interest in the Project based on the proximity of their community, and their assertion of Aboriginal rights and title governing traditional and cultural use of the land along the proposed pipeline corridor to maintain a traditional lifestyle. A number of methods have been used to inform Aboriginal communities, obtain feedback and identify issues about the Project including: community gatherings; face-to face meetings; targeted interviews; formal and informal discussions; and distribution of Project letters, newsletters, GIS data, maps and fact sheets as well as through the collection of Traditional Ecological Knowledge (TEK) with participating Aboriginal communities during biophysical field studies for the Project, Traditional Land Use (TLU) and socio-economic studies. The results of these engagement efforts have contributed to the development of the environmental assessment, including mitigation measures. Trans Mountain is committed to the continuation of an effective engagement program that satisfies all parties.

Trans Mountain has met with essentially all landowners along the proposed pipeline corridor. Meetings comprised discussions about the Project in general as well as requests for consent for Project-specific surveys. The meetings also provided an opportunity for landowners to ask questions and identify concerns regarding the Project.

The questions, issues, or concerns raised by landowners were categorized most frequently related to compensation issues, land impacts, land values, site-specific pipeline location and issues related to the existing TMPL line (see Volume 3B).

Landowners of approximately 85% of all tracts of land raised no comments or concerns at this phase of the program. Of those that did comment within Alberta, concerns are about environmental and land-related issues. In BC, the primary concerns relate to environmental and compensation/financial issues. Trans Mountain will continue to respond to concerns and issues of each landowner or occupant.

Corridor and Facility Site Selection

More than two thirds of the length of the proposed pipeline corridor parallels the existing TMPL right-of-way in order to reduce the environmental effects and facilitate efficient pipeline operations. However, paralleling the existing TMPL right-of-way was not possible in all cases because of engineering, constructability, geotechnical, environmental, socio economic, Aboriginal concerns or other reasons. In these locations, potential alternative corridors were examined. While the proposed pipeline will generally require a construction right-of-way of 45 m, it was decided to study and apply for a wider corridor (generally 150 m) to accommodate locations where field information was unavailable due to lack of access to public lands or where input from the environmental, socio-economic, geotechnical or other disciplines would be beneficial to guide final placement of the proposed pipeline centreline and associated right-of-way. It is recognized that corridor and route refinement is an iterative process that will continue throughout the review phase of the Project as more information becomes available.

Site selection criteria were used to choose the sites where facility sites will be located, including the pump stations and associated power lines, storage tanks and mainline block valves. Site selection is primarily focused on reducing disturbance by using existing facility locations to the extent possible. Similar site selection criteria will be applied to select temporary facility sites and construction workspace.

Environmental Setting

Lands traversed by the proposed pipeline corridor include: agricultural lands (disturbed by plowing for cultivation); hay and tame pasture; areas of aspen woodlands and mixed aspen forest, treed pasture; native vegetation; urban; industrial; and parks. Numerous water bodies are crossed by and in proximity to the proposed pipeline corridor.

Environmental setting information along the proposed pipeline corridor and at facilities is provided in this volume for the following elements identified in the NEB *Filing Manual*:

- physical and meteorological environment;
- soil and soil productivity;
- water quality and quantity;
- air emissions;
- greenhouse gas emissions;
- acoustic environment;
- fish and fish habitat;
- wetland loss or alteration;
- vegetation;

- wildlife and wildlife habitat; and
- species at risk.

The environmental setting related to the Westridge Marine Terminal is also provided for marine elements, including marine sediment and water quality, marine fish and fish habitat, marine mammals, marine birds and marine species at risk. The environmental setting was compiled based on the following sources:

- geotechnical, soil, groundwater, air quality, GHG, acoustic, fish, wetland, vegetation, wildlife, marine sediment and water quality, marine fish and fish habitat and marine birds field studies conducted for the Project;
- existing published literature including topographic maps, aerial photography, scientific papers and reference books, as well as municipal, provincial and federal government maps, reports, interactive websites, guides, information letters, fact sheets and databases; and
- engagement with Aboriginal communities (including TLU and traditional marine resource use studies, socio-economic studies and biophysical field study participation) as well as consultation with landowners, regulatory authorities, stakeholders and the general public.

The settings for each element are discussed in the context of the Footprint of the Project, a Local Study Area and a Regional Study Area. The settings discuss existing conditions within defined element-specific spatial boundaries.

Information in the environmental setting is supported by several supporting studies provided in Volume 5C, including:

- Acid Rock Drainage and Metal Leaching Potential Technical Report;
- Soils Technical Report;
- Air Quality and Greenhouse Gas Technical Report;
- Terrestrial Noise and Vibration Technical Report;
- Groundwater Technical Report;
- Fisheries (Alberta) Technical Report;
- Fisheries (British Columbia) Technical Report;
- Wetland Evaluation Technical Report;
- Vegetation Technical Report;
- Wildlife Technical Report;
- Wildlife Modelling and Species Accounts Technical Report;
- Marine Sediment and Water Quality – Westridge Marine Terminal Technical Report;
- Marine Resources – Westridge Marine Terminal Technical Report (including marine fish and fish habitat and marine mammals); and
- Marine Birds – Westridge Marine Terminal Technical Report.

Environmental Effects Assessment

Environmental elements potentially interacting with the Project include: physical and meteorological environment; soil and soil productivity; water quality and quantity; air emissions; greenhouse gas emissions; acoustic environment; fish and fish habitat; wetland loss or alteration; vegetation; wildlife and wildlife habitat; marine sediment and water quality; marine fish and fish habitat; marine mammals; marine birds; and species at risk. The description of the environmental setting (current state of the environment) within the Project area was compared against the Project description to assess potential environmental effects that might be caused by the Project. For this assessment, one or more indicators (*i.e.*, a biophysical, social or economic property or variable that society considers to be important and is assessed to predict Project-related changes and focus the impact assessment on key issues, often referred to as Valued Ecosystem Components) were selected to describe the present and predicted future condition of an element. One or more measurement endpoints (measurable parameters) were identified for each indicator to allow quantitative or qualitative measurement of potential Project effects.

The assessment evaluates the environmental effects of the construction (including reactivation/modification), operation, decommissioning and abandonment phases of each component of the Project. The assessment method includes the following steps.

1. Describe the environmental setting.
2. Identify key environmental elements that could be affected.
3. Define the indicators and measurement endpoints to be used to assess each element.
4. Determine spatial and temporal boundaries for each element.
5. Identify potential environmental effects for each indicator.
6. Develop appropriate technically and economically feasible site-specific mitigation and, where warranted, restitution measures that are technically and economically feasible.
7. Predict anticipated residual effects.
8. Determine the significance of residual effects.

Environmental effects arising from potential accidents and malfunctions are also considered. However, large onshore spill scenarios (including Westridge Marine Terminal) and marine spills are discussed in Volumes 7 and 8A, respectively. Changes to the Project caused by the environment are also considered in this volume.

To ensure that the potential adverse environmental effects are eliminated or reduced during Project activities, general and site-specific mitigation measures have been recommended based upon current industry-accepted standards, consultation with regulatory authorities, interested groups and individuals, engagement with Aboriginal communities, and the professional judgment of the assessment team. Mitigation measures are presented in the Project-specific Environmental Protection Plans (EPPs) (Volumes 6B through 6D) and are developed from element-specific technical reports. In addition, various federal and provincial regulatory authorities, and industry-accepted standards and guidelines are considered in this assessment and are referenced for each element.

Most of the potential effects on environmental indicators arising from construction of the Project can be readily mitigated by standard environmental mitigation measures common to pipeline projects in similar settings. There are no situations that meet the criteria of a significant adverse residual environmental effect as defined in Section 7.1 of this volume. Consequently, the identified residual effects of construction and operation of the Project on environmental indicators will be not significant for the pipeline and facilities component of the Project.

The Project was evaluated with respect to the objectives and goals of relevant land and resource use management plans, municipal development plans and government policies of the communities, counties and regional districts traversed by the proposed pipeline corridor and facilities. The planning, design, construction and operation of the Project will be consistent with key actions or objectives of these plans. In addition, for each element, it was determined that the Project does not hinder the ability of the respective agency to fulfill the relevant goals or objectives of these plans.

Cumulative Effects Assessment

The Project may act cumulatively with existing activities and reasonably foreseeable developments in the vicinity of the Project including agriculture (*e.g.*, crop production and livestock grazing), forestry, recreational activities, transportation activities (*e.g.*, vehicle and rail traffic, road infrastructure and highway maintenance), utilities activities (*e.g.*, transmission lines and gas distribution lines), rural and urban residential and commercial development, and industrial, oil and gas, and mineral resources developments. Cumulative effects associated with the Project were evaluated on a conservative basis for the element under consideration. Most of the Project's contribution to cumulative effects within the element-specific LSAs and RSAs that are likely to occur, are anticipated to be reversible in the short to long-term and are generally of low to medium magnitude. There are no situations that would result in a significant adverse cumulative environmental effect, as defined in Section 7.1, for the pipeline and facilities component of the Project.

Supplemental Studies

Supplemental (ongoing) studies may be warranted as the route is refined and optimized. At some locations, access for environmental and resource surveys was also not available at the time of field study. In those situations, information on adjacent lands, desktop studies and professional judgment based on the team's familiarity with pipeline issues and mitigation were used to predict potential effects. Ongoing studies will support effects assessment predictions and refine and augment site-specific environmental protection planning. Land access was available at intervals in all segments of the entire proposed pipeline corridor. Studies are proposed for soil and soil productivity, fish and fish habitat, wetlands, vegetation and wildlife and wildlife habitat. If findings change or significantly different conditions are observed that information will be provided to the NEB. The respective scope and timing (field and reporting schedule) for the planned supplemental filings are described in Section 9.0.

Current mitigation, management and contingency plans have been conservatively developed to address the expected findings from the ongoing studies and have been based on professional judgment relying on continuity of adjoining land parcels for which comprehensive field studies have been completed. The additional study requirements are not anticipated to change the significance conclusions in Sections 7.0 and 8.0 of Volume 5A.

Follow-up

Under the *CEA Act, 2012* and as described in the NEB *Filing Manual*, a follow-up program is defined as a program to verify the accuracy of the environmental assessment of a designated project, and to determine the effectiveness of any mitigation measures. Based on Project knowledge and comprehensive field studies to date, the need for follow-up programs under the *CEA Act, 2012* have been identified for select wildlife species at risk and various indicators within the Socio-economic Management Plan. Trans Mountain plans to collect additional information in 2014 to inform and refine the mitigation strategies recommended in the Environmental Protection Plans.

Conclusion

The environmental assessment concludes that the proposed pipeline and associated facilities (*e.g.*, pump stations, terminals, Westridge Marine Terminal) does not result in significant adverse residual environmental effects as defined in Section 7.1. Consequently, the identified residual effects of construction and operation of the Project on environmental indicators will be not significant for the pipeline and facilities component of the Project.

The environmental issues identified through engagement with Aboriginal communities, and consultation with landowners, regulatory authorities, stakeholders and the general public, as well as through literature reviews, field studies and the professional experience of the assessment team, are consistent with other projects of this nature. Most of the associated potential effects on environmental indicators arising from construction of the Project can be readily mitigated by standard environmental mitigation measures common to pipeline projects in similar settings.

Project design and industry and regulatory standards anticipate and address many of the Project's potential residual effects on the environment. Routing of the proposed pipeline corridor to parallel existing linear disturbances for most of its length (89%) has reduced the potential effects associated with construction and operation of the Project. Mitigation measures have been developed to further reduce the severity of potential adverse residual environmental effects. Implementation of the proposed mitigation measures will further reduce the adverse residual environmental effects associated with the construction and operation of the Project. Applicable proposed construction mitigation measures will form the basis of operation and maintenance procedures during the life of the Project.

GLOSSARY

Aboriginal Traditional Knowledge (ATK)	Knowledge that is held by, and unique to, Aboriginal peoples.
active	Referring to a geological process which is currently or recently occurring.
adverse effect	The impairment of or damage to the environment or the health of humans, or damage to property or loss of reasonable enjoyment of life or property.
Agricultural Land Reserve	Administered by the Agricultural Land Commission, the Agricultural Land Reserve is a provincial zone in which agriculture is recognized as the priority use and non-agricultural uses are controlled.
air quality	A measure of the chemical pollutant loading in the atmosphere. As a measure or metric, it is generally related to human health endpoints, odour thresholds or environmental effects that are developed and regulated by municipal, provincial or federal governments. Ambient air quality objectives or standards have been developed to reflect the more stringent effect and measured or predicted levels are commonly compared to these values as a gauge of compliance as well as the degree of quality of the air.
alluvial fan	A fan shape formed from the deposition of fluvial materials as a stream or river decreases in velocity.
anthropogenic	Materials modified by human activities so that the original properties of the material have been altered.
appropriate regulatory authority	The regulator(s) that will be consulted prior to and during construction regarding approvals, notifications, constraints and the direction of activities.
automated mainline block valves	Enable remotely operated automatic emergency shut-down and isolation of the pipeline along a given segment.
avoidance	A means to prevent a potential adverse effect through routing/siting of the project, changes to project design or construction timing.
bedrock	Underlying rock beneath surficial sediments, or the exposed rock at surface.
blanket	Where surficial material thickness is generally sufficient to mask underlying topography.
channel	A watercourse with defined bed and banks. Includes rivulets streams, creeks and rivers.
clast	Fragments of pre-existing mineral or rock which are broken off by physical weathering and can form clastic rocks.
colluvium	Unconsolidated material created and/or deposited during gravity-induced processes.
compensation	A means intended to compensate unavoidable and potentially significant or unacceptable effects and may consist of offsets (no net loss), research, education programs, and financial compensation (considered only when all other options have been exhausted).
construction right-of-way	Right-of-way area comprised of temporary workspace and the permanent easement that is disturbed during construction. Consists of four newly constructed 914 mm OD (NPS 36) pipeline segments from: Edmonton to Hinton, Alberta; Hargreaves to Darfield, BC; Black Pines to Hope, BC; Hope to Burnaby, BC; and one newly constructed pipeline segment containing two 762 mm OD (NPS 30) pipelines from Burnaby to the Westridge Marine Terminal.
cultivated land	Agricultural land use where the ground is usually tilled or disturbed regularly.
cumulative effects	Changes to the environment that are caused by an action in combination with other past, present and future human actions (‘action’ includes projects and activities).
delta	A triangular tract of sediment deposited at the mouth of a river.
demersal	At the bottom of a body of water (in contrast to pelagic).

GLOSSARY Cont'd

drainage/catchment area	The geographical area of a watershed drained by a river and its tributaries to a point along a watercourse or water body.
element	A technical discipline or discrete component of the biophysical or human environment identified in the NEB *Filing Manual.*
Environmental Alignment Sheets	A series of maps noting the locations of select environmental features that are encountered by the proposed pipeline corridor, associated potential issues and recommended mitigation measures.
eolian	Relating to the action of the wind.
erosion	The removal of soil and rock material from a stream bank or surface by the action of water or wind movement.
feasible	Capable of being reasonably accomplished or brought about, given environmental and economic consideration.
fluvial	Pertaining to the overland flow of water in streams or rivers, or the sediments deposited by such flow.
foothills	Gradual increases in elevation at the base of a mountain range, transition between plains and mountains.
Footprint	The area directly disturbed by surveying, construction, and clean-up and operation of the pipeline and associated physical works and activities (including, where appropriate, the permanent rights-of-way, pump stations, tanks, Westridge Marine Terminal, temporary construction workspace, temporary stockpile sites, temporary staging sites, construction camps, access roads and power lines).
foreshore	Riparian habitat along the shore, above the mean highest high water level.
freshet	Marks an increase in stream runoff as a result of snowmelt or combined rainfall and snowmelt runoff.
glaciofluvial	Pertaining to streams fed by glacial meltwater, or the deposits and landforms produced by such streams.
glaciolacustrine	Pertaining to lakes at the margins of glaciers, or the sediments and processes involving such lakes.
glaciomarine	Areas of glacier ice in close proximity to marine environments, or glacial sediment deposited from suspension or gravity processes into such environments.
hay land	Agricultural land use which is seeded with perennial, usually non-native grasses and forbs, and which is typically cut and baled regularly.
headwater	A tributary stream forming part of a river's source.
horizontal directional drill	A trenchless crossing method allowing for guided installation of a pipeline along a prescribed bore path by using a surface-launched drilling rig having minimal impact on the surrounding area. Commonly used for watercourse or dense infrastructure crossing.
hydrostatic testing	The use of water for pressure testing a pipeline to a pressure of at least 25% greater than the planned operating pressure in order to confirm integrity of the pipeline.
inactive	Referring to a geological process which is not currently or recently occurring.
Indian Reserve	A tract of land, the legal title to which is vested in Her Majesty, that has been set apart by Her Majesty for the use and benefit of a band.
indicator	A biophysical, social or economic property or variable that society considers to be important and is assessed to predict Project-related changes and focus the effects assessment on key issues. One or more indicators (often referred to as Valued Ecosystem or Valued Socio-economic Components) are selected to describe the present and predicted future condition of an element. Societal views are understood by the assessment team through published information such as management plans and engagement with regulatory authorities, the public, Aboriginal communities, and other interested groups.

GLOSSARY Cont'd

integrity dig	Excavations conducted to visually inspect sections of pipe and repair defects, if present.
International Area	The area extending beyond Canada.
intertidal	Marine habitat between the mean lowest low water level and the mean highest high water level.
isolated crossing	A trenched watercourse crossing method whereby the flow is diverted around or over the trench.
Kinder Morgan Canada Inc.	Kinder Morgan Canada Inc. (KMC) is a corporation owned by Kinder Morgan Energy Partners. KMC operates Trans Mountain Pipeline L.P., a general partner of Trans Mountain Pipeline ULC (Trans Mountain).
lacustrine	Pertaining to a low energy water body such as a lake, or the sediments deposited from settling and gravity processes into this environment.
lentic	Static or standing, non-flowing waters such as lakes, ponds and reservoirs.
loam	A fertile clay and sand based soil containing humus.
Local Study Area	The zone of influence or area where the element and associated indicators are most likely to be affected by Project construction and operation. This generally represents a buffer from the centre of the proposed pipeline corridor or edge of the facility.
lotic	A flowing body of fresh water, such as a river or stream.
Lower Mainland Developed Area	Urban and agricultural area in the Fraser Valley including the City of Chilliwack, City of Abbotsford, Township of Langley, City of Surrey, City of Coquitlam and City of Burnaby.
matrix	The finer grained mass of material within a rock containing larger grains, crystals or clasts.
measurement endpoint	One or more 'measurement endpoints' are identified for each indicator to allow quantitative or qualitative measurement of potential Project effects. The degree of change in these measurable parameters is used to characterize and evaluate the magnitude of Project-related environmental and socio-economic effects. A selection of the measurement endpoints may also be the focus of monitoring and follow-up programs, where applicable.
merchantable timber	Timber that will be sold to a timber processor.
mitigation measure	Mean measures for the elimination, reduction or control of a project's adverse environmental effects, including restitution for any damage to the environment caused by such effects through replacement, restoration, compensation or any other means, or a means of reducing or managing a project's adverse socio-economic effects.
moraine	A mass of sediment deposited at the margins of or beneath a glacier.
National Area	The area extending beyond Alberta and BC but confined to Canada.
National Energy Board	An independent federal agency established in 1959 by the Parliament of Canada to regulate international and interprovincial pipelines and associated facilities.
native grassland	Lands dominated by native grasses and forbs, generally exhibiting a high species diversity, abundant grass thatch and little evidence of regular ground disturbance.
nearshore	Area of water extending 10 m seaward of the low-water tide mark.
non-salvageable timber	Timber and woody debris that will not be used during and after pipeline construction that is deposed of.
Noxious weeds	A plant designated in accordance with the regulations as a Noxious weed and includes the plant's seeds. A person shall control a Noxious weed that is on land the person owns or occupies (*Weed Control Act*).
offshore	Area of water extending from continental shelf to the nearshore boundary.
open cut crossing	A trenched watercourse crossing method typically conducted when a watercourse is dry or frozen to bottom.

GLOSSARY Cont'd

organic	Sediments resulting from the accumulation, decomposition, and compaction of organic material.
overburden	All rock or soil above the bedrock horizon in a given area.
peat	A brown, soil-like material made partly of organics and characteristic of boggy, acidic ground.
pelagic	Open water (*i.e.,* near the surface or in the water column but not at the bottom of a body of water [in contrast to demersal]).
physiographic region	Division of land based on the overall characteristics of the geological structures and topography.
plain	A flat or very gently sloping surface with relief generally less than 1 m.
plateau	An area of high land, generally having relatively flat terrain.
Port Metro Vancouver	A non-shareholder, financially self-sufficient corporation established by the Government of Canada, and accountable to the federal Minister of Transport, responsible for the operation and development of the assets and jurisdictions of over 600 km of shoreline, extending from Point Roberts at the Canada/US border through Burrard Inlet to Port Moody and Indian Arm, and from the mouth of the Fraser River, eastward to the Fraser Valley.
post-construction monitoring	A type of monitoring program that may be used to verify that mitigation measures effectively mitigated the predicted adverse environmental effects.
practical	Capable of or suitable to being put into effect, given environmental and economic consideration.
Prohibited Noxious weeds	A plant designated in accordance with the regulations as a Prohibited Noxious weed and includes the plant's seeds. A person shall destroy a Prohibited Noxious weed that is on land the person owns or occupies (*Weed Control Act*).
proposed pipeline corridor	Generally a 150 m wide corridor encompassing the pipeline construction right-of-way and temporary workspace.
Provincial Area	The area extending beyond regional or administrative boundaries, but confined to Alberta and BC.
Reclamation	The process of establishing a recovery trajectory to allow the land to re-establish its former or other productive use. The land will have the ability to support the land use that existed prior to the disturbance, but may support a different land use depending on the land management goals following the disturbance. Soils will be managed at contaminated sites to facilitate vegetation cover re-establishment suited to the post-disturbance land use. Reclamation will be considered complete once landscape, soils and vegetation goals for reclamation have been achieved.
Reference Kilometres	Distances measured along the general centre of the proposed pipeline corridor, referred to as Reference Kilometres (RKs), measured approximately 1 km apart.
Regional Study Area	The area extending beyond the Local Study Area boundary where the direct and indirect influence of other activities could overlap with project-specific effects and cause cumulative effects on the environmental or socio-economic indicator. This varies for each element.
relict	A process or landform which was formed conditions different from the present.
relief	The vertical height of land between the lowest point and highest point in the landscape.
residual effects	Effects that are present after mitigation is applied.
right-of-way	A legally defined strip of land with defined boundaries in which the pipeline runs through properties owned by others.
rolling	Topographic expression characterized by elongated hills with slope angles generally between 3-15°m.

GLOSSARY Cont'd

root zone material	Organic matter rich surface soil found within shrub, treed or forested land uses.
salvageable timber	Merchantable timber without a market or non-merchantable timber salvaged for use during and after pipeline construction.
scour	The removal of material from a channel by the erosive action of water resulting in channel widening or channel bed lowering.
shoo-flies	Vehicle and equipment access to the construction right-of-way from each side of a watercourse crossing where vehicle and equipment crossing of the watercourse on the right-of-way is not practical.
significant contribution to a cumulative environmental effect	A high probability of occurrence of a permanent or long-term cumulative effect of high magnitude that cannot be technically or economically mitigated.
significant residual environmental effect	A high probability of occurrence of a permanent or long-term residual effect of high magnitude that cannot be technically or economically mitigated.
silt	Fine material particles ranging in size from 0.002-0.05 mm in diameter.
subtidal	Marine habitat below the mean lower low water level.
supplemental (ongoing) studies	Studies to be conducted post submission of the application to confirm the effects assessment conclusions and gather site-specific information for the implementation of mitigation from the Project-specific environmental protection plans.
surficial geology	The geology of materials at or near ground surface including soils and bedrock.
tame pasture	Agricultural land use which is dominated by perennial, non-native grasses and forbs, which is used primarily for livestock grazing.
terrace	A step-like landform that comprises a horizontal surface and a scarp face, typically bordering a shoreline or river floodplain.
till	Unsorted material deposited directly by glacial ice showing no stratification.
topsoil	Organic matter rich surface soil developed within a grassland land use.
Traditional Ecological Knowledge (TEK)	A subset of ATK that is primarily concerned with the environment.
traditional land use (TLU) / traditional land and resource use (TLRU) / traditional marine resource use (TMRU)	Current and former use of the land/water and its resources by Aboriginal peoples.
tributary	A river or stream flowing into a larger river or water body.
turbidity	A measure of the lack of clarity or transparency of water caused by biotic and abiotic suspended or dissolved substances and is measured in nephelometric turbidity units (NTUs).
unconsolidated	Non-lithified sediment that has no mineral cement or matrix binding its grains.
undulating	Topography comprising gently sloping hillocks and hollows with slopes angles generally less than 15°m.
veneer	Where surficial material thickness is sufficient to mimic underlying topography but not mask it completely.
warranted	Justify or necessitate a course of action.
Westridge Marine Terminal	Trans Mountain-owned marine loading facility located within Port Metro Vancouver that can accommodate ships up to 120,000 deadweight tonnes and barges. This facility also receives jet fuel, which is delivered to Vancouver International Airport through Trans Mountain's affiliate, Trans Mountain (Jet Fuel) Inc. The Westridge Marine Terminal has been in operation since 1957.
wetland	*"land that is saturated with water long enough to promote wetland or aquatic processes as indicated by poorly drained soils, hydrophytic vegetation and various kinds of biological activity which are adapted to a wet environment."* (National Wetland Working Group 1997).

ABBREVIATIONS AND ACRONYMS

AAC	Annual Allowable Cut
AARD	Alberta Agriculture and Rural Development
AB	Alberta
ABMI	Alberta Biodiversity Monitoring Institute
ACA	Alberta Conservation Association
ACCESS	ACCESS Pipeline Inc.
ACIMS	Alberta Conservation Information Management System
AEAE	Alberta Enterprise and Advanced Education
AENV	Alberta Environment
AER	Alberta Energy Regulator
AESRD	Alberta Environment and Sustainable Resource Development
AGCC	Alberta Ground Cover Classification
AIS	aquatic invasive species
Ajax	KGHM Ajax Mining Inc.
Ajax Project	Ajax Copper/Gold Project
ALR	Agricultural Land Reserve
AltaLink	AltaLink Management Ltd.
AMEC	AMEC Earth & Environmental
ANPC	Alberta Native Plant Council
ARD	acid rock drainage
asl	above sea level
ASL	ambient sound level
ASRD	Alberta Sustainable Resource Development
ATCO Electric	ATCO Electric Ltd.
ATCO Gas	ATCO Gas and Pipelines Ltd.
ATK	Aboriginal Traditional Knowledge
ATPR	Alberta Tourism, Parks and Recreation
ATV	all-terrain vehicle
AUC	Alberta Utilities Commission
AWC	Athabasca Watershed Council
bbl	Barrels
bbl/d	barrels per day
BC	British Columbia
BC CDC	British Columbia Conservation Data Centre
BC EAO	BC Environmental Assessment Office
BC Hydro	BC Hydro and Power Authority
BC ILMB	Integrated Land Management Bureau
BC IWMS	Identified Wildlife Management Strategy
BC MFLNRO	BC Ministry of Forests, Lands and Natural Resources Operations
BC MJTST	BC Ministry of Jobs, Tourism and Skills Training
BC MOE	BC Ministry of Environment
BC MOF	British Columbia Ministry of Forests
BC MTI	BC Ministry of Transportation and Infrastructure
BC MWLAP	British Columbia Ministry of Water, Lands and Air Protection
BC OGAA	British Columbia *Oil and Gas Activities Act*
BC OGC	BC Oil and Gas Commission
BEI	Broad Ecosystem Inventory
BESI	Balanced Environmental Services Inc.
BEU	Broad Ecosystem Unit
BG	Bunchgrass (biogeoclimatic zone)

ABBREVIATIONS AND ACRONYMS Cont'd

BGC Zone	Biogeoclimatic Zone
bgl	below ground level
BIEAP	Burrard Inlet Environmental Action Program
BMP	best management practice
Brookfield	Brookfield Renewable Power Inc.
BSL	base sound level
BTEX	benzene, toluene, ethylbenzene and xylene
CAC	criteria air contaminant
CAM	Cariboo Mountains
CAP	Cariboo Plateau
CAPP	Canadian Association of Petroleum Producers
CASA	Clean Air Strategic Alliance
CBT	Columbia Basin Trust
CCME	Canadian Council of Ministers of the Environment
CEA Act, 2012	*Canadian Environmental Assessment Act, 2012*
CEA Agency	Canadian Environmental Assessment Agency
CISS	cast-in-steel shell
CMAQ	Community Multiscale Air Quality
CN	Canadian National Railway Company
CO	carbon monoxide
CO_2	carbon dioxide
CO_{2e}	carbon dioxide equivalent
Coalspur	Coalspur Mines Ltd.
COP	Code of Practice
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
COSFRT	Canadian Oregon Spotted Frog Recovery Team
CP	Central Parkland
CPCN	Certificate of Public Convenience and Necessity
CSA	Canadian Standards Association
CWGI	Collaborative Watershed Government Initiative
CWH	Coastal Western Hemlock (biogeoclimatic zone)
CWS	Canadian Wildlife Service
dBA	decibel
DFO	Fisheries and Oceans Canada
DM	Dry Mixedwood
DNA	deoxyribonucleic acid
DUC	Ducks Unlimited Canada
EAC	Environmental Advisory Committee
Enbridge	Enbridge Pipelines Inc.
ENGO	environmental non-government organization
EO	Element Occurrence
EPA	Environmental Protection Agency
EPCOR	EPCOR Distribution and Transmission Inc.
EPP	Environmental Protection Plan
EPR	Eastern Pacific Ranges
ERA	Ecological Risk Assessment
ERCB	Alberta Energy Resources Conservation Board
ESA	Environmental and Socio-economic Assessment
ESCC	Endangered Species Conservation Committee
ESSF	Engelmann Spruce-Subalpine Fir (biogeoclimatic zone)
FBC	Fraser Basin Council

ABBREVIATIONS AND ACRONYMS Cont'd

FEARO	Federal Environmental Assessment Review Office
FMA	Forest Management Agreement
Footprint	Footprint Study Area
FortisBC	FortisBC Energy Inc.
FOTS	fibre-optic transmission system
FRL	Fraser Lowland
FSC	food, social and ceremonial
FVRD	Fraser Valley Regional District
FWA	Freshwater Atlas
FWMIS	Fisheries and Wildlife Management Information System
GBPU	Grizzly Bear Population Units
GHG	greenhouse gas
GIS	geographic information system
GLIMPS	Geographic Land Information Management and Planning System
Grand Rapids	Grand Rapids Pipeline GP Ltd.
GUU	Guichon Upland
GVRD	Greater Vancouver Regional District
H_2S	Hydrogen Sulfide
ha	hectare
HCL	Hydrogeological Consultants Ltd.
HDD	horizontal directional drill
HEPH	heavy extractable petroleum hydrocarbons
HOR	Hozameen Range
HORU	human occupancy and resource use
HP	horsepower
IBA	Important Bird Area
ICH	Interior Cedar-Hemlock (biogeoclimatic zone)
IDF	Interior Douglas-Fir (biogeoclimatic zone)
IHS Inc.	Information Handling Services Inc.
IMO	International Maritime Organization
Inter Pipeline	Inter Pipeline Ltd.
IR	Indian Reserve
ISCMV	Invasive Species Council of Metro Vancouver
ISMP	Integrated Stormwater Management Plan
ISQG	Interim Sediment Quality Guideline
Kerr Wood Leidal	Kerr Wood Leidal Associates Ltd.
kg	kilogram
km	kilometre
KMC	Kinder Morgan Canada Inc.
KP	kilometre post
kPa	kilopascal
kV	kilovolt
LEPH	light extractable petroleum hydrocarbons
LF	Lower Foothills
LFN	Low Frequency Noise
LFV	Lower Fraser Valley
LMDA	Lower Mainland Developed Area
LRMP	land and resource management plan
LRT	light rail transit
LSA	Local Study Area
LTOHA	Long-term Owl Habitat Area

ABBREVIATIONS AND ACRONYMS Cont'd

M	Montane
m	metre
MADT	monthly average daily traffic
MAXIM	MAXIM Power Corp.
MCRIP	Mountain Caribou Recovery Implementation Plan
MDP	municipal development plan
Mentiga	Mentiga Pedology Consultants Ltd.
MFHA	Managed Future Habitat Area
Mg	milligram
MH	Mountain Hemlock (biogeoclimatic zone)
MLBV	mainline block valve
mm	millimetre
MPMO	Major Projects Management Office
MS	Montane Spruce (biogeoclimatic zone)
Mt CO_{2e}	megatonnes carbon dioxide equivalent
MVA	megavolt ampere
MW	megawatt
NAIT	Northern Alberta Institute of Technology
NAPS	National Air Pollution Surveillance
NCD	non-classified drainage
NEB	National Energy Board
NEB Act	*National Energy Board Act*
NEB OPR	*National Energy Board Onshore Pipeline Regulations*
New Gold	New Gold Inc.
NGPLP	Northern Gateway Pipelines Ltd. Partnership
NGRT	Northern Goshawk Recovery Team
NH_3	ammonia
NIB	Nicola Basin
NO_2	nitrogen dioxide
NOAA	National Oceanic and Atmospheric Administration
NORM	naturally occurring radioactive material
NOx	oxides of nitrogen
NPC	Noise Pollution Control
NPK	Northern Park Ranges
NPRI	National Pollutant Release Inventory
NPS	nominal pipe size
NRC	National Research Council
NRCan	Natural Resources Canada
NSH	Northern Shuswap Highlands
NSWA	North Saskatchewan Watershed Alliance
NTU	nephelometric turbidity units
NVC	no visible channel
NWC	Northwestern Cascade Range
NWIPC	Northwest Invasive Plant Council
NWWG	National Wetland Working Group
OCP	official community plan
OD	outside diameter
OGMA	Old Growth Management Area
ON MOE	Ontario Ministry of Environment
OSCAR	oil spill containment and recovery
PAG	potentially acid generating

ABBREVIATIONS AND ACRONYMS Cont'd

PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PCEM	Post-Construction Environmental Monitoring
PCM	Post-Construction Monitoring
PEL	Probable Effects Levels
PFOWG	Provincial Flammulated Owl Working Group
PGSRT	Pacific Giant Salamander Recovery Team
PM	particulate matter
PMV	Port Metro Vancouver
PNT	Protective Notation
PP	Ponderosa Pine (biogeoclimatic zone)
PPV	peak particle velocity
PTS	permanent threshold shifts
QAES	Qualified Aquatic Environmental Specialist
QEP	Qualified Environmental Professional
RAP	Restricted Activity Period
RCA	Rockfish Conservation Area
RDFFG	Regional District of Fraser-Fort George
REBGV	Real Estate Board of Greater Vancouver
RISC	Resources Inventory Standards Committee
RK	reference kilometer
RMS	root mean square
RMTWG	Racer Management Team Working Group
ROV	remotely operated vehicle
RSA	Regional Study Area
RWDI	Rowan Williams Davies and Irwin Inc.
SARA	*Species at Risk Act*
Sasol	Sasol Canada Holdings Ltd.
SBS	Sub-Boreal Spruce (biogeoclimatic zone)
SCADA	supervisory control and data acquisition
Seaspan	Seaspan ULC
SEL	sound exposure level
SF_6	Sulfur hexafluoride
Shell	Shell Canada Ltd.
Sherrit	Sherrit International Corporation
SIRART	Southern Interior Reptile and Amphibian Recovery Team
SIWMC	Southern Interior Weed Management Committee
SO_2	sulphur dioxide
SOPET	Spotted Owl Population Enhancement Team
SO_x	Oxides of sulfur
SPL	sound pressure level
SRMP	sustainable resource management plan
Stantec	Stantec Consulting Ltd.
Teck	Teck Resources Ltd.
TEH	total extractable hydrocarbons
TEK	Traditional Ecological Knowledge
Telus	Telus Communications Corp.
TEM	terrestrial ecosystem mapping
TERA	TERA Environmental Consultants
TERMPOL	Technical Review Process of Marine Terminal Systems and Transshipment Sites
TEU	twenty-foot equivalent unit

ABBREVIATIONS AND ACRONYMS Cont'd

THB	Thompson Basin
the Project/TMEP	Trans Mountain Expansion Project
TLU/TLRU/TMRU	traditional land use / traditional land and resource use / traditional marine resource use
TMPL	Trans Mountain pipeline
TNRD	Thompson-Nicola Regional District
Trans Mountain	Trans Mountain Pipeline ULC
TransAlta	TransAlta Corp.
TransCanada	TransCanada PipeLines Limited
TRS	total reduced sulphur
TSA	Timber Supply Area
TSS	total suspended solids
TTS	temporary threshold shifts
TUC	Transportation/Utility Corridor
TVAU	Tank Vapour Activation Units
UBC	University of British Columbia
µg	microgram
µPa	micropascal
UF	Upper Foothills
UFT	Upper Fraser Trench
UNESCO	United Nations Educational, Scientific and Cultural Organization
US	United States
UTM	Universal Transverse Mercator
UWR	Ungulate Winter Range
VCU	vapour combustion unit
VEC and VSC	valued environmental and social component
Vista Project	Vista Coal Mine Project
VMA	viewshed modeling analysis
VOC / TVOC	volatile organic compound / total volatile organic compound
VRU	vapour recovery unit
Waterline	Waterline Resources Inc.
West Fraser	West Fraser Mills Ltd.
Weyerhaeuser	Weyerhaeuser Company Ltd.
WHA	Wildlife Habitat Area
WHSRN	Western Hemisphere Shorebird Reserve Network
WMU	Wildlife Management Unit
WPAC	Watershed Planning Advisory Council
YVR	Vancouver International Airport
YXX	Abbotsford International Airport
ZOI	zone of influence

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1.0 INTRODUCTION

1.1 Overview of the Project

Trans Mountain Pipeline ULC (Trans Mountain) is a Canadian corporation with its head office located in Calgary, Alberta. Trans Mountain is a general partner of Trans Mountain Pipeline L.P., which is operated by Kinder Morgan Canada Inc. (KMC), and is fully owned by Kinder Morgan Energy Partners, L.P. Trans Mountain is the holder of the National Energy Board (NEB) certificates for the Trans Mountain pipeline system (TMPL system).

The TMPL system commenced operations 60 years ago and now transports a range of crude oil and petroleum products from Western Canada to locations in central and southwestern British Columbia (BC), Washington State and offshore. The TMPL system currently supplies much of the crude oil and refined products used in BC. The TMPL system is operated and maintained by staff located at Trans Mountain's regional and local offices in Alberta (Edmonton, Edson, and Jasper) and BC (Clearwater, Kamloops, Hope, Abbotsford, and Burnaby).

The TMPL system has an operating capacity of approximately 47,690 m^3/d (300,000 bbl/d) using 23 active pump stations and 40 petroleum storage tanks. The expansion will increase the capacity to 141,500 m^3/d (890,000 bbl/d).

The proposed expansion will comprise the following:

- Pipeline segments that complete a twinning (or "looping") of the pipeline in Alberta and BC with about 987 km of new buried pipeline.
- New and modified facilities, including pump stations and tanks.
- Three new berths at the Westridge Marine Terminal in Burnaby, BC, each capable of handling Aframax class vessels.

The expansion has been developed in response to requests for service from Western Canadian oil producers and West Coast refiners for increased pipeline capacity in support of growing oil production and access to growing West Coast and offshore markets. NEB decision RH-001-2012 reinforces market support for the expansion and provides Trans Mountain the necessary economic conditions to proceed with design, consultation, and regulatory applications.

Application is being made pursuant to Section 52 of the *National Energy Board Act* (*NEB Act*) for the proposed Trans Mountain Expansion Project (referred to as "TMEP" or "the Project"). The NEB will undertake a detailed review and hold a Public Hearing to determine if it is in the public interest to recommend a Certificate of Public Convenience and Necessity (CPCN) for construction and operation of the Project. Subject to the outcome of the NEB Hearing process, Trans Mountain plans to begin construction in 2016 and go into service in 2017.

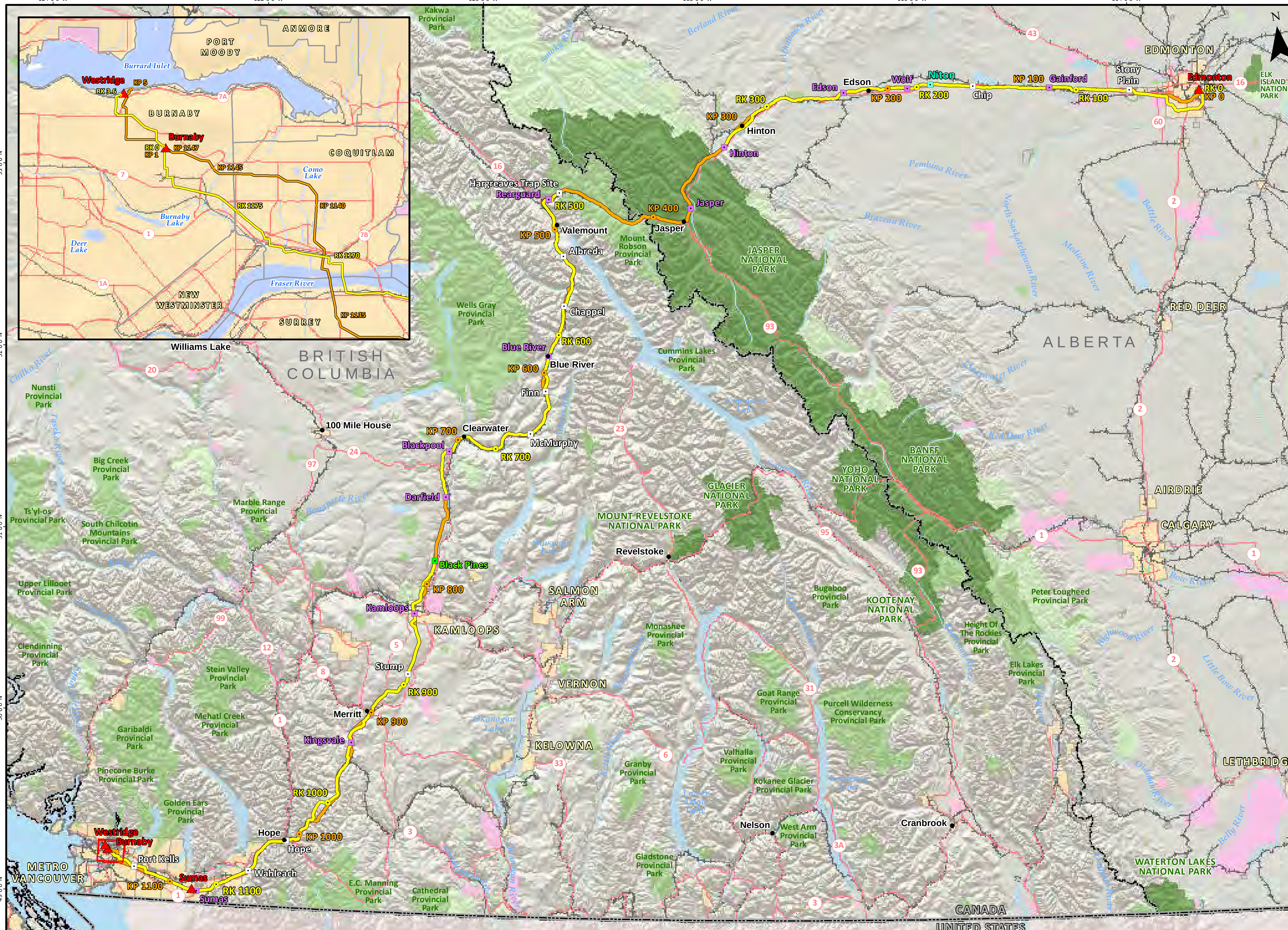
Trans Mountain has embarked on an extensive program to engage Aboriginal communities and to consult with landowners, government agencies (*e.g.*, regulators and municipalities), stakeholders, and the general public. Information on the Project is also available at www.transmountain.com.

The scope of the Project will involve:

- using existing active 610 mm (NPS 24) and 762 mm (NPS 30) OD buried pipeline segments;
- constructing three new 914 mm (NPS 36) OD buried pipeline segments totalling approximately 987 km:
  - Edmonton to Hinton – 339.4 km
  - Hargreaves to Darfield – 279.4 km
  - Black Pines to Burnaby – 367.9 km;

- reactivating two 610 mm (NPS 24) OD buried pipeline segments that have been maintained in a deactivated state:
    - Hinton to Hargreaves – 150 km
    - Darfield to Black Pines – 43 km;
- constructing two, 3.6 km long 762 mm (NPS 30) OD buried delivery lines from Burnaby Terminal to Westridge Marine Terminal (the Westridge delivery lines);
- installing 23 new sending or receiving traps (16 on the Edmonton-Burnaby mainlines), for in-line inspection tools, at nine existing sites and one new site;
- adding 35 new pumping units at 12 locations (i.e., 11 existing and one new pump station site);
- reactivating the existing Niton Pump Station that has been maintained in a deactivated state;
- constructing 20 new tanks located at the Edmonton (5), Sumas (1) and Burnaby (14) Terminals, preceded by demolition of 2 existing tanks at Edmonton (1) and Burnaby (1), for a net total of 18 tanks to be added to the system; and
- constructing one new dock complex, with a total of three Aframax-capable berths, as well as a utility dock (for tugs, boom deployment vessels, and emergency response vessels and equipment) at Westridge Marine Terminal, followed by the deactivation and demolition of the existing berth.

Figure 1.1 provides an overview of the location of the Project.



TRANS MOUNTAIN

FIGURE 1.1

PROJECT OVERVIEW
ALBERTA AND BRITISH COLUMBIA

TRANS MOUNTAIN
EXPANSION PROJECT

- Kilometre Post (KP)
- Reference Kilometre Post (RK)
- Trans Mountain Pipeline (TMPL)
- Trans Mountain Expansion Project Proposed Pipeline Corridor
- Terminal
- Pump Station (Pump Additions, Station Modifications and/or Scraper Facilities)
- New Pump Station (Proposed)
- Pump Station (Reactivated)
- Existing Pump Station
- Highway
- Railway
- City / Town / District Municipality
- Indian Reserve / Métis Settlement
- National Park
- Provincial Park
- Protected Area / Natural Area / Provincial Recreation Area / Wilderness Provincial Park / Conservancy Area
- Provincial Boundary
- International Boundary

Projection: LCC Modified. Routing: Baseline TMPL & Facilities: provided by KMC, 2012; Proposed Pipeline Corridor V6: provided by UPI, Aug. 23, 2013; Transportation: IHS Inc., 2013, BC Forests, Lands and Natural Resource Operations, 2012 & Natural Resources Canada, 2012; Geopolitical Boundaries: Natural Resources Canada, 2003, AltaLIS, 2013, IHS Inc., 2011, BC FLNRO, 2007 & ESRI, 2005; First Nation Lands: Government of Canada, 2013, AltaLIS, 2010 & IHS Inc., 2011; Hydrology: Natural Resources Canada, 2007 & BC Crown Registry and Geographic Base Branch, 2008; Parks and Protected Areas: Natural Resources Canada, 2012, AltaLIS, 2012 & BC FLNRO, 2008; ATS Grid: AltaLIS, 2009; Edmonton TUC: Alberta Infrastructure, 2011; Canadian Hillshade: TERA Environmental Consultants, 2008; US Hillshade: Copyright:© 2009 ESRI.

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tera ENVIRONMENTAL CONSULTANTS

Although there is no reason to believe that there are any errors associated with the data used to generate this product or in the product itself, users of these data are advised that errors in the data may be present.

MAP NUMBER		PAGE
201307_MAP_TERA_ESA_00341_REV0		SHEET 1 OF 1
DATE	TERA REF.	REVISION
December 2013	7894	0
SCALE	PAGE SIZE	DISCIPLINE
1:2,250,000	11x17	ESA
DRAWN	CHECKED	DESIGN
AJS	TGG	TGG

0 25 50 75 100 km

ALL LOCATIONS APPROXIMATE

201307_MAP_TERA_ESA_00341_Rev0.mxd

1.2 Purpose of the Environmental Assessment

As described in Section 3.0 of Volume 2, the Project will require a NEB CPCN pursuant to Section 52 of the *NEB Act* because the proposed pipeline crosses a provincial border and is greater than 40 km in length. In addition, according to the *Regulations Designating Physical Activities,* the Project is a designated project under the *Canadian Environmental Assessment Act, 2012* (*CEA Act, 2012*) because the new pipeline has a length greater than 40 km. The Environmental and Socio-economic Assessment (ESA) prepared for the Project considers the mandatory factors listed in Section 19(1) of the *CEA Act, 2012*, the factors listed in the NEB *Filing Manual* (NEB 2013a), and pertinent issues and concerns identified through consultation and engagement with Aboriginal communities, landowners, regulatory authorities, stakeholders and the general public.

Trans Mountain understands that the NEB will conduct the review of the TMEP under the *NEB Act* as well as the *CEA Act, 2012.*

The Project is federally regulated and subject to obtaining a CPCN from the NEB and complying with the terms and conditions imposed by the NEB. Trans Mountain intends to work with Provincial regulatory authorities, municipal authorities and other agencies to provide them the information they need to fulfill their permitting requirements if the NEB approves the Project. Examples of these authorizations are listed in Section 1.5 of Volume 2.

1.2.1 Scope of the Project

According to the NEB *Filing Manual*, the scope of the Project includes the activities and components required to carry out the Project and allow it to proceed. This combination of activities for pipelines and facilities is provided in Section 1.1.

There will be additional marine traffic to move the product from the Project. Although regulation and authorization of marine transportation is not specifically within the jurisdiction of the NEB, the environmental and socio-economic effects of the increased marine traffic is considered by Trans Mountain in accordance with the NEB's direction from their *List of Issues* for the Project, released on July 29, 2013 (NEB 2013b). The predicted increase in marine traffic related to the Project is discussed in Volume 8A, Marine Transportation. Volume 8A addresses the requirements of the NEB's *List of Issues* (July 29, 2013) (NEB 2013b) as they relate to increased marine shipping resulting from the Project, the *CEA Act, 2012* and the NEB's *Filing Requirements Related to the Potential Environmental and Socio-Economic Effects of Increased Marine Shipping Activities, Trans Mountain Expansion Project* (September 10, 2013) (NEB 2013c).

The potential effects of an operational pipeline or marine spill are evaluated in Volumes 7 and 8A, respectively, including the risk of a spill, spill response plans, and the potential effects of hypothetical spill scenarios. The evaluation of the hypothetical spill scenarios also includes a Human Health Risk Assessment (HHRA) and Ecological Risk Assessment (ERA).

1.2.2 Scope of the Assessment

Scoping is the process of identifying the physical works and activities to include within the ESA, and the biophysical and socio-economic elements are likely to be affected by the Project. Proper scoping reduces the risk of including unimportant or irrelevant information in the assessment or excluding factors that should be assessed (NEB 2013a).

The NEB's *List of Issues* (July 29, 2013) for the Project (NEB 2013b) is provided below. Issues 4 and 5 of this list specifically informed the ESA.

1. *The need for the proposed project.*
2. *The economic feasibility of the proposed project.*
3. *The potential commercial impacts of the proposed project.*

4. *The potential environmental and socio-economic effects of the proposed project, including any cumulative environmental effects that are likely to result from the project, including those required to be considered by the NEB's Filing Manual.*
5. *The potential environmental and socio-economic effects of marine shipping activities that would result from the proposed project, including the potential effects of accidents or malfunctions that may occur (addressed in Volume 8A).*
6. *The appropriateness of the general route and land requirements for the proposed project.*
7. *The suitability of the design of the proposed project.*
8. *The terms and conditions to be included in any approval the Board may issue.*
9. *Potential impacts of the project on Aboriginal interests.*
10. *Potential impacts of the project on landowners and land use.*
11. *Contingency planning for spills, accidents or malfunctions, during construction and operation of the project.*
12. *Safety and security during construction of the proposed project and operation of the project, including emergency response planning and third-party damage prevention.*

The Board does not intend to consider the environmental and socio-economic effects associated with upstream activities, the development of oil sands, or the downstream use of the oil transported by the pipeline.

Recognizing the scope of the assessment described above, Trans Mountain must submit an ESA for the proposed pipeline and facilities. Trans Mountain's ESA includes a description of the following:

- the environmental and socio-economic setting;
- the predicted beneficial and adverse effects of the proposed Project on the socio-economic and biophysical environment over the life of the Project;
- the methods used for effects analysis, and the rationale for selecting the methods chosen;
- the proposed inspection, monitoring and mitigation measures; and
- the predicted significance of residual Project effects and residual cumulative effects.

The biophysical assessment (note that terms biophysical and environmental are frequently used interchangeably in the ESA) considers the mandatory factors listed in Section 19(1) of the *CEA Act, 2012,* the factors listed in the NEB *Filing Manual* (NEB 2013a), and pertinent issues and concerns identified through Aboriginal engagement and consultation with landowners, regulatory authorities, stakeholders, and the general public. It should be noted that Aboriginal engagement and stakeholder consultation does not end with the filing of the application to the NEB. Engagement, consultation as well as refinement of the environmental and socio-economic mitigation measures, continue through the next phases of the regulatory process and project execution.

The biophysical assessment considers the potential effects of the Project on the environmental conditions within defined spatial and temporal boundaries. These boundaries will vary with the issues and biophysical elements or interactions to be considered, and will reflect:

- the biophysical baseline setting within the spatial boundaries of the Project;
- the construction, operation, maintenance and decommissioning and abandonment phases of the proposed physical works and physical activities;
- the time required for an effect to become evident;

- the time required for a population to recover from an effect and return to a pre-effect condition;
- the area directly affected by proposed physical works and physical activities; and
- the area in which a population functions and within which a Project effect may be felt.

The spatial boundaries consider one or more of the following areas, as summarized below and described in detail in Section 7.2. Figures showing the spatial boundaries used for each element are provided in Sections 5.0, 6.0 and 7.0 depending on the element in question.

- A **Footprint Study Area (Footprint)** consisting of the area directly disturbed by surveying, construction and clean-up of the pipeline and associated physical works and activities (including, where appropriate, the permanent right-of-way, pump stations, tanks, Westridge Marine Terminal, temporary construction workspace, temporary stockpile sites, temporary staging facilities, construction camps, access roads, power lines, etc).
- A **Local Study Area (LSA)** consisting of the zone of influence or area where the element and associated indicators are most likely to be affected by Project construction and operation. This generally represents a buffer from the centre of the proposed pipeline corridor. Detailed discussions regarding the element-specific LSAs and associated rationale are provided in Section 7.2.
- A **Regional Study Area (RSA)** consisting of the area extending beyond the LSA boundary where the direct and indirect influence of other activities could overlap with project-specific effects and cause cumulative effects on the indicator. For each element considered, a separate spatial RSA boundary was established in consideration of the regional effects of the Project on the individual element. Further rationale for the establishment of the RSAs is provided in Section 7.2.
- A **Provincial Area** that extends beyond regional or administrative boundaries, but is confined to Alberta and BC.
- A **National Area** that extends beyond Alberta and BC but is confined to Canada.
- An **International Area** that extends beyond Canada.

Individually established ecological boundaries are described within the discussions in Section 7.2 for each applicable biological element. Spatial ecological boundaries were determined by the distribution, movement patterns and potential zones of interaction between an element and the Project. The ecological boundary may be limited to the Footprint or extend beyond the physical boundaries of the area of the Project component since the distribution or movement of an element can be local, regional, provincial, national or international in extent.

Reconnaissance, detailed field studies and desktop studies considered a proposed pipeline corridor approximately 150 m wide, encompassing the pipeline construction right-of-way, temporary workspace, pump stations, and related facilities. In the event that an area of interest was identified, field crews expanded their survey as appropriate (the survey was not expanded to an area greater than the LSA) to identify the extent and distribution of the area of interest, and to ensure that a comprehensive assessment of the feature(s) were being surveyed.

The time frames of the biophysical assessment of the Project include the planning, construction (including reactivation/modification), operation, and decommissioning and abandonment phases. Pending regulatory approval, construction activities are expected to commence in Q1 2016 and extend to Q4 2017. The operation phase commences following completion of construction in Q4 2017 and extends for the useful life of the pipeline (approximately 50-70 years).

The biophysical assessment also considers residual and cumulative effects that are likely to result from the Project in combination with existing activities and reasonably foreseeable developments that have been or will be carried out. In areas where environmental field crews were not able to get access for resource surveys, desktop studies, literature reviews, information derived from study of adjacent lands and professional judgment were relied on to make predictions. Possible effects and available mitigation measures are well known and can be relied on to make assessment predictions. Where necessary to confirm impact predictions and gather site-specific information, Trans Mountain will be conducting additional studies on those areas where access was not available. Where warranted, follow-up studies may be recommended.

1.3 Overview of Volume 5A

The biophysical component of the ESA for the Project has been prepared under the guidance provided by the NEB *Filing Manual* and the requirements of the *CEA Act, 2012*. In addition, the mitigation measures, contingency and management plans provided in the project-specific Environmental Protection Plans (EPPs) for the pipeline, facilities and Westridge Marine Terminal (Volumes 6B, 6C and 6D), and information on the Environmental Alignment Sheets (Volume 6E) will form the foundation for future environmental management activities by Trans Mountain, particularly during the construction phase of the Project. The socio-economic component of the ESA for the Project is provided in Volume 5B. The environmental and socio-economic effects of increased Project-related marine vessel traffic are discussed in Volume 8A. Volume 5A is divided into the following sections.

1.0 **Introduction:** Provides the purpose of the environmental assessment, a description of the scope of the Project and the scope of the environmental assessment, an outline of Volume 5A and a summary of the Project team.

2.0 **Project Description:** Provides a description of the Project components and Project phases related to the pipeline and facilities component of the Project.

3.0 **Public Consultation, Aboriginal Engagement and Landowner Relations:** Provides a summary of public involvement and Aboriginal engagement activities conducted in preparation of the ESA for the pipeline and facilities component of the Project. This section discusses the engagement with Aboriginal communities and consultation with landowners, federal, provincial and municipal regulatory authorities, and other interested parties such as environmental non-government organizations (ENGOs), where applicable. The section also identifies key environmental issues raised during the consultation and engagement program. The consultation conducted in the preparation of this volume was designed to complement the Trans Mountain public consultation and Aboriginal engagement programs which is discussed in Volumes 3A, 3B and 3C.

4.0 **Corridor and Facility Site Selection:** Provides a detailed description of the proposed pipeline corridor selection processes and site selection process for pipeline facilities, pump stations and storage tanks.

5.0 **Environmental Setting for the Pipeline:** Provides a description of the current environmental conditions present along the proposed pipeline corridor and reactivated pipeline segments.

6.0 **Environmental Setting for Facilities:** Provides a description of the current environmental conditions present at pump stations, storage tank sites, the Westridge Marine Terminal and temporary facilities.

7.0 **Environmental Effects Assessment:** Describes the effects assessment and identifies the potential environmental effects, mitigation measures and potential residual effects, including an assessment of their significance for the following Project components: pipeline; temporary facilities; pump stations (including power lines); storage tanks; Westridge Marine Terminal; and reactivated pipeline segments.

8.0 **Cumulative Effects Assessment:** Provides a description of the Project's contribution to potential adverse cumulative effects as well as an assessment of their significance.

9.0 **Supplemental Studies:** Provides a description of the plans to carry out ongoing studies.

10.0 **Follow-up:** Provides a description of any proposed follow-up programs.

11.0 **Conclusion:** Provides conclusions related to the significance of potential adverse residual effects and cumulative effects associated with the pipeline and facilities components of the Project.

1.4 Project Team

The companies that assisted with the preparation of Volume 5A are listed in Table 1.4-1.

TABLE 1.4-1

PROJECT TEAM

Project Description Public Consultation, Aboriginal Engagement and Landowner Relations Corridor and Facility Site Selection	Trans Mountain Pipeline ULC (Trans Mountain)
Geotechnical evaluation and assessment	BGC Engineering Inc. TERA Environmental Consultants (TERA)
Soil survey and assessment	Mentiga Pedology Consultants Ltd. (Mentiga) TERA
Groundwater assessment	Waterline Resources Inc. (Waterline)
Air quality and greenhouse gas emissions Noise assessment	Rowan Williams Davies and Irwin Inc. (RWDI)
Fish and fish habitat survey and assessment	GeoMarine Environmental Consultants Ltd. Triton Environmental Consultants Ltd. TERA
Marine resources assessment (marine fish and marine mammals) Marine bird assessment Marine sediment and water quality assessment	Stantec Consulting Ltd. (Stantec)
Surface water assessment Wetland survey and assessment Vegetation survey and assessment Wildlife and wildlife habitat survey and assessment	TERA

Supporting biophysical technical reports are provided in Volume 5C. The technical reports provide discipline-specific background information, the methodology and results of field surveys and research conducted in support of the biophysical assessment. These technical reports and previous surveys and studies provide an information base for the pipeline and facilities component of the Project. The authors of the supporting technical reports also participated in the identification of potential effects, the evaluation of significance of residual effects and the development of mitigation measures within their respective disciplines.

1.5 References

1.5.1 Literature Cited

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2.0 PROJECT DESCRIPTION

This section provides a description of the Project's components and summarizes activities associated with the construction, operation, and decommissioning and abandonment phases of the pipeline and associated facilities.

2.1 Project Components

The following subsections describe the components of the Project and locations of the proposed and reactivated pipeline segments, proposed activities at pump stations, temporary facilities, proposed storage tank facilities, and the expansion of the Westridge Marine Terminal. More detailed descriptions are provided in Volume 2. The existing TMPL system and proposed and reactivated segments, as well as pump stations and terminals, are shown in Figure 1.1-1 of Section 1.0.

To delineate features along the proposed pipeline corridor, Reference Kilometre (RK) posts approximately 1 km apart have been established based on the general centre of the proposed pipeline corridor. RK 0.0 is located at the Edmonton Terminal where the existing TMPL system starts. The end of the existing TMPL system is located at the Burnaby Terminal (RK 1179.8), where two approximately 3.6 km long (RK 0 to RK 3.6) delivery lines extend from the Burnaby Terminal to the Westridge Marine Terminal.

The ESA is based on preliminary engineering and designs. In general, conservative assumptions have been used. However, further technical development during the upcoming phases of engineering and detailed design in 2014 and 2015 will confirm the current assessment of environmental effects. If there are substantive changes from the preliminary designs, additional assessment and regulatory consultation may be required.

2.1.1 Pipeline

2.1.1.1 New Pipeline

For the purposes of the environmental assessment, the proposed pipeline is divided into five distinct segments:

- The Edmonton to Hinton Segment extends from the existing Edmonton Terminal at SW 5-53-23 W4M (RK 0.0) and ties-in to the existing TMPL system at the Hinton Pump Station at NW 33-49-26 W5M (RK 339.4). The total length of the Edmonton to Hinton Segment is 339.4 km.
- The Hargreaves to Darfield Segment extends from the existing TMPL system at 20-B / 083-E-3 (RK 489.6) and ties-in to the existing TMPL system at the Darfield Pump Station at 75-B / 092-P-8 (RK 769.0). The total length of the Hargreaves to Darfield Segment is 279.4 km.
- The Black Pines to Hope Segment extends from the existing TMPL system at 41-K / 092-I-16 (RK 811.8) and ties-in to the proposed pipeline at the Hope Pump Station at 44-E / 092-H-6 (RK 1043.7). The total length of the Black Pines to Hope Segment is 231.9 km.
- The Hope to Burnaby Segment extends from the proposed pipeline at the Hope Pump Station at 44-E / 092-H-6 (RK 1043.7) and ties-in to the Burnaby Terminal at 25-D / 092-G-7 (RK 1179.8). The total length of the Hope to Burnaby Segment is 136.1 km.
- The Burnaby to Westridge Segment extends from the Burnaby Terminal at 25-D / 092-G-7 (RK 0.0) and ties-in to the Westridge Marine Terminal at 46-D / 092-G-7 (RK 3.6). The total length of the Burnaby to Westridge Segment is 3.6 km.

The proposed route of the new pipeline segments is identified along an approximately 150 m wide corridor. Although the proposed pipeline will generally require a construction right-of-way of 45 m, the corridor width varies along the route depending on the types of land use and potential engineering and environmental constraints.

The proposed pipeline corridor will parallel the existing TMPL system right-of-way to the greatest extent feasible considering, among other factors, present land uses and terrain adjacent to the existing TMPL system right-of-way. To reduce the area of new disturbance, the proposed pipeline corridor will parallel other existing linear disturbances where feasible. For the purposes of this ESA, existing linear disturbance include electrical transmission lines, oil and gas pipelines, fibre optic lines, railways, highways and permanent roads.

A summary of technical details for the proposed pipeline corridor is provided in Table 2.1-1. Technical details specific to reactivated segments are provided in the following subsection. An overview map of the existing TMPL system and the proposed pipeline corridor is provided in Section 1.0. Additional information pertaining to the alignment of the proposed pipeline corridor and the location and rationale of route deviations is provided in Section 4.0 and Volume 2.

TABLE 2.1-1

TECHNICAL DETAILS – PROPOSED PIPELINE CORRIDOR

Total Length (including Westridge delivery lines):	Approximately 990.5 km
Length Parallel to Existing TMPL:	661.6 km (66.8%)
Length Deviating from Existing TMPL:	328.9 km (33.2%)
Total Length Parallel to Other Existing Linear Features:	221.2 km (22.3%)
Total Length Deviating from Other Existing Linear Features:	107.8 km (10.9%)
Product:	Heavy synthetic crude oil and diluted bitumen (also capable of transporting light crude oil and light synthetic oil, if necessary)
Source Point:	Existing Edmonton Terminal at SW 5-53-23 W4M (RK 0.0)
Delivery Point:	Existing Sumas Terminal at a-097-B/092-G-01 (RK 1117.5), existing Burnaby Terminal at a-025-D/092-G-07 (RK 1179.8) and existing Westridge Marine Terminal at 46-D / 092-G-7 (RK 0.0 [Burnaby Terminal] to RK 3.6)
Pipe Size:	One 914.4 mm OD (NPS 36) pipeline from Edmonton Terminal to Burnaby Terminal and two 762 mm OD (NPS 30) Westridge delivery lines from Burnaby Terminal to Westridge Marine Terminal
Construction Footprint (typical) (construction right-of-way):	The construction right-of-way will typically be 45 m wide, including an approximately 18 m wide permanent easement. The remainder of the construction right-of-way width will be used as temporary workspace.
Construction Footprint (atypical) (construction right-of-way):	The construction right-of-way will be narrowed to 10 m or less where specific constraints or limitations are identified, such as parks and sensitive areas, confined valleys, urban areas, adjacent infrastructure or land features and when in proximity to the existing TMPL right-of-way.
Temporary Workspace:	Additional temporary workspace will be necessary at select locations to accommodate construction activities (*e.g.*, road, rail, buried utility line and water crossings, sharp sidebends, tie-ins, and locations where extra depth of cover, deep topsoil, three-lift handling or heavy grading is necessary). Trans Mountain will also acquire temporary workspace for Project construction needs such as stockpile sites, equipment storage sites, shoo-flies, contractor staging areas, borrow pits and construction work camps (refer to Section 2.1.2 for additional information).
Trench Depth	1.8-2.1 m, deeper at watercourses
Minimum Depth of Cover:	0.9 m (0.6 m in bedrock)
Typical Trench Width:	Approximately 2 m
Test Medium:	Water
New Above Ground Line Facilities:	Includes approximately 86 automated mainline block valves (MLBVs), scraper traps and a pressure control station (pending results of detailed hydraulic studies). Refer to Section 2.1.1.3 for a description of automated MLBVs and the pressure control station, and Sections 2.1.3 to 2.1.5 for information on scraper trap facilities at pump stations, storage terminals and the Westridge Marine Terminal, respectively.

2.1.1.2 Reactivated Pipeline Segments

The reactivated pipeline segments from Hinton to Hargreaves and Darfield to Black Pines generally parallel the existing TMPL right-of-way. The existing TMPL easement through Jasper National Park and Mount Robson Provincial Park is 6.1 m wide and 18 m wide, respectively. Outside the parks, the existing easement along the two segments is generally 18 m wide. Permanent surface disturbance along the reactivated segments will be limited to locations where automated MLBVs will be installed or where existing valves will be automated. Temporary surface disturbance will be limited to preparation for in-line inspection, defect repair and hydrostatic testing.

2.1.1.3 Pipeline Associated Permanent Facilities

Approximately 86 automated MLBVs will be installed along the pipeline for emergency shutdown and isolation of pipeline segments. Automated MLBVs will be constructed within the operating pipeline right-of-way and most will be sited adjacent to existing TMPL valves. Many automated MLBVs will be accessed by existing access roads, however, permanent access roads may be required at yet unspecified locations. Automated MLBVs will require a permanent power source. Typically, new power lines will only be used when there is a source nearby, thereby reducing any additional disturbance. Otherwise, alternative power sources such as solar panels, battery banks and/or nitrogen bottles will be used. Each automated MLBV installation will require a fenced and gravelled operating area of approximately 5 m x 12 m (60 m^2). The exact location of automated MLBVs and power sources utilized will be determined during the detailed engineering and design phase.

Pending results of detailed hydraulic studies, a pressure control station may be required for TMEP at the Hope Pump Station. The purpose of the station, if required, will be to control pressure in the pipeline to ensure product flows at a relatively steady rate as it leaves Kingsvale Pump Station (high elevation) and flows down slope toward the Lower Mainland (low elevation). The station will utilize the existing electrical distribution line and access road to the Hope Pump Station. No new lands will be required.

2.1.2 Pipeline Associated Temporary Facilities

Temporary Access Roads and Shoo-flies

Existing infrastructure will be used where practical for access during construction. Access to the new pipeline construction right-of-way, where it is not contiguous with the existing pipeline alignment, will be from existing public and private access points and roads (respecting traffic safety and concern for other users), controlled existing access, rights-of-way of others (*e.g.*, Canadian National Railway Company [CN], Telus, Spectra), and existing shoo-flies and trails. Only approved access will be used.

Where existing access is not sufficient or available, access might be improved along existing trails as necessary during construction by widening, re-grading or other means. Former access trails may also be reactivated and existing rights-of-way of others may be used to reduce disturbance.

Where new temporary access is required, all applicable authorizations and approvals will be sought on private and public lands, including parks and protected areas. Temporary access roads and shoo-flies will typically be 5 m wide to accommodate equipment and machinery.

Temporary Facility Sites

In addition to the pipeline easement and associated temporary workspace, land will be required for temporary sites, including:

- staging and stockpile sites;
- equipment storage sites;
- construction office sites;
- construction work camps (likely one in Alberta and two in BC);
- trenchless crossing work areas;
- borrow pits; and
- log decks.

Wherever practical, these temporary facilities will be located within previously disturbed areas to minimize overall Project disturbance. All temporary facility sites will be reviewed from an environmental perspective before their use.

Sewage and grey water will be treated in a temporary treatment facility on-site at each facility and hauled to regional facilities for disposal. Power will be supplied by generators and by the local electrical grid, where available.

If permitted, potable water at the facilities will be drawn from adjacent sources such as the Athabasca, Fraser, North Thompson, Coldwater and Coquihalla rivers, at rates acceptable to the appropriate regulatory authorities and filtered before use. Otherwise, potable water will be trucked in to each work camp site.

2.1.3 Pump Station Facilities

Pump stations are positioned along the existing TMPL system at 23 locations to maintain pressure and move the product along the line and monitor flow. To accommodate the expansion, the Project will include construction and operation of new pump stations serving the new pipeline at 10 of the existing pump station sites at Edmonton, Gainford, Wolf, Edson and Hinton in Alberta, and at Rearguard, Blue River, Blackpool, Kamloops and Kingsvale in BC. Two new pump stations will also be constructed and operated at a new greenfield site at Black Pines, BC to serve both the existing pipeline and new pipeline.

Pump stations are generally located within a fenced area on approximately 4 ha of land and contain the following: pumps and motors housed in a building; an electrical service building; an operator building; an electrical substation; and station piping and valves. Pump stations will be connected to the provincial power grid via new or existing power lines. Trans Mountain or a third party (*e.g.*, AltaLink Management Ltd., BC Hydro and Power Authority [BC Hydro]) will apply to the appropriate provincial regulatory authorities for electrical facilities necessary to connect with the provincial power lines. Existing access will be utilized for all pump stations with the exception of Black Pines, which will require construction of a permanent 5 m wide gravelled access road approximately 25 m in length, subject to final site selection and detailed engineering and design.

There will be one new 2,500 HP pumping unit installed on the NPS 24 pipeline heading south along the Puget Sound line from the Sumas Pump Station into Washington State. The existing Jasper Pump Station in Alberta will be relocated from the TMX Anchor Loop pipeline to serve TMPL system (currently deactivated). Valves, controls and other instruments will also be installed as part of the pump station modifications.

As an outcome of the TMEP, the Niton Pump Station will be reactivated (currently deactivated) to serve the existing pipeline and the existing pump stations at Wolf and Blue River will be deactivated since they will no longer be required for the existing TMPL system. The infrastructure that is currently in place at the deactivated pump stations will remain on-site should there be the need to reactivate either of the stations at some point in the future. The existing electrical service building and variable frequency drive building will, however, serve the new pump stations at Wolf and Blue River. The deactivated stations will be disconnected from the existing TMPL system and purged with nitrogen. All associated reactivation and deactivation activities will be conducted within the current fenced areas and no new disturbance will be required.

Although no changes to pumping capacity are anticipated at the Darfield Pump Station, valve modifications and installation of a new scraper trap (sending and receiving) are planned.

No work is planned at the following pump stations: Stony Plain and Chip, Alberta; and Albreda, Chappel, Finn, McMurphy, Stump, Hope, Wahleach and Port Kells, BC.

A summary of the location, components, present land use, land requirements and ancillary facilities (including scraper traps) at each pump station is provided in Table 2.1-2. Pump station schematics are provided in Volume 4A.

TABLE 2.1-2

TECHNICAL DETAILS – PUMP STATION ACTIVITIES

Pump Station and Location	Activities	Land Use and Land Requirements	Nearest Residence/Receptor from Facility Fence Line
Edmonton • RK 0.0 • SW 5-53-23 W4M	• new pump station[1] consisting of four electrically driven 5,000 HP pumps plus one spare[2] added to serve TMEP • new scraper facilities (sending) on TMEP • a new substation • a new power line (to be determined by provincial regulatory authority)[3] • fencing	industrial / within existing Trans Mountain-owned lands	• 1.9 km northwest and southeast
Gainford • RK 117.5 • NE 13-53-6 W5M	• new pump station[1] consisting of three electrically driven 5,000 HP pumps to serve TMEP • upgrades to existing substation • fencing	industrial and forested (clearing required) / within existing Trans Mountain-owned lands	• 140 m east
Niton • RK 191.4 • SW 34-53-13 W5M	• reactivate two existing 2,000 HP pumps to serve TMPL	industrial / within existing Trans Mountain-owned lands	• 1 km southwest
Wolf • RK 206.2 • NW 19-53-14 W5M	• new pump station[1] consisting of two electrically driven 5,000 HP pumps serving TMEP • existing pump building will be deactivated • fencing	industrial / within existing Trans Mountain-owned lands	• 600 m west-southwest
Edson • RK 247.1 • SW 18-53-18 W5M	• new pump station[1] consisting of three electrically driven 5,000 HP pumps serving TMEP • new scraper facilities (sending and receiving) on TMEP • replace existing substation • a new power line (to be determined by provincial regulatory authority)[3] • fencing and on-site gravel road	industrial / within existing Trans Mountain-owned lands	• 360 m west
Hinton • RK 339.4 • NW 33-49-26 W5M	• new pump station[1] consisting of three electrically driven 5,000 HP pumps serving TMEP • new scraper facilities (sending) on TMPL • fencing	industrial / will require acquisition of approximately 0.32 ha (35 m x 90 m) new land outside existing Trans Mountain-owned lands to the west	• 820 m southwest
Jasper • NW 2-46-1 W6M	• relocate two existing 2,500 HP pumps from the TMX Anchor Loop pipeline to TMPL (currently deactivated) • drag resistant agent injection facility requiring small storage tank (with secondary containment) and a high pressure injection pump	industrial / within Crown lands currently leased by Trans Mountain	• 1.3 km southeast
Rearguard • RK 498.3 • d-068-K/083-D-14	• new pump station[1] consisting of two electrically driven 5,000 HP pumps serving TMEP • remove scraper facilities (sending and receiving) from Hargreaves • new scraper facilities (sending and receiving) on TMPL and TMEP • fencing and on-site gravel road	industrial and disturbed forested (clearing required) / will require acquisition of approximately 0.7 ha (70 m x 100 m) new land outside existing Trans Mountain-owned lands to the east	• none within 2 km

TABLE 2.1-2 Cont'd

Pump Station and Location	Activities	Land Use and Land Requirements	Nearest Residence/Receptor from Facility Fence Line
Blue River • RK 614.7 • a-035-F/083-D-03	• new pump station[1] consisting of three electrically driven 5,000 HP pumps serving TMEP • existing pump building will be deactivated	industrial / within existing Trans Mountain-owned lands	• 30 m east and south
Blackpool • RK 736.8 • c-073-B/092-P-09	• new pump station[1] consisting of three electrically driven 5,000 HP pumps serving TMEP • upgrade existing transformer • fencing and on-site gravel road	industrial / within existing Trans Mountain-owned lands	• 150 m north-northwest
Darfield • RK 769 • d-075-B/092-P-08	• new scraper facilities (receiving) on TMEP • fencing	industrial and agricultural / will require acquisition of approximately 0.07 ha (23 m x 30 m) new land outside existing Trans Mountain-owned lands extending from the northwest corner of the property line	• 150 m south
Black Pines • RK 811.8 • d-041-K/092-I-16	• new pump station[1] consisting of two electrically driven 5,000 HP pumps serving TMEP • new pump station[1] consisting of two electrically driven 2,500 HP pumps serving TMPL • new substation to serve both lines • new scraper facilities (sending and receiving) on TMPL and TMEP • new access road approximately 5 m x 25 m[3] • new 138 kV power line approximately 50 m x 2.2 km[3] • fencing and on-site gravel road	forested (clearing required) / requires acquisition of approximately 150 m x 150 m (2.3 ha) of privately-owned land	• 600 m south
Kamloops • RK 850.8 • d-094-E/092-I-09	• new pump station[1] consisting of three electrically driven 5,000 HP pumps plus one spare[2] added to TMEP • new substation to serve TMEP • new scraper facilities (sending and receiving) on TMEP	industrial with grading required / within existing Trans Mountain-owned lands	• 520 m southeast
Kingsvale • RK 955.6 • b-023-L/092-H-15	• new pump station[1] consisting of two electrically driven 5,000 HP pumps serving TMEP • replace existing substation • new 138 kV power line approximately 50 m by 23.5 km[3] • fencing	forested (clearing and grading required) / within existing Trans Mountain-owned lands	• 300 m southwest
Sumas • RK 1113.8 • c-073-B/092-G-01	• one electrically driven 2,500 HP pump serving the Puget Sound line • upgrade existing substation	industrial / within existing Trans Mountain-owned lands	• 110 m southwest

Notes: 1 New pump stations require the installation of an electrical service building, pump building and operator building, as well as motors, instrumentation, station piping and valves. Existing electrical service buildings and operator buildings will be used where possible.

2 Spare pumps will remain inactive during normal operations.

3 Power line routing and the new access road will be confirmed during the detailed engineering and design phase.

2.1.4 Tank Facilities

To serve the expanded pipeline, a total of 20 new storage tanks will be constructed: 5 at the Edmonton Terminal; 1 at the Sumas Terminal; and 14 at the Burnaby Terminal. The new welded steel tanks will be similar in structure to the existing tanks at the terminals and installed on stable, engineered foundations within a bermed containment area.

After the site has been rough graded, foundations for each tank will be constructed. Foundation design parameters may vary across terminals based on the results of detailed geotechnical surveys. Leak-detection systems consisting of a passive-weeping channel between the liner and tank floor will be installed. An internal tank liner, covering the bottom and about 1 m up the shell, will be provided for corrosion prevention. Cathodic protection will be installed on all new tanks as an added measure to protect against corrosion. Tank control systems will include a radar gauging system for high and low level monitoring and overfill protection. Redundant instrumentation for overfill protection will be provided.

All tanks will have secondary containment consisting of compacted clay or a geo-synthetic liner. Secondary containment will be capable of containing 100% of the working volume of the largest tank plus 10% of the working volume of other tanks that share a common impoundment. The bermed area will be graded to direct all surface water to a runoff containment area, where it can be inspected before release. Surface runoff within these containment areas will be released through manually controlled valves following water quality monitoring. Drainage features will be designed and installed to ensure that no runoff originating off-site will be allowed to enter the proposed development area.

Additional components include valves, metering and provers, pumps and inter-connecting pipes. The existing fire-protection system and stormwater management system will be expanded to accommodate the additional tanks at each site. Final details will be determined during the detailed engineering and design phase.

A summary of technical details associated with the proposed storage tanks at the Edmonton, Sumas and Burnaby terminals is provided in Table 2.1-3. Terminal schematics are provided in Volume 4A.

TABLE 2.1-3

TECHNICAL DETAILS – STORAGE TANKS AND ASSOCIATED FACILITIES AT THE EDMONTON, SUMAS AND BURNABY TERMINALS

Technical Details	Edmonton Terminal	Sumas Terminal	Burnaby Terminal
Location	• RK 0 • SW 5-53-23 W4M	• RK 1117.5 • a-097-B/092-G-01	• RK 1179.8 • a-025-D/092-G-07
Nearest Residence/Receptor from Facility Fence Line	• 1.9 km northwest and southeast	• 60 m south	• approximately 50 m south
Product	diluted bitumen, synthetic bitumen, diluted synthetic bitumen, light crude and synthetic crude		
Existing Storage Tank Capacity	• 19 tanks with an approximate capacity of 429,270 m^3 (2.7 million bbl)[1]	• 6 storage tanks with an approximate capacity of 113,680 m^3 (715,000 bbl)	• 13 tanks with an approximate capacity of 270, 280 m^3 (1.7 million bbl)
New Storage Tank Capacity	• 2 x 34,980 m^3 (220,000 bbl) • 2 x 63,600 m^3 (400,000 bbl) • 1 x 11,920 m^3 (75,000 bbl)	• 1 x 27,820 m^3 (175,000 bbl)	• 2 x 39,750 m^3 (250,000 bbl) • 10 x 45,310 m^3 (285,000 bbl) • 2 x 53,260 m^3 (335,000 bbl)
Maximum Tank Height	21.3 m	17.1 m	18.3 m
Roof Type	external floating roof	fixed steel roof with internal floating roof	
Overall Site Area	47.2 ha	43.3 ha (only 11.6 ha currently disturbed)	76.7 ha
Total Containment Capacity	will allow for containment of 100% of the working volume of the largest tank plus 10% of the working volume of other tanks that share a common impoundment and stormwater		
Runoff Containment Area Size / Capacity	1-in-100-year storm event with a 24 hour duration period		
Pump Sizes	Seven 800 HP booster pumps (electric drive)	None	Eight 500 HP booster pumps (electric drive)
Test Water Source	from existing storage ponds filled with water diverted from nearby creeks (subject to existing or future permit approval conditions) and/or purchased from the municipal water supply		

TABLE 2.1-3 Cont'd

Technical Details	Edmonton Terminal	Sumas Terminal	Burnaby Terminal
Land Requirements	within existing Trans Mountain fence line on previously disturbed industrial lands	within the existing Trans Mountain property boundary, however, existing fence line will be moved approximately 20 m north (20 m x 350 m [0.7 ha] of new disturbance) to accommodate a new access road and earthworks for modifications to the tank secondary containment berm	within existing Trans Mountain fence line on previously disturbed industrial lands, however, disturbance to natural watercourses within the existing site boundaries will result in the loss of riparian vegetation as well as a change in natural surface flow patterns
Associated Infrastructure	on-site access roads to each new tank, power requirements/upgrades	on-site access road to the new tank, power requirements/upgrades are not required due to small increase in load at this facility	on-site access roads to each new tank and other associated facilities, power requirements/upgrades will be determined by BC Hydro (anticipated that approximately 5 MW of additional power will be required)
Other Activities	an existing 12,720 m^3 (80,000 bbl) tank will be dismantled and replaced by the new 11,920 m^3 (75,000 bbl) tank	to make space available for the new tank, a power line will be relocated approximately 20 m to the north and an existing containment berm will be dismantled and the area graded to support the foundation for the new tank. A new containment berm will be constructed before the new tank is put into operation	new scraper facilities for new pipeline (receiving) and Westridge delivery lines (sending), and an existing 12,720 m^3 (80,000 bbl) tank will be dismantled and replaced by one of the 45,310 m^3 (285,000 bbl) tanks

Note: 1 Trans Mountain is currently in the process of constructing the Edmonton Terminal Expansion Project, which involves constructing 10 new tanks and associated facilities at the Edmonton Terminal. This project was approved by the National Energy Board (NEB) in March 2008 and is now being constructed under Amending Order AO-005-XO-T246-04-2008. In February 2013, Trans Mountain applied to the NEB to vary Amending Order AO-005-XO-T246-04-2008 to permit construction of four additional tanks at the Edmonton Terminal for a total of 14 tanks. The NEB issued an Amending Order AO-006-XO-T246-04-2008 on June 20, 2013 and the four additional tanks are expected to come into service by late 2014. Furthermore, in July 2013 Trans Mountain applied to the NEB (File OF-Fac-Oil-T260-2013-04 01) to construct an additional two tanks at the Edmonton Terminal. Pending regulatory approval, the two tanks are expected to come into service by late 2014 or early 2015.

2.1.5 Westridge Marine Terminal

The Westridge Marine Terminal is located on the south shore of Burrard Inlet east of the Second Narrows at RK 3.6 (d-047-D/092-G-07) of the Westridge delivery lines. Preliminary design of the additional facilities at the Westridge Marine Terminal is currently underway. These plans include constructing the following dock facilities:

- one dock with three operational berths for Aframax tankers, with one of the three new berths equipped to accommodate oil and jet fuel barges; and
- one small utility dock with multiple berths for pilot launches, tugs, spill response vessels and equipment.

The proposed configuration of the new docks is provided in Volume 4A. Some near shore dredging might be necessary to accommodate construction of the new docks.

Each of the three tanker berths consists of a number of individual elements or structures arranged in accordance with accepted industry practice. Typical elements include:

- fender and mooring structures;
- vessel access towers;
- delivery and receipt pipeline systems, including loading arms;
- pedestrian catwalks connecting the dolphin structures to the central platform; and
- vapour recovery systems and fire-suppression systems.

The existing water lease will need to be expanded to accommodate the new docks. Foreshore lands will also be expanded along the lateral footprint to provide the necessary space for shore equipment and structures. The outer face of the fill will be protected with rip rap (stone armour) to prevent erosion.

New scraper receiving facilities will be installed for the two new Westridge delivery lines between the Burnaby Terminal and the Westridge Marine Terminal. The new scraper receiving facilities will be installed within the existing fence line of the Westridge Marine Terminal on previously disturbed lands owned by Trans Mountain.

The existing electrical substation and electricity supply line within the Westridge Marine Terminal will be upgraded as required. Electrical upgrades will be determined through a study to be conducted by BC Hydro. At this time, it is anticipated that an additional 3 MW of power will be required at this facility. No new roads will be required to access the terminal. However, an improved site access road and an expanded parking area for staff and contractors will be required. No new access will be constructed across the existing Canadian Pacific Rail line that bisects the facility.

The nearest residence is located approximately 75 m south of the Westridge Marine Terminal property boundaries.

2.2 Project Execution

This subsection describes the activities to be conducted as part of construction of the Project, including: construction of the new pipeline segments and associated permanent and temporary facilities; pipeline reactivation; pump station construction, expansion, reconfiguration, reactivation and deactivation; storage tank construction; and expansion of the Westridge Marine Terminal. It also describes the construction schedule and estimated workforce.

2.2.1 Construction Activities

Standard activities and equipment requirements for construction and other activities associated with the Project are described in Table 2.2-1. These activities are presented in their general order of occurrence. All of these activities are considered in the environmental effects assessment (see Section 7.0). For detailed descriptions of Project activities refer to Volume 4B.

TABLE 2.2-1

PROJECT ACTIVITIES

Construction Phase	Associated Activities
Engineering	All Project components will be designed and constructed in accordance with all applicable Canadian Standards Association (CSA) standards, the *National Energy Board Onshore Pipeline Regulations* (*NEB OPR*) and additional requirements described in Volume 4A.
New Pipeline Segments	
Construction Survey	Activities include line-of-sight clearing with chain saws (where needed), flagging and staking of the boundaries of the construction right-of-way and temporary workspace, as well as marking the trench line and existing utilities. Avoidance areas, such as protected habitats or rare plants, will also be appropriately fenced or flagged.
Clearing	Vegetation (trees, stumps, brush, grasses, crops and other vegetation) and snow will be cleared or mowed from the construction right-of-way and temporary workspace. Equipment used during clearing activities may include chainsaws, rotary grinders, feller-bunchers, hydro-axes or other tree-clearing and brushing equipment, as well as skidders, bulldozers and excavators. A stump mulcher will be utilized rather than grubbing on areas where topsoil or root zone material salvage and grading is not necessary.
Disposal	Timber and brush disposal options will be subject to agreements with occupants and the Crown. Merchantable timber will be salvaged as determined in the Timber Salvage Plan (Pipeline EPP [Volume 6B]). Residual woody materials will be disposed of by burning or chipping, unless otherwise directed by the Lead Environmental Inspector, Inspector(s) or the appropriate regulatory authority (*e.g.*, Alberta Environment and Sustainable Resource Development [AESRD], BC Ministry of Forests, Lands and Natural Resource Operations and/or British Columbia Ministry of Environment [BC MOE]). In the Lower Mainland where air quality is an issue and along highways where smoke may be a hazard, residual woody materials will be mulched in place or hauled to an approved disposal location.
Topsoil or Root Zone Material Salvage	In general, topsoil will be salvaged to ensure that the soil productivity is maintained in agricultural and grassland areas and root zone material will be salvaged where grading is necessary on treed lands. The width and depth of topsoil or root zone material salvage depends on a number of factors including the land use, soil conditions, microtopography, landowner and regulatory authority requests, and grading requirements. Equipment used during topsoil or root zone material handling activities may include bulldozers, graders and excavators.

TABLE 2.2-1 Cont'd

Construction Phase	Associated Activities
Grading	Following topsoil or root zone material salvage, grading will be conducted on irregular ground surfaces (including temporary workspace) to provide a safe work surface. Graders, excavators and bulldozers will be used for this activity. Ripping or blasting might be required where hard bedrock is encountered.
Stringing and Welding	The pipe will be transported by truck from stockpile sites to the construction right-of-way. The pipe will be bent, lined-up, welded, joint-coated and inspected, before being lowered into the trench. Is it anticipated that a mix of manual and mechanized welding will be used depending on terrain and anticipated productivity. Other equipment used during stringing and welding activities includes pipe trucks, booms, pick-up trucks, excavators and x-ray or ultrasonic inspection equipment mounted on pick-up trucks or skids.
Trenching	The trench will be excavated using tracked excavators to a depth sufficient to ensure the depth of cover is in accordance or in excess of applicable codes. The minimum depth of cover for the pipeline will generally be 0.9 m (the pipeline trench will be deeper at watercourse crossings, highway crossings etc.). Railway crossings and paved road crossings will generally be bored.
Lowering-In	The pipe will be lowered into the trench using sideboom tractors and excavators. Trench dewatering might be necessary at certain locations during lowering-in (*e.g.*, to ensure acceptable bedding for pipe, to prevent the pipe from floating or for performing tie-in welds).
Backfilling	Before backfilling, subsurface erosion-control structures such as trench breakers will be installed on steep slopes or long continuous slopes, along with subdrains, where warranted, to control subsurface drainage along the trench. The trench will be backfilled using excavators, graders, bulldozers or specialized backfilling equipment. Backfill material will generally consist of native-trench spoil material. Displaced subsoil will be crowned over the trench to compensate for settlement and any excess trench spoil will be feathered-out over adjacent portions of the construction right-of-way where topsoil or root zone material salvage has occurred. Padding may be necessary where the trench is created in areas of bedrock.
Testing	The pipeline segments will be hydrostatically pressure-tested in accordance with the *NEB OPR*, provincial legislation, codes of practice and guidelines as well as the latest version of CSA Z662. The pipeline will be pressure-tested in sequential segments, using water. Source water is likely to be drawn from the North Saskatchewan, Pembina and McLeod rivers for new pipeline in Alberta, and from the Fraser, Canoe, North Thompson, Thompson, Coldwater, Coquihalla and Sumas rivers for new pipeline in BC. Test water will be withdrawn and released in accordance with Alberta Codes of Practice (*i.e.*, Code of Practice for the Temporary Diversion of Water for Hydrostatic Testing of Pipelines and Code of Practice for the Release of Hydrostatic Test Water from Hydrostatic Testing of Petroleum Liquid and Gas Pipelines)and BC *Water Act* approval conditions. Upon completion, test water will be returned to its source basin. A detailed hydrostatic test plan will be developed and reviewed before the start of the hydrostatic pressure testing program.
Clean-Up and Reclamation	Initial clean-up and reclamation activities along disturbed portions of the construction right-of-way and temporary access trails (shoo-flies) will be initiated following backfilling, once weather and soil conditions permit. Debris remaining following construction will be removed and disposed of in compliance with local regulations. The construction right-of-way will be graded to restore pre-construction contours, where practical, and returned to a stable condition. The topsoil or root zone material will be replaced, with cross ditches and diversion berms installed on moderate and steep slopes to reduce the risk of erosion. On treed lands where erosion is not expected, natural revegetation will be the preferred method of reclamation. Non-cultivated agricultural and native grassland areas will be seeded with an appropriate seed mix unless otherwise directed by landowners or provincial or local authorities.
Watercourse Crossings	Options available for crossing watercourses include trenched (*e.g.*, isolation [dam and pump, flume] and open cut) and trenchless (horizontal directional drill [HDD] and bore) methods. The crossing method chosen will be based on the width, streamflow, channel morphology, subsurface geology, sensitivity and approach slopes. Additional information is provided in the Pipeline EPP (Volume 6B) and the fisheries technical reports (Volume 5C).
Permanent Pipeline Facilities	
Site Preparation	Sites located within the proposed easement will be prepared as part of the pipeline construction activities above. Sites located along the existing active or reactivated easements will involve clearing of snow and/or vegetation where present, salvaging of topsoil or root zone material and grading of the site, where warranted, using equipment similar to that described for construction of the pipeline.
Facility Construction	Once the infrastructure has been installed along the new pipeline or existing pipeline rights-of-way, the area inside the new fence line will be gravelled. The Pressure Control Station, if required, will be constructed entirely within the existing pump station boundary at Hope. Permanent pipeline-related facilities will be constructed as an integrated part of the pipeline construction. Permanent facilities work along the existing active and proposed reactivated segments will require surface disturbance confined to the existing right-of-way easement.
Potential Ancillary Infrastructure	Permanent Access Roads Activities associated with construction of new permanent access roads to the MLBVs (in the event any are required) and the Black Pines Pump Station include: surveying; clearing; salvaging and storing of topsoil or root zone material; grading; installing culverts at the road bar ditches; and clean-up and reclamation. Equipment used during access road construction includes bulldozers and graders. Distribution Power Lines Activities associated with the installation of distribution power lines to the MLBVs (in the event any are required) and the Pressure Control Station, if required, as well as the power lines at Black Pines and Kingsvale pump stations, include: surveying; clearing or mowing of brush; salvaging of topsoil or root zone material; drilling of holes; erecting poles; stringing of new cable; replacing topsoil or root zone material; and clean-up and reclamation. Equipment used to install distribution lines includes backhoes, bulldozers and drill equipment for the poles.

TABLE 2.2-1 Cont'd

Construction Phase	Associated Activities
Reactivated Segments	
Pipeline Inspection, Repairs and Cleaning	Before testing, reactivated pipeline segments will be assessed using in-line inspection tools. Specific locations along the pipeline will be physically inspected and repaired, if required, as determined necessary to ensure integrity. Following inspection, in-line cleaning tools will be used to scrub the pipe walls and remove residual hydrocarbon products and debris.
Testing	Following inspection and cleaning, the pipeline segments will be hydrostatically tested using similar procedures for new pipeline above. Source water is likely to be drawn from the Athabasca, Snaring, Miette and Fraser rivers as well as Moose Lake for the reactivated pipeline segment from Hinton to Hargreaves and from the North Thompson River for the reactivated pipeline segment from Darfield to Black Pines. Discharge water from hydrostatic testing of the previously in-service pipeline segments will require more extensive treatment than new pipeline segments due to the presence of residual hydrocarbons. Holding ponds or tanks will be used to provide storage for the discharge water, which will be treated on-site before release into the environment.
Temporary Facilities	
Site Preparation	Initial site preparation will involve clearing of vegetation where present, salvaging of topsoil or root zone material and grading, where warranted, using equipment similar to that described for construction of the pipeline.
Facility Construction	Sites may be gravelled and/or fenced, depending on site use.
Access	Access to the various types of temporary facilities will be controlled during site use, if warranted, for public safety and to prevent vandalism of equipment and/or facilities.
Facility Dismantle	Any above ground structures (*e.g.*, fencing, buildings) will subsequently be dismantled and removed from the site. Access roads and associated gravel will also be removed.
Reclamation	Reclamation procedures will be initiated following the dismantling of above ground structures using bulldozers, excavators and graders. Debris remaining at temporary facility sites will be removed and disposed of in compliance with local regulations. Site contours will be replaced and the site will be returned to a stable and maintenance-free condition. Depending on the intended land use of the site, topsoil or root zone material will be replaced where salvaged and disturbed areas will be seeded with an appropriate seed mix.
New, Expanded and Reconfigured Pump Stations	
Construction Survey	Activities include staking of the boundaries of the pump station site and temporary workspace as well as marking hot lines and existing utilities. Avoidance areas, such as protected habitats, will be appropriately fenced or flagged.
Clearing and Disposal	Activities associated with vegetation clearing and disposal at pump stations are described above under new pipeline segments.
Topsoil or Root Zone Material Salvage	Topsoil or root zone material, where present, will be salvaged from pump station sites where clearing and grubbing are required. The topsoil or root zone material will be stockpiled in low profile berms or piles adjacent to the site perimeter. The topsoil or root zone material location will be documented for future reference. Equipment used during topsoil or root zone material handling activities may include bulldozers, graders and excavators.
Grading	Following topsoil or root zone material salvage, grading will be conducted on irregular ground surfaces to provide a safe work surface. Graders, excavators, and bulldozers will be used for this activity. Ripping might be required where hard bedrock is encountered.
Piles and Foundations	Once the site is graded, piles will be driven into the ground using pile drivers, where required. In some instances, concrete foundations will be poured using concrete trucks, smoothing equipment, and forms.
Building Installation	Once the piles and foundations are in place, the buildings will be installed. Equipment used during this activity includes cranes, semi-trailers and trucks.
Electrical and Pipeline Connections	The electrical and piping connections will be completed once the buildings have been installed.
Potential Ancillary Infrastructure	Activities associated with construction of the new permanent access road and power line at Black Pines Pump Station and power line at Kingsvale Pump Station are described under permanent pipeline facilities above.
Testing	All systems and processes will be connected and tested. All piping will be pressure tested during fabrication and/or after installation.
Clean-Up and Reclamation	Upon completion of building activities, clean-up and reclamation procedures will be initiated using bulldozers, excavators and graders. Debris remaining at the pump stations will be removed and disposed of in compliance with local regulations. Surface water controls, recontouring, erosion controls and terrain stabilization will be incorporated where necessary. Gravel surfaces will be placed over high-traffic areas of the pump stations (including on-site gravel roads) and fencing will be installed around the sites where none is currently present.
Reactivated Pump Stations	
Inspection, Cleaning and Testing	Reactivation will involve the removal of the existing pumps, motors and valves; inspection, servicing, refurbishment and then reinstallation of these components, testing of the system, and then commissioning of the station, including mechanical, electrical, instrumentation and control systems.
Deactivated Pump Stations	
Inspection and Shut Down	Deactivation will involve shutting-in the pump station; isolating the pump station facilities from the pipeline; purging the pump station facility with nitrogen; maintaining existing power supply; and protecting the equipment as per the manufacturer's recommendations.
Storage Tanks	
Construction Survey	Activities include staking the tank boundaries and temporary workspace as well as marking hot lines and existing utilities.
Clearing and Disposal	Activities associated with vegetation clearing and disposal at terminals are described above under new pipeline segments.

TABLE 2.2-1 Cont'd

Construction Phase	Associated Activities
Topsoil or Root Zone Material Salvage	Topsoil and root zone material, where present, will be salvaged as described above under new, expanded and reconfigured pump stations.
Site Preparation	Following topsoil or root zone material salvage, grading will be conducted on irregular ground surfaces to provide a safe work surface and level tank foundation and to establish suitable drainage at the site. Low wet areas will be dewatered and suitable fill material will be imported as necessary. Graders, excavators and bulldozers will be used for this activity. Ripping may be required where hard bedrock is encountered.
Piles, Foundations and Tank Installation	Once the site is graded, piles will be installed. In some instances, concrete foundations will be poured using concrete trucks, smoothing equipment and forms. Tanks and buildings will be installed on prepared foundations. Secondary containment consisting of compacted clay or a geosynthetic liner will be constructed under and around the tanks. All necessary fire suppression and vapour recovery equipment will be installed. Equipment used during this activity includes welders, cranes, semi-trailers and trucks.
Electrical and Pipeline Connections and Testing	Piping connections will be completed once the tanks have been installed, and all systems and processes will be connected and tested.
Testing	Tanks will be hydrostatically tested. All piping will be pressure-tested during fabrication and/or after installation. Wherever possible, test water will be released to land within a containment structure (*e.g.*, into a lined tank bay). From there, it will be tested for contaminants before being treated and either trucked away or released to a natural water body or the municipal sewer system. If naturally occurring water is likely to be used for an extended period of time (*i.e.*, for multiple tanks), it may need to be treated to prevent the growth of algae or other organic contaminants. Depending on what treatment is used, there may be special requirements for discharge, particularly if the planned discharge is to the environment.
Clean-Up and Reclamation	Upon completion of building activities, clean-up and reclamation procedures will be initiated using bulldozers, excavators and graders. Debris remaining at the terminals will be removed and disposed of in compliance with local regulations. Surface water controls, recontouring, erosion controls and terrain stabilization will be incorporated where necessary. Gravel surfaces will be placed over high traffic areas of the terminals (including on-site gravel roads).
Westridge Marine Terminal	
Construction Survey	Activities include staking all boundaries of the marine terminal land and foreshore footprint and additional temporary workspace as well as marking hot lines and existing utilities.
Dredging	Dredging may be required for foreshore preparation. Equipment used during dredging activities will include barges and clamshell buckets.
Material Disposal	Dredge material will be collected and disposed of in accordance with provincial regulations and municipal bylaws and, if suitable, may be used if suitable for reclamation of the foreshore area and to increase the land base needed for the expansion of the facility.
Dock Construction	Marine structures will likely be supported by tubular steel piles installed into the seabed. Dock structures will be constructed of steel mooring dolphins and catwalks will be constructed of steel that span between the piles. Once the dock structures are completed, the topside equipment such as piping systems, loading arms, vapour recovery piping, and fire protection systems, will be installed. Construction of the docks will mostly be done using floating equipment such as barge-mounted pile drivers and marine derricks.
Existing Dock	Operations at the existing dock are anticipated to continue during construction of the new berths. Once the new docks are in-service, the existing dock will be completely decommissioned and removed. The structures will be removed from the water by removing topside equipment, demolishing the deck structures and extracting the piles from the seabed. If complete removal of the piles is not feasible, they will be cut off at or slightly below the seabed. The demolition material would be removed from site on a barge. Some materials, such as steel and concrete, may be reclaimed and recycled for use in other projects, and some will be disposed in a landfill.
Electrical and Pipeline Connections and Testing	All systems and processes will be connected and tested.
Testing and Inspection	All piping will be pressure-tested during fabrication and/or after installation and all process piping welds will be inspected using either x-ray or ultrasonic methods.
Clean-Up and Reclamation	Upon completion of building activities, clean-up and reclamation procedures will be initiated using barges, bulldozers, excavators and graders. Debris remaining at the terminal will be removed and disposed of in compliance with local regulations. Surface water controls, recontouring, erosion controls and terrain stabilization will be incorporated where necessary. Asphalt or gravel surfaces will be placed over high traffic areas of the terminal (including on-site gravel roads) and fencing will be installed around the sites where none is currently present.

2.2.2 Construction Schedule and Workforce

Pending regulatory approval of the Project, construction of the pipeline and facilities is scheduled over an approximately 24 month period to achieve the planned in-service date of late 2017. Preliminary plans provide for seven pipeline construction spreads, ranging from approximately 34.2 km to 290.4 km in length. It is anticipated that all seven spreads will generally be constructed concurrently during the following consecutive construction seasons: summer 2016; winter 2016/2017; and summer 2017. The length of the construction period for each spread depends on, among other variables, length, land uses, terrain and construction techniques for each spread.

Front-end preparatory activities such as construction right-of-way clearing and access preparation will commence within the first month or second month on any given spread, or earlier to avoid migratory bird windows, followed by topsoil or root zone material salvage, grading, stringing and welding, trenching, pipeline installation, backfilling, machine clean-up and pressure testing. Water crossing installations requiring instream activity will take place outside instream restricted activity periods (RAPs) in Alberta and within least risk windows in BC, unless otherwise approved by the appropriate regulatory authorities for specific watercourse crossings. Segments through wetlands will typically be constructed during dry conditions or frozen conditions to reduce disturbance. Final clean-up and reclamation activities will occur on dry, non-frozen ground throughout summer months of 2017 and 2018, with the exception of inaccessible wet areas, where activities will occur during frozen conditions. Localized remedial activities will occur over the following years for minor restoration repair and maintenance as dictated by weather events.

Pipeline construction activities are progressive. Consecutive phases of the pipeline construction process are expected to overlap as construction progresses along the construction right-of-way within a spread and amongst spreads (*i.e.*, right-of-way preparation, trench excavation, pipeline installation, backfilling and initial clean-up activities will all occur concurrently at different locations along the pipeline route). Crews will be working approximately three months at any given location on the right-of-way. Tie-in locations generally take longer to complete since they are routinely completed last, immediately before and after testing. Certain late stage activities such as testing and final clean-up may be postponed until suitable weather and soil conditions occur.

Activities associated with reactivation of the existing pipeline segments from Hinton to Hargreaves and Darfield to Black Pines will take place over a period of several months, with in-line inspection activities planned for Q3 2016, and excavation, repair and testing activities taking place in Q2 and Q3 of 2017, with operations planned during late 2017.

Construction and equipment installation at pump stations and tank terminals is expected to begin in Q1 2016 and take approximately 8 to 10 months for each pump station and between 14 and 23 months at the terminals, depending on, among other variables, scope, land use and construction techniques for each facility. The construction period for the Westridge Marine Terminal is expected to commence in Q4 2015 with the first berth expected to be in-service by Q3 2017. The second and third new berths are expected to be in-service by late 2017. Demolition of the existing berth is planned to commence in late 2017 after the new berths are commissioned.

A summary of the conceptual construction schedule for each pipeline spread and reactivated pipeline segments is provided in Tables 2.2-2 and 2.2-3, respectively, while Table 2.2-4 summarizes the conceptual construction schedule for pump stations, tanks and the Westridge Marine Terminal. The proposed schedules are subject to modification in response to regulatory approval conditions, outcomes of consultation and engagement, business considerations and market forces, as well as site-specific limitations and constraints, such as the influence of weather conditions on construction activities. For additional information, see Volume 4B.

TABLE 2.2-2

PROPOSED PIPELINE CONSTRUCTION SCHEDULE

Pipeline Spread[1]	From	To	2016												2017											
			J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Alberta																										
A1	RK 0	RK 49.0					■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■				
A2	RK 49.0	RK 339.4						■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■			
BC																										
BC1	RK 489.6	RK 769.0					■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
BC2	RK 811.8	RK 1018.0					■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
BC3	RK 1018.0	RK 1078.1					■	■	■	■	■	■							■	■	■	■	■	■	■	
BC4	RK 1078.1	RK 1148.0					■	■	■	■	■	■							■	■	■	■	■	■	■	
BC5	RK 1148.0	RK 1179.8					■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	

TABLE 2.2-2 Cont'd

Pipeline Spread[1]	From	To	2016												2017											
			J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Special Works																										
Lower Fraser River Crossing (RK 1168)							■	■	■	■	■															
Ledgeview Golf Course Crossing (RK 1119)															■	■										
Burnaby Terminal to Westridge Marine Terminal (RK 0 to RK 3.6)							■	■	■	■	■	■	■	■	■	■	■	■	■	■	■					

Note: 1 Access and clearing activities may start as early as January 2016 at any given location.

TABLE 2.2-3

PROPOSED PIPELINE REACTIVATION SCHEDULE

Reactivation Activities	2016												2017											
	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Preparation for In-Line Inspection Tool Runs					■	■	■	■																
In-Line Inspection Tool Runs									■															
Excavation and Repair																■	■	■	■	■				
Hydrostatic Testing																					■			

TABLE 2.2-4

PROPOSED FACILITIES CONSTRUCTION SCHEDULE

Facility[1]	2015			2016												2017											
	Q4			Q1			Q2			Q3			Q4			Q1			Q2			Q3			Q4		
Edmonton Terminal								■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
Edmonton Pump Station						■	■	■	■	■	■	■	■	■	■												
Gainford Pump Station								■	■	■	■	■	■	■	■	■											
Wolf Pump Station									■	■	■	■	■	■	■	■	■										
Edson Pump Station										■	■	■	■	■	■	■	■	■									
Hinton Pump Station											■	■	■	■	■	■	■	■	■								
Rearguard Pump Station												■	■	■	■	■	■	■	■	■							
Blue River Pump Station							■	■	■	■	■	■	■	■	■												
Blackpool Pump Station[2]								■	■	■	■	■	■	■	■	■											
Black Pines Pump Station[2]									■	■	■	■	■	■	■	■	■	■									
Kamloops Pump Station										■	■	■	■	■	■	■	■	■	■								
Kingsvale Pump Station												■	■	■	■	■	■	■	■	■							
Sumas Pump Station														■	■	■	■	■	■		■						
Sumas Terminal										■	■	■	■	■	■	■	■	■	■	■	■	■	■				
Burnaby Terminal				■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	
Westridge Marine Terminal		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■

Notes: 1 Access and clearing activities may start as early as January 2016 at any given location.

2 Activities at Darfield Pump Station (valve modifications and installation of a new scraper trap) will be conducted in conjunction with construction activities at either Blackpool or Black Pines pump stations.

It is estimated that the Project will require a construction workforce to provide over 1,324,000 worker-days in the 2016 to 2017 construction period, or over 60,000 full-time equivalent worker months.

Pipeline spreads will require approximately 400 to 600 workers per spread depending on, among other variables, length and timing of each spread, region and construction techniques utilized. Construction at terminals will require in the range of approximately 60 to 370 workers, depending on the number of new tanks to be installed and other activities. Construction activities at pump stations will require in the range of 55 to 80 workers, depending on the number of new pumps required and other activities. Construction at the Westridge Marine Terminal will require approximately 95 workers over much of the construction period.

Peak construction workforce for the entire Project (*i.e.*, peak activities combined between all Project components) is anticipated to be 4,475 workers during July 2017 (Figure 2.2-1).

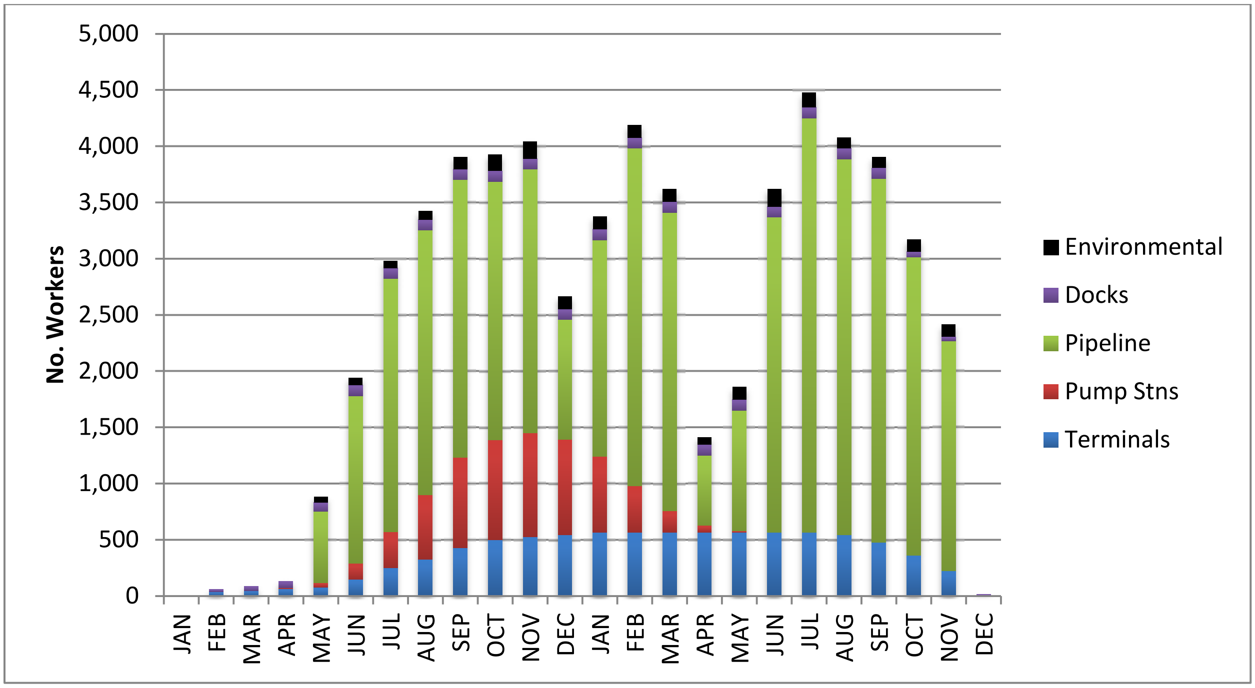


Figure 2.2-1 Estimated Direct Construction Workforce, 2016-2017 (Full-time Equivalent Worker-Months)

Required workforce skills will be varied and will include surveyors, heavy equipment operators, welders, electricians, mechanics, skilled labourers, truck drivers, supervisors, inspectors and monitors. The number of personnel working at any location along the pipeline or facility site will depend on the respective construction phase (*e.g.*, clearing, soil handling, grading, pump and tank installation, dock construction, testing and clean-up).

Large mainline crews construct most of the pipeline within each spread, while smaller specialty crews, working in parallel with mainline crews, complete construction in non-standard sections of the pipeline such as at road, rail, utility and watercourse crossings. Specialty contractors will likely be used for construction in urban or industrial development areas to ensure safe pipeline and facilities installation given the existing utilities and infrastructure situated in the Project area.

2.3 Project Operation

Operations and maintenance activities along the existing TMPL system will be expanded to include the new pipeline and facilities over the operating life of the Project (anticipated to extend beyond 50 years). The following subsections provide an overview of operation and maintenance activities for the Project as well as the anticipated operations schedule and estimated workforce. Additional details regarding Trans

Mountain's operation and maintenance activities, policies, programs and procedures are provided in Volume 4C.

2.3.1 Pipeline

Scheduling of operations and maintenance activities will coincide with periodic aerial and ground patrols of the existing TMPL system and associated facilities. All pipeline patrols are conducted by personnel familiar with the location and operation of the pipeline. Flow in the pipeline will be remotely monitored and controlled from Trans Mountain's existing control centre at the Edmonton Terminal. The pipeline will be maintained from existing bases at Edmonton, Edson, Jasper, Blue River, Clearwater, Kamloops, Hope, Abbotsford and Burnaby. No new pipeline maintenance bases will be required.

Pipeline and right-of-way operations and maintenance activities that could result in potential environmental effects include works associated with regular line patrols, vegetation management and integrity digs.

2.3.2 Pump Stations and Tanks

Routine facility inspections will be performed daily at storage tanks and twice per week at pump stations. The facilities will require periodic mowing of vegetation as well as occasional application of gravel on access roads and the sites. Non-residual herbicides will be used only where mowing and other mechanical methods of vegetation management are impractical, upon approval of the appropriate authority.

All Trans Mountain pump stations and storage tanks have automated leak detection and containment systems that are continuously monitored from the existing control centre at the Edmonton Terminal. Operating staff located at pump stations and terminals are trained in leak detection and emergency response as well as early identification of any potential site hazards such as potential erosion and ground instability. Storage tanks are also taken out of service periodically according to American Petroleum Institute requirements, and are cleaned, inspected and, if required, repaired before being returned back to service.

2.3.3 Westridge Marine Terminal

At the Westridge Marine Terminal, all vessel screening and loading operations have been, and will continue to be, directed by experienced loading masters, who have tanker command experience and are on-site during all vessel loadings. Additional operational details including activities performed by the loading master and preventative and site maintenance activities are provided in Volume 4C.

2.3.4 Operations Schedule and Workforce

Based upon construction beginning in Q1 2016, the operations phase of the Project is expected to begin in Q4 2017.

In addition to the existing Trans Mountain staff, once fully operational, the Project is expected to require 90 full-time personnel, of which 50 are anticipated to be located in BC and 40 are anticipated to be located in Alberta.

2.4 Decommissioning and Abandonment

It is difficult at this time to predict when or how the pipeline and facilities will be decommissioned and abandoned at the end of the Project's useful life. The existing TMPL system has been operating successfully for 60 years and will be safe and reliable for many more as a result of continuing proactive maintenance and integrity programs. The operational life of the new pipeline is anticipated to be as long or longer.

Trans Mountain is participating in and will comply with the process established by Stream 3 of the NEB Land Matters Consultation Initiative and Reasons for Decision RH-2-2008. In addition, as part of this application, Trans Mountain filed with the NEB a preliminary abandonment plan (see Volume 4C) providing a discussion of the abandonment planning strategy for the pipelines and facilities to be constructed for TMEP. The plan discusses general activities for the types of facilities that would be abandoned in place, abandoned in place with special treatment or removed. The plan also discusses general reclamation objectives and principles that would be applied during abandonment to return the right-of-way and facility sites to a state comparable with the surrounding environment. The methods of abandonment and reclamation that will ultimately be implemented for the Project will be determined at the time the pipeline is removed from operation, however, those determinations will be based on the most current sound scientific studies and accepted industry practice at that time. Any decommissioning or abandonment activities will require prior approval by the NEB and other applicable regulatory authorities. Decommissioning and abandonment is discussed further in Section 7.0, and also in Volume 4C, Section 12.0 Preliminary Abandonment Plan.

3.0 PUBLIC CONSULTATION, ABORIGINAL ENGAGEMENT AND LANDOWNER RELATIONS

Trans Mountain Pipeline ULC (Trans Mountain) has implemented and continues to conduct open, extensive and thorough public consultation, Aboriginal engagement and landowner relations programs. These programs were designed to reflect the unique nature of the Trans Mountain Expansion Project (TMEP or the Project) as well as the diverse and varied communities along the proposed pipeline and marine corridors. These programs were based on Aboriginal community, stakeholder and landowner groups' interests and inputs, knowledge levels, time and preferred method of engagement. In order to build relationships for the long-term, these programs were based on the principles of accountability, communication, local focus, mutual benefit, relationship building, respect, responsiveness, shared process, sustainability, timeliness and transparency.

This section provides a summary of the design of the public consultation (Section 3.1), Aboriginal engagement (Section 3.2) and landowner relations (Section 3.3) programs, as well as outcomes specific to biophysical elements considered in the Environmental and Socio-economic Assessment (ESA). The full description of the public consultation, Aboriginal engagement and landowner relations programs is located in Volume 3. The outcomes of the consultation and engagement activities for the pipeline and facilities component of the Project specific to socio-economic elements and for the marine transportation component of the Project that was assessed pursuant to the NEB's instruction in their List of Issues, issued July 29, 2013, are located in other sections and volumes of the application. Table 3.0-1 provides information on where these other consultation and engagement considerations are located.

TABLE 3.0-1

CONSULTATION INFORMATION LOCATION

Consultation Information	Application Location
Pipeline and Facilities	
Public Consultation	Volume 3A Volume 5B Section 3.1
Aboriginal Engagement	Volume 3B Volume 5B Section 3.2
Landowner Relations	Volume 3C Volume 5B Section 3.3
Marine Transportation	
Public Consultation	Volume 8A Section 3.1
Aboriginal Engagement	Volume 8A Section 3.2

3.1 Public Consultation

The principles of the stakeholder engagement program are based on public input as well as various stakeholder groups' interests, knowledge levels, time and preferred method of engagement. This subsection provides information on the stakeholder engagement program for the pipeline corridor and describes how stakeholder and public comments relating to the ESA were gathered as well as how these comments have been incorporated into the application.

3.1.1 Design of Public Consultation Program

As part of the stakeholder engagement program, Trans Mountain has taken on an open, extensive and thorough public consultation process, commonly known as stakeholder engagement. Engagement touched on all aspects of the Project along the proposed pipeline corridor between Strathcona County, Alberta (near Edmonton, Alberta) and Burnaby, BC and marine communities from Nanaimo to Sooke, Vancouver Island and Salt Spring Island, BC. Trans Mountain has reached out to the general public, community and business organizations, community leaders, elected officials and environmental groups to receive their input. Open houses and public presentations provided opportunities for public input and queries.

The Project team received feedback from public open houses (also referred to as information sessions), workshops, one-on-one meetings, public presentations, online discussion, comment forms, email and phone calls that have helped shape aspects of the Project. Key topics and issues are relayed to the appropriate Project team representative to be considered and incorporated in the application where applicable. For more Information on feedback from all engagement refer to Volume 3. Overall, engagement activities have provided feedback on the following:

- determining the scope of the ESA;
- identifying potential mitigation measures to reduce environmental and socio-economic effects;
- identifying potential benefits associated with the Project; and
- routing alternatives where it is not practical to follow the existing Trans Mountain Pipeline (TMPL) right-of-way.

The stakeholder engagement program is designed to foster participation from members of the public who have an interest in the scope, activities and routing of the Project. The program will seek meaningful input from stakeholders regarding proposed pipeline corridor, environmental effects, and socio-economic effects and benefits. The program will also share timely information with stakeholders to keep them informed throughout the process. Through preliminary evaluation of the pipeline corridor and surrounding communities, stakeholders that have a potential interest in the Project have been identified in the Table 3.1-1.

TABLE 3.1-1

IDENTIFIED STAKEHOLDER GROUPS FOR PIPELINE CORRIDOR

Stakeholder Type	Stakeholder Type Sub-Categories
Government Authorities	• Government of Canada (federal authorities) • Government of Alberta • Government of BC • municipal governments • regional governments • Transit Authority • universities and colleges
Environmental Non-Government Organizations (ENGOs)	• local ENGOs • provincial ENGOs • national ENGOs
Interest Groups	• chambers of commerce • economic development associations • recreation groups • labour groups • local and regional associations and organizations • business/industry associations • agricultural/environmental associations • local interest groups
Industry	• oil and gas industry • pipeline industry • potential suppliers and contractors • other infrastructure (*e.g.*, CN Rail) construction industries • terminal operators in Burrard Inlet (including other product terminals)
Public	• public living or working in pipeline corridor communities • public living outside of pipeline corridor communities

3.1.1.1 Public

The stakeholder engagement program includes public involvement in order to build awareness and understanding of the Project, manage information flow, identify concerns and issues as well as gather public input into Project plans and design. Trans Mountain's target audience included all interested and potentially affected parties along the proposed pipeline corridor.

3.1.1.2 Focus Participants

The stakeholder engagement program involved focused discussions with small groups of directly affected interested stakeholders. Stakeholders had the opportunity to provide feedback on the proposed pipeline corridor as well as important issues related to the ESA. These participants included representatives from local governments, community organizations, economic development organizations, recreational groups, and ENGOs. Through building relationships with the focus participants, Trans Mountain gathered informed input, identified issues or concerns and, where appropriate, developed early mitigation measures.

3.1.2 Geographic Reach of Public Consultation Program

Trans Mountain recognizes that the extensive scope and scale of the Project will result in interest by members of the broader public as well as stakeholders directly affected by the Project. In order to ensure that communications and engagement opportunities are appropriately tailored to the needs and interests of local communities, engagement activities were divided into pipeline corridor communities (those potentially affected directly by the proposed pipeline and related facilities) and Project-related marine corridor communities that were assessed pursuant to the NEB's instruction in their List of Issues, issued July 29, 2013. In addition, pipeline and marine corridor communities were further divided into the following five regions:

- Alberta;
- BC Interior;
- Lower Mainland/Fraser Valley;
- Mainland Coastal; and
- Island Coastal communities.

As Trans Mountain proceeded through the pre-application phase of the Project, the stakeholder engagement program allowed for the identification of new information and additional stakeholders. The grouping of these communities was completed following preliminary conversations with stakeholders and municipal governments to identify local interests and needs. Table 3.1-2 provides the regional break-down as well as the core communities associated with the proposed pipeline corridor and marine areas.

TABLE 3.1-2

STAKEHOLDER ENGAGEMENT – PIPELINE AND MARINE CORRIDOR COMMUNITIES

Pipeline Corridor			Marine Corridor	
Alberta	BC Interior	Lower Mainland/ Fraser Valley	Mainland Coastal	Island Coastal
• Strathcona County • Hamlet of Sherwood Park • City of Edmonton, • Parkland County • City of Spruce Grove • Town of Stony Plain • Village of Wabamun • Yellowhead County • Town of Edson • Town of Hinton • Municipality (Town) of Jasper	• Village of Valemount • Community of Blue River • Community of Avola • Community of Vavenby • District of Clearwater • Community of Little Fort • District of Barriere • City of Kamloops • City of Merritt • District of Hope* • Regional District of Fraser-Fort George (RDFFG) • Thompson-Nicola Regional District (TNRD)	• District of Hope[1] • Fraser Valley Regional District (FVRD) • City of Chilliwack • City of Abbotsford • Township of Langley • City of Coquitlam • City of Port Coquitlam • City of Burnaby** • City of Surrey • City of Vancouver • Metro Vancouver Regional District[2]	• City of Burnaby[2] • Village of Anmore • Village of Belcarra • City of North Vancouver • City of Port Moody • City of Richmond • City of Vancouver • City of White Rock • Corporation of Delta • District of North Vancouver • District of West Vancouver • Bowen Island Municipality • University Endowment Lands/Metro Vancouver Electoral Area "A" • Metro Vancouver Regional District[2] • Squamish Lillooet Regional District • Village of Lions Bay • District of Squamish	• Corporation of the City of Duncan • City of Nanaimo • Nanaimo Regional District • Alberni – Clayoquot Regional District • Corporation of the City of Victoria • Cowichan Valley Regional District • Corporation of the District of Central Saanich • District of Metchosin • District of North, Saanich • Corporation of the District of Oak Bay • Corporation of the District of District of Saanich • District of Sooke • Islands Trust Areas • Capital Regional District • Sunshine Coast Regional District • Town of Sidney • Corporation of the Township of Esquimalt

Notes: 1 The District of Hope, while a member of FVRD, is allocated for the purposes of stakeholder engagement activities under the BC Interior Region and the FVRD is allocated under the Lower Mainland/Fraser Valley Region.

2 Due to the location of the City of Burnaby and the Metro Vancouver Regional District, these two communities have been engaged under the Lower Mainland/Fraser Valley Region as well as the Mainland Coastal Region.

3.1.3 Phased Activities

The stakeholder engagement program adopted a phased approach to public and stakeholder engagement. Each phase was developed in response to information gathered from the previous phase as well as identified interests and needs. The current stakeholder engagement program consists of six phases which include:

- Phase 1 Engagement: Stakeholder and Issue Identification, May to September 2012;
- Phase 2 Engagement: Public Information and Input Gathering, October 2012 to January 2013;
- Phase 3 Engagement: Community Conversations, February to July 2013;
- Phase 4 Engagement: Feedback to Stakeholders and Application Filing, August to December 2013;
- Phase 5 Engagement: Regulatory Process to In-Service, January 2014 to in-service; and
- Phase 6 Engagement: Operational Consultation.

3.1.4 Stakeholder Engagement Program Execution

The stakeholder engagement program was designed to foster positive relationships with the public and stakeholders as well as provide opportunities for stakeholders to be involved in the engagement process.

Section 3.1.4.1 provides information on the activities that have taken place during the three phases of engagement activities conducted from the time of the Project announcement in May 2012 to the end of Phase 3 on July 31, 2013.

3.1.4.1 Enhance Communications Initiatives

The communications initiatives support the consultation activities by providing notification about the various engagement opportunities including public open houses, Community Workshops and online discussion activities.

From producing printed newsletters to talking about Project details on social media channels to answering public and media inquiries to participating in speaking opportunities, the stakeholder engagement and communications team uses a variety of methods to reach various audiences. The communications initiatives include:

- a comprehensive website with information about various components of the Project and the industry;
- proactively distributing Project updates via email to people who have signed up through the Project website, at open houses, or through other means;
- Twitter and YouTube posts to reach people who use social media channels;
- providing various forums for people to ask questions: toll-free phone line; email; a website question and answer forum; and direct letters;
- a full media relations service including a dedicated media toll-free phone line; and
- a modest advertising campaign aimed at notifying people about ways they can engage with members of the Project team – in person or online.

The Trans Mountain stakeholder engagement and communications team provides those interested in the Project with a range of sources of information and platforms to encourage discussion and education. For more information on the Project stakeholder engagement and communication strategy, refer to Volume 3A.

Phase 1 Engagement: Stakeholder and Issue Identification, May to September 2012

The first phase of engagement focused on Project introduction and the flow of Project information to government, municipalities and key stakeholders. This phase included identifying stakeholders with interest in participating in the engagement program, local community interests and concerns, and appropriate consultation methods. Trans Mountain provided information through mail and email, website posts as well hand delivering information to stakeholders at Project introduction meetings.

Phase 2 Engagement: Public Information and Input Gathering, October 2012 to January 2013

Phase 2 of the Trans Mountain Engagement Program continued the outreach and discussions with municipalities and other stakeholders. In addition, Trans Mountain conducted a series of public information sessions along the proposed pipeline corridor. Content and format varied by the needs and interests of the communities. Trans Mountain provided Project overview information as well as the scope of the pipeline corridor biophysical assessment. Trans Mountain focused on engaging the public through open house style information sessions and seeking input through conversation, feedback forms, online discussion, and a Project-specific twitter channel. Trans Mountain continued meeting with stakeholders and government representatives.

Trans Mountain attended the 2012 Union of British Columbia Municipalities (UBCM) convention in Victoria, BC, and later hosted a full day open house for UBCM delegates. In addition, Trans Mountain sent letters to local governments along the marine corridor offering individual meetings with representatives in Victoria, for which seven meetings with councils were arranged.

Environmental Non-Government Organizations

Research and early conversations guided the scope of engagement with stakeholders on environmental issues in different ways, based on the level of control and responsibility Trans Mountain has over each issue. Some common marine environmental concerns identified by stakeholders in this phase include effects of marine oil spills on the biodiversity, the fishery industry, human health as well as costs related to clean-up of potential marine spills, among others.

Public Open Houses

Public open houses were structured as drop-in events where members of the public were invited to attend, gain information and ask questions about the Project. Project information was displayed on story boards positioned throughout the venue. Technical experts including representatives from environment, routing, geotechnical, regulatory, operations, stakeholder engagement and media relations were on hand to answer questions and receive comments and concerns from attendees. In addition, material was available as handouts and posted on the Project's website.

Phase 3 Engagement: Community Conversations, February to July 2013

Phase 3 of the Trans Mountain Engagement Program focused on seeking meaningful input from stakeholders on the proposed approach to the ESA. Engagement meetings in this phase of the program included ESA Workshops, Community Workshops as well as focused public information sessions in some communities on proposed Project routing. Community meetings focused on sharing updated Project information, seeking meaningful input from affected stakeholders on proposed route alternatives in areas where it is likely that the proposed pipeline corridor will deviate from the existing TMPL right-of-way and seeking input from local stakeholders on potential Project effects and mitigation measures.

Environmental Non-Government Organizations

Engagement efforts in Phase 3 focused on local environmental groups based in communities along the pipeline and shipping corridor. Feedback from these local groups was particularly important during routing and ESA Workshops where local environmental knowledge helped to identify issues of concern in study areas as well as possible mitigation measures and possible compensation or net benefit initiatives to consider as part of the overall Project proposal.

ESA Workshops

In Phase 3, Trans Mountain hosted ESA Workshops to provide information on the proposed approach used for the Project ESA and to seek input from stakeholders regarding study approach, methodology and regions. The proposed Project traverses distinct geographic regions that include diverse ecosystems ranging from grasslands to rainforest. Regional experts were asked to attend ESA Workshops in representative communities in order to capture specialist knowledge for each region. The ESA Workshops targeted local and regional subject matter experts from municipal, federal and provincial governments, local ENGOs and other environmental interest groups. Trans Mountain hosted the ESA Workshops for Alberta in Edmonton, Alberta; and for BC in Kamloops, Surrey and Abbotsford.

The Project team provided attendees with a proposed overview of the ESA approach for the Project and sought the feedback of attendees on particular modules of the ESA including air, land and water. The ESA Workshop in Abbotsford, BC focused on soil and agriculture as these subjects were of greatest concern to the community. Input was solicited online for 2 weeks after each workshop; information presented at the workshops was made available online following each session. Feedback received at these sessions was shared with the relevant environmental disciplines and was considered in setting the scope and methodologies for the Project's biophysical assessment.

Community Workshops

In Phase 3, Trans Mountain hosted a series of Community Workshops along the proposed pipeline corridor to provide an opportunity for local stakeholders to receive updated information and provide feedback on issues and concerns relative to their community. Community Workshops were attended by stakeholders that held expertise on community interests, the environment, economic activity, recreation and land use. Participation included municipal representatives, local community representatives, business groups, recreational representatives and guides and outfitters. Community Workshops comprised of ESA poster presentations and oral presentations on land, air, water, and human activity as well as an exit survey. All information presented at the workshops was made available online the day following each session and was live for 3 weeks. Trans Mountain hosted Community Workshops for Alberta in Edmonton, Parkland County (Wabamun), Edson and Hinton. Trans Mountain hosted Community Workshops for BC in Valemount, Blue River, Clearwater, Kamloops, Merritt, Hope, Chilliwack, Abbotsford, Langley, Surrey, Coquitlam and Burnaby.

Phase 4 Engagement: Feedback to Stakeholders and Application Filing, August to December 2013

The goals of the Phase 4 stakeholder engagement program include sharing the results of the marine studies, environmental field studies with stakeholders, commencing communications on the application and next steps for engagement and communications following the filing of the application. Further details regarding refined Project plans prior to filing the application with the NEB will be shared with the public.

Engagement activities will include community and economic benefit presentations in conjunction with the Chambers of Commerce, attending events, one-on-one meetings, emergency response workshops and presentations/speaking opportunities. Meetings with local government and interested parties will be ongoing. Trans Mountain will continue digital engagement efforts and seek out more public opportunities to share information and gather feedback.

Planned Consultation on Reactivation

Trans Mountain is planning to reactivate two 610 mm (24 inch) segments of existing pipeline (from Hinton, Alberta to Hargreaves, BC and from Darfield, BC to Black Pines, BC) as part of the TMEP. Stakeholders include Parks Canada, the Town of Jasper, the Town of Hinton, Yellowhead County, BC Parks, local stewardship groups and the public. Project planning is currently underway and further stakeholder input will be sought as technical requirements for deactivation are further defined.

Phase 5 Engagement: Regulatory Process to In-Service, January 2014 to In-Service

Additional engagement phases will be developed to support the regulatory process and, if successful, the construction phases of the Project. The goals of these engagement phases will include sharing results of any new studies or work being completed on the Project, to communicate any changes to Project plans, to share information with stakeholders on the regulatory process and to engage on construction effects and mitigation measures. Additional objectives include communicating about the benefits of the Project to local stakeholders and engaging on environment offsets.

Engagement continues with environmental groups related to the Project in regard to refining environmental inputs for consideration in the ESA process, feedback on the approach to ecological compensation (conservation offsets), and the development and communication of geographic spill response plans. Engagement also continues with coastal stakeholders and Aboriginal communities related to environmental aspects of the Project. Trans Mountain is also encouraging new relationships between these groups and certified spill responders so that more information can be shared about areas of high ecological value on BC's southwest coast.

Phase 6 Engagement: Ongoing Operational Consultation, Post-Construction throughout Operational Life

Trans Mountain is committed to respectful, transparent and collaborative interactions with communities to develop long term effective relationships. Once the pipeline becomes operational, engagement opportunities will continue through the hosting open houses, providing newsletters and Project updates, making safety and public awareness presentations, participating in community events, regulatory processes and through ongoing informal meetings with stakeholders.

Initiatives to be activated during this phase will be developed in the lead up to construction. Trans Mountain is, however, committed to ongoing consultation in the communities in which it operates.

3.1.5 Summary of Outcomes of the Public Consultation Program as it Relates to Biophysical Elements

Trans Mountain designed the stakeholder engagement program to involve people who may be affected or have interest in the Project. Through the first three phases of engagement, Trans Mountain has had the opportunity to provide Project information through various methods and receive general comments as well as specific information for route and Project planning. Trans Mountain has engaged stakeholders in dialogue to discover the social and environmental issues or concerns that matter most to them. Trans Mountain has tracked these conversations and relayed the key topics to the Project representative to be considered and incorporated in the application where applicable. Tables 3.1-3 to 3.1-13 provide information on the key topics relating to the biophysical component of the ESA and where these topics are addressed in the application.

3.1.5.1 Physical and Meteorological Environment

TABLE 3.1-3

INTERESTS OR CONCERNS RELATED TO PHYSICAL AND METEOROLOGICAL ENVIRONMENT

Summary of Interest or Concern	Response Summary	Where Issue is Addressed in the Application
Geotechnical Concerns	Potential environmental effects, geotechnical conditions, and constructability concerns have been identified along the proposed pipeline corridor to ensure the Project can be built and operated safely. The focus of routing is to find the best route for the proposed pipeline so it can be built next to the existing TMPL pipeline where possible, and to minimize effects to properties. It is important to note that the assessment corridor is for the purposes of environmental and engineering studies and does not reflect the ultimate width or footprint of the proposed construction or new line. A discussion of geotechnical issues is provided under physical and meteorological environment in Sections 5.1 and 7.2.1.	Volume 5A Sections 4.0, 5.1 and 7.2.1
Geology at Hope-Bridal Falls	Detailed routing and engineering design has not yet begun. In due course, each segment of the proposed pipeline corridor will be carefully assessed by appropriate professionals for potential instability and hazards which may affect the construction and operation of the pipeline. Where necessary, steps will be taken to mitigate the effects of potential hazards. Where possible, steps to mitigate disturbances will be applied depending on circumstances of individual owners.	Volume 5A Sections 4.0, 5.1 and 7.2.1

3.1.5.2 Soil and Soil Productivity

TABLE 3.1-4

INTERESTS OR CONCERNS RELATED TO SOIL AND SOIL PRODUCTIVITY

Summary of Interest or Concern	Response Summary	Where Issue is Addressed in the Application
Soil conservation and erosion in the transportation utility corridor (TUC), especially community gardens and local recreational trails	Where present in non-forested areas, topsoil or root zone material will be salvaged to ensure that soil productivity is maintained. The width and depth of topsoil or root zone material salvage will depend on the land use, soil conditions, microtopography, regulatory authority requests and grading requirements. Any salvaged topsoil or root zone material will be separated from spoil piles and stored along the construction right-of-way and at facility sites in low-profile berms or windrows. A discussion of soils is provided under soil and soil productivity in Sections 5.2, 7.2.2 and 7.2.4. Mitigation measures are outlined in the Pipeline and Facilities Environmental Protection Plans (EPPs) (Volume 6B and 6C).	Volume 5A Sections 5.2, 7.2.2 and 7.4.2 Volume 5C Soils Technical Report Volume 6B Volume 6C

TABLE 3.1-4 Cont'd

Summary of Interest or Concern	Response Summary	Where Issue is Addressed in the Application
Potential erosion along and near the right-of-way, and potential increases in erosion due to clearing.	If wind or water erosion is evident during the construction phase of the Project, contractor equipment and personnel will be made available to control the erosion. During the construction phase, the Environmental Inspector, in consultation with Trans Mountain's environmental staff, will determine appropriate procedures to be implemented to control soil erosion and other soil handling problems that may be encountered. Similar procedures will be followed during the operational phase. A discussion of soils and the potential for erosion is provided under soil and soil productivity in Sections 5.2, 7.2.2 and 7.2.4. Mitigation measures for soil erosion are outlined in the Pipeline and Facilities EPPs (Volumes 6B and 6C).	Volume 5A Sections 5.2, 7.2.2 and 7.4.2 Volume 5C Soils Technical Report Volume 6B Volume 6C
Restoration of agricultural lands	Soils studies are completed to determine the type and condition of soils along the proposed pipeline corridor. The studies for the Project will mostly involve a ground based agricultural soil survey program. The surveys are designed to meet NEB requirements and to assist in Project design, construction and restoration. A discussion of soils is provided under soil and soil productivity in Sections 5.2, 7.2.2 and 7.2.4 of Volume 5A while agricultural land use is discussed under human occupancy and resource use (HORU) in Sections 5.4 and 7.2.4 of Volume 5B. Mitigation measures are outlined in the Pipeline and Facilities EPPs (Volumes 6B and 6C).	Volume 5A Sections 5.2, 6.0, 7.2.2 and 7.4.2 Volume 5B Sections 5.4 and 7.2.4 Volume 5C Soils Technical Report Volume 5D Agricultural Assessment Technical Report Volume 6B Volume 6C
Disturbance to soils and crops	Where present in non-forested areas, topsoil or root zone material will be salvaged to ensure that soil productivity is maintained. The width and depth of topsoil or root zone material salvage will depend on the land use, soil conditions, microtopography, regulatory authority requests and grading requirements. Any salvaged topsoil or root zone material will be separated from spoil piles and stored along the construction right-of-way and at facility sites in low-profile berms or windrows. Equipment used during topsoil or root zone material handling activities will include bulldozers, graders and backhoes. A discussion of soils is provided under soil and soil productivity in Sections 5.2, 7.2.2 and 7.2.4 of Volume 5A while agricultural land use is discussed under human occupancy and resource use in Sections 5.4 and 7.2.4 of Volume 5B. Mitigation measures are outlined in the Pipeline and Facilities EPPs (Volumes 6B and 6C).	Volume 5A Sections 5.2, 6.0, 7.2.2 and 7.4.2 Volume 5B Sections 5.4 and 7.2.4 Volume 5C Soils Technical Report Volume 5D Agricultural Assessment Technical Report Volume 6B Volume 6C

TABLE 3.1-4 Cont'd

Summary of Interest or Concern	Response Summary	Where Issue is Addressed in the Application
Invasion or spread of clubroot disease	Generally, the best available mitigation is to clean equipment involved in topsoil handling so that topsoil is not carried from landowner to landowner and/or from county to county. As presented in the Alberta Clubroot Management Plan (Alberta Agriculture and Rural Development 2010), and the Canadian Association of Petroleum Producers (CAPP) Best Management Practices: Clubroot Disease Management (2008), clubroot disease prevention involves a phased approach, with progressively more aggressive cleaning activities. In order, cleaning activities include: • removing most or all soil from equipment (*i.e.*, basic shovel cleaning and/or shovel and compressed air cleaning); • washing equipment with a power washer (preferably with hot water or steam); and • misting equipment with a weak disinfectant (one to two per cent bleach solution). Basic shovel and sweep cleaning stations are recommended between cultivated fields (*i.e.*, at changes in land use, landowner and/or road crossings) along the right-of-way as a relatively inexpensive way to reduce the potential spread of clubroot disease and weeds. Power wash and misting, are used together to prevent the spread of clubroot disease where risk is high or clubroot exists within the quarter section. Any site that warrants a power wash is considered worthwhile of cleaning with a bleach solution as well. There is less risk of spreading the disease when working on subsoil. Full right-of-way stripping has been used as a method of prevention. There is an expectation from some regulatory authorities that when landowners request special mitigation on their land that they be conducting the same practices on their land with their own equipment or the equipment they hire. Further mitigation is provided in the Pipeline EPP (Volume 6B) and is discussed under soil and soil productivity in Sections 5.2 and 7.2.2.	Volume 5A Sections 5.2 and 7.2.2 Volume 6B

Sources: Alberta Agriculture and Rural Development (2010), CAPP (2008)

3.1.5.3 Water Quality and Quantity

TABLE 3.1-5

INTERESTS OR CONCERNS RELATED TO WATER QUANTITY AND QUALITY

Summary of Interest or Concern	Response Summary	Where Issue is Addressed in the Application
Environmental effects of freshwater spills	Trans Mountain has comprehensive spill response plans in place for the TMPL and associated facilities. These plans are constantly being updated to keep them current and are regularly practiced through deployment exercises. While the specific strategies used in response to a spill will vary depending on the circumstances, the primary objectives in all cases is to ensure safety and to minimize environmental damage. There are a range of strategies available to achieve these objectives including mechanical recovery (using skimmers), *in situ* burning (controlled burning of the oil), and dispersion (use of dispersing agents to dilute and disperse the oil reducing its concentration). To ensure there are sufficient funds to remediate a spill, Trans Mountain is covered by insurance necessary to respond to all spills or releases from Trans Mountain pipelines and facilities. KMC monitors the insurance program continuously, and makes annual adjustments as necessary to ensure adequate coverage. In the event of a release, and in addition to prevention measures, steps would be taken to minimize the consequence of a release by quickly shutting down and isolating the damaged section of the pipeline or facility. Trans Mountain has developed comprehensive emergency response procedures that control centre and local operators must follow. These procedures, together with aerial and ground patrols, calls from the public to Trans Mountain's toll-free emergency number, and continuous supervisory control and data acquisition (SCADA) monitoring and leak detection systems combine to form the first line of defense in reducing the consequences of a spill. The SCADA and leak detection systems continuously monitor the pipeline for changes in operating parameters that would indicate a possible leak. Trans Mountain owns, maintains and operates dedicated spill response equipment at strategic points along the TMPL system corridor. Oil spill containment and recovery (OSCAR) units are located at Trans Mountain facilities in Edmonton and Jasper, Alberta, and in Blue River, Kamloops, Hope and Burnaby, BC. Each OSCAR unit contains about 300 m of oil recovery boom and support equipment, including a river jet boat for deployment. All equipment is helicopter transportable for delivery to remote locations not accessible by road. Specialized equipment has been developed in-house by Trans Mountain employees for intercepting and recovering oil, if required, from beneath the ice on frozen rivers and lakes. This equipment is stored in the Jasper and Edmonton OSCAR units.	Volume *7*
Potential effects of increased erosion on water bodies	If wind or water erosion is evident during the construction phase of the Project, contractor equipment and personnel will be made available to control the erosion. During the construction phase, the Environmental Inspector(s), in consultation with Trans Mountain's environmental staff, will determine appropriate procedures to be implemented to control soil erosion and other soil handling problems that may be encountered. Similar procedures will be followed during the operational phase. A discussion of potential erosion to waterbodies is provided under water quality and quantity, fish and fish habitat and wetlands in Sections 5.3, 5.7, 5.8, 7.2.3, 7.2.7 and 7.2.8. Mitigation measures are outlined in the Pipeline EPP (Volume 6B).	Volume 5A Sections 5.3, 5.7, 5.8, 7.2.3, 7.2.7 and 7.2.8 Volume 5C Fisheries (Alberta) Technical Report Fisheries (British Columbia) Technical Report Wetland Evaluation Technical Report Volume 6B
Groundwater/Hydrology/ Water Quality/Quantity Effect on private wells and potable water supplies Personal wells (Mt. Lehman, Sumas Prairie, Bradner) Concerns about Fraser Valley aquifer(s)	Trans Mountain has assessed water quality and/or quantity changes to nearby groundwater which may result in adverse effects for other stakeholder or environmental receptors. Trans Mountain reviewed existing geological, hydrogeological and other information to determine potential hydrogeological conditions along the pipeline right-of-way and proposed facilities; geographic information system (GIS) mapping and assessment strategies were applied. Trans Mountain developed site-specific hydrogeological investigation activities that included field verified surveys, hydraulic response testing, monitoring requirements and water quality parameter surveys. A discussion of groundwater quality and quantity is provided under water quality and quantity in Sections 5.3 and 7.2.3. Mitigation measures are outlined in the Pipeline EPP (Volume 6B).	Volume 5A Sections 5.3 and 7.2.3 Volume 5C Groundwater Technical Report Volume 6B

TABLE 3.1-5 Cont'd

Summary of Interest or Concern	Response Summary	Where Issue is Addressed in the Application
Precautions taken to protect streams and lakes (*e.g.,* valves)	The number of Emergency Shutoff Valves (ESVs) and Mainline Block Valves (MLBVs) for the proposed line has not yet been determined. The number and locations of ESVs and MLBVs will be guided by modeling studies that factor in local conditions and potential consequences. As Trans Mountain develops a detailed design and engineering work, the final locations of the valves will be designed to protect sensitive areas and minimize effects that are identified in the routing and design process. Other mitigation measures to protect water quality and quantity during construction are discussed under water quality and quantity in Section 7.2.3 and in the Pipeline EPP (Volume 6B).	Volume 5A Sections 5.3 and 7.2.3 Volume 6B
Water table is naturally high and there are buried springs along the west side of Edmonton	In the AESRD Water Well database, there is one spring noted on the west side of Edmonton (ID#88953) near the North Saskatchewan River (about 900 m from the centre of the proposed pipeline corridor). In that area (southern portion of the west side of Edmonton), the surficial materials contain shallow sand and gravel and are of higher permeability, thereby increasing the risk for potential contamination of groundwater. With regard to mitigation of concerns around springs, Trans Mountain will develop a mitigation plan commensurate with site-specific conditions. During construction, Trans Mountain will avoid blasting in proximity to the spring and consider other engineering mitigation measures.	Volume 5A Sections 5.3 and 7.2.3 Volume 5C Groundwater Technical Report

3.1.5.4 Air Emissions and Greenhouse Gas Emissions

TABLE 3.1-6

INTERESTS OR CONCERNS RELATED TO AIR EMISSIONS AND GREENHOUSE GAS EMISSIONS

Summary of Interest or Concern	Response Summary	Where Issue is Addressed in the Application
Potential odours emitted during construction and operations of the proposed pipeline hold the potential to be a nuisance	Petroleum odours can be a nuisance for Trans Mountain neighbours, and sometimes they can also signal a problem with operations. Trans Mountain investigates all odour reports since safe operations and protection of the environment are key to the business. Trans Mountain strives to minimize the effects of operations on neighbours by incorporating odour mitigation measures in day-to-day activities and Project work. In addition, Trans Mountain continues to take steps to enhance early leak detection system(s) and air monitoring/sampling protocol(s). Trans Mountain is looking into procuring technology to facilitate automated calls to residents in the area in the event of an emergency. A discussion of odours is provided under air emissions in Sections 5.4, 6.0 and 7.5.4. Mitigation measures are outlined in the Facilities EPP (Volume 6C).	Volume 5A Sections 5.4, 6.0 and 7.5.4 Volume 5C Air Quality and Greenhouse Gas Technical Report Volume 6C
Dust in the air due to construction is perceived to have potential effects on recreation and nearby neighbourhoods	From the commencement of the surveying and staking of the right-of-way to the final clean-up, a particular parcel of land could be disrupted for approximately 3 months. This timing is affected by many variables, however, every effort is made to minimize any effects to landowners. In areas where there may be a concern regarding the safety of the public, restricted areas are established. Noise, dust and other disturbances will be mitigated to avoid the effects on people near the construction. The issue of dust is provided as part of the criteria air contaminants discussion under air emissions in Sections 5.4 and 7.2.4 of Volume 5A. In addition, dust as a sensory disturbance to residents, recreational users and its potential effects on agricultural crops is discussed under human occupancy and resource use in Sections 5.4 and 7.2.4 of Volume 5B. Mitigation measures are outlined in the Pipeline and Facilities EPPs (Volumes 6B and 6C).	Volume 5A Sections 5.4 and 7.2.4 Volume 5B Sections 5.4 and 7.2.4 Volume 5C Air Quality and Greenhouse Gas Technical Report Volume 5D Agricultural Assessment Technical Report Socio-Economic Technical Report Volume 6B Volume 6C

3.1.5.5 *Acoustic Environment*

TABLE 3.1-7

INTERESTS OR CONCERNS RELATED TO ACOUSTIC ENVIRONMENT

Summary of Interest or Concern	Response Summary	Where Issue is Addressed in the Application
Noise pollution during construction Increase in noise from new pump stations	Noise from construction of the Project has the potential to affect a variety of land users including users of parks and protected areas, Aboriginal traditional areas, residential areas and outdoor recreation areas. The potential effects on human receptors are not anticipated to extend beyond the Acoustic Environment local study area. Trans Mountain will ensure equipment is well-maintained during construction to minimize air emissions and unnecessary noise. Additionally, Trans Mountain will restrict the duration that vehicles and equipment are allowed to sit and idle to less than 1 hour unless air temperatures are less than 0°C. Trans Mountain recognizes that many regional changes have occurred since the pipeline was installed over 60 years ago including urban encroachment near some of its existing pump stations and terminals and is aware that noise during operations is of concern to nearby residents. Ambient sound surveys representative of sound levels at noise receptors and existing facilities were conducted and, all noise level results were compared to Alberta Energy Regulator's *Directive 038 Noise Control* and the BC Oil and Gas Commission's (OGC's) *Noise Control Best Practices Guideline*. Standard mitigation plus noise-specific mitigation measures will be implemented. A discussion of noise during construction operations is provided under acoustic environment in Sections 5.6, 6.0, 7.2.6, 7.4.6 and 7.5.6 of Volume 5A. In addition, noise as a sensory disturbance to residents and other land users is discussed under human occupancy and resource use in Sections 5.4 and 7.2.4 of Volume 5B. Mitigation measures are outlined in the Pipeline and Facilities EPPs (Volumes 6B and 6C).	Volume 5A Sections 5.6, 6.0, 7.2.6, 7.4.6 and 7.5.6 Volume 5B Sections 5.4 and 7.2.4 Volume 5C Terrestrial Noise and Vibration Technical Report Volume 5D Socio-Economic Technical Report Volume 6B Volume 6C
Vibrations caused during pipeline construction	From the commencement of the surveying and staking of the right-of-way to the final clean-up, a particular parcel of land could be disrupted for approximately 3 months. This timing is affected by many variables, however, every effort is made to minimize potential effects to landowners. In areas where there may be a concern regarding the safety of the public, restricted areas are established. Noise, dust and other disturbances will be mitigated to avoid the effects on people near the construction. The issue of noise vibration is provided under acoustic environment in Sections 5.6 and 7.2.6 of Volume 5A. In addition, noise as a sensory disturbance to residents and other land users is discussed under human occupancy and resource use in Sections 5.4 and 7.2.4 of Volume 5B. Mitigation measures are outlined in the Pipeline EPP (Volume 6B).	Volume 5A Sections 5.6 and 7.2.6 Volume 5B Sections 5.4 and 7.2.4 Volume 5C Terrestrial Noise and Vibration Technical Report Volume 5D Socio-Economic Technical Report Volume 6B

3.1.5.6 Fish and Fish Habitat

TABLE 3.1-8

INTERESTS OR CONCERNS RELATED TO FISH AND FISH HABITAT

<table>
<tr><th>Summary of Interest or Concern</th><th>Response Summary</th><th>Where Issue is Addressed in the Application</th></tr>
<tr><td>Crossing methods and fish habitat disruption at the North Saskatchewan River, Blackmud and Whitemud creeks</td><td rowspan="2">Crossing methods specific to each watercourse will be determined in consultation with engineering and environmental specialists, as well as applicable regulatory authorities.
Crossings of wetlands and watercourses will be planned during suitable ground and weather conditions, with the consideration for sensitive fish and wildlife timing windows. Additionally, water quality will be monitored during all instream activity. Each watercourse will be approached correctly so the cumulative effects of changes to all the crossings and the surrounding watershed will be limited.
A summary of the watercourse crossings for the Project are provided in the Fisheries (Alberta) Technical Report, the Fisheries (BC) Technical Report and in the Pipeline and Facilities EPPs (Volumes 6B and 6C). Further discussion and mitigation measures to be implemented at watercourse crossings are mentioned under fish and fish habitat in Sections 5.7, 7.2.7 and 8.6.</td><td rowspan="2">Volume 5A
Sections 5.7, 7.2.7 and 8.6
Volume 5C
Fisheries (Alberta) Technical Report
Fisheries (British Columbia) Technical Report
Volume 6B
Volume 6C</td></tr>
<tr><td>Water crossing disturbances (Peach Pond fish habitat; salmon spawning at Nathan Creek; Vedder Creek)</td></tr>
<tr><td>Need to protect fish habitat at multiple stream crossings</td><td>Trans Mountain agrees that measures to protect sensitive environmental areas such as water bodies and riparian areas are critical. Trans Mountain takes a multi-layered approach to pipeline safety, including adopting measures such as strategically placed pipeline valves near waterways and trenchless river crossings at some locations.
Further discussion is provided under fish and fish habitat in Sections 5.7 and 7.2.7. Mitigation measures for fish and fish habitat are outlined in the Pipeline and Facilities EPPs (Volumes 6B and 6C).</td><td>Volume 5A
Sections 5.7 and 7.2.7
Volume 5C
Fisheries (Alberta) Technical Report
Fisheries (British Columbia) Technical Report
Volume 6B
Volume 6C</td></tr>
</table>

3.1.5.7 Wetlands

TABLE 3.1-9

INTERESTS OR CONCERNS RELATED TO WETLAND LOSS AND ALTERATION

<table>
<tr><th>Summary of Interest or Concern</th><th>Response Summary</th><th>Where Issue is Addressed in the Application</th></tr>
<tr><td>Wetland restoration</td><td>As part of Trans Mountain's commitment to environmental protection, Trans Mountain will minimize potential adverse effects to wetlands by expediting construction in and around wetlands, by restoring wetlands to their original configurations and contours, by segregating topsoil during excavation, by permanently stabilizing upland areas near wetlands as soon as possible after backfilling, by inspecting the right-of-way periodically during and after construction, and by repairing any erosion control or restoration features until permanent revegetation is successful.
Further discussion is provided under wetlands in Sections 5.8 and 7.2.8. Mitigation measures for wetlands are outlined in the Pipeline and Facilities EPPs (Volumes 6B and 6C).</td><td>Volume 5A
Sections 5.8 and 7.2.8
Volume 5C
Wetland Evaluation Technical Report
Volume 6B
Volume 6C</td></tr>
<tr><td>Routing across nearby wetlands, aquifers, lakes, streams</td><td rowspan="2">Crossings of wetlands and watercourses will be planned during suitable ground and weather conditions with the consideration for sensitive fish and wildlife timing windows. Additionally, water quality will be monitored during all instream activity. Each watercourse will be approached correctly so the cumulative effects of changes to all the crossings and the surrounding watershed will be limited.
Further discussion is provided under fish and fish habitat in Sections 5.7, 7.2.7 and 8.6.</td><td rowspan="2">Volume 5A
Sections 5.7, 7.2.7 and 8.6
Volume 5C
Fisheries (Alberta) Technical Report
Fisheries (British Columbia) Technical Report
Volume 6B</td></tr>
<tr><td>Protection of water bodies/wetlands</td></tr>
</table>

3.1.5.8 Vegetation

TABLE 3.1-10

INTERESTS OR CONCERNS RELATED TO VEGETATION

Summary of Interest or Concern	Response Summary	Where Issue is Addressed in the Application
Concern about changes to, and restoration of native vegetation composition	During the 2012 and 2013 field seasons, a number of environmental and engineering field programs were conducted to assess existing conditions and types of land use in the Project area, as well as identify possible socio-economic effects. These programs occurred in both Alberta and BC, and involved the work of a number of teams in various disciplines. Trans Mountain will fulfill all filing requirements in the NEB *Filing Manual*. Lands in Alberta, and lands outside the Agricultural Land Reserve in BC, will be reclaimed with native and non-native seed mixes developed for the Project that are based on vegetation field survey data and will follow consultation with landowners/lessees or appropriate regulatory authorities. Revegetation of lands in the Agricultural Land Reserve in BC will be undertaken in accordance with Schedule B, Site Reclamation Requirements in the *Agricultural Land Reserve Act*. Natural revegetation will be allowed in forested areas where erosion is not anticipated. Remedial and monitoring activities typically extend for a number of years following construction to ensure areas disturbed during construction are satisfactorily restored. Further discussion is provided under vegetation in Sections 5.9 and 7.2.9 while post-construction environmental monitoring is discussed in Volume 6A. Mitigation measures for vegetation are outlined in the Pipeline EPP (Volume 6B).	Volume 5A Sections 5.9 and 7.2.9 Volume 5C Vegetation Technical Report Volume 6A Volume 6B
Potential introduction of weeds by construction crews or equipment and measures for vegetation management along existing TMPL as well as new rights-of-way	Post-construction environmental monitoring and ongoing right-of-way maintenance will continue with efforts such as weed management, seeding and planting in selected areas. Mitigation measures are discussed under vegetation in Sections 5.9 and 7.2.9 and in the Pipeline EPP (Volume 6B) while post-construction environmental monitoring is discussed in Volume 6A.	Volume 5A Sections 5.9 and 7.2.9 Volume 6A Volume 6B
Visual effects of the right-of-way if it is left too exposed	Trans Mountain will construct soil berms planted with non forage woody species and install tree/shrub plantings at potential access points and viewsheds to the pipeline corridor to provide a visual screen to the proposed pipeline corridor.	Volume 6B Volume 6C
Clear cutting and vegetation management in the neighbourhoods of Callingwood and Brander Gardens Poor vegetation management along the TUC in Edmonton	Vegetation management on the right-of-way is an integral part of a comprehensive approach to pipeline safety. It allows Trans Mountain to protect the pipeline, ensure public safety, and provide access for maintenance, inspections and emergency response. Vegetation management is a planned process which Trans Mountain conducts regularly and has done before in other areas along the proposed pipeline corridor. Further discussion of mitigation measures for vegetation can be found in the Pipeline EPP (Volume 6B) while post-construction environmental monitoring is discussed in Volume 6A.	Volume 6A Volume 6B

TABLE 3.1-10 Cont'd

Summary of Interest or Concern	Response Summary	Where Issue is Addressed in the Application
Tree removal and vegetation management along existing TMPL and new rights-of-way Right-of-way width and tree removal Revegetation along the right-of-way	Trees, stumps, brush and other vegetation will be cleared from the construction right-of-way; temporary work sites; and permanent facilities that are not located on existing TMPL previously cleared easements. Timber harvesting and/or land clearing and debris disposal activities will be coordinated according to Provincial legislation or agreements. Where present in non-forested areas, topsoil or root zone material will be salvaged to ensure that soil productivity is maintained. The width and depth of topsoil or root zone material salvage will depend on the land use, soil conditions, microtopography, regulatory authority requests and grading requirements. Any salvaged topsoil or root zone material will be separated from spoil piles and stored along the construction right-of-way and at facility sites in low-profile berms or windrows. Equipment used during topsoil or root zone material handling activities will include bulldozers, graders and backhoes. Lands in Alberta, and lands outside the Agricultural Land Reserve in BC, will be reclaimed with native and non-native seed mixes developed for the Project that are based on vegetation field survey data and will follow consultation with landowners/lessees or appropriate regulatory authorities. Revegetation of lands in the Agricultural Land Reserve in BC will be undertaken in accordance with Schedule B, Site Reclamation Requirements in the *Agricultural Land Reserve Act*. Restoration and monitoring activities typically extend for a number of years following construction to ensure areas disturbed during construction are satisfactorily restored. Further discussion of mitigation measures for vegetation can be found in the Pipeline and Facilities EPPs (Volumes 6B and 6C) while post-construction environmental monitoring is discussed in Volume 6A.	Volume 6A Volume 6B Volume 6C
Disturbance to ecosystems including grasslands surrounding the pipeline	Trans Mountain is fully committed to environmental management, protection and stewardship of the land during the construction and operations of all its facilities. A comprehensive ESA has been completed for the Project. Over 30 types of environmental surveys have been completed by local and regional biologists and resource specialists in support of the ESA. Species of special status have been identified and assessed as part of this Project. Pipeline construction is a sequential series of activities, which do not remain in one area for an extended period of time. EPPs and Environmental Alignment Sheets form part of the application submitted to the NEB, and document the construction right-of-way and provide mitigation strategies to help avoid or minimize environmental effects from construction. Further discussion on grasslands is provided in Section 7.2.9 Vegetation. The Pipeline and Facilities EPPs and Environmental Alignment Sheets can be found in Volumes 6B, 6C and 6E respectively.	Volume 5A Sections 5.9 and 7.2.9 Volume 5C Vegetation Technical Report Volume 6B Volume 6C Volume 6E
Identification and preservation of rare plant communities and species at risk as well as the prevention of the introduction/spread of invasive species	Environmental and socio-economic studies have been conducted to assess existing conditions and types of land use in the Project area, as well as possible socio-economic effects. During the 2012 and 2013 field seasons, a number of environmental and engineering field programs were conducted for the proposed Project. These programs took place in both Alberta and BC, and involve the work of a number of teams in various disciplines. The studies included a vegetation field study to record the presence of rare plant communities and species at risk, as well as the identification of weeds. Weed control measures have been introduced as part of the ESA and included in the Pipeline and Facilities EPPs. Further discussion is provided under vegetation in Sections 5.9 and 7.2.9 and in the Vegetation Technical Report. Mitigation measures are outlined in the Pipeline and Facilities EPPs (Volumes 6B and 6C).	Volume 5A Sections 5.9 and 7.2.9 Volume 5C Vegetation Technical Report Volume 6B Volume 6C

3.1.5.9 Wildlife and Wildlife Habitat

TABLE 3.1-11

INTERESTS OR CONCERNS RELATED TO WILDLIFE AND WILDLIFE HABITAT

Summary of Interest or Concern	Response Summary	Where Issue is Addressed in the Application
Effects from construction noise during nesting season Big Lake by Edmonton – important waterbody for birds	A suite of mitigation measures are proposed to reduce the potential effects of the Project on birds. For example, measures will be implemented to reduce the Project footprint to the extent feasible. Clearing and construction activities will be conducted outside the migratory bird restricted activity periods (RAP) set out by Environment Canada, to the extent practical. In the event clearing or construction activities are scheduled during the migratory bird RAP, Trans Mountain will work with Environment Canada to determine site-specific alternate mitigation. Mitigation options include pre-clearing, non-intrusive nest surveys, applying protective buffer around an active nest, or non-intrusive monitoring. Further discussion is provided under wildlife in Section 7.2.10. Mitigation measures for wildlife are outlined in the Pipeline EPP (Volume 6B).	Volume 5A Section 7.2.10 Volume 5C Wildlife Technical Report Wildlife Modelling and Species Accounts Technical Report Volume 6B
Protection of migratory bird patterns, decreasing food supply	Field surveys have been conducted and supplemental surveys will be completed in 2014 to confirm important breeding and fall staging waterbodies for migratory waterbirds. Appropriate mitigation (*e.g.*, scheduling to avoid periods when birds congregate, protective buffers) will be implemented to reduce the potential Project effects on migratory birds. The Project is unlikely to have a substantial effect on food supply for migratory birds. Nesting habitat was modelled for several bird indicators to provide an estimation of potential habitat change resulting from the Project. Models for nesting habitat are defined as the habitat used for nesting and caring for young, including foraging habitat for species that defend territories that include both nesting and foraging habitat (*e.g.*, most songbirds). Further discussion is provided under wildlife in Section 7.2.10. Mitigation measures for wildlife are outlined in the Pipeline EPP (Volume 6B).	Volume 5A Section 7.2.10 Volume 5C Wildlife Technical Report Wildlife Modelling and Species Accounts Technical Report Volume 6B
Effects on birds in forested areas	The potential effects of the Project and mitigation measures to reduce effects are discussed in Section 7.2.10 of Volume 5A. The results of habitat models completed for forest nesting birds provide an estimate of the anticipated Project effects on nesting habitat for various forest nesting birds and bird communities.	Volume 5A Section 7.2.10 Volume 5C Wildlife Modelling and Species Accounts Technical Report Volume 6A Volume 6B
Effects on birds and mammals from diminished air quality due to loss of trees during construction	Change in air quality from clearing of trees is unlikely to have a measurable effect on wildlife. Further discussion of air emissions associated with the Project is provided under air emissions in Section 7.2.4.	Volume 5A Section 7.2.4
Protection of wildlife habitat and migration	A suite of mitigation measures will be implemented to reduce the potential effects of the Project on wildlife habitat and movement patterns. Mitigation measures include alignment of the proposed route parallel to and contiguous with existing linear features, minimizing the Project footprint to the maximum extent feasible, scheduling activity to avoid periods when migratory birds congregate at important staging areas and limiting barriers to wildlife movement. Further discussion and additional mitigation is provided under wildlife in Section 7.2.10. Mitigation measures for wildlife are outlined in the Pipeline, Facilities, and Westridge Marine Terminal EPPs (Volumes 6B, 6C and 6D).	Volume 5A Section 7.2.10 Volume 5C Wildlife Technical Report Volume 6B Volume 6C Volume 6D

TABLE 3.1-11 Cont'd

Summary of Interest or Concern	Response Summary	Where Issue is Addressed in the Application
Potential for habitat fragmentation with linear construction across multiple watercourses	The three main components of habitat fragmentation are habitat loss, reduced habitat patch size and increased isolation of patches. Effects of habitat fragmentation will be reduced by alignment of the proposed route parallel to and contiguous with existing linear features, and minimizing the Project footprint to the maximum extent feasible. Specific measures are recommended for protection of riparian areas, including riparian buffers (*i.e.*, reduced footprint), minimum disturbance construction (*e.g.*, hand clearing, avoiding grading and grubbing) and reclamation. Further discussion is provided under wildlife in Section 7.2.10. Mitigation measures for wildlife are outlined in the Pipeline EPP (Volume 6B).	Volume 5A Section 7.2.10 Volume 5C Wildlife Technical Report Volume 6B
Disruption to birds and animals in Surrey Bend Park	Mitigation will be implemented to minimize disruption of wildlife and wildlife habitat in Surrey Bend Park. Alignment of the proposed route parallel to and contiguous with existing linear disturbances, and utilizing shared workspace to the extent practical, will reduce the Project footprint within the Park. Mitigation to reduce effects on habitat, limit barriers to movement, avoid attraction of wildlife to the work site, minimize sensory disturbance and protect site-specific habitat features of importance is discussed in Section 7.2.10 and the Pipeline EPP (Volume 6B). Coastal riparian small mammals were included as an indicator for the assessment of wildlife and wildlife habitat. Pacific water shrew was specifically addressed in the assessment. Mitigation to reduce potential Project effects on Pacific water shrew were developed to be consistent with provincial guidance, and include: establishing a 100 m buffer from any identified Pacific water shrew habitat during construction, to the extent feasible; replanting native vegetation (shrubs and trees) within 30 m of a stream or wetland identified as Pacific water shrew habitat to regenerate cleared vegetation; and placement of coarse woody debris over the right-of-way within 30 m of a stream or wetland identified as Pacific water shrew habitat. In the event that Pacific water shrews are identified at a stream or wetland crossed by the proposed route, a capture and release may be required to temporarily/permanently relocate individual shrews.	Volume 5A Section 7.2.10 Volume 5C Wildlife Technical Report Volume 6B

3.1.5.10 Species at Risk

TABLE 3.1-12

INTERESTS OR CONCERNS RELATED TO SPECIES AT RISK

Summary of Interest or Concern	Response Summary	Where Issue is Addressed in the Application
Potential effects to endangered species	Indicators selected to assess the effects of the Project include various species at risk. Mitigation to reduce the effects of the Project on species at risk is included in Sections 7.0 and 8.0. With application of the proposed mitigation and commitments to work with regulatory authorities to develop additional mitigation, where warranted, the residual effects of the Project and contribution of the Project to cumulative effects on species at risk are concluded to be not significant. Further discussion is provided under vegetation, wildlife and species at risk in Sections 7.2.9, 7.2.10 and 7.2.11. Mitigation measures for species at risk are outlined in the Pipeline, Facilities and Westridge Marine Terminal EPPs (Volumes 6B, 6C and 6D).	Volume 5A Sections 7.0, 7.2.9, 7.2.10, 7.2.11 and 8.0 Volume 5C Vegetation Technical Report Fisheries (Alberta) Technical Report Fisheries (British Columbia) Technical Report Wildlife Technical Report Marine Resources – Westridge Marine Terminal Technical Report Marine Birds – Westridge Marine Terminal Technical Report Volume 6B Volume 6C Volume 6D

3.1.5.11 Ecological Risk

TABLE 3.1-13

INTERESTS OR CONCERNS RELATED TO ECOLOGICAL RISK

Summary of Interest or Concern	Response Summary	Where Issue is Addressed in the Application
Protection of parks and ecologically sensitive areas	Project routing criteria include avoidance of environmentally sensitive areas, to the extent practical. Where sensitive areas cannot be practically avoided, alignment of the proposed route parallel to and contiguous with existing linear disturbances will minimize the Project footprint within sensitive areas, and mitigation will be implemented to reduce the Project's residual effects. The assessment of Project effects on parks and sensitive areas, including routing criteria and mitigation strategies to reduce the predicted effects, is included in Sections 4.0 and 7.0 of Volumes 5A and 5B. Mitigation measures are provided in the Pipeline and Facilities EPPs (Volumes 6B and 6C). Ecological risk related to large spills is discussed in Volume 7.	Volume 4A Volume 5A Sections 4.0 and 7.0 Volume 5B Sections 4.0 and 7.0 Volume 6B Volume 6C Volume 7

3.1.5.12 Consultation Activities with Federal and Provincial Authorities

Specific disciplines consulted with federal, provincial, regional and municipal authorities throughout the proposed pipeline corridor. For applicable biophysical elements, a summary table provides detailed information on the agency contacted, name and title of contact, method of contact, date of engagement, reason for engagement, key interests and concerns as well as any commitments or follow-up actions required.

TABLE 3.1-14

SUMMARY OF CONSULTATION ACTIVITIES RELATED TO GROUNDWATER QUANTITY AND QUALITY

Stakeholder Group/Agency Name	Name and Title of Contact	Method of Contact	Date of Consultation Activity	Reason For Engagement	Issues/Concerns	Commitments/ Follow-up Actions/Comments	Where Issue is Addressed in the Application
PROVINCIAL CONSULTATION – BRITISH COLUMBIA							
BC Ministry of Forest, Lands and Natural Resource Operations (BC MFLNRO)	Michele Lepitre, Regional Hydrogeologist, South Coast Region, BC MFLNRO	Email	November 11, 2012	Project Introduction Discuss review of Vedder River Fan Aquifer in Chilliwack concerns, Sumas Mountain spill in 2012.	Vedder River Fan Aquifer identified as highly vulnerable, MFLNRO aware of public concerns related to the aquifer. Sumas Mountain spill was of public concern, however, MFLNRO was not contacted in relation to any related groundwater issues.	None.	Volume 5A Sections 5.3.3 and 7.2.3 Volume 5C Groundwater Technical Report
BC Ministry of Environment (BC MOE)	Vicki Carmichael, Senior Hydrogeologist, Water Protection and Sustainability Branch Environmental Sustainability Division	Telephone	February 20, 2013	Project Introduction Request a teleconference/webex to allow the TMEP team to discuss the Project and obtain information for the groundwater review process	MOE is unable to comment on the process until the regulatory review process is initiated.	The TMEP is under the jurisdiction of the NEB.	N/A
STAKEHOLDER CONSULTATION – BRITISH COLUMBIA							
City of Chilliwack	David Blain		November 9, 2012	To introduce the Project and to identify water sources among other subjects.	Raised concerns about groundwater and the Vedder River Fan Aquifer, potential effects of an accident or malfunction on groundwater.	None.	Volume 5A Sections 5.3.3 and 7.2.3 Volume 5C Groundwater Technical Report

TABLE 3.1-14 Cont'd

Stakeholder Group/Agency Name	Name and Title of Contact	Method of Contact	Date of Consultation Activity	Reason For Engagement	Issues/Concerns	Commitments/ Follow-up Actions/Comments	Where Issue is Addressed in the Application
Community of Blue River	Hughes, P. Director of Environmental Services. Thompson-Nicola Regional District	Meeting	May 29, 2013	To introduce the Project and to identify water sources.	Two community drinking water system wells.	Confirm location of wells relative to proposed pipeline corridor.	N/A
Community of Vavenby	Hughes, P. Director of Environmental Services. Thompson-Nicola Regional District	Meeting (Clearwater)	June 5, 2013	To introduce the Project and to identify water sources.	North Thompson River – no wells.	None.	N/A
District of Clearwater	Madden, S. Services Coordinator. Thompson-Nicola Regional District	Meeting	June 5, 2013	To introduce the Project and to identify water sources.	Deep well that serves the fire department near proposed pipeline corridor.	Confirm location of well relative to proposed pipeline corridor.	N/A
City of Kamloops	Fretz, J. Sustainability and environmental Services Manager	Meeting	June 6, 2013	To introduce the Project and to identify water sources.	Campbell Creek community system and the Heffley private water utility which are both sourced from wells.	Confirm location of wells relative to proposed pipeline corridor.	N/A

TABLE 3.1-15

SUMMARY OF CONSULTATION ACTIVITIES RELATED TO AIR EMISSIONS AND GREENHOUSE GAS EMISSIONS

Stakeholder Group/Agency Name	Name and Title of Contact	Method of Contact	Date of Consultation Activity	Reason For Engagement	Issues/Concerns	Commitments/Follow-up Actions/Comments	Where Issue is Addressed in the Application
FEDERAL CONSULTATION							
Environment Canada	Roxanne Vingarzan, Head (Air Quality Science Unit)	Meeting	November 21, 2012	Project introduction. Air quality and greenhouse gas (GHG) assessment approach.	Requested addition of air quality monitoring stations for inclusion in baseline assessment. Requested model evaluation. Recommended assessment for secondary ozone, particulate matter and visibility.	Air quality monitoring stations added. Model evaluation added. Assessment for secondary ozone, particulate matter and visibility added.	Volume 5A Sections 5.4, 7.2.4, 7.3.4, and 7.4.4 Volume 5C Air Quality and Greenhouse Gas Technical Report
PROVINCIAL/MUNICIPAL CONSULTATION – BRITISH COLUMBIA							
BC Ministry of Environment and Metro Vancouver	Ali Ergudenler, Senior Engineer (Air Quality Policy and Management Division)	Meeting	November 20, 2012	Project introduction. Air quality and GHG assessment approach.	Requested assessment for odour as per Odour Management Policy currently being drafted. Requested discussion of Project effects on overall climate change. Recommended assessment for secondary particulate matter and ozone.	Assessments for odour, secondary particulate matter and ozone added. Discussion of Project effects on overall climate change added.	Volume 5A Sections 5.4, 7.2.4, 7.3.4 and 7.4.4 Volume 5C Air Quality and Greenhouse Gas Technical Report
FVRD	Alison Stewart, Senior Planner (Strategic Planning and Initiatives)	Meeting	November 20, 2012	Project introduction. Air quality and GHG assessment approach.	Requested assessment for secondary ozone and particulate matter.	Assessment for secondary particulate matter and ozone added.	Volume 5A Sections 5.4, 7.2.4, 7.3.4 and 7.4.4 Volume 5C Air Quality and Greenhouse Gas Technical Report

TABLE 3.1-15 Cont'd

Stakeholder Group/Agency Name	Name and Title of Contact	Method of Contact	Date of Consultation Activity	Reason For Engagement	Issues/Concerns	Commitments/Follow-up Actions/Comments	Where Issue is Addressed in the Application
Port Metro Vancouver (PMV)	Gary Olszewski, Environmental Specialist	Meeting	November 21, 2012	Air quality and GHG assessment approach.	Requested Project assessment approach to be aligned with PMV general approach.	The overall assessment approach was discussed and it was noted that it is aligned with PMV general approach.	Volume 5A Sections 5.4, 5.5, 7.2.4, 7.2.5, 7.5.4 and 7.5.5 Volume 5C Air Quality and Greenhouse Gas Technical Report Volume 8A Sections 4.3.3 and 4.3.4 Volume 8B Marine Air Quality and Greenhouse Gas – Marine Transportation Technical Report

Acoustic Environment

TABLE 3.1-16

SUMMARY OF CONSULTATION ACTIVITIES RELATED TO ACOUSTIC ENVIRONMENT

Stakeholder Group/Agency Name	Name and Title of Contact	Method of Contact	Date of Consultation Activity	Reason For Engagement	Issues/Concerns	Commitments/Follow-up Actions/Comments	Where Issue is Addressed in the Application
PROVINCIAL/LOCAL CONSULTATION – BRITISH COLUMBIA							
PMV	Gary Olszewski, Environmental Specialist	Meeting	October, 2013	Atmospheric Environment assessment approach.	Requested Project assessment approach to be aligned with PMV expectation that local noise requirements would be followed.	The assessment for noise and vibration uses the applicable provincial guidance and regulation.	N/A

TABLE 3.1-17

SUMMARY OF CONSULTATION ACTIVITIES RELATED TO FISH AND FISH HABITAT IN ALBERTA

Stakeholder Group/Agency Name	Name and Title of Contact	Method of Contact	Date of Consultation Activity	Reason For Engagement	Issues/Concerns	Commitments/ Follow-Up Actions/ Comments	Where Issue is Addressed in the Application
FEDERAL CONSULTATION							
Fisheries and Oceans Canada (DFO)	Jennifer Simpson, Team Leader Brenda Andres, Environmental Assessment Analyst	Meeting	September 14, 2012	Project introduction. Outline methods and approach to fish and fish habitat investigations along the Project length. Brief review of regulatory changes.	No concerns with general methodology. Data will be collected as per provincial standards.	None.	N/A
DFO	Dave Pehl, Habitat Protection Officer, Oil and Gas Unit	Meeting	September 25, 2013	Project introduction. Outline methods and approach to fish and fish habitat investigations along the Project length. Brief review of regulatory changes.	No concerns with the general methodology. Need to ensure that compensation/offset projects have high probability of success.	Engage DFO at the time of developing Fish Habitat Compensation/Offset. Ensure First Nation involvement in development and implementation.	N/A
PROVINCIAL CONSULTATION – ALBERTA							
AESRD	Daryl Waters, Senior Fisheries Biologist Stephen Spencer, Fisheries Biologist Don Hildebrandt, Fisheries Technician George Sterling, Senior Fisheries Biologist	Email	June 29, 2012	Request for fish research licence for fish sampling during 2012.	None.	Permit received from Spruce Grove office.	N/A
AESRD	George Sterling, Senior Fisheries Biologist Ryan Cox, Fisheries Biologist	Email	July 4, 2012	Request for site-specific location and habitat use information for Athabasca rainbow trout in Edson area.	None.	Information received from Edson office.	Volume 5A Section 7.2.7 Volume 5C Fisheries (Alberta) Technical Report

TABLE 3.1-17 Cont'd

Stakeholder Group/Agency Name	Name and Title of Contact	Method of Contact	Date of Consultation Activity	Reason For Engagement	Issues/Concerns	Commitments/ Follow-Up Actions/ Comments	Where Issue is Addressed in the Application
AESRD	Daryl Waters, Senior Fisheries Biologist Stephen Spencer, Fisheries Biologist Don Hildebrandt, Fisheries Technician George Sterling, Senior Fisheries Biologist)	Email	July 9, 2012	Request of existing site-specific fall spawning and location information.	None.	Information received from Edson and Spruce Grove offices.	Volume 5A Section 7.2.7 Volume 5C Fisheries (Alberta) Technical Report
AESRD	Daryl Waters, Senior Fisheries Biologist Stephen Spencer, Fisheries Biologist Don Hildebrandt, Fisheries Technician George Sterling, Senior Fisheries Biologist	Email	September 12, 2012	Request of existing site-specific spring spawning and location information.	None.	Information received from Spruce Grove office.	Volume 5A Section 7.2.7 Volume 5C Fisheries (Alberta) Technical Report
AESRD	George Sterling, Senior Fisheries Biologist Ryan Cox, Fisheries Biologist	Email	March 6, 2013	Request for site-specific location and habitat use information for Athabasca rainbow trout in Edson to Hinton area.	None.	Information received from Edson office.	Volume 5A Section 7.2.7 Volume 5C Fisheries (Alberta) Technical Report
AESRD	Daryl Waters, Senior Fisheries Biologist Stephen Spencer, Fisheries Biologist Don Hildebrandt, Fisheries Technician George Sterling, Senior Fisheries Biologist	Email	March 27, 2013	Request for fish resource license for fish sampling during 2013.	None.	Permit received from Spruce Grove office.	N/A
AESRD	Denyse Guillion, Fisheries Biologist	Phone	April 11, 2013	Fish resource license request.	Correction of legal location of select sites.	Corrected locations provided by TERA.	N/A
AESRD	Don Hildebrandt, Fisheries Technician	Phone	April 15, 2013	Request for site condition update.	None.	None.	N/A

TABLE 3.1-17 Cont'd

Stakeholder Group/Agency Name	Name and Title of Contact	Method of Contact	Date of Consultation Activity	Reason For Engagement	Issues/Concerns	Commitments/ Follow-Up Actions/ Comments	Where Issue is Addressed in the Application
AESRD	George Sterling, Senior Fisheries Biologist, Ryan Cox, Fisheries Biologist	Email/Phone	June 4 and July 30, 2013	Request for reference of fish sample locations and known Athabasca rainbow trout locations.	None.	Information received from Edson office.	Volume 5A Section 7.2.7 Volume 5C Fisheries (Alberta) Technical Report
AESRD	Ryan Cox, Fisheries Biologist	Phone/Email	August 27, 2013	Request fish presence information for Happy Creek, Maskuta Creek and clarity on Athabasca rainbow trout sampling results.	None.	Information received from Edson office.	Volume 5A Section 7.2.7 Volume 5C Fisheries (Alberta) Technical Report
AESRD	Daryl Waters, Senior Fisheries Biologist ; Owen Watkins, Fisheries Technician	Email	June 26, 2013, September 20, 2013, and November 6, 2013	Request information for: known location of lake sturgeon spawning habitat in the North Saskatchewan River; fish presence and corresponding locations within Blackmud and Whitemud creeks.	None.	Information received from Spruce Grove office.	Volume 5A Section 7.2.7 Volume 5C Fisheries (Alberta) Technical Report
AESRD	Don Hildebrandt, Fisheries Technician	Email	November 19, 2013	Submission of fish and fish habitat data as required by provincial permitting. Inquiry on fish capture results and provision of presence information for Arctic grayling at Little Brule Creek.	None.	None.	Volume 5A Section 7.2.7 Volume 5C Fisheries (Alberta) Technical Report

TABLE 3.1-18

SUMMARY OF CONSULTATION ACTIVITIES RELATED TO FISH AND FISH HABITAT IN BRITISH COLUMBIA

Stakeholder Group/Agency Name	Name and Title of Contact	Method of Contact	Date of Consultation Activity	Reason For Engagement	Issues/Concerns	Commitments/ Follow-Up Actions/ Comments	Where Issue is Addressed in the Application
FEDERAL CONSULTATION							
DFO	Jennifer Simpson, Team Leader Brenda Andres, Environmental Assessment Analyst	Meeting	September 14, 2012	Project introduction. Outline methods and approach to fish and fish habitat investigations along the Project length. Brief review of regulatory changes.	No concerns with general methodology. Data will be collected as per provincial standards.	None.	N/A
DFO	Dave Pehl, Habitat Protection Officer, Oil and Gas Unit	Meeting	September 25, 2013	Project introduction. Outline methods and approach to fish and fish habitat investigations along the Project length. Brief review of regulatory changes.	No concerns with the general methodology. Need to ensure that compensation projects have high probability of success.	Engage DFO at the time of developing Fish Habitat Compensation. Ensure First Nation involvement in development and implementation.	Volume 5A Sections 5.7 and 7.2.7 Volume 5C Fisheries (British Columbia) Technical Report
PROVINCIAL CONSULTATION – BC							
Pacific Salmon Foundation	--	Meeting	October 2, 2013	To review overall strategy for compensation/offset.	Projects should be strategic to yield the maximum benefit.	Ensure Foundation is engaged on the development of compensation/offset plans.	Volume 5A Sections 5.7 and 7.2.7 Volume 5C Fisheries (British Columbia) Technical Report

TABLE 3.1-19

SUMMARY OF REGULATORY ACTIVITIES RELATED TO WETLAND LOSS AND ALTERATION

Stakeholder Group/Agency Name	Name and Title of Contact	Method of Contact	Date of Consultation Activity	Reason For Engagement	Issues/Concerns	Commitments/ Follow-up Actions/ Comments	Where Issue is Addressed in the Application
FEDERAL CONSULTATION							
Environment Canada	Andrew Robinson, Wildlife Biologist, BC	Meeting	December 6, 2011	Wetland evaluation methods were presented for discussion.	No concerns with methods were brought forward.	None.	N/A
Environment Canada	Harp Gill Andrew Robinson Paul Gregoire	Meeting	April 17, 2013	Wetland evaluation methods, study areas and indicators were presented for discussion.	Address alteration of wetland habitat function related to wildlife quantitatively.	None.	Volume 5A Sections 5.8 and 7.2.8 Volume 5C Wetland Evaluation Technical Report
PROVINCIAL CONSULTATION – ALBERTA							
AESRD	Muhammad Aziz, Team Lead, Water Team, Spruce Grove Central Region – Environmental Operations Rick Nutbrown, Water Administration Engineer, Spruce Grove Central Region – Environmental Operations	Meeting	June 21, 2013	Provide a Project overview and discussion of: Local Study Area (LSA) and Regional Study Area (RSA) boundaries, cumulative effects approach, survey methodologies and mitigation recommendations.	No concerns were brought forward.	None.	N/A
MUNICIPAL CONSULTATION – ALBERTA							
Strathcona County	Jocelyn Thrasher-Haug, Manager, Environmental and Open Space Planning	Email	July 29, 2013 August 6, 2013	Clarifying what regulatory requirements need to be met in regards to wetland disturbance as a result of Project construction.	Continued follow-up with Strathcona County in progress.	Further consultation will continue as required.	Volume 5A Sections 5.8 and 7.2.8 Volume 5C Wetland Evaluation Technical Report

Vegetation

TABLE 3.1-20

SUMMARY OF CONSULTATION ACTIVITIES RELATED TO VEGETATION

Stakeholder Group/Agency Name	Name and Title of Contact	Method of Contact	Date of Consultation Activity	Reason For Engagement	Issues/Concerns	Commitments/Follow-up Actions/Comments	Where Issue is Addressed in the Application
FEDERAL CONSULTATION							
Environment Canada – Canadian Wildlife Service (CWS)	Paul Gregoire, Senior Environmental Assessment Officer	Meeting (see below) Mr. Greogoire via Telephone	April 17, 2013	Review work plans for the wildlife, vegetation, wetland and marine components for the Project. Preliminary KIs and field survey methods were introduced and discussed.	--	April 19, 2013: the list of preliminary wildlife KIs is sent to Environment Canada for further review and comment. April 21, 2013: a copy of the meeting minutes is sent to Environment Canada for review. May 21, 2013: Environment Canada reviews the meeting minutes and provides comments and questions. Further comment is also provided on the list of preliminary wildlife indicators. May 22, 2013: Environment Canada provides additional comments on the width of the Wetlands and Vegetation LSAs and suggests that the wetlands functional assessment include surveys to identify the presence and distribution of migratory birds and species at risk in relation to specific potentially affected wetlands and associated riparian areas. August 25, 2013: a copy of the revised meeting minutes is provided to Environment Canada that responds to their questions from May 21 and 22, 2013. The approach involving spring and summer surveys by regional vegetation specialists was accepted.	Volume 5A Sections 5.9 and 7.2.9 Volume 5C Vegetation Technical Report

TABLE 3.1-20 Cont'd

Stakeholder Group/Agency Name	Name and Title of Contact	Method of Contact	Date of Consultation Activity	Reason For Engagement	Issues/Concerns	Commitments/Follow-up Actions/Comments	Where Issue is Addressed in the Application
Environment Canada – CWS	Harp Gill, Senior Environmental Assessment Officer Jennifer Wilson, Special Projects Officer Andrew Robinson, Senior Environmental Assessment Officer Rene McKibbin, Environmental Assessment Officer (Advisor to Environment Canada with Gebauer and Associates) Paul Gregoire, Senior Environmental Assessment Officer	Meeting Mr. Greogoire via Telephone	April 17, 2013	Project introduction. Review of work plans including terrestrial ecosystem mapping (TEM) Survey methodologies. Review of the results of consultation with provincial ecologists.	Environment Canada asked how much new right-of-way there would be, how all information could be collected in 1 year of field work and if there was any existing TEM that could be used. Environment Canada asked why all field work being conducted, especially wetlands, could not be fed back into TEM. Environment Canada asked what data sources would be used for TEM. Environment Canada accepted TERA's use of Survey Intensity Level 5 and acknowledged that some compromises had to be made given the scope of the Project, but emphasized that the approach needs to be justified and defensible.	TERA offered additional details about timelines and plans for supplementary TEM mapping and field plots in fall 2013 and 2014. TERA offered additional details about TEM data sources.	Volume 5A Sections 5.9 and 7.2.9 Volume 5C Vegetation Technical Report
Environment Canada – CWS	Jan Kirkby, Landscape Ecologist	Email	November 7, 2013	Project introduction. TEM Survey methodologies.	No response to date.	None.	N/A
PROVINCIAL CONSULTATION – ALBERTA							
City of Edmonton	Daniel Laubhann, city's weed group	Email	April 17 to 22, 2013	Project Introduction. Weeds of concern. Preferred invasive species control practices.	Weeds of concern list and city's *Integrated Pest Management Policy* provided. Concern with spread of weeds from Parkland County and Yellowhead highway. Request for detailed map of Project area within city.	More detailed map was provided on October 8, 2013.	Volume 5A Sections 5.9 and 7.2.9 Volume 5C Vegetation Technical Report
Strathcona County	Joel Gould, Agricultural Fieldman Diana Laviolette Brown, Assistant Agricultural Fieldman Lori Mills, Energy Exploration Liaison	Email	September 30, 2013	Project Introduction. Weeds of concern. Preferred invasive species control practices.	Provided information on a clubroot positive location and weeds of concern along the Project. Additional comments possible following confirmation of route.	None.	Volume 5A Sections 5.9 and 7.2.9 Volume 5C Vegetation Technical Report

TABLE 3.1-20 Cont'd

Stakeholder Group/Agency Name	Name and Title of Contact	Method of Contact	Date of Consultation Activity	Reason For Engagement	Issues/Concerns	Commitments/Follow-up Actions/Comments	Where Issue is Addressed in the Application
Parkland County	James Leskiw, Supervisor, Agricultural Agronomics	Email, Telephone	April 17 to 22, 2013	Project Introduction. Weeds and crop diseases of concern. Preferred invasive species and crop disease control practices.	Provided list of clubroot positive fields. Recommended the Clubroot Management Plan be followed. Concerns regarding spread and introduction of Noxious and Prohibited Noxious weeds. Request for detailed map of Project area within county.	More detailed map was provided on October 8, 2013.	Volume 5A Sections 5.9 and 7.2.9 Volume 5C Vegetation Technical Report
City of Spruce Grove	Info@sprucegrove.org	Email Telephone	April 17, 2013 – No response was received Follow-up email and call on September 30, 2013	Project introduction. Weeds of concern. Preferred invasive species control practices.	No response.	On September 30, 2013, the email mailbox was full and message was undeliverable. A call was placed to the city. No one responded and there was no voicemail.	N/A
Town of Stony Plain	Rudy Zacharias, Communications Coordinator	Email	April 17 to 18, 2013	Project introduction. Weeds and crop diseases of concern. Preferred invasive species and crop disease control practices.	Provided list of weeds of concern. Inquired about equipment decontamination procedures, weed control/eradication plans and regular weed inspection plans for right-of-way.	May 6, 2013 provided answers to questions regarding mitigation for decontamination of equipment, weed management and monitoring.	Volume 5A Sections 5.9 and 7.2.9 Volume 5C Vegetation Technical Report
Village of Wabamun	Trevor Anderson, Economic Development Officer/Marketing Coordinator	Email	April 17 to 18, 2013	Project introduction. Weeds and crop diseases of concern. Preferred invasive species and crop disease control practices.	Have no specific concerns regarding weeds or crop diseases.	None.	N/A
Wabamun Lake Provincial Park	Matthew Wheatley, Conservation Biologist, Provincial Parks Division	Email	October 25, 2013	Project introduction. Weeds and crop diseases of concern. Preferred invasive species and crop disease control practices.	Awaiting response.	None.	N/A
Yellowhead County	Sonja Pichette, Agricultural Services Coordinator	Email	April 17 to 24, 2013	Project introduction. Weeds and crop diseases of concern. Preferred invasive species and crop disease control practices.	Provided a list of weeds of concern and the general location of clubroot positive fields which are all considerably distant from the proposed Project.	None.	Volume 5A Sections 5.9 and 7.2.9 Volume 5C Vegetation Technical Report
Alberta Conservation Information Management System (ACIMS)	Lorna Allen	Email	September 13, 2013	Rare ecological community confirmation.	--	None.	N/A

TABLE 3.1-20 Cont'd

Stakeholder Group/Agency Name	Name and Title of Contact	Method of Contact	Date of Consultation Activity	Reason For Engagement	Issues/Concerns	Commitments/Follow-up Actions/Comments	Where Issue is Addressed in the Application
PROVINCIAL CONSULTATION – BRITISH COLUMBIA							
Regional District of Fraser Fort George	Jim Martin, Chief Administrative Officer	Email	April 17 to 22, 2013	Project introduction. Weeds and crop diseases of concern. Preferred invasive species and crop disease control practices.	Referred to Andrea Eastham of the NWIPC.	Follow-up email was sent to Andrea Eastham on September 30, 2013.	N/A
Northwest Invasive Plant Council (NWIPC)	Andrea Eastham, Program Manager	Email	April 17, 2013 Follow-up email was sent on September 30, 2013	Project introduction. Weeds and crop diseases of concern. Preferred invasive species and crop disease control practices.	On October 3, 2013, a list of sites treated for invasive plant infestations was provided. Species of concern were identified as well as issues from to the TMX Anchor Loop project that they wish to avoid with the current Project. Concerns include spread and introduction of infestations. Requested maintaining clean storage sites and clean vehicles and equipment (with inspections and reporting), treating infestations prior to construction, comply with no herbicide and bio-release sites and submitting invasive species data to the provincial database. Expressed desire to participate in the invasive management component of the Project.	None.	Volume 5A Sections 5.9 and 7.2.9 Volume 5C Vegetation Technical Report
TNRD	Peter Hughes, Director of Environmental Services Jamie Vieira, Operations Supervisor, Environmental Health Services	Email	April 17, 2013	Project introduction. Weeds and crop diseases of concern. Preferred invasive species and crop disease control practices.	On June 28, 2013, the Pest Management Plan was provided. Reference was made to provincial Noxious weeds, regionally-listed weeds and the *Invasive Plant Regulation* under the *Forest and Range Practices Act (FRPA)* as well as to treatment methods. It was recommended to contact David Ralph of the Invasive Plant Program at the BC MFLNRO as well as Jo-Ann Fox, the Manager of the Southern Interior Weed Management Committee (SIWMC).	On October 9, 2013, David Ralph was emailed for input. On April 18, 2013 Jo-Anne Fox was emailed for input.	Volume 5A Sections 5.9 and 7.2.9 Volume 5C Vegetation Technical Report
BC MFLNRO	David Ralph, Invasive Plant Program	Email	October 9, 2013	Project introduction. Weeds and crop diseases of concern. Preferred invasive species and crop disease control practices.	Awaiting response.	Follow-up again in November.	N/A

TABLE 3.1-20 Cont'd

Stakeholder Group/Agency Name	Name and Title of Contact	Method of Contact	Date of Consultation Activity	Reason For Engagement	Issues/Concerns	Commitments/Follow-up Actions/Comments	Where Issue is Addressed in the Application
SIWMC	Jo-Anne Fox, Coordinator	Email	April 18, 2013	Project introduction. Weeds and crop diseases of concern. Preferred invasive species and crop disease control practices.	Provided the Thompson-Nicola Strategic Plan 2013 identifying species of concern and management methods.	None.	N/A
FVRD	Stacey Barker, Manager of Environmental Services	Email	April 17, 2013 Follow-up email was sent on October 1, 2013	Project introduction. Weeds and crop diseases of concern. Preferred invasive species and crop disease control practices.	On October 2, 2013, a list of weed species of concern and a website with location, distribution and treatment information was proposed. Recommended conducting field surveys for weeds immediately prior to construction.	None.	Volume 5A Sections 5.9 and 7.2.9 Volume 5C Vegetation Technical Report
Fraser Valley Invasive Plant Council (FVIPC)	Jeanne Hughes, Coordinator	Email	April 17, 2013 Follow-up email was sent on October 1, 2013	Project introduction. Weeds and crop diseases of concern. Preferred invasive species and crop disease control practices.	Awaiting response.	None.	N/A
Greater Vancouver Regional District (GVRD)	Alison Evely, Natural Resource Management Specialist Heather McNell, Regional Planning Division Manager	Email	April 17, 2013 Follow-up email was sent on October 1, 2013	Project Introduction. Weeds and crop diseases of concern. Preferred invasive species and crop disease control practices.	On October 3, 2013, the Integrated Pest Management Plan identifying weeds of concern and treatment approaches was provided (Evely 2012). Reference was also made to the Invasive Species Council of Metro Vancouver (ISCMV) website for information.	None.	Volume 5A Sections 5.9 and 7.2.9 Volume 5C Vegetation Technical Report
ISCMV	Jennifer Grenz, Manager Tasha Murray, Administration and Education Manager	Email	April 17, 2013 Follow-up email was sent on October 1, 2013	Project introduction. Weeds and crop diseases of concern. Preferred invasive species and crop disease control practices.	Awaiting response.	None.	N/A
BC Conservation Data Centre (CDC)	cdcdata@gov.bc.ca	Email	April 18, 2013	Request resources regarding rare ecological communities for which there is little or no information in Land Management Handbooks.	Provided some additional links to information sources.	None.	N/A
BC CDC	Jenifer Penny	Email Telephone	June 17, 2013 to present	Information on the status of unranked liverworts.	Provided preliminary information on the status of unranked liverworts in BC.	Requested that high level information on all liverwort occurrences (not just rare species) be submitted to the BC CDC to assist in ranking.	Volume 5A Sections 5.9 and 7.2.9 Volume 5C Vegetation Technical Report
Government of BC	Corey Erwin, Vegetation Ecologist	Email	July 27, 2012	Project introduction. TEM Survey methodologies.	No response to date.	None.	N/A

TABLE 3.1-20 Cont'd

Stakeholder Group/Agency Name	Name and Title of Contact	Method of Contact	Date of Consultation Activity	Reason For Engagement	Issues/Concerns	Commitments/Follow-up Actions/Comments	Where Issue is Addressed in the Application
Thompson-Okanagan Region, Government of BC	Michael Ryan, Research Ecologist	Telephone	August 28 and September 12, 2012	Project introduction. TEM Survey methodologies.	Michael Ryan invited TERA to follow-up via email.	See below.	N/A
		Email	October 26 to November 15, 2012	Project introduction. TEM Survey methodologies.	Michael Ryan advised Survey Intensity Level 4 and requested additional details about existing TEM relevant to the Project. Michael Ryan offered contact information for other regional ecologists. Michael Ryan advised how to correlate the 2005 draft Biogeoclimatic Ecosystem Classification (BEC) for the Thompson-Okanagan Region with the current Red and Blue-listed rare ecological communities.	TERA offered additional detail about rare plant and rare ecological community surveys as justification for Survey Intensity Level 5. TERA offered additional details about existing TEM. TERA requested further comment on Survey Intensity Level 5 with regards to additional. No further comment has been received.	Volume 5A Sections 5.9 and 7.2.9 Volume 5C Vegetation Technical Report
		Email	February 22 to April 15, 2013	Land Management Handbook advice.	TERA requested input on which Land Management Handbooks to use to classify vegetation communities in the MSmw1 and ESSFmw1. Michael Ryan provided draft Land Management Handbooks by Lloyd *et al.* (2005) and a cross walk table between the site series in the ESSFmw1 and the ESSFmw.	None.	Volume 5A Sections 5.9 and 7.2.9 Volume 5C Vegetation Technical Report
Omineca and NE Region, Government of BC	Bruce Rogers, Research Ecologist	Email	October 29 to November 23, 2012	Project introduction. TEM Survey methodologies.	Bruce Rogers advised Survey Intensity Level 4. Bruce Rogers requested PDF of the proposed pipeline corridor showing the ESSFmm1.	TERA offered additional detail about rare plant and rare ecological community surveys as justification for Survey Intensity Level 5. TERA offered additional details about existing TEM. TERA sent requested PDF. TERA requested further comment on Survey Intensity Level 5 with the additional surveys. No further comment has been received.	Volume 5A Sections 5.9 and 7.2.9 Volume 5C Vegetation Technical Report
Coastal Region, Government of BC	Dr. Sari Sanders, Research Ecologist	Email	October 29 to November 15, 2012	Project introduction. TEM Survey methodologies.	No response to date.	None.	N/A
Provincial Lichen Expert	Trevor Goward	Meeting, Telephone, Email	March to November 2013	Lichen specimen identification; consultation regarding lichen species rarity.	Provided identifications and expert experience regarding species that are not ranked by the BC CDC and those that are tracked but are not considered provincially rare or requiring mitigation.	None.	Volume 5A Sections 5.9 and 7.2.9 Volume 5C Vegetation Technical Report

TABLE 3.1-20 Cont'd

Stakeholder Group/Agency Name	Name and Title of Contact	Method of Contact	Date of Consultation Activity	Reason For Engagement	Issues/Concerns	Commitments/Follow-up Actions/Comments	Where Issue is Addressed in the Application
Provincial Lichen Expert	Curtis Bjork	Email	October 2013	Consultation regarding lichen and bryophyte species rarity.	Provided expert experience regarding species that are not ranked by the BC CDC and those that are tracked but are not considered provincially rare or requiring mitigation.	None.	Volume 5A Sections 5.9 and 7.2.9 Volume 5C Vegetation Technical Report
Provincial Bryophyte Expert	Terry McIntosh	Email	March to October 2013	Coordinating field survey; bryophyte specimen confirmation.	Conducted field surveys; provided confirmation of *Schistidium* moss specimens.	None.	Volume 5A Sections 5.9 and 7.2.9 Volume 5C Vegetation Technical Report
Provincial Bryophyte Expert	Rene Belland	Email	October to November 2013	Consultation regarding bryophyte species rarity.	Provided expert experience regarding tracked species.	None.	Volume 5A Sections 5.9 and 7.2.9 Volume 5C Vegetation Technical Report
Provincial Bryophyte Expert	Peter Whitehead	Meeting, Telephone, Email	March to November 2013	Coordinating field survey; consultation regarding bryophyte species rarity.	Conducted field surveys; provided expert experience regarding species that are tracked but are not considered provincially rare or requiring mitigation.	None.	Volume 5A Sections 5.9 and 7.2.9 Volume 5C Vegetation Technical Report
Provincial Bryophyte Expert	Sandra Davis	Meeting, Telephone, Email	March to November 2013	Bryophyte specimen identification; consultation regarding bryophyte species rarity.	Provided identifications and expert experience regarding species that are not ranked by the BC CDC and those that are tracked but are not considered provincially rare or requiring mitigation.	None.	Volume 5A Sections 5.9 and 7.2.9 Volume 5C Vegetation Technical Report
Provincial Rare Plant Expert	Matt Fairbarns	Email	June 18, 2013 to present	Input on survey timing, habitats and whether or not preferred habitat is on the proposed right-of-way for the species in the rare plant potential tables.	Provided us with tracked changes in the potential tables on July 3 and 4, 2013.	None.	Volume 5A Sections 5.9 and 7.2.9 Volume 5C Vegetation Technical Report

Wildlife and Wildlife Habitat

TABLE 3.1-21

SUMMARY OF CONSULTATION ACTIVITIES RELATED TO WILDLIFE AND WILDLIFE HABITAT

Stakeholder Group/Agency	Name and Title of Contact	Method of Contact	Date of Consultation Activity	Reason For Engagement and Issues/Concerns	Commitments/Follow-up Actions/Comments	Where Issue is Addressed in the Application
FEDERAL CONSULTATION						
Environment Canada – CWS	Harp Gill, Senior Environmental Assessment Officer, Pacific and Yukon Region	Email	March 15, 2013 March 25, 2013 March 27, 2013	Provide shapefiles of proposed pipeline corridor (March 15 and 27). Send draft Work Plans and preliminary indicators for wildlife, vegetation and wetland components for the Project (March 25) prior to meeting on April 17, 2013.	None.	N/A
Environment Canada	Harp Gill, Senior Environmental Assessment Officer, Pacific and Yukon Region, CWS Jennifer Wilson, Special Projects Officer, Pacific and Yukon Region, CWS Andrew Robinson, Senior Environmental Assessment Officer, Pacific and Yukon Region, CWS Rene McKibbin, Environmental Assessment Officer, Pacific and Yukon Region, CWS Martin Gebauer, Advisor to Environment Canada, Pacific and Yukon Region Paul Gregoire, A/Head Program & Planning Coordination, Prairie & Northern Region, CWS (via conference call)	Meeting in Delta, BC	April 17, 2013	Review work plans for the wildlife, vegetation, wetland and marine wildlife components for the Project. Preliminary indicators and field survey methods were introduced and discussed.	April 19, 2013: the list of preliminary wildlife indicators is sent to Environment Canada for further review and comment. April 21, 2013: a copy of the Meeting Minutes is and sent to Environment Canada for review. May 21, 2013: Environment Canada reviews the Meeting Minutes and provides comments and questions. Further comment is also provided on the list of preliminary wildlife indicators. May 22, 2013: Environment Canada provides additional comments on the width of the Wetlands/Vegetation LSA, and that the wetlands functional assessment includes surveys to identify the presence and distribution of migratory birds and species at risk in relation to specific potentially affected wetlands and associated riparian areas. August 25, 2013: a copy of the revised Meeting Minutes is provided to Environment Canada that responds to their questions provided in the Meeting Minutes (May 21, 2013), as well as the additional comment provided on May 22, 2013 are provided to Environment Canada.	Volume 5A Sections 5.10 and 7.2.10 Volume 5C Wildlife Technical Report
Environment Canada – CWS	Paul Gregoire, A/Head Program & Planning Coordination, Prairie & Northern Region	Meeting in Edmonton, Alberta	June 7, 2013	Review proposed corridor, preliminary wildlife indicators, and wildlife field program.	None.	Volume 5A Sections 5.10 and 7.2.10 Volume 5C Wildlife Technical Report

TABLE 3.2-21 Cont'd

Stakeholder Group/Agency	Name and Title of Contact	Method of Contact	Date of Consultation Activity	Reason For Engagement and Issues/Concerns	Commitments/Follow-up Actions/Comments	Where Issue is Addressed in the Application
Environment Canada – CWS	Harp Gill, Senior Environmental Assessment Officer, Pacific and Yukon Region	E-mail	August 1, 2013	Request information on candidate critical wildlife habitat that may be encountered along the proposed pipeline corridor, including pacific water shrew habitat mentioned during the Surrey Community Interest Workshop.	September 9, 2013: A data-sharing agreement is signed and Environment Canada provides hard-copy maps of candidate critical habitat for: pacific water shrew; Williamson's sapsucker; Oregon forest snail; Toothcup; coastal giant salamander; barn owl (western population); Lewis's woodpecker; American badger; Townsend's mole; and whitebark pine.	Volume 5A Sections 5.10 and 7.2.10 Volume 5C Wildlife Technical Report
Environment Canada – CWS	Harp Gill, Senior Environmental Assessment Officer, Pacific and Yukon Region	E-mail	August 25, 2013	Provide updated Meeting Minutes from April 17, 2013 meeting. Send for review the following: updated wildlife indicator list, information on the LSA and RSA boundaries; send information and maps showing proposed grizzly bear and caribou RSA boundaries. Request if the proposed pipeline corridor encounters any known habitat sites for band-tailed pigeon, and if there are any other conflicts with important habitat (not publically available) with the proposed pipeline corridor. Ask for clarification that the Pacific and Yukon Region is the primary contact for the Project and that all correspondence will be provided to P. Gregoire (Prairie and Northern Region, Edmonton).	September 4, 2013: Environment Canada responds that the Pacific and Yukon Region will be the primary contact and correspondence will be forwarded to P. Gregoire (Edmonton). September 19, 2013: Environment Canada responds they do not have any comments on the study area boundaries. September 30, 2013: Environment Canada provides a response related to band-tailed pigeon and notes that they do not have specific mapping layers for band-tailed pigeon, however, they may be encountered throughout the Coast Range at low and mid-elevations up to the central coast. Environment Canada recommends that they be considered as a sensitive species for the coastal portion of the Project, as this area is within the species range and contains suitable habitat.	Volume 5A Sections 5.10 and 7.2.10 Volume 5C Wildlife Technical Report
Environment Canada – CWS	Jennifer Wilson, Special Projects Officer, Pacific and Yukon Region	Email	September 30, 2013	Environment Canada provides additional feedback on wildlife indicators.	None.	Volume 5A Sections 5.10 and 7.2.10 Volume 5C Wildlife Technical Report
PROVINCIAL CONSULTATION - ALBERTA						
AESRD (Edmonton)	Dave Hobson, Wildlife Biologist	Email	August 26, 2013	Provide a summary of the protective notations (PNTs) and trumpeter swan lakes that are encountered by the proposed pipeline corridor and request feedback related to mitigation. Provide information on the LSA and RSA study area boundaries, including the grizzly bear RSA for review.	September 6, 2013: AESRD notes that the proposed pipeline corridor is generally close to Highway 16 and the primary concern for grizzly bears relates to the creation of new access. Feedback was provided on trumpeter swan lakes and the PNTs within the area covered by the Edson office.	Volume 5A Sections 5.10 and 7.2.10 Volume 5C Wildlife Technical Report

TABLE 3.2-21 Cont'd

Stakeholder Group/Agency	Name and Title of Contact	Method of Contact	Date of Consultation Activity	Reason For Engagement and Issues/Concerns	Commitments/Follow-up Actions/Comments	Where Issue is Addressed in the Application
AESRD (Upper Athabasca Region, Hinton)	Jeff Kneteman, Senior Wildlife Biologist	Email	September 11, 2013	Provide an introduction to the Project and a summary of the PNTs that are encountered by the proposed pipeline corridor and request feedback related to mitigation. Request feedback on potential long-toed salamander breeding pond near the existing Hinton pump station. Provide information on the LSA and RSA study area boundaries, including the grizzly bear RSA for review.	September 15, 2013: AESRD responds that primary recommendation is to prioritize the conservation and immediate placement of topsoil, including protecting native species propagules and restoration of the native plant community composition and structure as quickly as possible. Winter construction is the best timing with respect to minimizing risk to salamanders. It is preferred that an additional pipeline not be located nearest the breeding pond (*i.e.*, on the pond side).	Volume 5A Sections 5.10 and 7.2.10 Volume 5C Wildlife Technical Report
PROVINCIAL CONSULTATION – BRITISH COLUMBIA						
BC MFLNRO (Fraser-Fort George District, Prince George)	Brady Nelless, A / Landbase Stewardship Section Head	Email	August 10, 2012	Provide introduction to the Project and a preliminary list of wildlife indicators and background information on indicator selection. Request a meeting to discuss the following: • habitats of concern in proximity to the proposed route in your region (*e.g.,* protected areas, sensitive habitat features, etc.); • a review of preliminary wildlife indicators to be used in the environmental assessment; • available data that would be useful in supporting a thorough examination of potential effects on wildlife in the region; • recommended field protocols, particularly any that may differ from the Resources Inventory Standards Committee (RISC) standard protocols; • recent habitat models that have been developed and validated for species of interest in the region; • recommended individuals or groups for further consultation; and • any other concerns or questions.	August 20, 2012: MFLNRO responds that Kevin Hoekstra will by the Regional contact for this Project.	Volume 5A Sections 5.10 and 7.2.10 Volume 5C Wildlife Technical Report
BC MFLNRO (Omineca Region, Prince George)	Kevin Hoekstra, Ecosystem Biologist	Email	August 28, 2012 May 23, 2013 July 31, 2013 October 16, 2013	Provide shape-file of the proposed pipeline corridor as it is updated.	---	N/A
		Telephone	September 7, 2012	Project Introduction and routing review. BC MFLNRO noted that the proposed corridor is located in valley and will parallel other linear corridors and would like to see the natural buffer that is between the existing highway and existing TMPL right-of-way maintained. The pipeline does not cross known wildlife features, WHA or UWR, however, there are elk and white-tail deer in the area. Reclamation should avoid using seed that is palatable to wildlife to prevent an increased chance of wildlife mortality.	September 7, 2012: Will contact again to discuss the Project in more detail (indicator species, study boundaries and recommended surveys).	Volume 5A Sections 5.10 and 7.2.10 Volume 5C Wildlife Technical Report

TABLE 3.2-21 Cont'd

Stakeholder Group/Agency	Name and Title of Contact	Method of Contact	Date of Consultation Activity	Reason For Engagement and Issues/Concerns	Commitments/Follow-up Actions/Comments	Where Issue is Addressed in the Application
BC MFLNRO (Omineca Region, Prince George) (cont'd)	See above	Email	January 8, 2013	Send preliminary winter transect locations and proposed field survey methods for review.	January 11, 2013: MFLNRO recommends a winter transect near the interface between Cranberry Marsh and the crown land to the west, and notes the other locations are suitable including a transect located in the riparian area of Camp Creek.	Volume 5A Sections 5.10 and 7.2.10 Volume 5C Wildlife Technical Report
		Email	March 11, 2013	Request information on existing models for mountain caribou and concerns related to routing within caribou range.	March 12, 2013: BC MFLNRO responds that the only habitat modelling is related to the caribou recovery plan. Within the Omineca Region, the proposed pipeline corridor parallels the existing TMPL right-of-way and is outside the known caribou range.	Volume 5A Sections 5.10 and 7.2.10 Volume 5C Wildlife Technical Report
		E-mail	August 16, 2013	Provide a description of RSA and LSA boundaries; maps showing proposed grizzly bear and caribou RSA; and an updated wildlife indicator list for review and feedback.	---	N/A
		Telephone	October 24, 2013	Discuss information provided on August 16, 2013. No concerns associated with the proposed study area boundaries and indicator list.	October 24, 2013: provide preliminary moose model (Draft Species Account/Model Assumptions/TEM ratings) for review.	Volume 5A Sections 5.10 and 7.2.10 Volume 5C Wildlife Technical Report
BC MFLNRO (Thompson-Nicola District, Kamloops)	John Surgenor, Wildlife Biologist Robyn Reudink, Ecosystem Biologist	Email	July 4, 2012	Provide introduction to the Project and a preliminary list of wildlife indicators and background information on indicator selection. Request a meeting to discuss the following: • habitats of concern in proximity to the proposed route in your region (*e.g.,* protected areas, sensitive habitat features, etc.); • a review of preliminary wildlife indicators to be used in the environmental assessment; • available data that would be useful in supporting a thorough examination of potential effects on wildlife in the region; • recommended field protocols, particularly any that may differ from the RISC standard protocols; • recent habitat models that have been developed and validated for species of interest in the region; • recommended individuals or groups for further consultation; and • any other concerns or questions.	August 14, 2012: MFLNRO responds that Robyn Reudink will by the Regional contact for this Project.	Volume 5A Sections 5.10 and 7.2.10 Volume 5C Wildlife Technical Report

TABLE 3.2-21 Cont'd

Stakeholder Group/Agency	Name and Title of Contact	Method of Contact	Date of Consultation Activity	Reason For Engagement and Issues/Concerns	Commitments/Follow-up Actions/Comments	Where Issue is Addressed in the Application
BC MFLNRO (Thompson-Nicola District, Kamloops)	Robyn Reudink, Ecosystem Biologist,	Meeting in Kamloops, BC	October 30, 2012	Review wildlife indicator species and selection criteria, available data for the Region, information on timing restrictions and setback distances, and methods for the wildlife field program.	December 3, 2012: in response to the meeting on October 30, 2012, MFLNRO provides a letter that outlines provincial information and data sources and general recommendations for Project assessments from the Thompson-Nicola District (Ecosystem Section).	Volume 5A Sections 5.10 and 7.2.10 Volume 5C Wildlife Technical Report
BC MFLNRO (South Coast Region, Surrey)	Scott Barrett, Resource Stewardship Manager Sylvia Letay, Ecosystem Officer	Email/ Telephone	July 4, 2012	Provide introduction to the Project and a preliminary list of wildlife indicators and background information on indicator selection. Request a meeting to discuss the following: • habitats of concern in proximity to the proposed route in your region (*e.g.,* protected areas, sensitive habitat features, etc.); • a review of preliminary wildlife indicators to be used in the environmental assessment; • available data that would be useful in supporting a thorough examination of potential effects on wildlife in the region; • recommended field protocols, particularly any that may differ from the RISC standard protocols; • recent habitat models that have been developed and validated for species of interest in the region; • recommended individuals or groups for further consultation; and • any other concerns or questions.	August 10, 2012: no response from MFLNRO, therefore send email to Daniel Hirner (MFLNRO in Surrey) to request clarification on who will be the Regional contact for this Project. J. Hirner (Conservation Specialist) responds to clarify that Scott Barrett will be the Regional contact for the South Coast Region.	Volume 5A Sections 5.10 and 7.2.10 Volume 5C Wildlife Technical Report
BC MFLNRO (South Coast Region, Surrey)	Scott Barrett, Resource Stewardship Manager	E-mail	August 16, 2013	Provide a description of RSA and LSA boundaries; maps showing proposed grizzly bear and caribou RSA; and an updated list of wildlife indicators for review and feedback.	None.	Volume 5A Sections 5.10 and 7.2.10 Volume 5C Wildlife Technical Report

TABLE 3.1-22

SUMMARY OF CONSULTATION ACTIVITIES RELATED TO MARINE SEDIMENT AND WATER QUALITY

Stakeholder Group/ Agency Name	Name and Title of Contact	Method of Contact	Date of Consultation Activity	Reason For Engagement	Issues/ Concerns	Commitments/Follow-up Actions/Comments	Where Issue is Addressed in the Application
FEDERAL CONSULTATION							
Environment Canada	Kristi Trainor, Head, Marine Program Environmental Assessment and Marine Programs	Email memo to Environment Canada	September 21, 2012	Project introduction, submission of preliminary sediment work plan.	Study area boundary, indicators (potential contaminants of concern) and sampling methods.	None.	Volume 5A Sections 6.2 and 7.6.8 Volume 5C Marine Sediment and Water Quality – Westridge Marine Terminal Technical Report
		Email memo from Environment Canada	December 7, 2012	Environment Canada feedback on preliminary sediment work plan.	Analytical parameters, scope of baseline information, collection of sufficient information for an environmental assessment and for a disposal at sea application.	Telephone meeting for December 20, 2012.	Volume 5A Sections 6.2 and 7.6.8 Volume 5C Marine Sediment and Water Quality – Westridge Marine Terminal Technical Report
		Telephone Meeting Email memo	December 20, 2012	Telephone meeting to discuss Environment Canada comments.	As described for December 7.	Revised work plan.	Volume 5A Sections 6.2 and 7.6.8 Volume 5C Marine Sediment and Water Quality – Westridge Marine Terminal Technical Report
		Email memo to Environment Canada	January 31, 2013	Submitted revised sediment work plan.	Study area, potential contaminants of concern, sampling methods.	None.	Volume 5A Sections 6.2 and 7.6.8 Volume 5C Marine Sediment and Water Quality – Westridge Marine Terminal Technical Report

TABLE 3.1-22 Cont'd

Stakeholder Group/ Agency Name	Name and Title of Contact	Method of Contact	Date of Consultation Activity	Reason For Engagement	Issues/ Concerns	Commitments/Follow-up Actions/Comments	Where Issue is Addressed in the Application
Environment Canada (cont'd)	Sean Standing, Senior Program Scientist Environmental Assessment and Marine Programs	Telephone call	March 12, 2013	Discuss revised sampling work plan (changed footprint) and Project details.	Alternatives to dredging, uncertainty in final dredge footprint.	Revised work plan.	Volume 5A Sections 6.2 and 7.6.8 Volume 5C Marine Sediment and Water Quality – Westridge Marine Terminal Technical Report
		Email memo to Environment Canada	April 5, 2013	Revised sampling work plan (changed footprint) and Project details.	--	None.	Volume 5A Sections 6.2 and 7.6.8 Volume 5C Marine Sediment and Water Quality – Westridge Marine Terminal Technical Report
		Telephone call and follow-up emails	April 10, 2013 April 11, 2013 April 26, 2013	Discuss revised sampling work plan (changed footprint but not finalized) and Project details.	Alternatives to dredging, uncertainty in final dredge footprint.	Environment Canada approved the April 5 work plan. However, the work plan was withdrawn as the level of information requested by Environment Canada for disposal at sea permitting is greater than required for environmental assessment. Agreed to follow the April 5 work plan, adding sites to assess alternative dredge options.	Volume 5A Sections 6.2 and 7.6.8 Volume 5C Marine Sediment and Water Quality – Westridge Marine Terminal Technical Report
OTHER CONSULTATION							
PMV	Kim Keskinen, PMV	Email	November. 23, 2012 November 26, 2012	Review of draft sediment work plan.	PMV asked for clarification of dredge depth.	Provided dredge depth.	Volume 5A Sections 6.2 and 7.6.8 Volume 5C Marine Sediment and Water Quality – Westridge Marine Terminal Technical Report

TABLE 3.1-22 Cont'd

Stakeholder Group/ Agency Name	Name and Title of Contact	Method of Contact	Date of Consultation Activity	Reason For Engagement	Issues/ Concerns	Commitments/Follow-up Actions/Comments	Where Issue is Addressed in the Application
PMV (cont'd)	Kim Keskinen, PMV	Email	April 5, 2013	Update on current dredge footprint and sampling plan.	--	Provided revised sediment work plan.	Volume 5A Sections 6.2 and 7.6.8 Volume 5C Marine Sediment and Water Quality – Westridge Marine Terminal Technical Report
	Darrell Desjardin, PMV	Email	April 19, 2013	Sampling program information.	PMV issued a permit for sediment sampling.	Confirm disposal options for collected sediment.	Volume 5A Sections 6.2 and 7.6.8 Volume 5C Marine Sediment and Water Quality – Westridge Marine Terminal Technical Report

Marine Resources (*i.e.*, Marine Fish and Fish Habitat and Marine Mammals)

TABLE 3.1-23

SUMMARY OF CONSULTATION ACTIVITIES RELATED TO MARINE FISH AND FISH HABITAT AND MARINE MAMMALS

Stakeholder Group/ Agency Name	Name and Title of Contact	Method of Contact	Date of Consultation Activity	Reason For Engagement	Issues/ Concerns	Commitments/ Follow-up Actions/Comments	Where Issue is Addressed in the Application
FEDERAL CONSULTATION							
DFO	Brenda Andres, EA Analyst, EA and Major Projects Unit	Meeting	September 14, 2012	Project Introduction. Intertidal, subtidal, and riparian habitat survey methodology. Overview of assessment methodology for marine resources. LSA/RSA boundaries.	No concerns with proposed survey methodology or approach to assessment were raised.	Agreed to schedule another meeting in 2013.	Volume 5A Sections 6.2, 7.6.9 and 7.6.11 Volume 5C Marine Resources – Westridge Marine Terminal Technical Report

TABLE 3.1-23 Cont'd

Stakeholder Group/ Agency Name	Name and Title of Contact	Method of Contact	Date of Consultation Activity	Reason For Engagement	Issues/ Concerns	Commitments/Follow-up Actions/Comments	Where Issue is Addressed in the Application
CWS/Environment Canada	Harp Gill, Senior Environmental Assessment Officer	Meeting	April 16, 2013	Scope of effects and indicator selection for marine resources.	No concerns with indicator selection or effects being considered were raised.	Provided CWS/Environment Canada with list of marine resources indicators for further consideration.	Volume 5A Sections 6.2, 7.6.9 and 7.6.11 Volume 5C Marine Resources – Westridge Marine Terminal Technical Report
DFO	David Pehl	Meeting	September 25, 2013	Project introduction. Marine resources indicators. Key issues/effects for marine resources. Approach to habitat compensation/ offsetting.	No concerns with indicator selection or effects being considered were raised.	Agreed to develop habitat compensation/ offsetting plans during the permitting phase of the Project.	Volume 5A Sections 6.2, 7.6.9 and 7.6.11 Volume 5C Marine Resources – Westridge Marine Terminal Technical Report

Marine Birds

TABLE 3.1-24

SUMMARY OF CONSULTATION ACTIVITIES RELATED TO MARINE BIRDS

Stakeholder Group/ Agency Name	Name and Title of Contact	Method of Contact	Date of Consultation Activity	Reason For Engagement	Issues/Concerns	Commitments/ Follow-up Actions/ Comments	Where Issue is Addressed in the Application
FEDERAL CONSULTATION							
Environment Canada	Andrew Robinson, Wildlife Biologist	Meeting	September 25, 2012	Project introduction and marine bird field study methods for the Marine Birds LSA.	No concerns were raised for methods of assessing birds in Marine Birds LSA.	None.	Volume 5A Sections 6.2 and 7.6 Volume 5C Marine Birds – Westridge Marine Terminal Technical Report
Environment Canada	Andrew Robinson and Martin Gebauer, Wildlife Biologists	Meeting	April 16 2013	Project introduction and selection of environmental indicators.	Validity of the selected group of marine bird indicator species to represent potential environmental effects for all species.	Other potential species and species at risk were discussed as candidates. Environment Canada noted that field work to assess current marine bird biodiversity and habitat use would be of value.	Volume 5A Sections 6.2 and 7.6 Volume 5C Marine Birds – Westridge Marine Terminal Technical Report

3.2 Aboriginal Engagement

Since April 2012, Trans Mountain has engaged with Aboriginal communities that might have an interest in the Project or have Aboriginal interests potentially affected by the Project, based on the proximity of their community and their assertion of traditional and cultural use of the land along the proposed pipeline corridor to maintain a traditional lifestyle. Trans Mountain respects the Aboriginal and treaty rights, unique culture, diversity, languages and traditions of Aboriginal people. Trans Mountain acknowledges the importance of teaching, the significance of culture and language and the considerable traditional knowledge that has been passed on for generations and as such is committed to continued listening, learning and working with Aboriginal people to ensure that knowledge and advice is considered and incorporated in the Project. The Aboriginal Engagement Program is based on mutual respect, timeliness, accountability and transparency in order to build positive and productive relationships for the long-term.

This subsection provides information on the Aboriginal Engagement Program for the Project and describes how the results of Project engagement activities relating to the ESA were gathered as well as how these results have been incorporated into the application. The Aboriginal Engagement Program was developed in accordance with the KMC Aboriginal Policy and Volume 3B provides detailed information on Trans Mountain's approach to the Aboriginal Engagement Program as well as detailed information on the Trans Mountain vision and the principles and goals of the engagement program and engagement activity to date.

For purposes of this application, the engagement activities conducted to date are reported up to November 30, 2013. The results of ongoing engagement efforts will be reported in supplemental filings.

3.2.1 Design of Aboriginal Engagement Program

3.2.1.1 Identification of Aboriginal Communities and Aboriginal Groups

Beginning in 2012 Trans Mountain worked in collaboration with the federal government and provincial ministries to identify Aboriginal communities and Aboriginal groups for engagement. Aboriginal communities in BC were identified as those within a 10 km buffer of the corridor. Of these, there are Aboriginal communities who are negotiating treaties within the BC Treaty Commission process and those that are not currently engaged in the BC treaty process. Aboriginal communities in Alberta were identified as those within a 100 km buffer of the corridor.

Trans Mountain also contacted each of the provincial government ministries (the BC Ministry of Aboriginal Relations and Reconciliation and the Alberta Ministry of Aboriginal Affairs) and received guidance on the development of engagement lists for the Project. In addition to engagement with the federal and provincial ministries, further engagement took place in early 2012 with representatives from the Major Projects Management Office (MPMO), NEB, and BC OGC regarding communities and groups to include in the Aboriginal Engagement Program.

The result was a comprehensive list of 103 Aboriginal communities with traditional territories located within 10 km of the corridor in BC and 100 km in Alberta, and two non-land based BC Métis groups included in the engagement list: the BC Métis Federation; and the Métis Nation of BC. In total, Trans Mountain is engaged with 105 Aboriginal communities and Aboriginal groups. Geographically, in Alberta and BC there are substantial areas of shared territory with the 103 communities engaged.

Details regarding the identification of communities that might have an interest in the Project or having Aboriginal interests potentially affected by the Project are provided in Volume 3B.

3.2.1.2 Aboriginal Communities and Aboriginal Groups Engaged

The following is a list of the 103 Aboriginal communities and two non-land based BC Métis groups in proximity to the pipeline corridor and marine corridor that was assessed pursuant to the NEB's instruction in their List of Issues, issued July 29, 2013, that might have an interest in the Project or have Aboriginal interests potentially affected by the Project:

Aboriginal Communities Located in the Edmonton to Alberta/British Columbia Border Region

Alexander First Nation	Louis Bull Tribe	Samson Cree Nation
Alexis Nakota Sioux Nation	Métis Regional Council Zone IV of the Métis Nation of Alberta (Region 4)	Sturgeon Lake Cree Nation
Aseniwuche Winewak Nation	Montana First Nation	Sunchild First Nation
Enoch Cree Nation	Nakcowinewak Nation of Canada	
ErmineskinCree Nation	O'Chiese First Nation	
Foothills Ojibway First Nation	Paul First Nation	
Horse Lake First Nation	Saddle Lake Cree Nation	

Aboriginal Communities Located in the Alberta/British Columbia Border to Kamloops Region

Adams Lake Indian Band	Lhtako Dene Nation	Splatsin First Nation
Aseniwuche Winewak Nation	Neskonlith Indian Band	Tk'emlúps te Secwepemc
Ashcroft Indian Band	Oregon Jack Creek Band	Toosey Indian Band
Canim Lake Band (Tsq'escenemc Nation)	Shuswap Indian Band	Whispering Pines (Clinton Indian Band)
Little Shuswap Indian Band	Simpcw First Nation	Xat'sull First Nation (Soda Creek)
Lheidli T'enneh	Skeetchestn First Nation	

Aboriginal Communities Located in the Kamloops to Hope Region

Boothroyd Band	Lower Similkameen Indian Band	Siska Indian Band
Boston Bar Band	Lytton First Nation	Skuppah Indian Band
Coldwater Indian Band	Nicomen Indian Band	Spuzzum First Nation
Cook's Ferry Indian Band	Nooaitch Indian Band	St'uxwtews (Bonaparte Indian Band)
Kanaka Bar	Penticton Indian Band	Upper Nicola Indian Band
Lower Nicola Indian Band	Shackan Indian Band	Upper Similkameen Indian Band

Aboriginal Communities Located in the Hope to Burnaby Terminal/Burrard Inlet Region

Aitchelitz First Nation	Popkum First Nation	Squamish First Nation
Chawathil First Nation	Qayqayt First Nation	Squiala First Nation
Cheam First Nation	Scowlitz First Nation	Sts'ailes Band (Chehalis Indian Band)
Katzie First Nation	Seabird Island Band	Sumas First Nation
Kwantlen First Nation	Semiahmoo First Nation	Tsawwassen First Nation
Kwaw-kwaw-aplit First Nation	Shxw'ow'hamel First Nation	Tsleil-Waututh Nation
Kwikwetlem First Nation	Shxwha:y Village	Tzeachten First Nation
Leq'á:mel First Nation	Skawahlook First Nation	Union Bar First Nations
Matsqui First Nation	Skowkale First Nation	Yakweakwioose First Nation
Musqueam First Nation	Skwah First Nation	Yale First nation
Peters Indian Band	Soowahlie First Nation	

Aboriginal Communities Located in the Marine Corridor

Cowichan Tribes	Pacheedaht First Nation	Songhees Nation
Esquimalt Nation	Pauquachin First Nation	Stz'uminus First Nation (Chemainus)
Halalt First Nation	Pacheedaht First Nation	T'Sou-ke First Nation
Hwlitsum First Nation	Scia'new Indian Band (Beecher Bay)	Tsartlip First Nation
Lake Cowichan First Nation	Sechelt Indian Band	Twawout First Nation
Lyackson First Nation	Snaw-Naw-As (Nanoose)	Tseycum First Nation
Malahat First Nation	Snuneymuxw First Nation	Stz'uminus First Nation (Chemainus)

Aboriginal Groups – Non-Boundary Specific

BC Métis Federation
Métis Nation of BC

3.2.1.3 Associations, Councils and Tribes

Trans Mountain has also engaged with multiple Aboriginal associations, councils, and tribes of which many of the Aboriginal communities listed in Section 3.2.1.3 are members. Additional details are provided in Volume 3B.

Cowichan Nation Alliance

The Cowichan Nation Alliance is an organization that was identified by Trans Mountain as an entity that might have an interest in the Project or having Aboriginal interests potentially affected by the Project. Made up of eight member communities, for the purposes of the Project, Trans Mountain is engaging with the following member communities who have indicated an interest in the Project:

- Cowichan Tribes;
- Halalt First Nation;
- Hwlitsum First Nation;
- Penelakut Tribe; and
- Stz'uminus First Nation.

Trans Mountain continues to engage with individual member communities and the Cowichan Nation Alliance to further enhance the Aboriginal Engagement Program.

Okanagan Nation Alliance

The Okanagan Nation Alliance is an organization that was identified by Trans Mountain as an entity that might have an interest in the Project or having Aboriginal interests potentially affected by the Project. Made up of eight member communities, for the purposes of the Project, Trans Mountain is engaged with the following four member communities who have indicated an interest in the Project:

- Lower Similkameen Indian Band;
- Penticton Indian Band;
- Upper Nicola Band; and
- Upper Similkameen Indian Band.

Trans Mountain continues to engage with the individual member communities and the Okanagan Nation Alliance to further enhance the Aboriginal Engagement Program.

Nicola Tribal Association

The Nicola Tribal Association is an organization that was identified by Trans Mountain as an entity that might have an interest in the Project or having Aboriginal interests potentially affected by the Project. Made up of seven member nations, for the purposes of the Project, Trans Mountain is engaged with the following Nicola Tribal Association member communities who have indicated an interest in the Project:

- Nicomen Indian Band;
- Nooaitch Indian Band; and
- Shacken Indian Band.

Trans Mountain continues to engage with the individual member communities and the Nicola Tribal Association to further enhance the Aboriginal Engagement Program.

Tk'emlúp Te Secwépemc

Tk'emlúp Te Secwépemc is an organization that was identified by Trans Mountain as an entity that might have an interest in the Project or having Aboriginal interests potentially affected by the Project.

As an administrative body working with communities with shared territories, for the purposes of the Project, Trans Mountain is engaged with the following Stkemlupsemc Te Secwepemc member communities who have indicated an interest in the Project:

- Skeetchestn First Nation; and
- Tk'emlúp Te Secwépemc.

Trans Mountain continues to engage with the individual member communities and the Tk'emlúp Te Secwépemc to further enhance the Aboriginal Engagement Program.

Ts'elxweyeqw Tribe Management Limited

Ts'elxweyeqw Tribe Management Limited is an organization that was identified by Trans Mountain as an entity that might have an interest in the Project or having Aboriginal interests potentially affected by the Project. Ts'elxweyeqw Tribe Management Limited is comprised of the following communities (all of which are engaged with the Project):

- Aitchelitz First Nation;
- Shxwha:y Village;
- Skowkale First Nation;
- Soowahlie Indian Band;
- Squiala First Nation;
- Tzeachten First Nation; and
- Yakweakwioose First Nation.

For the purposes of a Capacity Funding Agreement, the following Aboriginal communities are engaged with Ts'elxweyeqe Tribe:

- Kwaw-kwaw-apilt First Nation; and
- Shwah First Nation.

Additionally, for the purposes of an Integrated Cultural Assessment, the following two Aboriginal communities are engaged with the Project:

- Cheam First Nation; and
- Sumas First Nation.

Trans Mountain continues to engage with the individual member communities and Ts'elxweyeqw Tribe Management Limited to further enhance the Aboriginal Engagement Program.

3.2.1.4 Engagement Method

The Aboriginal Engagement Program uses a comprehensive Aboriginal engagement process led by experienced engagement advisors in Alberta and BC, working with a group of professionals who are specialized in the areas of Aboriginal relations, law, economic development, education, training, employment and procurement. Trans Mountain's engagement process for the Project is flexible, allowing each community and group to engage in meaningful dialogue in the manner they choose and in a way that meets their objectives and values.

In May 2012, the Trans Mountain Aboriginal engagement team was created and Aboriginal engagement team field advisors were assigned to each of the groups based on their knowledge and experience. Each advisor is a professional experienced in engagement.

The Aboriginal Engagement Program focuses on:

- enhancing trusting and respectful relationships;
- sharing Project information – Project scope, routing options, safety and emergency response, scheduling and environmental field study components;
- negotiating group and community-specific protocols, capacity agreements, Letters of Understanding (LOUs) and Mutual Benefit Agreements (MBAs), as appropriate;
- facilitating Traditional Land Use (TLU) studies, socio-economic interviews and Traditional Ecological Knowledge (TEK) collection;
- identifying potential effects and addressing concerns;
- discussing the adequacy of planned mitigation and opportunities; and
- identifying education, training, employment and procurement opportunities.

3.2.1.5 Comprehensive Aboriginal Engagement Process

Acting as a framework for the engagement process, the following activities provide guidance to ensure a comprehensive and consistent process in working with each of the communities identified by Trans Mountain.

As outlined in Volume 3B, each community has the opportunity to engage with Trans Mountain in the manner they choose, depending on Project interests and potential effects:

- Project announcement;
- initial contact with Aboriginal community or Aboriginal group;
- meetings with Chief and Council, and meetings with staff;
- negotiate and execute confidential LOU/capacity agreement;
- host community information session(s);
- conduct TLU studies and socio-economic interviews;
- identify interests and concerns;
- identify mitigation options;
- provide additional capacity funding, if required; and
- negotiate and execute confidential mutual benefits agreement.

In December 2013, at the time of filing, Trans Mountain continues to actively engage with all Aboriginal communities that have been identified as having an interest in the Project or have Aboriginal interests potentially affected by the Project. Engagement with Aboriginal communities is at varying stages in the engagement process. Specific detail about the engagement activities and the status of engagement with each group can be found in Section 1.5 of Volume 3B and within Appendix A of Volume 3B.

3.2.1.6 Incorporating Aboriginal Traditional Ecological Knowledge

TEK does not have a stand-alone section in the ESA. However, TEK information has been incorporated throughout Volumes 5A and 5B, where appropriate. TEK has contributed by supplementing the methodology of the fish and fish habitat, vegetation, wetlands, wildlife and wildlife habitat field studies. TEK has also contributed by adding results that western science may not have gathered or considered, confirmed results that had been collected through scientific field studies as well as identifying and confirming issues of concern that would need to be addressed in the ESA.

Review of collected TEK and discussions of potential Project-related effects and mitigation strategies described in this ESA were conducted directly with participating community members during the field surveys. Approximately 28 Aboriginal communities were engaged in the TEK program with over 200 participants involved in field surveys. Confirmation of the accuracy of the information incorporated and approval of the inclusion of the confidential and proprietary information in Project planning occurred in the field and during community follow-up results review (Table 3.2-1). The TEK collected has been incorporated into the fish and fish habitat, vegetation, wetlands, wildlife and wildlife habitat settings of this ESA (Section 5.0) and was used to assist in the assessment of the potential effects of the Project. The issues that were raised and where they are considered in Volume 5A ESA – Biophysical are summarized in Table 3.2-2.

3.2.2 Implementation

A number of methods have been used to inform Aboriginal communities, obtain feedback and identify issues about the Project including: Project letters; meetings; phone conversations; email dialogue; newsletters; public information sessions; the Project website; and over 4,000 engagement activities have been carried out to date. The results of these engagement efforts, in conjunction with the collection of TEK as described in Section 3.2.2.3, Environment Field Participation have contributed to the development of the ESA for the pipelines and facilities components of the Project (Volumes 5A and 5B), including mitigation and enhancement measures. A detailed overview of the engagement activities implemented to date and a detailed summary of engagement with each Aboriginal community is available in Volume 3B.

3.2.2.1 Employment, Education and Training

Trans Mountain is committed to supporting the sustainability of Aboriginal communities through the creation of employment opportunities over the life of the proposed Project and is committed to the development of an Aboriginal workforce through effective and accessible training programs to maximize participation in available employment opportunities.

As detailed in Volume 3B, Trans Mountain is working in partnership with communities to achieve the objectives of the Aboriginal Peoples Training Policy to enhance employment opportunities with all interested communities, including marine communities.

3.2.2.2 Project Letters, Update Newsletters and Trans Mountain Website

The communications materials forwarded to communities that might have an interest in the Project or have Aboriginal interests potentially affected by the Project by Trans Mountain included the following:

- Project notification and introduction letter;
- advanced notice of field study work letter and field study process brochure;
- Project update letters and newsletters including updates to the Project website content, regulatory filings and participation funding;
- letter invitations to meet to discuss routing options for those communities where the existing TMPL system encounters Indian Reserve (IR) lands; and

- Project Description as filed with the NEB.

The formal kick-off for Project engagement began with a Project notification letter sent from Ian Anderson, President, KMC on May 29, 2012. Three versions of the letter were created and distributed depending on community location and proximity to the pipeline right-of-way.

The ESA Approach Summary document issued in March 2013 intended to provide an overview of Trans Mountain's understanding of the environmental and socio-economic context of the Project at the time of its release. Since its release, Trans Mountain continues to actively engage with regulatory authorities, stakeholders and Aboriginal communities on the methods, indicators and spatial boundaries listed in the approach document. Methods, indicators, and spatial boundaries for many of the environmental and socio-economic elements were revised based on comments received. In May 2013, Trans Mountain filed the Project Description for the Trans Mountain Expansion Project with the NEB which included updated information on key issues and indicators.

Communication materials have been compiled to meet NEB filing requirements and details (including samples) of these materials are provided in Volume 3B.

3.2.2.3 Project Meetings

Following distribution of the Project notification letter, Trans Mountain contacted Aboriginal communities to set up in-person meetings to discuss the Project with Chief and Council, staff and community members. The primary purpose of Project meetings is to share Project-related information. For initial meetings specifically with Chief and Council or community staff, the primary objective is to determine the community's interest in engagement and to develop a process for involvement in Project activities. A presentation titled "Aboriginal Engagement Program: Trans Mountain Expansion Project" is used during initial meetings to share Project details with attendees (see Volume 3B). Copies of the presentation were left with attendees post-meeting. Routing maps and operational information is also discussed at Project meetings and questions from meeting attendees are addressed.

Meetings and community gatherings were arranged with the assistance of community council leadership and staff. In general, open houses and introductory meetings were conducted by both Trans Mountain and TERA, while TERA conducted subsequent meetings as representatives of Trans Mountain.

Meetings with Aboriginal leadership and staff, harvesters and trappers were an important method of engagement. Meetings were held to:

- introduce the Project (timelines, Project description, regulatory requirements and process);
- provide a broad understanding of the NEB process;
- discuss methods for conducting engagement in the community;
- negotiate work plans and funding for those Aboriginal communities who propose to conduct their own TLU studies or socio-economic data collection (further discussion in Volume 5B);
- initiate environmental field work;
- identify economic development opportunities;
- identify capacity issues with Aboriginal communities to address ability of the community to participate in the Project review;
- identify community concerns, interests and opportunities;
- obtain input and feedback on environmental field studies; and
- identify site-specific concerns and interests for harvesters.

Meetings with specific communities are summarized in Volume 3B. Table 3.2-2 provides further information regarding issues and concerns identified through Project-related meetings with Aboriginal communities.

3.2.2.4 Environmental Field Program Participation

The purpose of Aboriginal participation during the environmental field program is to incorporate Aboriginal views and the additional knowledge of the land that has accumulated over generations and passed down from the Elders into the consideration of potential Project-related environmental effects. The collection of TEK for the Project focused on Aboriginal additional knowledge of the land and field reconnaissance was conducted along Crown lands potentially disturbed by Project construction, including associated physical works and activities. The objectives of Aboriginal participation during the environmental field surveys are to:

- document the TEK of Aboriginal communities;
- augment the design and execution of the field surveys;
- inform baseline/existing conditions;
- identify potential effects of the Project on environmental resources;
- integrate TEK into the consideration and mitigation of environmental effects; and
- contribute to final Project design.

TERA, on behalf of Trans Mountain, was commissioned to facilitate the participation of potentially affected Aboriginal communities during the environmental field studies conducted for the Project. Engagement for the Project was initiated in spring 2012 and continued throughout 2013. Opportunities for Project participation were made available to potentially affected Aboriginal communities that have an interest in the Project, based on their proximity to the Project or their assertion of traditional and cultural rights of the land.

An important issue identified by the participating Aboriginal communities was the need for their participation and contribution to the environmental field programs, while balancing capacity limitations in their respective lands departments. The field program was designed to provide Aboriginal community members with the opportunity to provide TEK information to the ESA. Interpreters were made available in the field upon the request of a given community, as warranted. Dates detailed in Table 3.2-1 may not correspond to dates noted in the biophysical technical reports (Volume 5C). The reason for this discrepancy is that additional time was spent in the field with Aboriginal participants for mobilization and demobilization to study areas, pre-field work meetings, wrap up meetings and to evaluate alternate routes.

The methods used to determine how participants were to be involved in Project field surveys were common to all Aboriginal communities. Each field survey was discussed with the community, usually with staff from the lands department. This discussion included the details regarding the type of work to be conducted, the timing and the proposed locations. Based on the described field work to be conducted, the Aboriginal communities chose their own members who would participate in each program. The participating Aboriginal communities are listed in Table 3.2-1 from east to west in relation to the Project.

TABLE 3.2-1

ENVIRONMENTAL FIELD STUDY PARTICIPATION FOR THE PROJECT

Aboriginal Community	Winter Aquatics	Open Water Aquatics	Wildlife	Wetlands	Bryolichen Survey	Terrestrial Ecosystem Mapping	Rare Plant Survey	Follow-up Results Review
Edmonton to Hinton Segment								
Saddle Lake Cree Nation	--	May 7 to 15, 2013 May 22 to June 1, 2013 June 8 to 12, 2013	June 18 to 27, 2013 July 4 to 9, 2013	August 15 to 21, 2012 May 27 to June 1, 2013	May 20 to 21, 2013	May 18 to 27, 2013	June 7 to 13, 2013 June 18 to 29, 2013 July 16 to 22, 2013	November 28, 2013
Enoch Cree Nation	September 6, 2012 September 17 to 19, 2012 February 6 to 10, 2013	August 15 to 18, 2012 June 8 to 12, 2013	March 5 to 10, 2013	June 3 to 5, 2013	--	August 15 to 21, 2012 May 18 to 22, 2013	June 7 to 13, 2013 August 4, 8 to 9, 11, 2013	November 28, 2013
Alexander First Nation	October 22 to 28, 2012 February 6 to 10, 2013	August 15 to 18, 2012 May 7 to 14, 2013 May 22 to June 1, 2013 June 8 to 12, 2013	March 5 to 10, 2013 June 18 to 27, 2013 July 4 to 9, 2013 July 26 to August 1, 2013	May 27 to June 1, 2013	--	August 15 to 21, 2012 May 18 to 27, 2013	June 7 to 13, 2013 June 18 to 29, 2013 July 16 to 22, 2013	November 28, 2013
Samson Cree Nation	September 6, 2012 September 17 to 19, 2012 October 22 to 28, 2012 February 6 to 10, 2013	August 15 to 18, 2012 May 7 to 15, 2013 May 22 to June 1, 2013	September 28 to 29, 2012 March 5 to 10, 2013 June 18 to 27, 2013	May 27 to June 1, 2013 July 25 to 30, 2013	May 20 to 21, 2013	August 16 to 21, 2012 May 18 to 27, 2013	June 7 to 13, 2013 June 18 to 29, 2013	November 28, 2013
Ermineskin Cree Nation	October 22 to 28, 2012 February 6 to 10, 2013	August 15 to 18, 2012 May 7 to 15, 2013 May 22 to June 1, 2013 June 8 to 12, 2013	June 18 to 27, 2013 July 4 to 9, 2013 September 28 to 29, 2012	August 15 to 21, 2012 May 27 to June 1, 2013 July 25 to 30, 2013	May 20 to 21, 2013	August 15 to 21, 2012 May 18 to 27, 2013	June 7 to 13, 2013 June 18 to 29, 2013	October 31, 2013
Montana First Nation	September 6, 2012 September 17 to 19, 2012 October 22 to 28, 2012 February 6 to 10, 2013	August 15 to 18, 2012 May 7 to 15, 2013 May 22 to June 1, 2013	September 28 to 29, 2012 March 5 to 10, 2013 July 4 to 9, 2013	August 15 to 21, 2012 May 27 to June 1, 2013	May 20 to 21, 2013	August 16 to 21, 2012	June 18 to 29, 2013	November 28, 2013
Louis Bull Tribe	September 6, 2012 October 22 to 28, 2012 February 6 to 10, 2013	August 15 to 18, 2012 May 8 to 14, 2013 June 8 to 12, 2013	July 4 to 9, 2013	August 15 to 21, 2012 May 1 to 2, 2013 May 29 to 31, 2013 July 25 to 30, 2013	--	August 15 to 21, 2012	June 18 to 29, 2013	November 28, 2013
Alexis Nakota Sioux First Nation	October 22 to 28, 2012	August 15 to 18, 2012 May 7 to 15, 2013 May 22 to June 1, 2013	June 18 to 27, 2013 September 28 to 29, 2012	August 15 to 21, 2012 May 27 to June 1, 2013	May 20 to 21, 2013	August 15 to 21, 2012 May 18 to 27, 2013	June 7 to 13, 2013	To be determined

TABLE 3.2-1 Cont'd

Aboriginal Community	Winter Aquatics	Open Water Aquatics	Wildlife	Wetlands	Bryolichen Survey	Terrestrial Ecosystem Mapping	Rare Plant Survey	Follow-up Results Review
Paul First Nation	--	May 7 to 15, 2013 May 22 to June 1, 2013 June 8 to 12, 2013	March 7 to 10, 2013 June 18 to 27, 2013 July 4 to 9, 2013 July 26 to August 1, 2013	--	--	--	June 7 to 13, 2013 July 16 to 22, 2013	November 8, 2013
Nakcowinewak Nation of Canada	February 6 to 10, 2013	May 7 to 14, 2013 May 22 to June 1, 2013 June 8 to 12, 2013	March 5 to 10, 2013 June 18 to 27, 2013	--	--	May 18 to 27, 2013	June 7 to 13, 2013 June 18 to 29, 2013 August 3 to 14, 2013	November 25, 2013
Sunchild First Nation	October 22 to 28, 2012 February 6 to 10, 2013	May 7 to 14, 2013 May 22 to June 1, 2013 June 8 to 12, 2013	September 28 to 29, 2012 March 5 to 10, 2013 June 18 to 27, 2013	August 15 to 21, 2012 May 27 to June 1, 2013	--	August 15 to 21, 2012 May 18 to 27, 2013	June 7 to 13, 2013 August 3 to 14, 2013	November 28, 2013
Hargreaves to Darfield Segment								
Lheidli T'enneh	--	June 4 to 11, 2013 June 18 to 20, 2013 July 17 to 24, 2013 August 9 to 10, 2013	June 3 to 14, 2013	June 11 to 18, 2013 July 11 to 15, 2013	--	--	May 11 to 12, 2013 May 19, 2013 June 27 to 29, 2013	November 28, 2013
Aseniwuche Winewak Nation	--	June 4 to 11, 2013 June 18 to 19, 2013 August 9 to 10, 2013	June 3 to 14, 2013	June 11 to 18, 2013	--	--	June 27 to 29, 2013 August 10 to 12, 2013	November 28, 2013
Lhtako Dene Nation	--	--	--	--	--	--	June 29, 2013	To be determined
Simpcw First Nation	--	June 4 to 11, 2013 June 18 to 21, 2013 July 4 to 11, 2013 July 17 to 24, 2013 August 9 to 14, 2013	June 3 to 14, 2013 August 13 to 16, 2013	June 11 to 18, 2013 July 11 to 15, 2013	--	--	June 18 to 29, 2013 August 2 to 13, 2013	N/A
Tk'emlúps te Secwepemc	--	April 12 to 19, 2013	--	--	--	--	--	To be determined
Canim Lake Band	--	--	--	July 11 to 15, 2013 July 12 to 13, 2013	--	--	--	November 5, 2013
Black Pines to Hope Segment								
Lower Nicola Indian Band	--	April 8 to 12, 2013 May 7 to 16, 2013 July 10 to 12, 2013 August 7 to 14, 2013	--	--	--	April 16 to 18, 2013	May 17, 2013 July 21 to 25, 2013	November 28, 2013
Nicola Tribal Association	---	July 10 to 12, 2013 July 18 to 20, 2013 August 7 to 14, 2013	June 12 to 14, 2013	--	--	--	--	November 28, 2013

TABLE 3.2-1 Cont'd

Aboriginal Community	Winter Aquatics	Open Water Aquatics	Wildlife	Wetlands	Bryolichen Survey	Terrestrial Ecosystem Mapping	Rare Plant Survey	Follow-up Results Review
Hope to Burnaby Segment								
Yale First Nation	---	April 9 to 17, 2013 May 1 to 2, 2013 May 7 to 13, 2013 May 24 to 29, 2013 July 23, 2013	May 28 to June 7, 2013 June 13 to 14, 2013 June 28, 2013 July 28 to 31, 2013 September 9 to 10, 2013	--	--	April 12 to 15, 2013	May 22 to 26, 2013 July 13 to 25, 2013	November 28, 2013
Chawathil First Nation	--	April 9 to 17, 2013 April 25 to 28, 2013 May 7 to 13, 2013 May 24 to 29, 2013 July 12 to 23, 2013	May 28 to June 7, 2013 June 13, 2013 June 28, 2013	--	--	April 12 to 15, 2013	May 16, 2013 May 22 to 26, 2013 July 13 to 25, 2013	November 28, 2013
Shxw'ōwhámel First Nation	--	April 9 to 17, 2013 April 25 to 28, 2013 May 24 to 29, 2013 July 15 to 17, 2013 July 23, 2013	May 28 to June 7, 2013 July 23 to August 1, 2013 September 9 to 10, 2013	--	--	April 12 to 15, 2013	May 22 to 26, 2013 July 13 to 25, 2013	November 28, 2013
Cheam First Nation	November 3-9, 2012 November 20-21, 2012	April 9 to 17, 2013 April 25 to 28, 2013	--	--	--	April 12 to 15, 2013	--	November 28, 2013
Seabird Island Band	November 3-9, 2012 November 20-21, 2012	April 9 to 17, 2013 April 25 to 28, 2013	September 9 to 10, 2013	--	--	April 12 to 15, 2013	--	November 28, 2013
Popkum First Nation	--	April 9 to 17, 2013 April 25 to May 2, 2013 July 15 to 17, 2013	May 28 to June 7, 2013 July 23 to August 1, 2013	--	--	--	May 22 to 26, 2013	November 28, 2013
Scowlitz First Nation	--	April 9 to 17, 2013 April 25 to 26, 2013 May 24 to 29, 2013	May 23 to 28, 2013	--	--	--	--	November 28, 2013
Leq'á:mel First Nation	--	April 9 to 17, 2013 April 25 to 28, 2013 May 24 to 29, 2013	May 23 to 28, 2013 May 28 to June 7, 2013 July 23 to August 1, 2013	--	--	April 12 to 15, 2013	May 7 to 10, 2013 May 22 to 26, 2013	November 8, 2013
Kwantlen First Nation	November 20-21, 2012	April 9 to 17, 2013 April 25 to 28, 2013 May 24 to 29, 2013	May 23 to June 7, 2013	--	--	--	--	November 28, 2013

A Band Counsel Resolution was received by Trans Mountain which delegated authority to the Nicola Tribal Association to act on behalf of Nooaitch Indian Band, Nicomen Indian and Shackan Indian Band for Project engagement. TEK from the Simpcw First Nation field participants was unavailable for inclusion in the application by TERA, however, all field participants contributed to the discussion of potential Project-related effects on resources and participated in the discussion of potential mitigation measures to reduce potential Project-related effects.

During the field surveys, traditional methods of resource procurement were discussed, as well as modern methods currently employed. Seasonality of resource harvesting was also important information shared by the Aboriginal participants. Geographical locations were identified, as were areas that are not used and the reasons why. Potential mitigation measures to reduce any Project-related effects on a resource were also discussed during the field surveys. Open discussions occurred regularly between participants and biophysical specialists regarding the resources present and available to Aboriginal communities. These discussions were important to help build relationships among the field crews. Aboriginal participants spoke about aspects of the environment that were important to them and the importance of the resource from a western science perspective was also discussed. The TEK collected during the field surveys has added results that western science may not have gathered or considered, confirmed results that had been collected through the field surveys, as well as identified and confirmed issues of concern to be addressed in the ESA. The TEK collected is also used to assist in the review of potential Project-related effects on environmental resources.

3.2.3 Summary of Outcomes of the Aboriginal Engagement Program for Biophysical Elements

The results of engagement have helped refine the ESA for the Project. With this information, Trans Mountain identified issues, addressed concerns and responded to questions. Engagement has also provided Aboriginal communities with an understanding of the Project.

Although a wide range of issues were raised by community members and representatives throughout the Aboriginal engagement process, recurring themes have emerged, including the following:

- protection of the environment and the potential effects of spills on land and in water including the marine environment;
- potential construction and operation effects on inland fisheries, wildlife health and habitat, aquifers, watercourse crossings and wetlands;
- effects of dredging in proximity to the Westridge Marine Terminal; and
- pollution at Westridge Marine Terminal.

Results of the engagement have been considered and incorporated throughout the ESA – Biophysical where relevant, including the effects assessment and mitigation and enhancement measures. The issues identified by participating Aboriginal communities through engagement activities for the Project are described in Table 3.2-2. References to where these issues are considered in the application are also provided Table 3.2-2. Detailed information on engagement activities conducted and opportunities provided for Project input to date with each Aboriginal community is presented in Appendix A of Volume 3B.

3.2.4 Future Aboriginal Engagement Activities

Following submission of the application to the NEB, including the ESA, Trans Mountain will continue engagement with Aboriginal communities to provide updates on the status of the Project and discuss proposed mitigation and enhancement measures. Information updates will continue to be sent to Aboriginal communities. From information sharing to continued environmental field studies to address interests and concerns, Trans Mountain is committed to the continuation of an effective engagement program that satisfies all parties. As described in Volume 3B, Trans Mountain will continue engagement through the regulatory process and into Project development and operations. Trans Mountain will also continue its liaison with the Crown and provide updates regarding Trans Mountain's engagement activities with Aboriginal communities potentially affected by the Project.

TABLE 3.2-2

SUMMARY OF INTERESTS OR CONCERNS IDENTIFIED THROUGH ENGAGEMENT ACTIVITIES WITH ABORIGINAL COMMUNITIES FOR THE PROJECT

Summary of Interest or Concern	Aboriginal Community	Response Summary[1]	Where Issue is Addressed in the Application
Potential loss of beaver habitat, beaver lodges and request to trap and release live beaver	Saddle Lake Cree Nation Alexander First Nation Samson Cree Nation Ermineskin Cree Nation Montana First Nation Louis Bull Tribe Alexis Nakota Sioux First Nation Paul First Nation Nakcowinewak Nation Of Canada Sunchild First Nation Aseniwuche Winewak Nation Lheidli T'enneh Simpcw First Nation Tk'emlúp Te Secwépemc	As part of Trans Mountain's commitment to environmental protection, Trans Mountain will minimize potential adverse effects to wetlands by expediting construction in and around wetlands, by restoring wetlands to their original configurations and contours, by segregating topsoil during excavation, by permanently stabilizing upland areas near wetlands as soon as possible after backfilling, by inspecting the right-of-way periodically during and after construction, and by repairing any erosion control or restoration features until permanent revegetation is successful. Trans Mountain will ensure that in Alberta, in the event that beaver dams or lodges will be disturbed, notification will be provided provincial permits will be obtained prior to commencing activities. In additional, DFO will be notified 14 days prior to beaver dam removal and removals will be conducted in accordance with conditions of DFO's Alberta *Operational Statement for Beaver Dam Removal*. In BC, in the event that beaver dams or lodges will be disturbed, notification will be submitted to the appropriate regional Habitat Officer of the MFLNRO at least 45 days prior to beaver dam removal, as per Section 40 of the *Water Regulation*. Following this notification, a Ministry of Natural Resource Operations Wildlife Sundry Permit will be obtained to remove a beaver dam. Standards and best practices for beaver dam removal are identified in the BC *Standards and Best Practices for Instream Works*. Further discussion is provided under wetlands and wildlife in Sections 5.8, 5.10, 7.2.8 and 7.2.10. Mitigation measures for wildlife and wetlands are outlined in the Pipeline EPP (Volume 6B).	Volume 5A Sections 5.8, 5.10, 7.2.8 and 7.2.10 Volume 5C Wetland Evaluation Technical Report Wildlife Technical Report Volume 6B

TABLE 3.2-2 Cont'd

Summary of Interest or Concern	Aboriginal Community	Response Summary[1]	Where Issue is Addressed in the Application
Increased access for hunters during construction Increased lines-of-sight affecting predator-prey dynamics due to clearing activities Potential effects to wildlife and wildlife habitat Potential for construction activities to limit use of game trails, restricting wildlife movement	Sunchild First Nation Saddle Lake Cree Nation Enoch Cree Nation Alexander First Nation Samson Cree Nation Ermineskin Cree Nation Montana First Nation Louis Bull Tribe Alexis Nakota Sioux First Nation Paul First Nation Nakcowinewak Nation Of Canada Aseniwuche Winewak Nation Lheidli T'enneh Simpcw First Nation Lhtako Dene Nation Whispering Pines (Clinton Indian Band) Lower Nicola Indian Band Nicola Tribal Association Yale First Nation Chawathil First Nation Shxw'ow'hamel First Nation Cheam First Nation Ts'elxweyeqw Tribe Management Limited Seabird Island Band Popkum First Nation Scowlitz First Nation Leq'á:mel First Nation Kwantlen First Nation	The three main components of habitat fragmentation are habitat loss, reduced habitat patch size and increased isolation of patches. Effects of habitat fragmentation will be reduced by alignment of the proposed route parallel to and contiguous with existing linear features, and minimizing the Project footprint to the maximum extent feasible. A suite of mitigation measures will be implemented to reduce the potential effects of the Project on wildlife habitat, movement and mortality risk. Mitigation to reduce effects on habitat, limit barriers to movement, avoid attraction of wildlife to the work site, minimize sensory disturbance and protect site-specific habitat features of importance is discussed in the Section 7.2.10 and the Pipeline EPP (Volume 6B). Trans Mountain will facilitate wildlife movement during construction by ensuring the contractor conducts work expeditiously to maintain a tight construction spread to reduce the duration of the open trench and to reduce potential barriers and hazards to wildlife, and by placing gaps in the pipe. During construction, Trans Mountain will manage access (human and predator) at slope changes, crossings (*i.e.,* watercourse, road, pipeline right-of-way and railway) and bends. Measures will be implemented to reduce access (human and predator) along the pipeline right-of-way and will include using woody debris as rollback, and planting trees and/or shrubs at select locations along the pipeline right-of-way. Where rollback and coarse woody debris are needed for access management, erosion control and habitat enhancement, the contractor will ensure that a sufficient supply is set aside for this purpose during final clean-up. Habitat connectivity will be restored by redistributing large-diameter slash (rollback) over select locations on the pipeline right-of-way (*e.g.,* where high levels of coarse woody debris occur prior to construction), to provide cover and facilitate movement of wildlife. Further discussion is provided under wildlife in Section 7.2.10 and the Wildlife Technical Report of Volume 5C. Mitigation measures for wildlife are outlined in the Pipeline EPP (Volume 6B).	Volume 5A Section 7.2.10 Volume 5B Section 7.2.4 Volume 5C Wildlife Technical Report Volume 6B
Sensory disturbance to wildlife during construction activities	Enoch Cree Nation Alexander First Nation Samson Cree Nation Ermineskin Cree Nation Montana First Nation Louis Bull Tribe Alexis Nakota Sioux First Nation Paul First Nation Nakcowinewak Nation Of Canada Simpcw First Nation	Trans Mountain recognizes that many regional changes have occurred since the pipeline was installed over 60 years ago including urban encroachment near some of its existing pump stations and terminals and is aware that noise during operations is of concern to nearby residents. Ambient sound surveys representative of sound levels at noise receptors and existing facilities will be conducted and, all noise level results will be compared to Alberta Energy Regulator's *Directive 038 Noise Control* and the BC OGC's *Noise Control Best Practices Guideline*. Trans Mountain will ensure equipment is well-maintained during construction to minimize air emissions and unnecessary noise. Additionally, Trans Mountain will restrict the duration that vehicles and equipment are allowed to sit and idle to less than one hour unless air temperatures are less than 0°C. Standard mitigation plus noise-specific mitigation measures will be implemented. Mitigation to reduce light and visual effects may include landscaping to limit visual effects to wildlife and the public (*i.e.,* leave a vegetation buffer) and installing lighting control systems in the facility site that permit the reduction of the amount of lighting during periods of low activity. Further discussion is provided under noise and wildlife in Sections 7.2.6, 7.2.10, 7.4.6 and 7.5.6 in Volume 5A and discussion of aesthetics/visual effects is provided under HORU in Sections 5.4 and 7.2.4 in Volume 5B. Mitigation measures for noise, wildlife and visual effects are outlined in the Pipeline and Facilities EPPs (Volumes 6B and 6C).	Volume 5A Sections 7.2.6, 7.2.10, 7.4.6 and 7.5.6 Volume 5B Sections 5.4 and 7.2.4 Volume 5C Terrestrial Noise and Vibration Technical Report Volume 5D Socio-Economic Technical Report Volume 6B Volume 6C

TABLE 3.2-2 Cont'd

Summary of Interest or Concern	Aboriginal Community	Response Summary[1]	Where Issue is Addressed in the Application
Sweep for bear dens prior to construction Disturbance of wildlife dens during construction	Saddle Lake Cree Nation Enoch Cree Nation Alexander First Nation Samson Cree Nation Ermineskin Cree Nation Montana First Nation Louis Bull Tribe Alexis Nakota Sioux First Nation Paul First Nation Nakcowinewak Nation Of Canada Sunchild First Nation Aseniwuche Winewak Nation Lheidli T'enneh Simpcw First Nation Chawathil First Nation Scowlitz First Nation Leq'á:mel First Nation	In the event an active grizzly bear den is found, AESRD will be contacted to discuss mitigation strategies. Recommended setbacks are 750 m for high disturbance activities (*i.e.,* conventional pipelines) and 500 m for medium disturbance activities (*i.e.,* conventional pipeline parallel to a linear corridor) from October 1 to April 30. Trans Mountain will ensure the contractor implements a setback of 750 m for high disturbance activities (*i.e.,* conventional pipelines) and 500 m for medium disturbance activities (*i.e.,* conventional pipeline parallel to a linear corridor) in the event an active grizzly bear den is discovered from October 1 to April 30. In Alberta, in the event an active mammal den is found, a 100 m setback is recommended. Mitigation may include monitoring the den and/or modifying the construction schedule to avoid activity until the den is inactive. Further discussion is provided under wildlife in Section 7.2.10. Mitigation measures for wildlife are outlined in the Pipeline EPP (Volume 6B).	Volume 5A Section 7.2.10 Volume 5C Wildlife Technical Report Volume 6B See above
Effects on endangered species Potential effects to caribou and caribou habitat	Canim Lake Band Lower Nicola Indian Band Aseniwuche Winewak Nation Lheidli T'enneh Simpcw First Nation	RAPs, least risk work windows and setback distance guidelines will be considered under Alberta and BC frameworks to provide effective management for selected wildlife species. The contractor will notify the CWS if clearing of complex habitat (*e.g.,* forests) is scheduled to occur during the migratory bird nesting period; (May 7 to August 20 ([wetlands April 20 to August 25)] in Alberta; and March 15 to August 15 in BC. Additionally, Trans Mountain will discuss the timing of their activity with AESRD and BC regulatory authorities and maintain contact during the construction period to advise them of the construction progress and anticipated completion date within sensitive/key ecological areas. Construction, routine maintenance and operational activities will be scheduled outside the spring period for caribou (generally mid-March to mid-July), unless otherwise approved by AESRD. Further discussion is provided under wildlife and species at risk in Sections 7.2.10 and 7.2.11. Mitigation measures for wildlife and species at risk are outlined in the Pipeline EPP (Volume 6B).	Volume 5A Sections 5.10, 5.11, 7.2.10 and 7.2.11 Volume 6B
Loss of bat habitat during construction	Semiahmoo First Nation	The TMEP has the potential to affect bats and their habitat. In Alberta, roosts and hibernation sites of northern long-eared bats have a year round 300 m setback from high disturbance activities; 100 m setback from medium disturbance activities and a 50 m setback from low disturbance activities. In BC, bat roosts will be protected from disturbance by humans and other sensory disturbances. A 125 m buffer will be implemented from bat hibernacula (from October 1 to April 30 or maternity roost (from May 1 to August 31). If disturbance of a hibernacula or maternity roost is unavoidable, consultation with BC MFLNRO will be conducted to discuss practical options and mitigation strategies. Additionally, Trans Mountain will discuss the timing of their activity with AESRD and BC regulatory authorities and maintain contact during the construction period to advise them of the construction progress and anticipated completion date within sensitive/key ecological areas. Further discussion is provided under wildlife in Section 7.2.10. Mitigation measures for wildlife are outlined in the Pipeline EPP (Volume 6B).	Volume 5A Section 7.2.10 Volume 5C Wildlife Technical Report Volume 6B

TABLE 3.2-2 Cont'd

Summary of Interest or Concern	Aboriginal Community	Response Summary[1]	Where Issue is Addressed in the Application
Potential effects to fish and habitat	Saddle Lake Cree Nation Enoch Cree Nation Alexander First Nation Samson Cree Nation Métis Nation of Alberta (Region 4) Ermineskin Cree Nation Montana First Nation Louis Bull Tribe Alexis Nakota Sioux First Nation Paul First Nation Nakcowinewak Nation Of Canada Sunchild First Nation Aseniwuche Winewak Nation Lheidli T'enneh Simpcw First Nation Lhtako Dene Nation Canim Lake Band Whispering Pines (Clinton Indian Band) BC Metis Federation Tk'emlúp Te Secwépemc Lower Nicola Indian Band Nicola Tribal Association Yale First Nation Chawathil First Nation Shxw'ow'hamel First Nation Cheam First Nation Peters Band Seabird Island Band Popkum First Nation Scowlitz First Nation Leq'á:mel First Nation Semiahmoo First Nation Kwantlen First Nation Squamish First Nation Musqueam Indian Band Pacheedaht First Nation Ts'elxweyeqw Tribe Management Limited T'sou-ke First Nation	Trans Mountain agrees that measures to protect sensitive environmental areas such as water bodies and riparian areas are critical. Trans Mountain takes a multi-layered approach to pipeline safety, including adopting measures such as strategically placed pipeline valves near waterways and trenchless river crossings at some locations. Crossing methods specific to each watercourse will be determined in consultation with engineering and environmental specialists, as well as applicable regulatory authorities. Crossings of wetlands and watercourses will be planned during suitable ground and weather conditions with consideration for sensitive fish and wildlife timing windows. Additionally, water quality will be monitored during all instream activity. Each watercourse will be approached correctly so the cumulative effects of changes to all the crossings and the surrounding watershed will be limited. A summary of the watercourse crossings for the Project are provided in the Fisheries (Alberta) Technical Report and the Fisheries (BC) Technical Report in Volume 5C. Further discussion and mitigation measures to be implemented at watercourse crossings are mentioned under fish and fish habitat in Sections 5.7 and 7.2.7 and the Pipeline EPP (Volume 6B).	Volume 5A Sections 5.7 and 7.2.7 Volume 5C Fisheries (Alberta) Technical Report Fisheries (British Columbia) Technical Report Volume 6B

TABLE 3.2-2 Cont'd

Summary of Interest or Concern	Aboriginal Community	Response Summary[1]	Where Issue is Addressed in the Application
Sensory disturbance to birds and disturbance of bird habitat during construction	Saddle Lake Cree Nation Enoch Cree Nation Alexander First Nation Samson Cree Nation Ermineskin Cree Nation Montana First Nation Louis Bull Tribe Alexis Nakota Sioux First Nation Paul First Nation Nakcowinewak Nation Of Canada Sunchild First Nation Aseniwuche Winewak Nation Lheidli T'enneh Simpcw First Nation Canim Lake Band Whispering Pines (Clinton Indian Band) Lower Nicola Indian Band Yale First Nation Chawathil First Nation Shxw'ow'hamel First Nation Cheam First Nation Ts'elxweyeqw Tribe Management Limited Seabird Island Band Popkum First Nation Scowlitz First Nation Leq'á:mel First Nation	Trans Mountain will work with Environment Canada and comply with the *Migratory Birds Convention Act, 1999, Migratory Bird Sanctuary Regulations* and any provincial and territorial wildlife agencies related to the proposed Project components and effects. Clearing and preconstruction activities will be conducted outside the minimum migratory bird RAP of May 1 to July 31 where practical. Clearing and mowing outside of the appropriate timing window or within the migratory bird season RAP will only be allowed where nest surveys have been completed by a qualified Wildlife Resource Specialist within 7 days of the commencement of clearing and no nesting activity was observed within the applicable setback distance. In the event an active nest is found, a protective buffer will be established around the nest. The size of the buffer will be influenced by the status of the bird. The spatial boundaries of the survey will include at least 30 m beyond the staked construction boundaries for migratory song birds and 50 m in native grassland areas; and 100 m for raptors and waterfowl. If the active nest belongs to a bird with a species-specific buffer, then that buffer applies. In the event that a nest is discovered, an appropriate mitigation strategy will be selected by the Lead Environmental Inspector and Environmental Inspector(s) or Wildlife Resource Specialist from the Wildlife Species of Concern Discovery Contingency Plan (Appendix B of Volume 6B). Further discussion is provided under wildlife in Sections 5.10 and 7.2.10. Mitigation measures for wildlife, including bird habitat, are outlined in the Pipeline EPP (Volume 6B).	Volume 5A Sections 5.10 and 7.2.10 Volume 5C Wildlife Technical Report Volume 6B
Disturbance and loss of amphibian habitat during construction	Saddle Lake Cree Nation Alexander First Nation Samson Cree Nation Alexis Nakota Sioux First Nation Nakcowinewak Nation Of Canada Sunchild First Nation Lower Nicola Indian Band Yale First Nation Leq'á:mel First Nation	Field surveys were conducted for wetlands along the proposed pipeline corridor to identify amphibian habitat. In Alberta, in the event that a western toad breeding pond is found, a year-round 100 m setback distance is recommended. In BC, identified amphibian breeding ponds will be protected by implementing appropriate buffers (150 m undeveloped; 100 m rural; 30 m urban). A year-round 400 m federal setback distance is recommended for western toad breeding ponds and wintering sites. If the proposed construction right-of-way is located within the recommended buffer, consultation will be conducted with the appropriate regulatory agencies to determine the appropriate mitigation measures. Standard wetland construction and reclamation mitigation will be applied (*e.g.,* minimal disturbance, recontouring, reclamation, monitoring and remedial measures) to support habitat reclamation as needed. The Contractor will ensure fencing is installed around wetlands for clearing and construction activities scheduled during the amphibian breeding period (spring), where warranted, to protect important habitat. Amphibian salvage will be conducted prior to clearing and construction activities at known amphibian breeding pond locations. Best Management Practices for Amphibian and Reptile Salvages in BC will be adhered to. Consultation with regulatory authorities will be conducted as appropriate if the proposed pipeline corridor is located within the recommended setback distance of an amphibian breeding pond. Further discussion is provided under wildlife in Section 7.2.10. Mitigation measures for wildlife are outlined in the Pipeline EPP (Volume 6B).	Volume 5A Sections 5.10 and 7.2.10 Volume 5C Wildlife Technical Report Volume 6B

TABLE 3.2-2 Cont'd

Summary of Interest or Concern	Aboriginal Community	Response Summary[1]	Where Issue is Addressed in the Application
Potential loss of wetland habitat, function and water quality also affecting wildlife and vegetation during construction of the Project	Saddle Lake Cree Nation Alexander First Nation Samson Cree Nation Ermineskin Cree Nation Montana First Nation Louis Bull Tribe Alexis Nakota Sioux First Nation Paul First Nation Nakcowinewak Nation Of Canada Sunchild First Nation Lheidli T'enneh Canim Lake Band Yale First Nation Chawathil First Nation Shxw'ow'hamel First Nation Popkum First Nation Leq'á:mel First Nation	As part of Trans Mountain's commitment to environmental protection, Trans Mountain will minimize potential adverse effects to wetlands by expediting construction in and around wetlands, by restoring wetlands to their original configurations and contours, by segregating topsoil during excavation, by permanently stabilizing upland areas near wetlands as soon as possible after backfilling, by inspecting the right-of-way periodically during and after construction, and by repairing any erosion control or restoration features until permanent revegetation is successful. Crossings of wetlands and watercourses will be planned during suitable ground and weather conditions with consideration for sensitive fish and wildlife timing windows. Additionally, water quality will be monitored during all instream activity. Each watercourse will be approached correctly so the cumulative effects of changes to all the crossings and the surrounding watershed will be limited. A summary of the watercourse crossings for the Project are provided in the Fisheries (Alberta) Technical Report and the Fisheries (BC) Technical Report in Volume 5C. Further discussion is provided under fish and fish habitat and wetlands in Sections 5.7, 5.8, 7.2.7 and 7.2.8. Mitigation measures for fish and fish habitat and wetlands are outlined in the Pipeline EPP (Volume 6B).	Volume 5A Sections 5.7, 5.8 ,7.2.7, 7.2.8 and 8.6 Volume 5C Fisheries (Alberta) Technical Report Fisheries (British Columbia) Technical Report Wetland Evaluation Technical Report Volume 6B
Avoid loss of tree stands	Saddle Lake Cree Nation Enoch Cree Nation Alexander First Nation Samson Cree Nation Ermineskin Cree Nation Montana First Nation Alexis Nakota Sioux First Nation Paul First Nation Nakcowinewak Nation Of Canada Sunchild First Nation Lhtako Dene Nation Canim Lake Band Lower Nicola Indian Band Yale First Nation Shxw'ow'hamel First Nation Chawathil First Nation Cheam First Nation Seabird Island Band	One of Trans Mountain's objectives is to use, or abut, the existing TMPL right-of-way where practical. In some cases, trees can be a source of natural sound that masks man-made noises and provide a visual buffer to the right-of-way. Trans Mountain is committed to best practices in reclamation, always striving for opportunities leading to advancement. As with all of its construction projects, Trans Mountain will reclaim any areas that are affected by the Project. Trans Mountain is committed to reclamation of the pipeline right-of-way and surrounding areas following construction. Following construction, Trans Mountain aims to return the right-of-way to pre-construction conditions, to the extent practical. This could include adding new footpaths, developing new habitats, improving water crossings or bettering migration corridors. Reclamation efforts could include the planting of native plant and grass species, riparian and wetland areas, wildlife habitats and any other areas disturbed during construction. Post-construction environmental monitoring and ongoing right-of-way maintenance will continue following construction (see Volume 6A). If warranted, site-specific mitigation measures based on location and species will be determined once the route is finalized in accordance with the Rare Ecological Community and Rare Plant Population Management Plan (Appendix C of Volume 6B). Further discussion is provided under vegetation in Section 7.2.9. Mitigation measures for vegetation are outlined in the Pipeline and Facilities EPPs (Volumes 6B and 6C).	Volume 5A Sections 5.9 and 7.2.9 Volume 5C Vegetation Technical Report Volume 6A Volume 6B Volume 6C

TABLE 3.2-2 Cont'd

Summary of Interest or Concern	Aboriginal Community	Response Summary[1]	Where Issue is Addressed in the Application
Reclaim Project lands to pre-construction state	Saddle Lake Cree Nation Enoch Cree Nation Alexander First Nation Samson Cree Nation Ermineskin Cree Nation Montana First Nation Alexis Nakota Sioux First Nation Foothills Ojibway Society Paul First Nation Nakcowinewak Nation Of Canada Sunchild First Nation Canim Lake Band Tk'emlúp Te Secwépemc Chawathil First Nation Shxw'ow'hamel First Nation Ts'elxweyeqw Tribe Management Limited Musqueam Indian Band	Trans Mountain will implement the Reclamation Management Plan (Appendix C of Volume 6B) that includes construction reclamation measures to be implemented prior to, during and following pipeline installation in order stabilize and revegetate affected lands that in time achieve land productivity along the right-of-way equivalent to the adjacent land use and ensuring the ability of the land to support various land uses. Construction reclamation activities are measures conducted as part of the main construction program. The primary goal of reclamation measures is to reduce adverse effects of pipeline construction and return the affected lands to a stable, non-erosive condition that will promote the re-establishment of land productivity. This process involves measures such as: topsoil and root zone material salvage; subsoil conditioning and grade and drainage re-establishment; topsoil and root zone material replacement; installation and maintenance of temporary and permanent erosion and sediment control measures; and revegetation. During the 2012 and 2013 field seasons, a number of environmental and engineering field programs were conducted to assess existing conditions and types of land use in the Project area, as well as identify possible socio-economic effects. These programs occurred in both Alberta and BC, and involved the work of a number of teams in various disciplines. Trees, stumps, brush and other vegetation will be cleared from the construction right-of-way; temporary work sites; and permanent facilities that are not located on existing TMPL previously cleared easements. Timber harvesting and/or land clearing and debris disposal activities will be coordinated according to Provincial legislation or agreements. Where present in non-forested areas, topsoil/root zone material will be salvaged to ensure that soil productivity is maintained. The width and depth of topsoil or strippings salvage will depend on the land use, soil conditions, microtopography, regulatory authority requests and grading requirements. Any salvaged topsoil or root zone material will be separated from spoil piles and stored along the construction right-of-way and at facility sites in low-profile berms or windrows. Equipment used during topsoil/root zone material handling activities will include bulldozers, graders and backhoes. Lands in Alberta, and lands outside the Agricultural Land Reserve in BC, will be reclaimed with native and non-native seed mixes developed for the Project that are based on vegetation field survey data and will follow consultation with landowners/lessees or appropriate regulatory authorities. Discussions with the Agricultural Land Commission will be ongoing to discuss potential effects of the Project on Agricultural Land Reserve lands. Restoration and monitoring activities typically extend for a number of years following construction to ensure areas disturbed during construction are satisfactorily restored. Further discussion is provided under vegetation in Sections 5.9 and 7.2.9. Mitigation measures for vegetation are outlined in the Pipeline and Facilities EPPs (Volumes 6B and 6C).	Volume 5A Sections 5.9 and 7.2.9 Volume 5C Vegetation Technical Report Volume 6A Volume 6B Volume 6C
Request for wildlife monitors during construction and post-construction site visits with Aboriginal communities Involve Elders in Project reclamation work	Enoch Cree Nation Samson Cree Nation Métis Nation of Alberta (Region 4) Tk'emlúp Te Secwépemc	Trans Mountain will continue to engage Aboriginal communities through all phases of the Project. The EPPs provide mitigation measures developed in response to issues identified during Project planning, stakeholder consultation, Aboriginal engagement and regulatory discussions. Aboriginal Monitors onsite through the construction to commissioning of the of the Project will work with environmental inspector to provide traditional knowledge to the construction program to ensure protection of the environment; to discuss upcoming traditional and western science elements with the environmental inspector to insure protection and monitoring; and to monitor mitigation success in protecting the environment. Aboriginal engagement is discussed in Volume 3B and the use of Aboriginal Monitors is discussed in Volume 6A. The Pipeline and Facilities EPPs can be found in Volumes 6B and 6C, respectively.	Volume 3B Volume 6A Volume 6B Volume 6C

TABLE 3.2-2 Cont'd

Summary of Interest or Concern	Aboriginal Community	Response Summary[1]	Where Issue is Addressed in the Application
Spread of invasive species and use of chemical vegetation management	Saddle Lake Cree Nation Enoch Cree Nation Samson Cree Nation Alexander First Nation Ermineskin Cree Nation Montana First Nation Louis Bull Tribe Alexis Nakota Sioux First Nation Paul First Nation Sunchild First Nation Nakcowinewak Nation Of Canada Aseniwuche Winewak Nation Lheidli T'enneh Canim Lake Band Lhtako Dene Nation Whispering Pines (Clinton Indian Band) Lower Nicola Indian Band Nicola Tribal Association Nooaitch Indian Band Yale First Nation Chawathil First Nation Shxw'ow'hamel First Nation Ts'elxweyeqw Tribe Management Limited Seabird Island Band Popkum First Nation Scowlitz First Nation Leq'á:mel First Nation Tzeachten First Nation Semiahmoo First Nation Kwantlen First Nation Squamish First Nation Musqueam Indian Band	Trans Mountain will utilize an Integrated Vegetation Management (IVM) approach to carry out problem vegetation management practices for the Project and to meet the overall objectives of IVM for all Trans Mountain pipelines and facilities. Trans Mountain will ensure the contractor implements weed management (*i.e.,* using proper application of chemical, mechanical or manual measures, or a combination of all) at locations identified within the pre-construction weed survey to a level that is consistent with weed management observed adjacent to the eventual construction right-of-way to reduce the potential for weed infestations following construction. The contractor will restrict all vehicular traffic to the approved and staked construction right-of-way, workspace and access roads. The contractor will also ensure equipment arrives at all construction sites clean and free of soil or vegetative debris. Inspect and identify equipment deemed to be acceptable with a suitable marker, such as a sticker. No equipment arriving in a dirty condition will be allowed on site until it has been cleaned. Trans Mountain will consult with the public, adjacent landowners and Aboriginal communities affected by the Project regarding problem vegetation management and methods of treatment. IVM is an adaptive management process involving the use of various methods in a cost effective and responsible manner to reduce the use of herbicides, promote healthy ecosystems, provide measurable results and facilitate better management of problem vegetation. The Weed and Vegetation Management Plan (Appendix C of Volume 6B) for the Project will address non-chemical, cultural and chemical techniques for problem vegetation management along the construction right-of-way through recommendations of vegetation management procedures, which include timing considerations; select methods and equipment; and specific vegetation management procedures based on prevention, identification, monitoring, treatment thresholds, vegetation management options and post-treatment evaluation considerations. Further discussion is provided under vegetation in Sections 5.9 and 7.2.9. Mitigation measures for vegetation are outlined in the Pipeline and Facilities EPPs (Volumes 6B and 6C).	Volume 5A Sections 5.9 and 7.2.9 Volume 5C Vegetation Technical Report Volume 6B Volume 6C
Soil Reclamation/Topsoil Salvage	Alexander First Nation Louis Bull Tribe Alexis Nakota Sioux First Nation Sunchild First Nation Paul First Nation Nakcowinewak Nation Of Canada Leq'á:mel First Nation	Where present in non-forested areas, topsoil/root zone material will be salvaged to ensure that soil productivity is maintained. The width and depth of topsoil/root zone material salvage will depend on the land use, soil conditions, microtopography, regulatory agency requests and grading requirements. Any salvaged topsoil/root zone material will be segregated and stockpiled along the construction right-of-way and at facility sites in low-profile berms or in piles adjacent to the site perimeter. An Agricultural Management Plan (Appendix C of Volume 6B) been developed to particularly reduce effects on agriculture, which includes measures related to proper soil handling and reseeding. Subsoil and topsoil stoniness on right-of-way will match that off right-of-way (stone size and density) on agricultural land and native grasslands. Further discussion is provided under soil and soil productivity in Sections 5.2 and 7.2.2. Mitigation measures for soil and soil productivity are outlined in the Pipeline EPP (Volume 6B).	Volume 5A Sections 5.2 and 7.2.2 Volume 5C Soils Technical Report Volume 6B

TABLE 3.2-2 Cont'd

Summary of Interest or Concern	Aboriginal Community	Response Summary[1]	Where Issue is Addressed in the Application
Cumulative effects of industrial development on plants	Alexander First Nation Samson Cree Nation Ermineskin Cree Nation Louis Bull Tribe Alexis Nakota Sioux First Nation Sunchild First Nation Lheidli T'enneh Lhtako Dene Nation Nicola Tribal Association Yale First Nation Chawathil First Nation Shxw'ow'hamel First Nation	Potential Project-related cumulative effects will be mitigated with implementation of the following design and construction measures. Align the proposed pipeline corridor to follow existing linear features such as pipelines and disturbed areas such as facilities/clearings to the extent practical. Encourage rapid regeneration of natural vegetation. The Project's contribution to cumulative effects with reasonably foreseeable developments is assessed in Section 8.0, including Project's contribution to cumulative effects on vegetation in Section 8.8. Mitigation measures are presented in the Pipeline EPP (Volume 6B).	Volume 5A Sections 5.9, 7.2.9, 8.0 and 8.8 Volume 6B
Post signage to share Aboriginal traditional plant use knowledge near the Project, excluding medicinal plant use or confidential knowledge	Enoch Cree Nation Alexander First Nation Métis Nation of Alberta (Region 4) Ermineskin Cree Nation Montana First Nation Paul First Nation Nakcowinewak Nation Of Canada Aseniwuche Winewak Nation Lheidli T'enneh Lhtako Dene Nation Whispering Pines (Clinton Indian Band) Tk'emlúp Te Secwépemc Lower Nicola Indian Band Nicola Tribal Association Yale First Nation Popkum First Nation Le'qa:mel First Nation	Trans Mountain is committed to continued listening, learning and working with Aboriginal people to ensure that knowledge and advice is fully considered and incorporated in the Project. Trans Mountain will continue to engage Aboriginal communities to identify continued opportunities for sharing of knowledge during all phases of the Project. Aboriginal engagement is discussed further in Volume 3B.	Volume 3B

TABLE 3.2-2 Cont'd

Summary of Interest or Concern	Aboriginal Community	Response Summary[1]	Where Issue is Addressed in the Application
Oil spills/leaks, concerns for speed of response if such a spill/leak was to occur	Saddle Lake Cree Nation Alexander First Nation Samson Cree Nation Ermineskin Cree Nation Montana First Nation Louis Bull Tribe Alexis Nakota Sioux First Nation Paul First Nation Nakcowinewak Nation Of Canada Sunchild First Nation Whispering Pines (Clinton Indian Band) Lower Nicola Indian Band Nicola Tribal Association Yale First Nation Chawathil First Nation Shxw'ow'hamel First Nation Cheam First Nation Ts'elxweyeqw Tribe Management Limited Popkum First Nation Scowlitz First Nation Leq'á:mel First Nation Tsleil-Waututh Nation Chemainus First Nation Cowichan Nation Aliance Halalt First Nation Penelakut First Nation	Safety is a top priority and is at the core of who Trans Mountain is as a company. Dedicated staff work to maintain the integrity of the pipeline through Trans Mountain's maintenance, inspection, and awareness programs. While no spill is acceptable to Trans Mountain, accidents can happen. Trans Mountain agrees that measures to protect sensitive environmental areas such as water bodies and riparian areas are critical. This is why Trans Mountain takes a multi-layered approach to pipeline safety, including taking measures such as strategically placed pipeline valves near waterways and drilled river crossings at some locations. Trans Mountain control centre operators monitor the pipeline 24 hours per day, 7 days a week, 365 days a year using a sophisticated leak detection system as well as pressure and flow alarms. Operators are prepared to shut the pipeline down immediately if there is any indication of a potential problem on the pipeline. In the event of an emergency, Trans Mountain will immediately mobilize all of the necessary resources to minimize its effect on the public and the environment. Trans Mountain has comprehensive spill response plans in place for the Trans Mountain pipeline and facilities. These plans are constantly being updated to keep them current and are regularly practiced through deployment exercises. While the specific strategies used in response to a spill will vary depending on the circumstances, the primary objectives in all cases are to ensure safety and to minimize environmental damage. To ensure there are sufficient funds to remediate a spill, Trans Mountain is covered by insurance necessary to respond to all spills or releases from Trans Mountain's pipelines and facilities. Trans Mountain monitors the insurance program continuously, and makes annual adjustments as necessary to ensure adequate coverage. Accidents and malfunctions are discussed in Section 7.9. Large onshore oil spills are discussed in Volume 7.	Volume 5A Section 7.9 Volume 6B Volume 6C Volume 7
Increased erosion and run-off	Alexander First Nation Ermineskin Cree Nation Alexis Nakota Sioux First Nation Paul First Nation Sunchild First Nation Lheidli T'enneh Whispering Pines (Clinton Indian Band) Yale First Nation Chawathil First Nation Shxw'ow'hamel First Nation Cheam First Nation Ts'elxweyeqw Tribe Management Limited Seabird Island Band Popkum First Nation Scowlitz First Nation Leq'á:mel First Nation Tsleil-Waututh Nation	If wind or water erosion is evident during the construction phase of the Project, contractor equipment and personnel will be made available to control the erosion. During the construction phase, the Environmental Inspector, in consultation with Trans Mountain's environmental staff, will determine appropriate procedures to be implemented to control soil erosion and other soil handling problems that may be encountered. Similar procedures will be followed during the operational phase. Further discussion is provided under soil and soil productivity in Sections 5.2, 7.2.2 and 7.4.2. Mitigation measures for soil and soil productivity are outlined in the Pipeline EPP (Volume 6B).	Volume 5A Sections 5.2, 7.2.2 and 7.4.2 Volume 5C Soils Technical Report Volume 6B

Note: 1 Detailed mitigation measures are outlined in the Project-specific EPPs (Volumes 6B, 6C and 6D).

3.3 Landowner Relations

The primary objectives of the landowner relations program were to introduce the Project to landowners and occupants and obtain approval for land access on a timely basis to support required engineering and environmental surveys. Over the long-term, the program objectives are obtaining landowner understanding, acceptance, and land rights for survey, construction, restoration and transition to operations. This approach also serves to preserve good relationships that currently exist and reinforce positive relations into operations.

Land stakeholder groups include private landowners, freehold and Crown occupants, and public landowners (federal, provincial, and municipal). Landowner issues include land rights, compensation, land-specific construction and restoration activities, as well as broader Project and policy issues. The program will attempt to engage all appropriate internal groups where necessary to address issues and concerns effectively.

Trans Mountain designed the program with the following objectives:

- introduce the Project to landowners in a manner that establishes a basis for a positive ongoing working relationship;
- support engineering and environment disciplines in determining Project routing and facility configuration by obtaining landowner survey consent;
- develop the Land Program Strategy to guide land rights acquisition;
- acquire necessary land rights to enable the Project to be constructed and placed into operation;
- obtain necessary third-party crossing approvals to enable the Project to be constructed safely;
- provide support to the regulatory applications and the regulatory process for the Project;
- support construction and restoration activities, including post-construction damage settlements; and
- transfer Project land information and landowner files to Trans Mountain Operations.

Trans Mountain recognizes the program must adapt to the needs of landowners and the Project, therefore, Trans Mountain will continuously review and assess the program to ensure that it is being conducted in the most effective and efficient manner.

3.3.1 Design of Program

Trans Mountain and its land agents began implementing the program in April 2012, and it continues to be an ongoing process. Internal processes within the program continue to evolve to better support the Project and in response to changes within engineering, environmental, and operational functions. A detailed description of the program is provided in Volume 3C.

3.3.1.1 Landowner Notification

Trans Mountain identified a proposed pipeline corridor of generally 150 m width along the entire length of the Project. The corridor typically follows the TMPL system right-of-way but deviations have been identified as necessary. A land titles search to confirm the land and interest ownership was then initiated for lands within the proposed pipeline corridor. As the Project route is finalized, additional landowners and occupants may be identified; contact with newly identified landowners and occupants will be consistent with the format identified in Section 1.3.3 of Volume 3A.

<u>Notification of Landowners</u>

Trans Mountain and its land agents commenced the program in April 2012 and it continues to be an ongoing process. To ensure that Trans Mountain introduced the Project to landowners along the existing system, an initial contact letter (Volume 3C) was sent to all 2,390 landowners.

An additional letter was hand delivered to all urban residents along the TMPL system right-of-way in Edmonton, Alberta, and the BC Lower Mainland in August 2012 to inform the residents that Trans Mountain intended to pursue alternative routing in their communities.

Notification of Crown Occupants

A mail out was conducted with select Crown tenure holders with interests crossed by the proposed pipeline corridor who had not been contacted via other methods (*e.g.,* through the lands team or other disciplines on the assessment team). The mail out process was designed to provide an opportunity for the selected tenure holders (*e.g.*, agricultural tenure holders, commercial recreation tenure holders, guide-outfitters and registered trap line tenure holders) to identify key concerns related to Project activities and/or provide feedback on land/resource use patterns that may be affected.

3.3.1.2 Consultation and Survey Consent

The program uses a direct contact approach as it enables Trans Mountain's land agents to personally provide information to landowners and occupants about the Project and proposed studies. It also provides landowners and Crown occupants an opportunity to ask questions and identify concerns about the Project or the TMPL. These questions and concerns are passed on to the Project team. Trans Mountain's intention is to provide response to each landowner or occupant's concern or issue. The process has begun and will continue through all phases of landowner and occupant engagement.

Landowners and occupants located within the proposed pipeline corridor and likely to be directly affected by the Project were requested to provide consent for engineering and environmental study. Requests were usually made face-to-face and written or verbal consent was accepted.

Along this corridor, 1,325 landowners and 295 Crown rights holders in Alberta were contacted. In BC, 4,013 landowners and 615 Crown rights holders and pending land purchasers were contacted (Table 3.3-1).

TABLE 3.3-1

LANDOWNERS AND OCCUPANTS WITHIN THE PROPOSED PIPELINE CORRIDOR

Group	Alberta	BC	Total
Private Landowners	1,325	4,013	5,338
Crown Occupants and Pending Purchasers	295	615	910
Total	1,620	4,628	6,248

The approach provided an opportunity to collect information on aspects of the land which could be helpful in defining a route or potential effects of the Project on the environment.

Communication with landowners and occupants is ongoing and questions or concerns will continue to be addressed throughout the life of the Project.

3.3.1.3 Corridor Survey Limitations

Landowners and Occupants

Some landowners and occupants refused to provide consent for surveys. Surveys were not completed on those respective land parcels. The occurrences of refusal are intermittently distributed throughout the length of the Project.

The reasons, when provided, varied substantially. Where opportunities existed, an agent revisited the landowner or occupant to verify their position or determine if circumstances had changed that would allow provision of consent.

Some landowners and occupants consented to survey but such surveys were to be restricted to the TMPL right-of-way only. Areas between the right-of-way and the proposed pipeline corridor boundaries were not accessible.

BC Provincial Parks

Application was made to BC Parks in December 2012 for an Education and Research Park Use Permit to conduct environmental studies within BC Parks. In June 2013, BC Parks requested the application be revised and re-submitted for only intrusive types of surveys (*e.g.*, ground disturbances and electro-fishing). With permission from BC Parks, certain non-intrusive studies have been conducted on some Park lands. The Education and Research Park Use permit application was approved on November 15, 2013.

Indian Reserves

The TMPL crosses 15 IRs and the Aboriginal engagement team is involved in various stages of negotiation with each of the respective Aboriginal communities. Some Aboriginal communities have provided explicit consent for surveys, while others are anticipated to provide a decision on the matter in the near future.

Tk'emlúps Te Secwépemc

Tk'emlúps Te Secwépemc requested Trans Mountain to defer environmental field studies on traditional lands until Tk'emlúps Te Secwépemc was prepared to participate. The request affected studies within the corridor from the proposed Black Pines Pump Station in BC (reference kilometre [RK] 811.9) to Trans Mountain's Stump Pump Station (RK 862.7). Trans Mountain respected their request and postponed studies in June 2013 and part of July 2013. Further delay would result in lost study opportunities due to seasonal effects; therefore, with permission from Tk'emlúps Te Secwépemc, Trans Mountain resumed environmental studies on the traditional lands.

3.3.1.4 Land Acquisition

Section 5.4 of Volume 2 provides a detailed description of Land Acquisition.

3.3.1.5 Ongoing Relations

Trans Mountain will remain in contact with affected landowners and occupants throughout the Project life. Questions or concerns regarding the Project will be addressed as they arise. Once system operations commence, all landowner information will be transferred to Trans Mountain operations as the permanent record of land data.

3.3.2 Summary of Outcomes of the Public Consultation Program as it Relates to Biophysical Elements

The data presented in this subsection was collected from April 2012, to July 31, 2013. Updates from the program will be filed with the NEB as updates when requested.

Landowner meetings comprised discussions about the Project in general as well as requests for consent for Project-specific surveys. The meetings also provided an opportunity for landowners to ask questions and identify concerns regarding the Project. Tables 3.3-2 to 3.3-9 provide information on the key topics relating to the biophysical assessment and where these topics are addressed in the application.

3.3.2.1 Physical and Meteorological Environment

TABLE 3.3-2

INTERESTS OR CONCERNS RELATED TO PHYSICAL AND METEOROLOGICAL ENVIRONMENT

Summary of Interest or Concern	Response Summary	Where Issue is Addressed in the Application
Landowner noted area prone to rockslide; flood control done by province in 1971	The TMEP will be incorporated into Trans Mountain's existing Pipeline Integrity Program. Trans Mountain's Pipeline Integrity Program has years of experience maintaining the existing TMPL. Through the Pipeline Integrity Program, Trans Mountain performs aerial surveillance to monitor for geotechnical events – such as landslides, hydrological (stream or river crossings) or third-party activity at least once a month for every section of the route. Additionally, on-ground surveys of all water crossings take place on a regularly scheduled basis. A discussion of geotechnical issues is provided under physical and meteorological environment in Sections 5.1 and 7.2.1. Additional details and site-specific information on terrain and natural hazards is provided in the Terrain Mapping and Geohazard Inventory of Volume 4A.	Volume 5A Sections 5.1 and 7.2.1 Volume 4A Terrain Mapping and Geohazard Inventory

3.3.2.2 Soil and Soil Productivity

TABLE 3.3-3

INTERESTS OR CONCERNS RELATED TO SOIL AND SOIL PRODUCTIVITY

Summary of Interest or Concern	Response Summary	Where Issue is Addressed in the Application
Property is a potato farm. Occupant has soil handling concerns. The occupant also advised that the potato farm has had potato cyst nematode issues	An Agricultural Management Plan (Appendix C of Volume 6B) has been developed to particularly reduce effects on agriculture, which includes measures related to topsoil handling, soil compaction, management of crop disruption, and crop and productivity loss. A discussion of soils, including potato cyst nematode, is provided under soil and soil productivity in Sections 5.2, 7.2.2 and 7.2.4. Mitigation measures are outlined in the Pipeline and Facilities EPPs (Volume 6B and 6C).	Volume 5A Sections 5.2, 7.2.2 and 7.4.2 Volume 5C Soils Technical Report Volume 6B Volume 6C
Several landowner concerns over the spread of clubroot	Generally, the best available mitigation for the spread of clubroot is to clean equipment involved in topsoil handling so that topsoil is not carried from landowner to landowner and/or from county to county, as presented in the Alberta *Clubroot Management Plan* (Alberta Agriculture and Rural Development 2010) and CAPP *Best Management Practices for Clubroot Disease* (CAPP 2008). A discussion of clubroot is provided under soil and soil productivity in Sections 5.2 and 7.2.2. Mitigation measures for clubroot are outlined in the Pipeline EPP (Volumes 6B).	Volume 5A Sections 5.2 and 7.2.2 Volume 5C Soils Technical Report Volume 6B
Landowner voiced concerns over ditch compaction	A detailed soil survey of soils with agricultural capability was conducted for the TMEP and soils susceptible to compaction and rutting have been identified. An Agricultural Management Plan (Appendix C of Volume 6B) has been developed to particularly reduce effects on agriculture, which includes measures related to soil compaction. A discussion of soils is provided under soil and soil productivity in Sections 5.2 and 7.2.2. Mitigation measures to reduce soil compaction are outlined in the Pipeline EPP (Volume 6B).	Volume 5A Sections 5.2 and 7.2.2 Volume 5C Soils Technical Report Volume 6B

TABLE 3.3-3 Cont'd

Summary of Interest or Concern	Response Summary	Where Issue is Addressed in the Application
Landowner concerns regarding excess rocks on right-of-way prior to seeding	A detailed soil survey of soils with agricultural capability was conducted for the TMEP and excessively stony soils have been identified. Trans Mountain will pick stones on cultivated, hayland, pasture and native grassland land uses so that the stone content of exposed subsoils that have been disturbed by construction activity is equivalent to that of exposed subsoils that have not been disturbed. After topsoil replacement, stones will be picked on agricultural and native grasslands so that the construction right-of-way surface is equivalent (*i.e.,* stone size and density) to that of adjacent lands. Stones will be disposed of at locations approved by landowner or appropriate regulatory authority, where warranted. A discussion of soils is provided under soil and soil productivity in Sections 5.2 and 7.2.2. Mitigation measures for excess subsoil and topsoil stoniness are outlined in the Pipeline EPP (Volume 6B).	Volume 5A Sections 5.2 and 7.2.2 Volume 5C Soils Technical Report Volume 6B
Landowner concern regarding proper soil handling and accuracy, excess stoniness and roots, and proper reseeding as per landowner preference	Where present in non-forested areas, topsoil or root zone material will be salvaged to ensure that soil productivity is maintained. A detailed soil survey of soils with agricultural capability was conducted for the TMEP that identified the soil series encountered along the proposed pipeline corridor. The width and depth of topsoil or root zone material salvage will depend on the land use, soil conditions, microtopography, regulatory authorities' requests and grading requirements. Any salvaged topsoil or root zone material will be segregated and stockpiled along the construction right-of-way and at facility sites in low-profile berms or in piles adjacent to the site perimeter. An Agricultural Management Plan (Appendix C of Volume 6B) has been developed to reduce effects on agricultural lands, which includes measures related to proper soil handling and reseeding. Subsoil and topsoil stoniness on right-of-way will be equivalent to that off right-of-way (stone size and density) on agricultural land and native grasslands. A discussion of soils is provided under soil and soil productivity in Sections 5.2 and 7.2.2. Mitigation measures are outlined in the Pipeline EPP (Volume 6B).	Volume 5A Sections 5.2 and 7.2.2 Volume 5C Soils Technical Report Volume 6B

3.3.2.3 *Water Quality and Quantity*

TABLE 3.3-4

INTERESTS OR CONCERNS RELATED TO WATER QUANTITY AND QUALITY

Summary of Interest or Concern	Response Summary	Where Issue is Addressed in the Application
Landowner requests testing of wells, concerned about water backing up and flooding Landowner water quality concerns and testing requirements in the event water backs up into well Potential concern regarding drainage and lagoon Landowner concerned about flooding water well from construction Landowner concerned that the disturbance during construction could lead to silt in water well and lower water quality Several general landowner concern regarding effects to nearby wells	Trans Mountain has conducted groundwater studies to determine water wells in proximity to the proposed pipeline corridor. Prior to construction, Trans Mountain's Hydrogeological Professional, in consultation with landowners and the appropriate regulatory authorities, will determine if springs and wells used for domestic purposes located within the immediate vicinity of the construction right-of-way will be sampled for water quality and flow rate prior to the commencement of construction. Trans Mountain will re establish or replace a potable water supply, as required, should a registered or known water well located within 30 m of the construction right-of-way be damaged (*i.e.,* diminishment in quantity and/or quality) during pipeline installation. Trans Mountain will follow-up with landowner to gather details of flooding concern. A discussion of groundwater quality and quantity is provided under water quality and quantity in Sections 5.3 and 7.2.3. Mitigation measures are outlined in the Pipeline EPP (Volume 6B).	Volume 5A Sections 5.3 and 7.2.3 Volume 5C Groundwater Technical Report Volume 6B
Landowner concerns regarding the potential for erosion from drainage corridor across the pipeline, as well as bank destabilization and subsequent flooding	The Reclamation Management Plan (see Appendix C of Volume 6B) will be implemented to re-establish stream banks and approaches, and restore natural drainage patterns following construction, and appropriate erosion control measures will be implemented. Post-construction environmental monitoring and ongoing right-of-way maintenance will identify areas where additional erosion and drainage control as well as bank stabilization measures are required. A discussion of erosion and watercourse crossing mitigation and reclamation strategies is provided under water quality and quantity and fish and fish habitat in Sections 5.3, 5.7, 7.2.3 and 7.2.7. Mitigation measures are outlined in the Pipeline EPP (Volume 6B), while post-construction environmental monitoring is discussed in Volume 6A.	Volume 5A Sections 5.3, 5.7, 7.2.3 and 7.2.7 Volume 5C Fisheries (Alberta) Technical Report Fisheries (British Columbia) Technical Report Volume 6A Volume 6B
Several landowner concerns regarding stream crossings on property	Trans Mountain conducted studies along the proposed pipeline corridor to identify all watercourse crossings. Appropriate watercourse crossing methods have been selected in consideration of the size, environmental sensitivities of the watercourse and the period of construction. Each watercourse will be approached correctly so the cumulative effects of changes to all the crossings and the surrounding watershed would be limited. Further discussion is provided under water quality and quantity and fish and fish habitat in Sections 5.3, 5.7, 7.2.3 and 7.2.7. Mitigation measures are outlined in the Pipeline EPP (Volume 6B), while post-construction environmental monitoring is discussed in Volume 6A.	Volume 5A Sections 5.3, 5.7, 7.2.3 and 7.2.7 Volume 5C Fisheries (Alberta) Technical Report Fisheries (British Columbia) Technical Report Volume 6A Volume 6B
The landowner is concerned with the quality and production of the six artisan springs on the property being affected	Prior to construction, Trans Mountain's Hydrogeological Professional, in consultation with landowners and the appropriate regulatory authorities, will determine if springs and wells used for domestic purposes located within the immediate vicinity of the construction right-of-way will be sampled for water quality and flow rate prior to the commencement of construction. A discussion of groundwater quality and quantity is provided under water quality and quantity in Sections 5.3 and 7.2.3. Mitigation measures are outlined in the Pipeline EPP (Volume 6B).	Volume 5A Sections 5.3 and 7.2.3 Volume 5C Groundwater Technical Report Volume 6B

TABLE 3.3-4 Cont'd

Summary of Interest or Concern	Response Summary	Where Issue is Addressed in the Application
Landowner is concerned regarding the aquifer as it is the only source of drinking water in Chilliwack, BC	Trans Mountain will assess water quality and/or quantity changes to nearby groundwater which may result in adverse effects for other stakeholder or environmental receptors. Trans Mountain reviewed existing geological, hydrogeological and other information to determine potential hydrogeological conditions along the pipeline right-of-way and proposed facilities; GIS mapping and assessment strategies were applied. Trans Mountain developed site-specific hydrogeological investigation activities that included field verified surveys, hydraulic response testing, monitoring requirements and water quality parameter surveys. A discussion of groundwater quality and quantity is provided under water quality and quantity in Sections 5.3 and 7.2.3. Mitigation measures are outlined in the Pipeline EPP (Volume 6B).	Volume 5A Sections 5.3 and 7.2.3 Volume 5C Groundwater Technical Report Volume 6B

3.3.2.4 Acoustic Environment

TABLE 3.3-5

INTERESTS OR CONCERNS RELATED TO ACOUSTIC ENVIRONMENT

Summary of Interest or Concern	Response Summary	Where Issue is Addressed in the Application
Increased noise near residence from pipeline construction Increased noise in town during construction where there are many residential properties	Pipeline construction is expected to last for approximately 3 months at any location along the propose pipeline corridor. However, within that period, the various phases of construction will occur consecutively. Noise, dust and other disturbances are mitigated to avoid the effects on people near the construction. Ambient sound surveys representative of sound levels at noise receptors and existing facilities were conducted and, all noise level results were compared to Alberta Energy Regulator's *Directive 038 Noise Control* and the BC OGC's *Noise Control Best Practices Guideline*. Standard mitigation such as maintaining equipment in good working condition and maintaining noise suppression equipment on all construction machinery and vehicles in good order will be implemented. In urban environments, Trans Mountain will prepare noise management plan for implementation during construction. A discussion of noise during pipeline construction and operations is provided under acoustic environment in Sections 5.6 and 7.2.6 of Volume 5A. In addition, noise as a sensory disturbance to residents and other land users, is discussed under human occupancy and resource use in Sections 5.4 and 7.2.4 of Volume 5B. Mitigation measures are outlined in the Pipeline EPP (Volume 6B).	Volume 5A Sections 5.6 and 7.2.6 Volume 5B Sections 5.4 and 7.2.4 Volume 5C Terrestrial Noise and Vibration Technical Report Volume 5D Socio-Economic Technical Report Volume 6B

TABLE 3.3-5 Cont'd

Summary of Interest or Concern	Response Summary	Where Issue is Addressed in the Application
Landowner property located near pump station; raised noise, light and visual concerns Several landowner concerns regarding excessive noise at existing pump stations. Requesting sound surveys to ensure noise is within regulation	Trans Mountain will ensure equipment is well-maintained during construction to minimize air emissions and unnecessary noise. Additionally, Trans Mountain will restrict the duration that vehicles and equipment are allowed to sit and idle to less than 1 hour unless air temperatures are less than 0°C. Trans Mountain recognizes that many regional changes have occurred since the pipeline was installed over 60 years ago including urban encroachment near some of its existing pump stations and terminals and is aware that noise during operations is of concern to nearby residents. Ambient sound surveys representative of sound levels at noise receptors and existing facilities were conducted and, all noise level results were compared to Alberta Energy Regulator's *Directive 038 Noise Control* and the BC OGC's *Noise Control Best Practices Guideline*. Standard mitigation plus noise-specific mitigation measures will be implemented. Mitigation to reduce light and visual effects may include landscaping to limit visual effects to wildlife and the public (*i.e.,* leave a vegetation buffer) and installing lighting control systems in the facility site that permit the reduction of the amount of lighting during periods of low activity. A discussion of noise during construction and operations is provided under acoustic environment in Sections 5.6, 6.0, 7.2.6, 7.4.6 and 7.5.6 of Volume 5A. In addition, noise and visual sensory disturbance to residents and other land users is discussed under human occupancy and resource use in Sections 5.4 and 7.2.4 of Volume 5B. Mitigation measures are outlined in the Pipeline and Facilities EPPs (Volume 6B and 6C).	Volume 5A Sections 5.6, 6.0, 7.2.6, 7.4.6 and 7.5.6 Volume 5B Sections 5.4 and 7.2.4 Volume 5C Terrestrial Noise and Vibration Technical Report Volume 5D Socio-Economic Technical Report Volume 6B Volume 6C
Landowner concern regarding vibrations caused during pipeline construction and potential damage to residence	Pipeline construction is expected to last for approximately 3 months at any location along the propose pipeline corridor. However, within that period, the various phases of construction will occur consecutively. In areas where there may be a concern regarding the safety of the public, restricted areas are established. Noise, dust and other disturbances are mitigated to avoid effects on people near the construction. The issue of noise vibration is provided under acoustic environment in Sections 5.6 and 7.2.6 of Volume 5A. In addition, noise as a sensory disturbance to residents and other land users is discussed under human occupancy and resource use in Sections 5.4 and 7.2.4 of Volume 5B. Mitigation measures are outlined in the Pipeline EPP (Volume 6B).	Volume 5A Sections 5.6 and 7.2.6 Volume 5B Sections 5.4 and 7.2.4 Volume 5C Terrestrial Noise and Vibration Technical Report Volume 5D Socio-Economic Technical Report Volume 6B

3.3.2.5 Wetlands

TABLE 3.3-6

INTERESTS OR CONCERNS RELATED TO WETLANDS

Summary of Interest or Concern	Response Summary	Where Issue is Addressed in the Application
Landowner voiced concern over a nearby wetland and the potential effects on the beaver that lives in the wetland Landowner voiced concern over a nearby wet area	As part of Trans Mountain's commitment to environmental protection, Trans Mountain will minimize potential adverse effects to wetlands by expediting construction in and around wetlands, by restoring wetlands to their original configurations and contours, by segregating topsoil during excavation, by permanently stabilizing upland areas near wetlands as soon as possible after backfilling, by inspecting the right-of-way periodically during and after construction, and by repairing any erosion control or restoration features until permanent revegetation is successful. Further discussion is provided under wetlands in Sections 5.8 and 7.2.8, as well as wildlife in Sections 5.10 and 7.2.10. Mitigation measures for wetlands and wildlife are outlined in the Pipeline EPP (Volume 6B).	Volume 5A Sections 5.8, 5.10, 7.2.8 and 7.2.10 Volume 5C Wetland Evaluation Technical Report Wildlife Technical Report Volume 6B

3.3.2.6 Vegetation

TABLE 3.3-7

INTERESTS OR CONCERNS RELATED TO VEGETATION

Summary of Interest or Concern	Response Summary	Where Issue is Addressed in the Application
Landowner voiced concerns over crop growth on right-of-way, tree removal, fencing and cattle trampling newly seeded area on the right-of-way	An Agricultural Management Plan (Appendix C of Volume 6B) has been developed to particularly reduce effects on agricultural lands, which includes measures related to weed management, re-seeding, soil compaction, livestock access, drainage and irrigation lines, management of crop disruption, and crop and productivity loss. Trans Mountain will install temporary fences, if warranted, to restrict grazing and trampling of the seeded construction right-of-way until vegetation becomes established or less palatable. Further discussion is provided under vegetation in Sections 5.9 and 7.2.9, while agricultural land use is discussed under human occupancy and resource use in Sections 5.4 and 7.2.4 of Volume 5B. Mitigation measures for agriculture and vegetation are outlined in the Pipeline EPP (Volume 6B), while post-construction environmental monitoring is discussed in Volume 6A.	Volume 5A Sections 5.9 and 7.2.9 Volume 5B Sections 5.4 and 7.2.4 Volume 5C Soils Technical Report Vegetation Technical Report Volume 5D Agricultural Assessment Technical Report Socio-Economic Technical Report Volume 6A Volume 6B
Numerous landowners voiced concerns about weeds and weed control methods	Trans Mountain takes responsibility for returning any lands disrupted during construction to the same, or better condition than existed before construction (within the confines of safe right-of-way management). Trans Mountain will work with the landowner to address his concerns about the use of herbicides and weed control, however, Trans Mountain does not take responsibility for private landscaping needs unrelated to construction. Weed control will comply with local standards, KMC's policy and the Project's EPP. A Weed and Vegetation Management Plan (Appendix C of Volume 6B) has been developed to prevent the introduction and spread of weeds during construction. Post-construction environmental monitoring and ongoing right-of-way maintenance will continue with efforts such as weed management, seeding and planning in selected areas. Mitigation measures are discussed under vegetation in Section 7.2.9 and in the Pipeline EPP (Volume 6B), while post-construction environmental monitoring is discussed in Volume 6A.	Volume 5A Sections 5.9 and 7.2.9 Volume 5B Sections 5.4 and 7.2.4 Volume 5C Soils Technical Report Vegetation Technical Report Volume 5D Agricultural Assessment Technical Report Volume 6A Volume 6B

TABLE 3.3-7 Cont'd

Summary of Interest or Concern	Response Summary	Where Issue is Addressed in the Application
Landowner opposed to any increase in right-of-way width and has concerns with ability to restore right-of-way to original condition Numerous landowners voiced concerns regarding tree removal and vegetation management/reclamation	One of Trans Mountain's objectives is to use, or abut, the existing right-of-way where practical. The landowners concern with respect to potentially increased right-of-way width will be considered. In some cases, trees can be a source of natural sound that masks man-made noises and provide a visual buffer to the right-of-way. Trans Mountain will endeavour to mitigate effects to landowners. If tree removal is unavoidable, discussions with the landowner may lead to agreement of some form of reclamation or compensation. Trans Mountain is committed to industry accepted best practices in reclamation, always striving for opportunities leading to advancement. As with all of its construction projects, Trans Mountain will reclaim any areas that are affected by the Project. Trans Mountain is committed to reclamation of the pipeline right-of-way and surrounding areas following construction. Following construction, Trans Mountain aims to return the right-of-way to pre-construction conditions, to the extent possible. This could include replacing footpaths, restoring habitats, improving water crossings or bettering migration corridors. Reclamation efforts could include the establishment of native plant and grass species, riparian and wetland areas, wildlife habitats and any other areas disturbed during construction. Post-construction environmental monitoring and ongoing right-of-way maintenance will continue following construction. Further discussion is provided for vegetation and other biophysical elements in Sections 5.0 and 7.0. Mitigation and reclamation measures, including a Reclamation Management Plan, are outlined in the Pipeline EPP (Volume 6B), while post-construction environmental monitoring is discussed in Volume 6A.	Volume 5A Sections 5.0 and 7.0 Volume 6A Volume 6B
Landowners concerns regarding loss of vegetation along right-of-way and exposure to highway	The primary design objective is to construct the Project within the existing pipeline right-of-way, and where this is not possible, minimize any new linear disturbance. Trans Mountain takes responsibility for returning any lands disrupted during construction to the same, or better condition than existed before construction (within the confines of safe right-of-way management). Trans Mountain would work with each landowner on this and could involve such things as replanting appropriate vegetation, recontouring and monitoring for weed invasion. Mitigation measures are discussed under vegetation in Section 7.2.9 of Volume 5A and in the Pipeline EPP (Volume 6B). In addition, visual sensory disturbance to residents and other land users is discussed under human occupancy and resource use in Sections 5.4 and 7.2.4 of Volume 5B.	Volume 5A Sections 5.9 and 7.2.9 Volume 5B Sections 5.4 and 7.2.4 Volume 5C Vegetation Technical Report Volume 5D Socio-Economic Technical Report Volume 6B
Landowner concerns regarding sensitive grasslands	Trans Mountain takes responsibility for returning any lands disrupted during construction to the same, or better condition than existed before construction (within the confines of safe right-of-way management). A comprehensive environmental assessment was completed for the Project. Over 30 types of environmental surveys were completed by local and regional biologists, botanists and resource specialists. The results of the surveys are provided in Volume 5C. Species of special status and their habitats were identified and assessed as part of the Project. Pipeline construction is a sequential series of activities, which do not remain in one area for an extended period of time. Detailed EPPs have been submitted to the NEB as part of the application, which document the construction right-of-way and provide mitigation strategies to help avoid or minimize environmental effects from construction. The Reclamation Management Plan (Appendix C of Volume 6B) will be implemented and post-construction environmental monitoring and ongoing right-of-way maintenance will continue with efforts such as weed management, seeding and planning in selected areas. Mitigation measures are discussed under vegetation in Section 7.2.9 and in the Pipeline EPP (Volume 6B), while post-construction environmental monitoring is discussed in Volume 6A.	Volume 5A Section 7.2.9 Volume 5C Vegetation Technical Report Volume 6A Volume 6B

3.3.2.7 Wildlife and Wildlife Habitat

TABLE 3.3-8

INTERESTS OR CONCERNS RELATED TO WILDLIFE AND WILDLIFE HABITAT

Summary of Interest or Concern	Response Summary	Where Issue is Addressed in the Application
Potential fox den on property	Wildlife habitat features, such as an active fox den, will be reviewed prior to construction to determine their status and the appropriate mitigation (*e.g.*, setback and timing window) will be applied that is consistent with provincial regulatory guidance. Trans Mountain will work with regulatory authorities to discuss appropriate alternate mitigation in the event that the recommended setback/timing window from an active mammal den cannot be practically implemented during construction. Alternative mitigation may include monitoring the den and/or modifying the construction schedule to avoid activity until the den is no longer active.	Volume 5A Section 7.2.10 Volume 5C Wildlife Technical Report Volume 6B
Landowners concerned about the potential effects to ravines on property used as wildlife bedding grounds	Project routing criteria include avoidance of environmentally sensitive areas, to the extent practical. Where sensitive areas cannot be practically avoided, alignment of the proposed route parallel to and contiguous with existing linear disturbances will minimize the Project footprint within sensitive areas, and mitigation will be implemented to reduce the Project's residual effects. A suite of mitigation measures will be implemented to reduce the potential effects of the Project on wildlife habitat, movement and mortality risk. Mitigation to reduce effects on habitat, limit barriers to movement, avoid attraction of wildlife to the work site, minimize sensory disturbance and protect site-specific habitat features of importance is discussed in the ESA sections noted.	Volume 4A Volume 5A Section 7.2.10 Volume 5C Wildlife Technical Report Volume 6A Volume 6B
Landowners advised that the two concrete silos near or on the existing right-of-way contain barn owls and pigeons Landowner advised that in the creek on subject property, there are frogs that are a species at risk	A suite of mitigation measures have been proposed to reduce Project effects on wildlife and wildlife habitat. In addition, Trans Mountain has initiated discussions with Environment Canada and BC MFLNRO regarding development of additional mitigation strategies, where warranted, to address potential Project effects on species at risk and their habitat. Trans Mountain will continue to engage landowners regarding routing and mitigation to address the Project effects on species at risk and their habitat. Wildlife surveys were conducted for the Project in 2013. Supplemental surveys will be conducted, where warranted. The results of field studies will be used to inform mitigation strategies for the Project.	Volume 4A Volume 5A Section 7.2.10 Volume 5C Wildlife Technical Report Volume 6A Volume 6B
Landowner concern regarding eagle nest on property	The mitigation measures proposed to reduce potential Project effects on nesting raptors have been developed to be consistent with provincial regulatory guidance. Measures are detailed in the ESA sections noted, and include establishment of setbacks or protective buffers, scheduling clearing in proximity to active nests outside of sensitive periods, and development of Nest Management Plans and installation of replacement structures, where warranted. Trans Mountain will work with regulatory authorities to cooperatively develop appropriate mitigation strategies, and will continue to engage landowners regarding routing and mitigation to address the Project effects on wildlife and wildlife habitat.	Volume 4A Volume 5A Section 7.2.10 Volume 5C Wildlife Technical Report Volume 6A Volume 6B

3.3.2.8 Ecological Risk

TABLE 3.3-9

INTERESTS OR CONCERNS RELATED TO ECOLOGICAL RISK

Summary of Interest or Concern	Response Summary	Where Issue is Addressed in the Application
Several landowner concerns regarding the potential environmental effects to land and/or water, including groundwater and salmon-bearing watercourses, that may be caused by a break in the line or spill during construction or operation	Safety is a top priority and is at the core of who Trans Mountain is as a company. Dedicated staff work to maintain the integrity of the pipeline through Trans Mountain's maintenance, inspection, and awareness programs. While no spill is acceptable to Trans Mountain, accidents can happen. Trans Mountain agrees that measures to protect sensitive environmental areas such as water bodies and riparian areas are critical. This is why Trans Mountain takes a multi-layered approach to pipeline safety, including taking measures such as strategically placed pipeline valves near waterways and drilled river crossings at some locations. Trans Mountain control centre operators monitor the pipeline 24 hours per day, 7 days a week, 365 days a year using a sophisticated leak detection system as well as pressure and flow alarms. Operators are prepared to shut the pipeline down immediately if there is any indication of a potential problem on the pipeline. In the event of an emergency, Trans Mountain will immediately mobilize all of the necessary resources to minimize its effects on the public and the environment. Trans Mountain has comprehensive spill response plans in place for the Trans Mountain pipeline and facilities. These plans are constantly being updated to keep them current and are regularly practiced through deployment exercises. While the specific strategies used in response to a spill will vary depending on the circumstances, the primary objectives in all cases are to ensure safety and to minimize environmental damage. To ensure there are sufficient funds to remediate a spill, Trans Mountain is covered by insurance necessary to respond to all spills or releases from Trans Mountain's pipelines and facilities. Trans Mountain monitors the insurance program continuously, and makes annual adjustments as necessary to ensure adequate coverage. Further discussion and mitigation for spills during construction or operation are provided in Sections 5.0 and 7.0 of Volume 5A and the Pipeline and Facilities EPPs (Volumes 6B and 6C). Pipeline spills during operation are discussed in Volume 7.	Volume 5A Sections 5.0 and 7.0 Volume 6B Volume 6C Volume 7

3.4 References

3.4.1 Literature Cited

Alberta Agriculture and Rural Development. 2010. Alberta Clubroot Management Plan. Website: http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/agdex11519. Accessed: November 2013.

Canadian Association of Petroleum Producers. 2008. Best Management Practices Clubroot Disease Management. Canadian Association of Petroleum Producers Publication 2008-1030. 7 pp. Prepared by the Canadian Association of Petroleum Producers Clubroot Management Plan Committee.

4.0 CORRIDOR AND FACILITY SITE SELECTION

The Project includes further looping of the existing 1,150 km TMPL system from Edmonton to Burnaby in operation since 1953. The 987 km of pipeline that will be looped as part of TMEP traverses a wide range of landforms from flat farmland to mountainous terrain. Land use varies from densely populated urban areas around Edmonton, Vancouver and elsewhere to sparsely populated rural agricultural and forested Crown lands. The pipeline segments to be constructed as part of the Project will also potentially cross over 500 rivers and streams, 8 provincial parks and 13 Indian Reserves (IRs).

An overview of the general routing objectives/criteria and proposed pipeline corridor is provided in Section 4.2 of Volume 2. A more detailed description of the pipeline corridor and selection process is provided in Section 2.8 of Volume 4A.

This section provides an overview of the selection process for the proposed pipeline corridor, including a discussion of how environmental, socio-economic, Aboriginal engagement, stakeholder consultation and other factors influenced pipeline corridor selection. While the proposed pipeline will generally require a construction right-of-way of 45 m, a 150 m corridor was selected to define the boundaries of the environmental resource surveys, landowner contacts and other survey needs.

This section also describes the site selection for permanent facilities such as terminals, pump stations (including access roads and power lines) and mainline block valves, as well as the site selection process for temporary facilities used during construction, such as staging and stockpile sites, equipment storage sites, construction office sites, construction work camps, work areas for trenchless watercourse crossings, temporary access roads, borrow pits and log decks.

4.1 Overview of Corridor Selection Process

This subsection provides a summary of the TMEP corridor selection process. Throughout this subsection, the abbreviation “KP” refers to “Kilometre Posts”, approximately 1 km apart, along the existing TMPL easement or right-of-way (also known as Line 1 in Volumes 2 and 4), while the abbreviation “RK” refers to “Reference Kilometres”, approximately 1 km apart along the proposed pipeline corridor (also known as Line 2 in Volumes 2 and 4). The reader is also directed to view Figure 4.1-1 for general reference to KPs and RKs and the preliminary photomosaic Environmental Alignment Sheets at a scale of 1:15,000 in Alberta and 1:10,000 in BC that are provided in Volume 6E.

Early in the Project planning process, Trans Mountain decided to maximize usage of the existing TMPL 18 m wide right-of-way to the greatest extent practical to reduce environmental and socio-economic effects and facilitate efficient pipeline operations. The existing TMPL pipeline has been operating safely for more than 60 years and its location is well known to local TMPL operations crews, landowners, surface management agencies and local emergency responders. By constructing on or adjacent to the existing TMPL right-of-way, the number of new or additional landowners is reduced. Furthermore, landowners and surface management agencies are accustomed to the presence of a pipeline, and understand the types of land practices that maintain pipeline safety. The environmental and socio-economic effects can generally be reduced by constructing beside the existing TMPL right-of-way since it is possible to share temporary workspace that has been previously affected by construction, thereby minimizing the width of land and amount of vegetation to be disturbed. Similar benefits occur where the new pipeline is planned beside rights-of-way of other linear facilities, including other pipelines, power lines, highways, roads, railways, fiber optic transmission systems (FOTS) and other utilities. Finally, access to the right-of-way and power lines to the pump stations are already established, reducing the need to create additional disturbance for ancillary facilities.

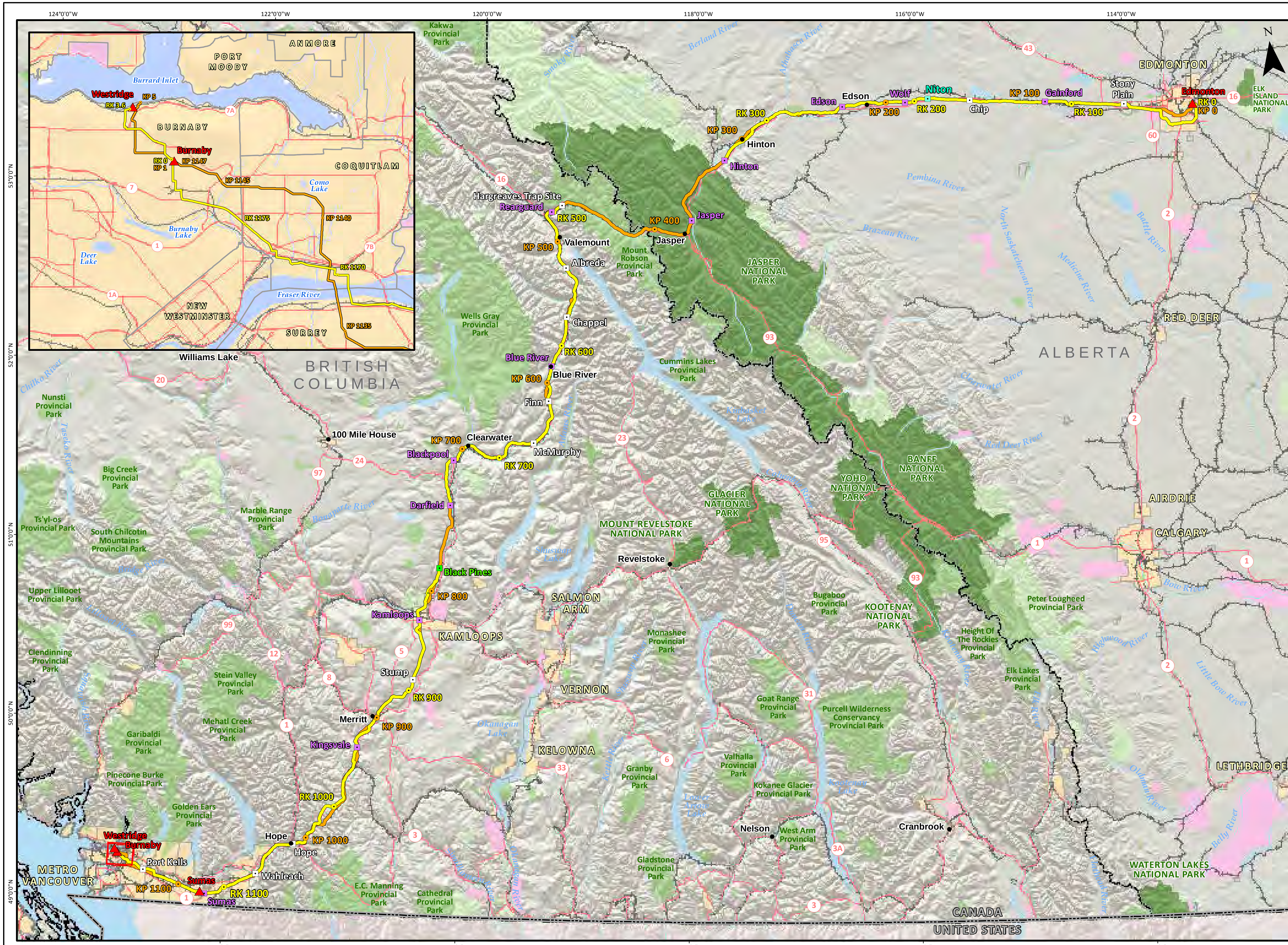
Following detailed field surveys as described in Section 2.8 of Volume 4A, it was determined that, while it was possible to construct on or adjacent to the existing TMPL right-of-way for approximately two thirds of the TMEP distance (see note in Section 4.3), it was not possible in all cases due to engineering, constructability, geotechnical, environmental, socio-economic, Aboriginal interests or other reasons. At these locations, a number of potential alternative corridors were examined. Major alternative corridors that were considered but rejected are described in Section 4.2. Selected alternative corridors involving major deviations from the existing TMPL right-of-way worthy of a more detailed evaluation are also described in Section 4.2. The proposed pipeline corridor is summarized in Section 4.3.

TRANS MOUNTAIN

FIGURE 4.1-1

PROJECT OVERVIEW
ALBERTA AND BRITISH COLUMBIA

TRANS MOUNTAIN EXPANSION PROJECT



- Kilometre Post (KP)
- Reference Kilometre Post (RK)
- Trans Mountain Pipeline (TMPL)
- Trans Mountain Expansion Project Proposed Pipeline Corridor
- Terminal
- Pump Station (Pump Additions, Station Modifications and/or Scraper Facilities)
- New Pump Station (Proposed)
- Pump Station (Reactivated)
- Existing Pump Station
- Highway
- Railway
- City / Town / District Municipality
- Indian Reserve / Métis Settlement
- National Park
- Provincial Park
- Protected Area / Natural Area / Provincial Recreation Area / Wilderness Provincial Park / Conservancy Area
- Provincial Boundary
- International Boundary

Projection: LCC Modified. Routing: Baseline TMPL & Facilities: provided by KMC, 2012; Proposed Pipeline Corridor V6: provided by UPI, Aug. 23, 2013; Transportation: IHS Inc., 2013, BC Forests, Lands and Natural Resource Operations, 2012 & Natural Resources Canada, 2012; Geopolitical Boundaries: Natural Resources Canada, 2003, AltaLIS, 2013, IHS Inc., 2011, BC FLNRO, 2007 & ESRI, 2005; First Nation Lands: Government of Canada, 2013, AltaLIS, 2010 & IHS Inc., 2011; Hydrology: Natural Resources Canada, 2007 & BC Crown Registry and Geographic Base Branch, 2008; Parks and Protected Areas: Natural Resources Canada, 2012, AltaLIS, 2012 & BC FLNRO, 2008; ATS Grid: AltaLIS, 2009; Edmonton TUC: Alberta Infrstructure, 2011; Canadian Hillshade: TERA Environmental Consultants, 2008; US Hillshade: Copyright:© 2009 ESRI

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Although there is no reason to believe that there are any errors associated with the data used to generate this product or in the product itself, users of these data are advised that errors in the data may be present.

MAP NUMBER		PAGE
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DRAWN: AJS	CHECKED: TGG	DESIGN: TGG

0 25 50 75 100 km

ALL LOCATIONS APPROXIMATE

201311_MAP_TERA_RT_00496_Rev0.mxd

4.2 Environmental, Socio-Economic and Associated Factors Considered in Pipeline Corridor Selection

Environmental, socio-economic, Aboriginal engagement, stakeholder consultation and other factors relating to pipeline corridor selection are discussed from east to west in the direction of pipeline flow. In general, the factors influencing selection of the proposed pipeline corridor are more complex in BC than Alberta. The bulk of the Rocky Mountains on the continental divide were crossed by the TMX Anchor Loop Project constructed in 2008, however, the proposed pipeline corridor must still cross several interior mountain ranges before entering the rich agricultural land and urban development in the Lower Mainland. A large portion of the urban development in the Lower Mainland, Kamloops and elsewhere has occurred after construction of TMPL in 1953. Likewise, the provincial parks potentially encountered by the Project have been established since TMPL was built.

4.2.1 Edmonton to Hinton Segment

This pipeline segment is characterized by dense urban development in the east, graduating to scattered country residential development, agricultural land and forests in the west.

Given that the TMPL Edmonton Terminal is on the east side of the City of Edmonton, it is difficult for a pipeline heading to the West Coast to avoid traversing the city. Trans Mountain examined three alternative corridors through Edmonton, each requiring a crossing of the North Saskatchewan River, the primary environmental feature in the area. The original TMPL 18 m right-of-way bypassed the then southern limits of the city, but 60 years of urban growth have caused the city boundaries to move many kilometres further south (see Plate 1 at the end of Section 4.2). Rather than run adjacent to hundreds of residential properties, Trans Mountain chose to take advantage of the Edmonton Transportation/Utility Corridor (TUC) established by the Province of Alberta in the 1970s. Accordingly, a major deviation from the existing TMPL right-of-way to the south takes place in the first 45 km of pipeline corridor. Final placement of TMEP within the TUC will be as directed by Alberta Infrastructure, the TUC administrator. Trans Mountain also examined the TUC around the north side of Edmonton but rejected that corridor when Alberta Infrastructure advised that a private land in-holding currently blocks the north TUC to future pipelines.

The proposed pipeline corridor rejoins the TMPL right-of-way west of Edmonton, following it through less developed areas of the City of Spruce Grove and the Town of Stony Plain before entering more rural landscapes and scattered country residential development in Parkland County. The existing TMPL right-of-way traverses Wabamun Lake Provincial Park for several kilometres. Wabamun Lake Provincial Park is located on the north shore of Wabamun Lake and was established as a provincial park in 1955 after construction of TMPL in 1953. The current proposed pipeline corridor passes north of the park; however, recent discussions with Alberta Tourism, Parks and Recreation indicate that it may be possible to follow TMPL through the park. During consultation, public stakeholders were open to routing the alternative corridor through the park, as it is in a utility corridor and adjacent to Highway 16. From an environmental and socio-economic perspective, crossing through the park parallel to the existing TMPL right-of-way is preferable because it is shorter, parallels an existing right-of-way, has fewer highway and road crossings and affects fewer private landowners.

Further west, the proposed pipeline corridor generally follows the TMPL right-of-way, crossing the Pembina River and McLeod River close to or beside the existing right-of-way towards the Town of Edson, which is bypassed immediately to the south. For the remainder of the length in Alberta, the proposed pipeline corridor generally follows the TMPL right-of-way with one main exception. Since the existing TMPL right-of-way passes through the middle of the Town of Hinton for 10.7 km, crossing adjacent to a number of residential and other private properties including a golf course, an improvement was made to follow a proposed new Highway 16 bypass that avoids the developed part of the town to the south. The proposed pipeline corridor then rejoins the TMPL right-of-way and eventually connects to the previously looped section of TMPL at the Hinton Pump Station.

4.2.2 Hargreaves to Darfield Segment

This pipeline segment is characterized by mountainous forested terrain alternating with dispersed rural residential and agricultural parcels in narrow mountain river valleys.

Commencing at Hargreaves Trap Site on the west side of Mount Robson Provincial Park and the western flank of the Rocky Mountains, the proposed pipeline corridor generally follows the TMPL right-of-way through the Fraser River valley except for a deviation to avoid Rearguard Falls Provincial Park and a crossing of the Fraser River west of the existing Rearguard Pump Station. Crossing the Fraser River east of Rearguard Pump Station is unavoidable, however, a dual crossing will be installed to avoid crossing the park and the Fraser River at a second location. The proposed pipeline corridor then rejoins the TMPL right-of-way, crossing over a height of land to enter the Rocky Mountain Trench. The Village of Valemount is bypassed to the west. Further south, the proposed pipeline corridor follows the existing TMPL right-of-way through successive narrow mountain valleys occupied by Camp Creek and the Albreda River, respectively.

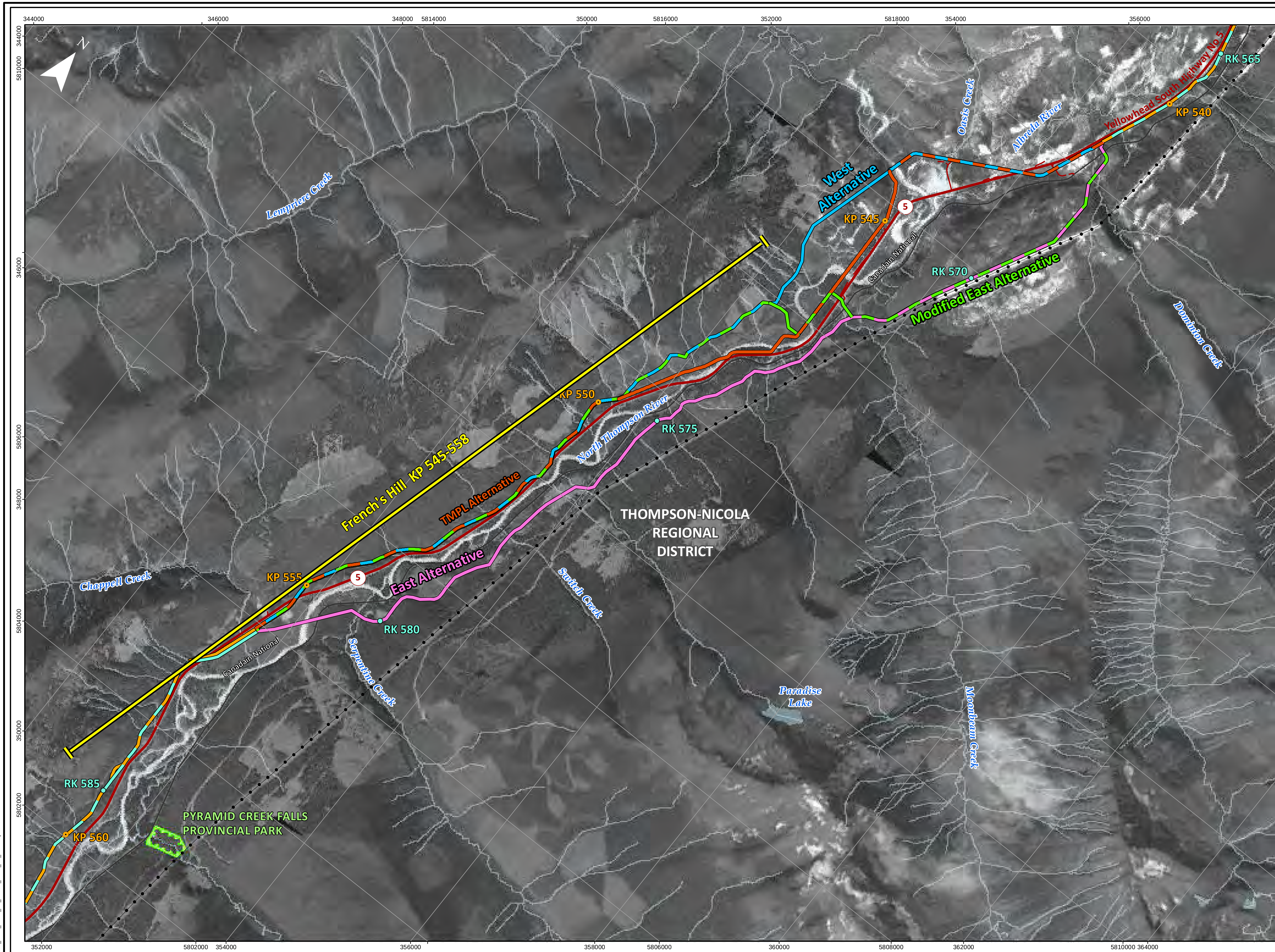
As it continues to follow the existing TMPL right-of-way in a southerly direction, the proposed pipeline corridor enters the North Thompson River valley, which it generally follows for several hundred kilometres as far as the City of Kamloops. In the upper reaches of the valley, the TMPL right-of-way crosses the North Thompson River five times in less than 4 km. One crossing of the North Thompson River is unavoidable, however, an alternative corridor with reduced effects on watercourse crossings was sought by conducting field reconnaissance and gathering readily available resource information (see Figure 4.2-1 and Table 4.2-1). Following a study of four alternative corridors, the East Alternative is preferred since it: crosses the North Thompson River only once; crosses the least amount of Riparian Reserve Zone, Old Growth Management Area and critical moose winter range; is relatively short; has the fewest highway crossings; and avoids French's Hill, a known rapid earth slide hazard. For these reasons, the proposed pipeline corridor deviates from the TMPL right-of way to incorporate the East Alternative which parallels a nearby BC Hydro high voltage transmission line and forestry road for approximately 15 km.

The proposed pipeline corridor continues to generally follow the existing TMPL right-of-way, descending the narrow, forested North Thompson River valley towards the Community of Blue River, entering the Interior Plateau. At Blue River, the proposed pipeline corridor is located immediately west of the community adjacent to the existing TMPL right-of-way and passes through the existing Blue River Pump Station. An alternative corridor from Blue River to the District of Clearwater was investigated. It would have involved: deviating from the North Thompson River valley; bypassing Blue River Pump Station; ascending 800 m up a steep hill; dropping into the upper reaches of the Raft River watershed; and then paralleling the Raft River to rejoin the TMPL right-of-way at Clearwater. Although 15% shorter, this alternative was rejected since it would encounter unacceptable pipe hydraulics and open up new corridor in habitat for a *Species at Risk Act* (*SARA*)-listed species – the Groundhog Mountain Caribou herd. South of Blue River, the proposed pipeline corridor continues to generally follow the existing TMPL right-of-way in the North Thompson River valley, except for an easterly deviation south of Froth Creek to avoid potential slope instability issues along Highway 5 at a place locally known as Messiter Hill. For the most part, the eastern deviation follows existing forestry roads, cut blocks and a BC Hydro high voltage transmission line. Further on, the proposed pipeline corridor rejoins the TMPL right-of-way as far south as Finn Creek Provincial Park.

Finn Creek Provincial Park is a Class A Park designated in 1996. Since it was uncertain whether BC Parks would permit a second pipeline in the park, Trans Mountain examined alternative corridors, both in the field and using readily available information sources (see Figure 4.2-2 and Table 4.2-2). Three alternatives were studied and evaluated from an environmental and socio-economic perspective. It was concluded that, assuming BC Parks approval, the TMPL Trenchless Alternative is preferred because it is short and involves a trenchless crossing of both Finn Creek and the northern tip of the park. If a trenchless crossing proves not feasible following further geotechnical field investigations, and assuming BC Parks approval, a conventional crossing of the park is preferred because it is the shortest alternative, parallels an existing right-of-way, avoids crossing an unnamed creek and does not involve clearing a new corridor to the east. BC Parks recently approved Trans Mountain's Stage 1 request to proceed to a Stage 2 application in the BC Parks boundary adjustment process.

Further south, the proposed pipeline corridor continues following the existing TMPL right-of-way through the widening North Thompson River valley, passing by the communities of Avola, Vavenby and the District of Clearwater before encountering two portions of the North Thompson River Provincial Park, a Class A Provincial Park designated in 1967. The northern portion of the park and the Clearwater River crossing is unavoidable whereas there is an alternative to avoid the southern portion of the park to the west. Two alternative corridors were studied and evaluated from an environmental and socio-economic perspective (see Figure 4.2-3 and Table 4.2-3). It was concluded that, assuming BC Parks approval, the TMPL Alternative through the park is preferable because it is shorter, avoids highway crossings and encounters fewer private parcels. The current proposed pipeline corridor passes west of the park, although BC Parks recently approved Trans Mountain's Stage 1 request to proceed to a Stage 2 application in the BC Parks boundary adjustment process. The Stage 2 application would also incorporate the northern portion of the park described above.

Further south, the proposed pipeline corridor continues along the North Thompson River valley in the Interior Plateau, following the TMPL right-of-way as far south as Darfield Pump Station.



TRANS MOUNTAIN

FIGURE 4.2-1

FIVE NORTH THOMPSON RIVER CROSSINGS ALTERNATIVE CORRIDORS

TRANS MOUNTAIN EXPANSION PROJECT

Five North Thompson River Crossings Alternative Corridors

- TMPL Alternative
- West Alternative
- Modified East Alternative
- East Alternative
- Reference Kilometre Post (RK)
- Trans Mountain Expansion Project Proposed Pipeline Corridor
- Kilometre Post (KP)
- Trans Mountain Pipeline (TMPL)
- Highway
- Paved Road
- Resource Road
- Transmission Line
- Railway
- Watercourse
- Park or Protected Area
- Waterbody

Projection: NAD 1983 UTM Zone 11N. Baseline TMPL Route Revision 0, provided by KMC, May 2012. Proposed Corridor V6 provided by UPI, August 23, 2013; Transmission Lines: BC Hydro, 2011; Transportation: IHS Inc., 2007, BC FLNRO, 2012; Geopolitical Boundaries: Natural Resources Canada, 2003, IHS Inc., 2011; First Nation Lands: Government of Canada, 2013, BC FLNRO, 2005; Hydrology: BC FLNRO, 2008; Civic Facilities: DMTI Spatial Inc., 2013; Imagery: Provided by KMC, 2013, NASA Geospatial Interoperability Program 2005.

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Although there is no reason to believe that there are any errors associated with the data used to generate this product or in the product itself, users of these data are advised that errors in the data may be present.

MAP NUMBER		PAGE
201308_MAP_TERA_RT_00391_REV0_01_5THOMPSONS		SHEET 1 OF 1
DATE: December 2013	TERA REF.: 7894	REVISION: 0
SCALE: 1:50,000	PAGE SIZE: 11x17	DISCIPLINE: RT
DRAWN: SES	CHECKED: TGG	DESIGN: DM

0 0.5 1 1.5 2 km

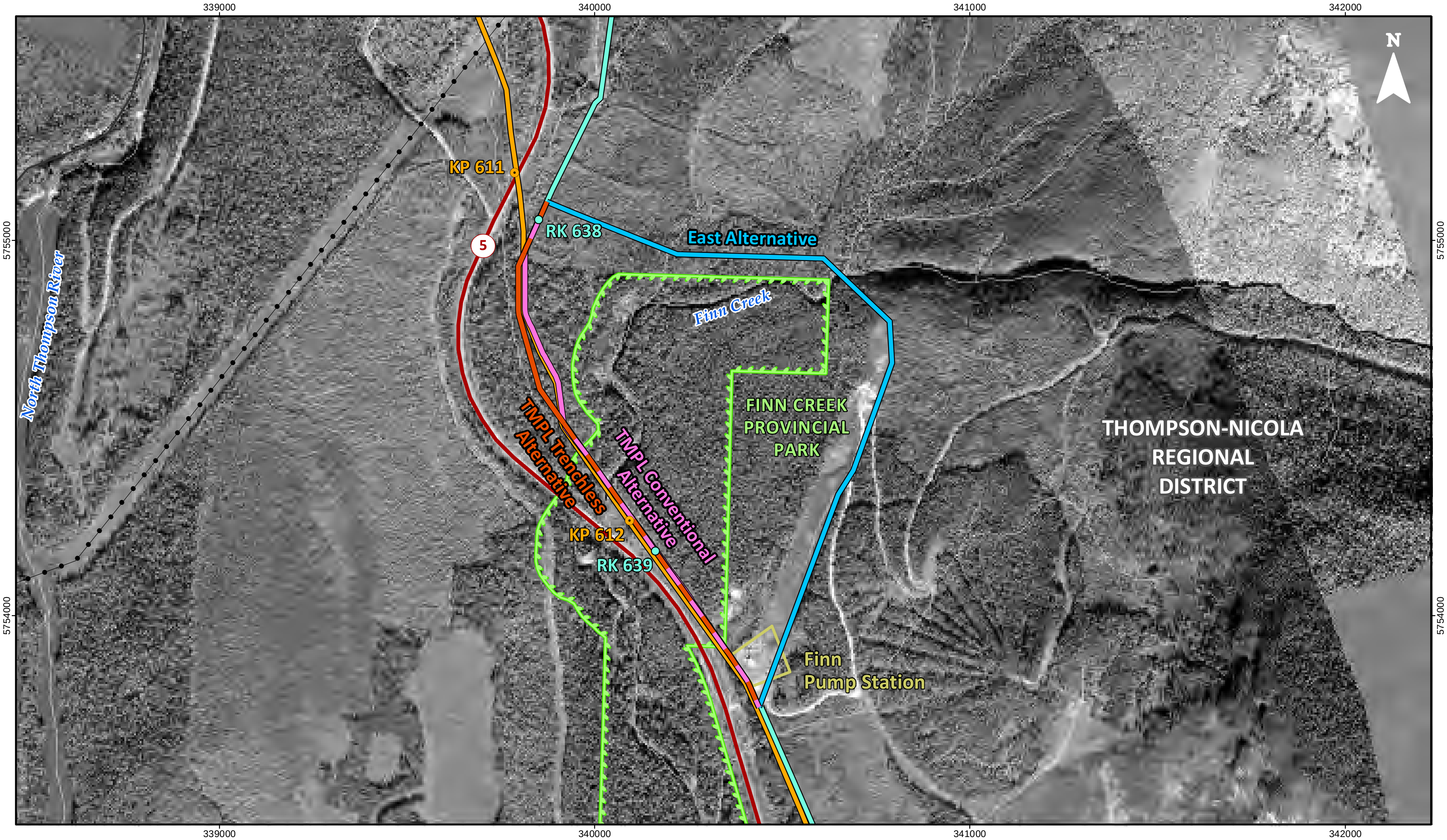
ALL LOCATIONS APPROXIMATE

201308_MAP_TERA_RT_00391_Rev0_01_5Thompsons.mxd

TABLE 4.2-1

EVALUATION OF ALTERNATIVE CORRIDORS – FIVE NORTH THOMPSON RIVER CROSSINGS (KP 541.1 TO KP 555.9) (RK 567.1 TO RK 581.8)

Factors	TMPL Alternative	West Alternative	Modified East Alternative	East Alternative
LENGTHS				
Length of pipeline corridor (km)	14.9	14.7	15.5	14.7
Length following existing TMPL right-of-way (km)	14.9	9.7	7.4	0.2
Length following other linear features (other pipelines, power lines, highways, roads, FOTS, railways, etc.) (km)	0	2.6	5.9	10.8
Length of "new" corridor (km)	0	2.4	2.2	3.7
Total parallels (km)	14.9	12.3	13.3	11.0
CROSSINGS				
No. of highway crossings (No.)	4	4	4	0
No. of road (arterial, collector, local) crossings (No.)	0	0	0	0
No. of railway crossings (No.)	0	0	2	2
Crossings of named rivers (No.)	6 (5 x North Thompson River; Albreda River)	2 (North Thompson River; Albreda River)	1 (North Thompson River)	1 (North Thompson River)
Crossings of named creeks (No.)	3 (Dominion Creek; Oasis Creek; Moonbeam Creek)	2 (Dominion Creek; Oasis Creek)	2 (Dominion Creek; Moonbeam Creek)	4 (Dominion Creek; Switch Creek; Serpentine Creek; Moonbeam Creek)
Crossings of other watercourses (No.)	12	19	11	10
Total watercourses (No.)	21	23	14	15
GEOTECHNICAL				
Length crossing slopes > 50% on the fall line (km)	0	0	0	0
Length crossing slopes > 50% on sidehill (km)	1.0	1.5	1.6	2.4
Natural hazard potential (km)	High: 0.5 Medium: 1.7 Low: 12.7	High: 0.1 Medium: 2.0 Low: 12.6	High: 0.2 Medium: 1.7 Low: 13.6	High: 0.9 Medium: 2.0 Low: 11.8
Length of thin veneer of overburden or exposed bedrock (km)	1.7	3.2	3.4	2.6
HYDRAULIC ACCEPTABILITY	Yes	Yes	Yes	Yes
LAND				
Indian Reserve (km)(name)	0	0	0	0
Provincial Crown (km)	14.9	14.7	15.3	14.1
Private (km)	0	0	0.2	0.6
Unknown Parcels (km)	0	0	0	0
ENVIRONMENT				
Length within Riparian Reserve Zone (km)	2.8	0.5	0.5	0.2
Old Growth Management Area (legal) (km)	1.7	1.6	2.3	1.1
Old Growth Management Area (non-legal) (km)	0	0	0	0
Late winter or early winter habitat for mountain caribou (km) (Wells Gray or Groundhog)	8.6	9.0	9.0	8.7
Wetlands crossed (km), community forests crossed (km), woodlots crossed (km), designated Ungulate Winter Range (km), and Wildlife Habitat Areas (km)(species)	0	0	0	0
SOCIO-ECONOMIC				
Parks and protected areas (km)(name), Agricultural Land Reserve (km), and community watersheds (No.)	0	0	0	0
Land and Resource Management Plan (LRMP) area (km)(name)	14.9 (Kamloops LRMP)	14.7 (Kamloops LRMP)	15.5 (Kamloops LRMP)	14.7 (Kamloops LRMP)
LRMP Resource Management Zones crossed (km)(zone)	14.9 (Tk'emlúps te Secwepemc Traditional Territory) 14.9 (Visually Sensitive Areas) 11.1 (Critical Moose Winter Range)	14.7 (Tk'emlúps te Secwepemc Traditional Territory) 14.7 (Visually Sensitive Areas) 8.8 (Critical Moose Winter Range)	15.5 (Tk'emlúps te Secwepemc Traditional Territory) 11.4 (Visually Sensitive Areas) 6.0 (Critical Moose Winter Range)	9.9 (Tk'emlúps te Secwepemc Traditional Territory) 14.7 (Visually Sensitive Areas) 0.7 (Critical Moose Winter Range)
ABORIGINAL AND STAKEHOLDER ENGAGEMENT				
Aboriginal Support	No major comments received to date. Consultation ongoing.	No major comments received to date. Consultation ongoing.	No major comments received to date. Consultation ongoing.	No major comments received to date. Consultation ongoing.
Stakeholder Support	No notable feedback on this route option. Stakeholders are interested in reducing the number of river crossings.	Support for alternatives that reduce the number of river crossings without increasing environmental risk.	Support for alternatives that reduce the number of river crossings without increasing environmental risk.	Support for alternatives that reduce the number of river crossings without increasing environmental risk.
CONSTRUCTABILITY AND COST				
Constructability	5 North Thompson River crossings: 2 trenchless, 3 open cut; 1 Albreda River trenchless crossing.	New corridor along west side of valley; 1 North Thompson River crossing (open cut); 1 Albreda River crossing - trenchless crossing rejected due to slope instability issues.	Follows BC Hydro right-of-way; new corridor across to west side of valley; 1 North Thompson River crossing (trenchless).	Follows BC Hydro right-of-way, logging roads and new corridor along east side of valley; 1 North Thompson River crossing (trenchless).
Estimated Construction Cost ($ millions)	$55.8	$48.6	$51.1	$49.2



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0 0.25 0.5 KM
ALL LOCATIONS APPROXIMATE

MAP NUMBER		PAGE
201308_MAP_TERA_RT_00391_REV0_02_FINNCREEK		SHEET 1 OF 1
DATE: December 2013	TERA REF.: 7894	REVISION: 0
SCALE: 1:15,000	PAGE SIZE: 8.5 x 11	DISCIPLINE: RT
DRAWN: SES	CHECKED: TGG	DESIGN: DM

Finn Creek Provincial Park Alternative Corridors

- TMPL Conventional Alternative
- TMPL Trenchless Alternative
- East Alternative
- Reference Kilometre Post (RK)
- Kilometre Post (KP)
- Trans Mountain Expansion Project Proposed Pipeline Corridor
- Trans Mountain Pipeline (TMPL)
- Transmission Line
- Watercourse
- Highway
- Railway
- Finn Creek Provincial Park

Projection: NAD 1983 UTM Zone 11N. Baseline TMPL Route Revision 0, provided by KMC, May 2012. Proposed Corridor V6 provided by UPI, August 23, 2013; Transmission Lines: BC Hydro, 2011; Transportation: IHS Inc., 2007, BC FLNRO, 2012; Geopolitical Boundaries: Natural Resources Canada, 2003, IHS Inc., 2011, BC FLNRO, ; First Nation Lands: Government of Canada, 2013, BC FLNRO, 2005; Hydrology: BC FLNRO, 2008; Imagery: Provided by KMC, 2013, NASA Geospatial Interoperability Program 2005.

TRANS MOUNTAIN

FIGURE 4.2-2

FINN CREEK PROVINCIAL PARK ALTERNATIVE CORRIDORS

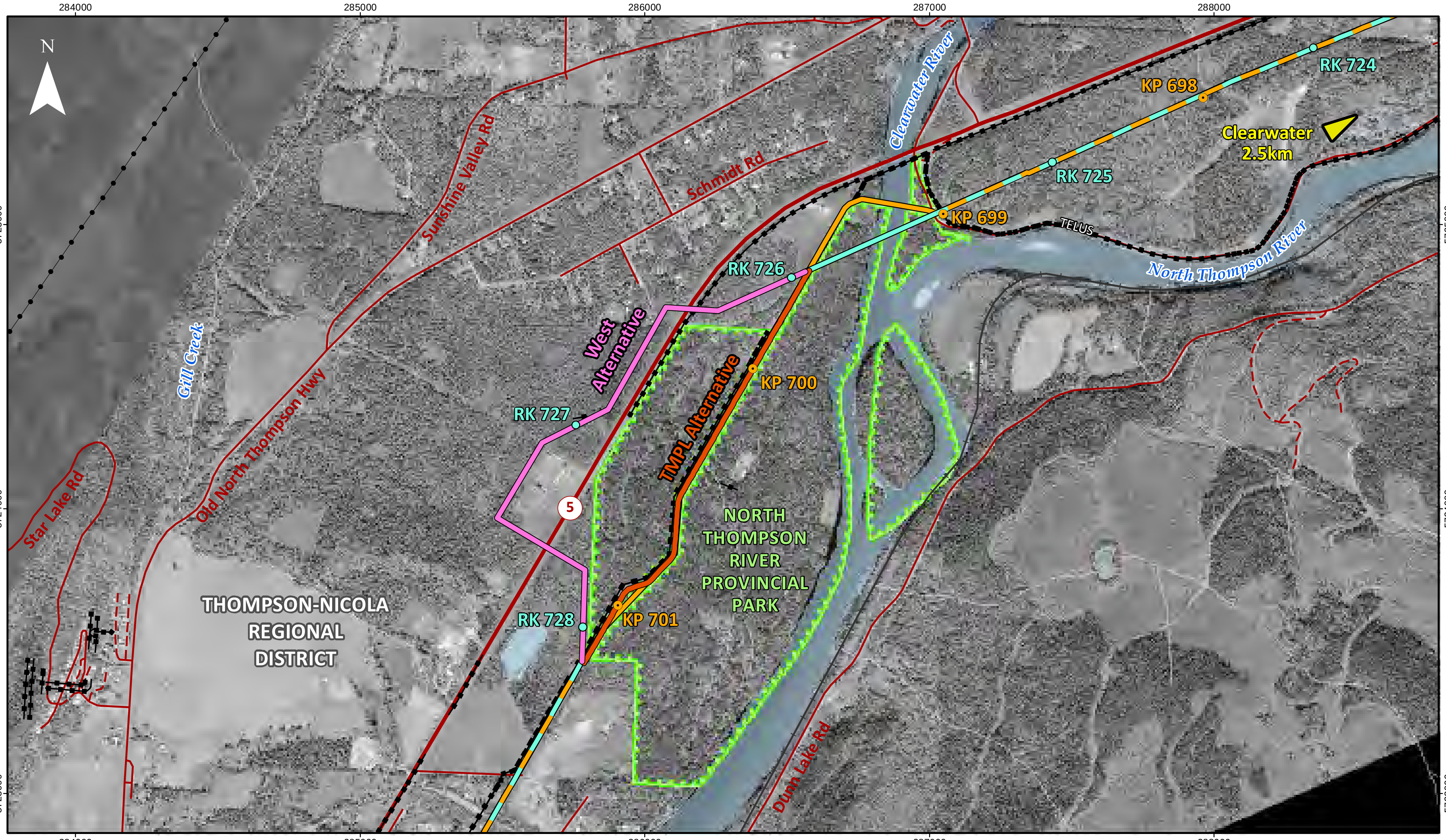
TRANS MOUNTAIN EXPANSION PROJECT

201308_MAP_TERA_RT_00391_Rev0_02_FinnCreek.mxd

TABLE 4.2-2

EVALUATION OF ALTERNATIVE CORRIDORS – FINN CREEK PROVINCIAL PARK (KP 611.2 TO KP 612.6) (RK 638.0 TO RK 639.5)

Factors	TMPL Alternative (Conventional)	TMPL Alternative (Trenchless)	East Alternative
LENGTHS			
Length of pipeline corridor (km)	1.5	1.6	2.1
Length following existing TMPL right-of-way (km)	1.4	1.6	0.1
Length following other linear features (other pipelines, power lines, highways, roads, FOTS, railways, etc.) (km)	0	0	1.3
Length of "new" corridor (km)	0.1	0	0.7
Total parallels (km)	1.4	1.6	1.4
CROSSINGS			
No. of highway crossings (No.)	0	0	0
No. of road (arterial, collector, local) crossings (No.)	0	0	0
No. of railway crossings (No.)	0	0	0
Crossings of named rivers (No.)	0	0	0
Crossings of named creeks (No.)	1 (Finn Creek)	1 (Finn Creek)	1 (Finn Creek)
Crossings of other watercourses (No.)	0	0	1
Total watercourses (No.)	1	1	2
GEOTECHNICAL			
Length crossing slopes > 50% on the fall line (km)	0	0	0
Length crossing slopes > 50% on sidehill (km)	0	0	0.1
Natural hazard potential (km)	High: 0.0 Medium: 0.0 Low: 1.5	High: 0.0 Medium: 0.0 Low: 1.5	High: 0.0 Medium: 0.0 Low: 2.1
Length of thin veneer of overburden or exposed bedrock (km)	0.0	0.0	0.0
HYDRAULIC ACCEPTABILITY	Yes	Yes	Yes
LAND			
Indian Reserve (km)(name)	0	0	0
Provincial Crown (km)	1.5	1.6	2.1
Private (km)	0	0	0
ENVIRONMENT			
Old Growth Management Area (legal) (km)	0	0	0.3
Old Growth Management Area (non-legal) (km)	0.1	0.1	0
Late winter or early winter habitat for mountain caribou (km) (Wells Gray or Groundhog)	0.8	0.8	0
Length within Riparian Reserve Zone (km), wetlands crossed (km), community forests crossed (km), woodlots crossed (km), designated Ungulate Winter Range (km), and Wildlife Habitat Areas (km) (species)	0	0	0
SOCIO-ECONOMIC			
Parks and protected areas (km)(name)	0.7 (Finn Creek Provincial Park) - would require boundary adjustment	0.7 (Finn Creek Provincial Park) - would require boundary adjustment	0
Agricultural Land Reserve (km)	0	0	0
Community watersheds (No.)	0	0	0
LRMP area (km) (name)	1.5 (Kamloops LRMP)	1.6 (Kamloops LRMP)	2.1 (Kamloops LRMP)
LRMP Resource Management Zones crossed (km)(name)	1.5 (Tk'emlúps te Secwepemc Traditional Territory) 1.5 (Visually Sensitive Areas)	1.6 (Tk'emlúps te Secwepemc Traditional Territory) 1.6 (Visually Sensitive Areas)	2.1 (Tk'emlúps te Secwepemc Traditional Territory) 2.1 (Visually Sensitive Areas)
ABORIGINAL AND STAKEHOLDER ENGAGEMENT			
Aboriginal Support	No major comments received to date. Consultation ongoing.	No major comments received to date. Consultation ongoing.	No major comments received to date. Consultation ongoing.
Stakeholder Support	General support for alternatives that avoid or reduce effects on provincial parks.	General support for alternatives that avoid or reduce effects on provincial parks.	General support for alternatives that avoid or reduce effects on provincial parks.
CONSTRUCTABILITY AND COST			
Constructability	Flow isolation crossing of Finn Creek and conventional trench construction through the balance of Finn Creek Provincial Park. Relatively flat terrain through the park south of the Creek.	Trenchless crossing of Finn Creek and Finn Creek Provincial Park.	Isolated crossing of Finn Creek and conventional trench construction bypassing Finn Creek Provincial Park to the east. Difficult terrain with extensive grade work on steep slopes in close proximity to BC Hydro line.
Estimated Construction Cost ($ millions)	$2.9	$6.8	$4.9



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0 0.25 0.5 0.75 KM

ALL LOCATIONS APPROXIMATE

MAP NUMBER		PAGE
201308_MAP_TERA_RT_00391_REV0_03_NTHOMPSONR-PP		SHEET 1 OF 1
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SCALE: 1:20,000	PAGE SIZE: 8.5 x 11	DISCIPLINE: RT
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North Thompson River Provincial Park Alternative Corridors

- TMPL Alternative
- West Alternative
- Reference Kilometre Post (RK)
- Kilometre Post (KP)
- Trans Mountain Expansion Project Proposed Pipeline Corridor
- Trans Mountain Pipeline (TMPL)
- Highway
- Railway
- Paved Road
- Resource Road
- Transmission Line
- Fiber Optic Transmission System (FOTS)
- Watercourse
- North Thompson River Provincial Park

Projection: NAD 1983 UTM Zone 11N. Baseline TMPL Route Revision 0, provided by KMC, May 2012. Proposed Corridor V6 provided by UPI, August 23, 2013; Transmission Lines: BC Hydro, 2011; Transportation: IHS Inc., 2007, BC FLNRO, 2012; Geopolitical Boundaries: Natural Resources Canada, 2003, IHS Inc., 2011; First Nation Lands: Government of Canada, 2013, BC FLNRO, 2005; Hydrology: BC FLNRO, 2008; FOTS: ICIS, 2012; Imagery: Provided by MKC, 2013, NASA Geospatial Interoperability Program 2005.

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TRANS MOUNTAIN

FIGURE 4.2-3

NORTH THOMPSON RIVER PROVINCIAL PARK ALTERNATIVE CORRIDORS

TRANS MOUNTAIN EXPANSION PROJECT

201308_MAP_TERA_RT_00391_Rev0_03_NThompsonR-PP.mxd

TABLE 4.2-3

EVALUATION OF ALTERNATIVE CORRIDORS – NORTH THOMPSON RIVER PROVINCIAL PARK (KP 699.6 TO KP 701.2) (RK 725.9 TO RK 728.1)

Factors	TMPL Alternative	West Alternative
LENGTHS		
Length of pipeline corridor (km)	1.6	2.2
Length following existing TMPL right-of-way (km)	1.6	0.2
Length following other linear features (other pipelines, power lines, highways, roads, FOTS, railways, etc.) (km)	0	1.3
Length of "new" corridor (km)	0	0.7
Total parallels (km)	1.6	1.5
CROSSINGS		
No. of highway crossings (No.)	0	2
No. of road (arterial, collector, local) crossings (No.)	3	2
No. of railway crossings (No.)	0	0
Crossings of named rivers (No.)	0	0
Crossings of named creeks (No.)	0	0
Crossings of other watercourses (No.)	0	0
Total watercourses (No.)	0	0
GEOTECHNICAL		
Length crossing slopes > 50% on the fall line (km)	0	0
Length crossing slopes > 50% on side hill (km)	0	0
Natural hazard potential (km)	High: 0.0 Medium: 0.0 Low: 1.6	High: 0.0 Medium: 0.0 Low: 2.2
Length of thin veneer of overburden or exposed bedrock (km)	0.0	0.0
HYDRAULIC ACCEPTABILITY	Yes	Yes
LAND		
Indian Reserve (km) (name)	0	0
Provincial Crown (km)	1.4	0.4
Private (km)	0.2	1.6
Unknown Parcels (km)	0	0.2
No. of private parcels (No.)	1	6
ENVIRONMENT		
Old Growth Management Area (non-legal) (km)	0.2	0
Length within Riparian Reserve Zone (km), wetlands crossed (km), community forests crossed (km), woodlots crossed (km), Wildlife Habitat Areas (km) (species), designated Ungulate Winter Range (km), late winter or early winter habitat for mountain caribou (km) (Wells Gray or Groundhog) , and Old Growth Management Area (legal) (km)	0	0
SOCIO-ECONOMIC		
Parks and protected areas (km) (name)	1.4 (North Thompson River Provincial Park) - would require boundary adjustment.	0
Agricultural Land Reserve (km)	0	0
Community watersheds (No.)	0	0
Municipalities crossed	Clearwater	Clearwater
LRMP area (km) (name)	2.0 (Kamloops LRMP)	2.2 (Kamloops LRMP)
ABORIGINAL AND STAKEHOLDER ENGAGEMENT		
Aboriginal Support	No major comments received to date. Consultation ongoing.	No major comments received to date. Consultation ongoing.
Stakeholder Support	General support for alternatives that avoid provincial parks.	General support for alternatives that avoid provincial parks.
CONSTRUCTABILITY AND COST		
Constructability	TMPL Alternative is slightly hummocky requiring additional extra work space in park for grade cuts.	West Alternative crosses to the west side of Highway 5 to avoid North Thompson River Provincial Park and passes through terrain equivalent to the TMPL Alternative before crossing back to the east side of Highway 5 to rejoin the TMPL corridor.
Estimated Cost ($ millions)	$3.1	$4.2

4.2.3 Black Pines to Hope Segment

This pipeline segment is characterized by rolling grasslands in the vicinity of Kamloops and Merritt in the north, graduating to forested and mountainous terrain in the south.

From the location of the proposed Black Pines Pump Station (see Section 4.4) in the Interior Plateau, the proposed pipeline corridor follows the TMPL right-of-way on the west side of the lower North Thompson River valley, which now averages 2 km in width, becoming increasingly settled and agricultural. The community of Westsyde in the City of Kamloops has recently expanded along a broad terrace of the river, encroaching on the TMPL right-of-way (see Plate 2). Lac du Bois Grassland Protected Area is located immediately west of Westsyde. The protected area was first established in 1996 after TMPL was constructed and additional lands were added through a designated expansion in 2013. These additions overlap the existing TMPL right-of-way at two short locations north of Westsyde and at a longer location (1.5 km) in the Batchelor Hills area further south, which is unavoidable. During the consultation process, strong community support was expressed by some stakeholders for a corridor west of Westsyde through the protected area following a FOTS right-of-way (see Plate 3), while others raised concerns about effects of the Project on the protected area. Both alternative corridors were studied and evaluated from an environmental and socio-economic perspective (see Figure 4.2-4 and Table 4.2-4). It was concluded that, assuming BC Parks approval, the West Alternative is preferred because it crosses slightly fewer watercourses, considerably fewer private parcels and avoids the community of Westsyde. BC Parks recently approved Trans Mountain's Stage 1 request to proceed to a Stage 2 application in the BC Parks boundary adjustment process. The Stage 2 application would also incorporate the 2013 additional lands described above.

The proposed pipeline corridor then rejoins the TMPL right-of-way and crosses the Thompson River just east of the Kamloops Airport, ascending the south slope of the river valley to eventually connect to the Kamloops Pump Station on the south side of Highway 5.

The proposed pipeline corridor generally follows the existing TMPL right-of-way across a semi-forested upland plateau from Kamloops to Merritt, with three possible exceptions. The first is a jog to the west on the property of the proposed KGHM Ajax Mining Inc. copper and gold mine to avoid Jacko Lake and a narrow valley, where there is insufficient room to install a second pipeline. Further south, the existing TMPL right-of-way crosses the corners of two IRs north of Merritt (Zoht 5 and Zoht 4), where minor deviations avoiding the IRs are being considered in addition to following beside TMPL through the IRs.

The proposed pipeline corridor follows the existing TMPL right-of-way through the eastern limits of the City of Merritt in the Nicola River valley, cutting the northwest corner of the Joeyaska IR No. 2. A minor deviation avoiding the IR to the north and west is also being considered. Further south, the proposed pipeline corridor continues to follow the existing TMPL right-of-way up the Coldwater River valley, traversing Coldwater IR No. 1 for 7 km.

Based on correspondence from the Coldwater Indian Band, several alternative corridors east and west of the IR were studied and evaluated from an environmental and socio-economic perspective (see Figure 4.2-5 and Table 4.2-5). The currently proposed pipeline corridor is the East Corridor, although the Modified East Alternative is also under consideration. From an environmental and socio-economic perspective, and with the Coldwater Indian Band's approval, the preferred corridor would switch to the TMPL Modified Alternative Corridor as it: is the shortest; generally parallels an existing right-of-way; crosses the fewest watercourses; encounters the least amount of bedrock; and crosses the least amount of designated Ungulate Winter Range habitat.

Further south, the proposed pipeline corridor rejoins the existing TMPL right-of-way ascending the narrowing Coldwater River valley to just south of Kingsvale Pump Station. The terrain becomes increasingly mountainous as the proposed pipeline corridor extends further south through the Hozameen Range of the Cascade Mountains. From Kingsvale Pump Station, the proposed pipeline corridor deviates from the existing TMPL right-of-way several times to parallel the Spectra gas pipeline right-of-way which generally parallels the existing TMPL right-of-way in the Coldwater River valley area. These deviations are generally undertaken to take advantage of better terrain, to reduce the number of Coldwater River crossings or to minimize the length in the Riparian Reserve Zone.

In the upper reaches of the Coldwater River valley, the existing TMPL right-of-way is in close proximity to Coldwater River Provincial Park for 2 km, crosses the divide into the Coquihalla Summit Recreation Area and continues southwards through the Coquihalla Lakes area, over a 185 m "Jump Off" into the narrow gorge locally known as Coquihalla Canyon, eventually crossing the Coquihalla River 13 times in less than 20 km (see Plate 4). There is limited working room in Coquihalla Canyon for a second pipeline and constructability is a concern. An alternative corridor with reduced effects on water crossings was sought. After considerable field reconnaissance, a West Alternative Corridor was identified which follows a combination of a Spectra gas pipeline right-of-way, a FOTS right-of-way and the right-of-way of the relatively recently constructed Coquihalla Highway (Highway 5) through the Boston Bar Creek drainage west of Coquihalla Canyon. Both alternative corridors were studied and evaluated from an environmental and socio-economic perspective (see Figure 4.2-6 and Table 4.2-6). It was concluded that the West Alternative is preferred because it: entails 1 river crossing as opposed to 16; crosses considerably less terrain with high natural hazard potential; has considerably less length through the Riparian Reserve Zone, Old Growth Management Areas, and designated Ungulate Winter Range; avoids Coldwater River Provincial Park and crosses slightly less of the Coquihalla Summit Recreation Area. The two corridors rejoin where Boston Bar Creek flows into the Coquihalla River.

From this point to the District of Hope, the proposed pipeline corridor follows the narrow and steep Coquihalla River valley beside one of the existing rights-of-way occupied either by TMPL, Coquihalla Highway, Spectra or FOTS, depending upon the most constructible terrain and other factors. For example, the existing TMPL right-of-way traverses Coquihalla River Provincial Park for 3 km, whereas the proposed pipeline corridor avoids the park altogether. Once in the District of Hope, the proposed pipeline corridor generally follows the existing TMPL or the Spectra rights-of-way and, at the request of the Union Bar Indian Band, avoids the Kawkawa Lake IR No. 16. The proposed pipeline corridor continues west, crossing the Coquihalla River upstream of its confluence with the Fraser River and entering Hope Pump Station.

4.2.4 Hope to Burnaby Segment

West of the District of Hope, the proposed pipeline corridor generally follows the existing TMPL and Highway 1 (Trans-Canada Highway) rights-of-way in the narrow strip of land between the Fraser River and the Skagit Range of the Cascade Mountains. The remainder of the proposed pipeline corridor traverses the rich agricultural lands of the Lower Mainland of BC, which becomes increasingly urbanized from the Fraser Valley Regional District west to Metro Vancouver. Most of the agricultural lands are part of the provincial Agricultural Land Reserve. The proposed pipeline corridor generally follows the existing TMPL right-of-way unless otherwise specifically mentioned.

The proposed pipeline corridor continues west into the Lower Mainland, although minor deviations are being considered to avoid Ohamil IR No. 1, Peters IR No. 1A and Popkum IR No. 1. East of the City of Chilliwack, the proposed pipeline corridor crosses to the north side of the Trans-Canada Highway to parallel a BC Hydro power line in order to avoid a crossing of Bridal Veil Falls Provincial Park and Popkum IR No. 2. A small portion of Cheam Lake Wetland Regional Park is crossed for approximately 100 m, although in response to considerable opposition from the public and Fraser Valley Regional District, minor deviations are being considered in this area to avoid the park.

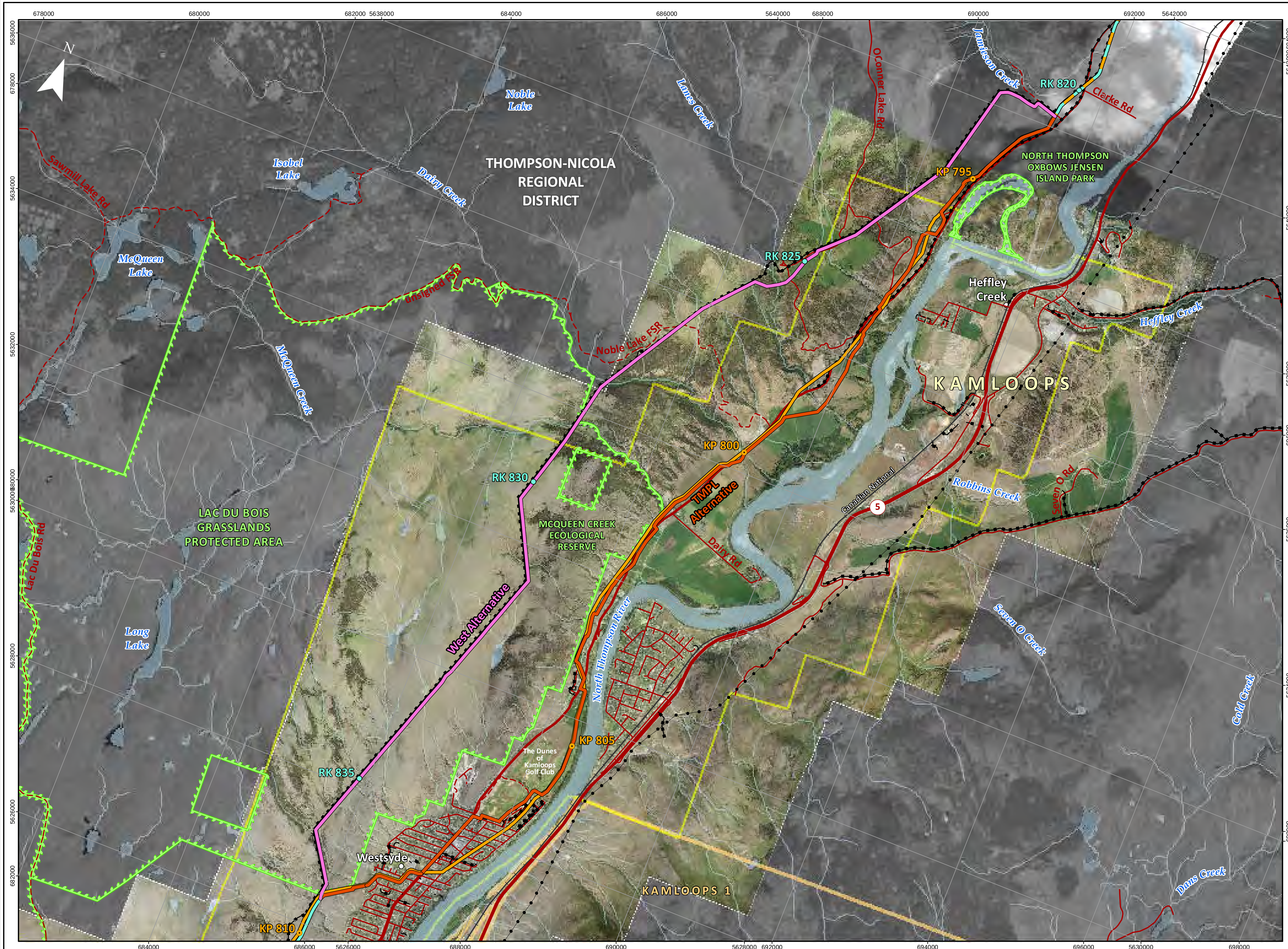
Further west, the proposed pipeline corridor passes through the City of Chilliwack, with minor deviations being considered to avoid crossing Grass IR No. 15 and Tzeachten IR No. 13. The Vedder River is the major watercourse crossed in the Chilliwack area. Further west, the proposed pipeline corridor enters the City of Abbotsford, crossing the Sumas River and surrounding agricultural Sumas Prairie before ascending the forested south flank of Sumas Mountain. The existing TMPL right-of-way provides for a branchline to access TMPL's Sumas Terminal. On the west side of Sumas Mountain, the proposed pipeline corridor crosses increasingly urbanized areas and a golf course in the vicinity of Clayburn. Towards the western end of the City of Abbotsford, the proposed pipeline corridor crosses the Matsqui Main IR No. 2, although a minor deviation is being considered to the south. The proposed pipeline corridor then enters the Township of Langley and continues along the existing TMPL right-of-way until the vicinity of the Salmon River valley south of Fort Langley. From this point onwards to the Fraser River crossing, urbanization in Langley and the City of Surrey has encroached considerably on the existing TMPL right-of-way in the past 60 years, making contiguous looping extremely difficult. For this reason an alternative pipeline corridor was sought. Trans Mountain chose to take advantage of the existing

Canadian National Railway Company (CN) right-of-way and new South Fraser Perimeter Road corridor on the south side of the Fraser River. Accordingly, the proposed pipeline corridor leaves the existing TMPL right-of-way near a golf course and heads north on new corridor a short distance across farmland in the Salmon River valley before reaching the CN right-of-way. Minor deviations in the Salmon River area are being considered to follow property lines, a second golf course and avoid a local natural area further north if possible before joining the CN right-of-way. From this point, the proposed pipeline corridor turns west, paralleling the CN right-of-way and later the South Fraser Perimeter Road right-of-way in a westerly direction through Langley and Surrey to the crossing location of the Fraser River near the Port Mann Bridge. The proposed pipeline corridor traverses the edge of the Surrey Bend Regional Park for about 3 km, although a minor deviation is being considered to reduce this length by taking advantage of surplus land released from the recently constructed South Fraser Perimeter Road project.

Two primary locations are being considered to cross the main stem of the Fraser River between the cities of Surrey and Coquitlam using horizontal directional drilling (HDD), a trenchless method of construction (see Plate 5). Currently, the proposed pipeline corridor is located approximately 500 m east of the existing TMPL pipeline, but an alternative location is being considered on the east side of the Port Mann Bridge. On the north side of the Fraser River, urbanization in the cities of Coquitlam and Burnaby has encroached considerably on the existing TMPL right-of-way in the past 60 years to make contiguous looping extremely difficult (see Plate 6). The proposed pipeline corridor follows the Lougheed Highway, although a deviation is being considered to traverse existing industrial lands and railway easements within the Brunette River Conservation Area. Both the proposed pipeline corridor and the deviation eventually connect to TMPL's Burnaby Terminal via other city streets.

4.2.5 Burnaby to Westridge Segment

From the Burnaby Terminal to the Westridge Marine Terminal on Burrard Inlet, urbanization in the City of Burnaby has encroached considerably on the existing TMPL right-of-way in the past 60 years to make contiguous looping with twin 762 mm (NPS 30) OD buried delivery lines extremely difficult. The proposed pipeline corridor follows alongside Burnaby Mountain Parkway, Hastings Street, and Cliff Avenue before turning east into TMPL's Westridge Marine Terminal. Other more direct alternatives involving partial or total trenchless (HDD or tunnel) methods of construction are also under consideration.



TRANS MOUNTAIN

FIGURE 4.2-4

LAC DU BOIS GRASSLANDS PROTECTED AREA ALTERNATIVE CORRIDORS

TRANS MOUNTAIN EXPANSION PROJECT

Lac Du Bois Grasslands Protected Area Alternate Corridors

- TMPL Alternative
- West Alternative
- Reference Kilometre Post (RK)
- Trans Mountain Expansion Project Proposed Pipeline Corridor
- Kilometre Post (KP)
- Trans Mountain Pipeline (TMPL)
- Highway
- Paved Road
- Resource Road
- Railway
- Fiber Optic Transmission System (FOTS)
- Transmission Line
- Other Existing Pipeline
- Populated Place
- Urban Area
- Park or Protected Area
- Waterbody
- Watercourse
- Indian Reserve

Projection: NAD 1983 UTM Zone 10N. Baseline TMPL Route Revision 0, provided by KMC, May 2012. Proposed Corridor V6 provided by UPI, August 23, 2013; Transmission Lines: BC Hydro, 2011; Transportation: IHS Inc., 2007, BC FLNRO, 2012; Geopolitical Boundaries: Natural Resources Canada, 2003, IHS Inc., 2011; First Nation Lands: Government of Canada, 2013, BC FLNRO, 2005; Hydrology: BC FLNRO, 2008; Civic Facilities: DMTI Spatial Inc. 2013; Spectra Pipelines and FOTS Lines: KMC, 2012; Imagery: Provided by KMC, 2013, NASA Geospatial Interoperability Program 2005.

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MAP NUMBER		PAGE
201308_MAP_TERA_RT_00391_REV0_4_LACDUBOISPP		SHEET 1 OF 1
DATE: December 2013	TERA REF.: 7894	REVISION: 0
SCALE: 1:50,000	PAGE SIZE: 11x17	DISCIPLINE: RT
DRAWN: TPH	CHECKED: TGG	DESIGN: DM

0 0.5 1 1.5 2 km

ALL LOCATIONS APPROXIMATE

201308_MAP_TERA_RT_00391_Rev0_4_LacDuBoisPP.mxd

TABLE 4.2-4

EVALUATION OF ALTERNATIVE CORRIDORS – LAC DU BOIS GRASSLANDS PROTECTED AREA (KP 793.5 TO KP 809.4) (RK 820.5 TO RK 836.9)

Factors	TMPL Alternative	West Alternative
LENGTHS		
Length of pipeline corridor (km)	16.6	16.4
Length following existing TMPL right-of-way (km)	12.6	0.1
Length following other linear features (other pipelines, power lines, highways, roads, FOTS, railways, etc.) (km)	2.5	15.7
Length of "new" corridor (km)	1.5	0.6
Total parallels (km)	15.1	15.8
CROSSINGS		
No. of highway crossings (No.)	0	0
No. of road (arterial, collector, local) crossings (No.)	24	4
No. of main power line crossings (No.)	0	0
No. of distribution power line crossings (No.)	1	0
No. of railway crossings (No.)	0	0
Crossings of named rivers (No.)	0	0
Crossings of named creeks (No.)	3 (Dairy Creek; McQueen Creek; Lanes Creek)	3 (Dairy Creek; McQueen Creek; Lanes Creek)
Crossings of other watercourses (No.)	25	23
Total watercourses (No.)	28	26
GEOTECHNICAL		
Length crossing slopes > 50% on the fall line (km)	0	0
Length crossing slopes > 50% on sidehill (km)	0.2	0
Natural hazard potential (km)	High: 0.0 Medium: 1.7 Low: 14.8	High: 0.0 Medium: 0.0 Low: 16.4
Length of thin veneer of overburden or exposed bedrock (km)	0.6	3.2
Hydraulic Acceptability	Yes	Yes
LAND		
Indian Reserve (km) (name)	0	0
Provincial Crown (km)	2.0	13.7
Private (km)	14.5	1.8
Unknown Parcels (km)	0	0.9
No. of private parcels (No.)	72	4
ENVIRONMENT		
Length within Riparian Reserve Zone (km)	0.1	0
Woodlots crossed (km)	0.4	0
Wildlife Habitat Areas (km) (species), Old Growth Management Area (legal) (km), Old Growth Management Area (non-legal) (km), designated Ungulate Winter Range (km), wetlands crossed (km), and late winter or early winter habitat for mountain caribou (km) (Wells Gray or Groundhog)	0	0
SOCIO-ECONOMIC		
Parks and protected areas (km) (name)	0.2 (Lac Du Bois Grasslands Protected Area) - would require boundary adjustment	7.9 (Lac Du Bois Grasslands Protected Area) - would require boundary adjustment
Agricultural Land Reserve (km)	11.6	10.2
Community watersheds (No.)	0	0
Municipalities crossed	Kamloops	Kamloops
LRMP area (km) (name)	16.6 (Kamloops LRMP)	16.4 (Kamloops LRMP)
LRMP Resource Management Zones crossed (km)	Tk'emlúps te Secwepemc Traditional Territory (16.6) Visually Sensitive Areas (16.6) Settlement Resource Management Zone (3.7)	Tk'emlúps te Secwepemc Traditional Territory (16.4) Visually Sensitive Areas (11.7) Critical Deer Winter Range (7.2)
ABORIGINAL AND STAKEHOLDER ENGAGEMENT		
Aboriginal Support	No major comments received to date. Consultation ongoing.	No major comments received to date. Consultation ongoing.
Stakeholder Support	Westsyde residents have expressed strong support for avoiding Westsyde and traversing the Protected Area. If the West Alternative is not possible then this option is preferred by stakeholders.	Naturalists concerned about Protected Area and mitigation/compensation for environmental effects.
CONSTRUCTABILITY AND COST		
Constructability	TMPL parallel combined with complex in-street construction along Westsyde Road plus some residential backyard construction.	FOTS parallel along north west slope through Lac Du Bois Grassland Protected Area.
Estimated Construction Cost ($ millions)	$50.0	$30.6

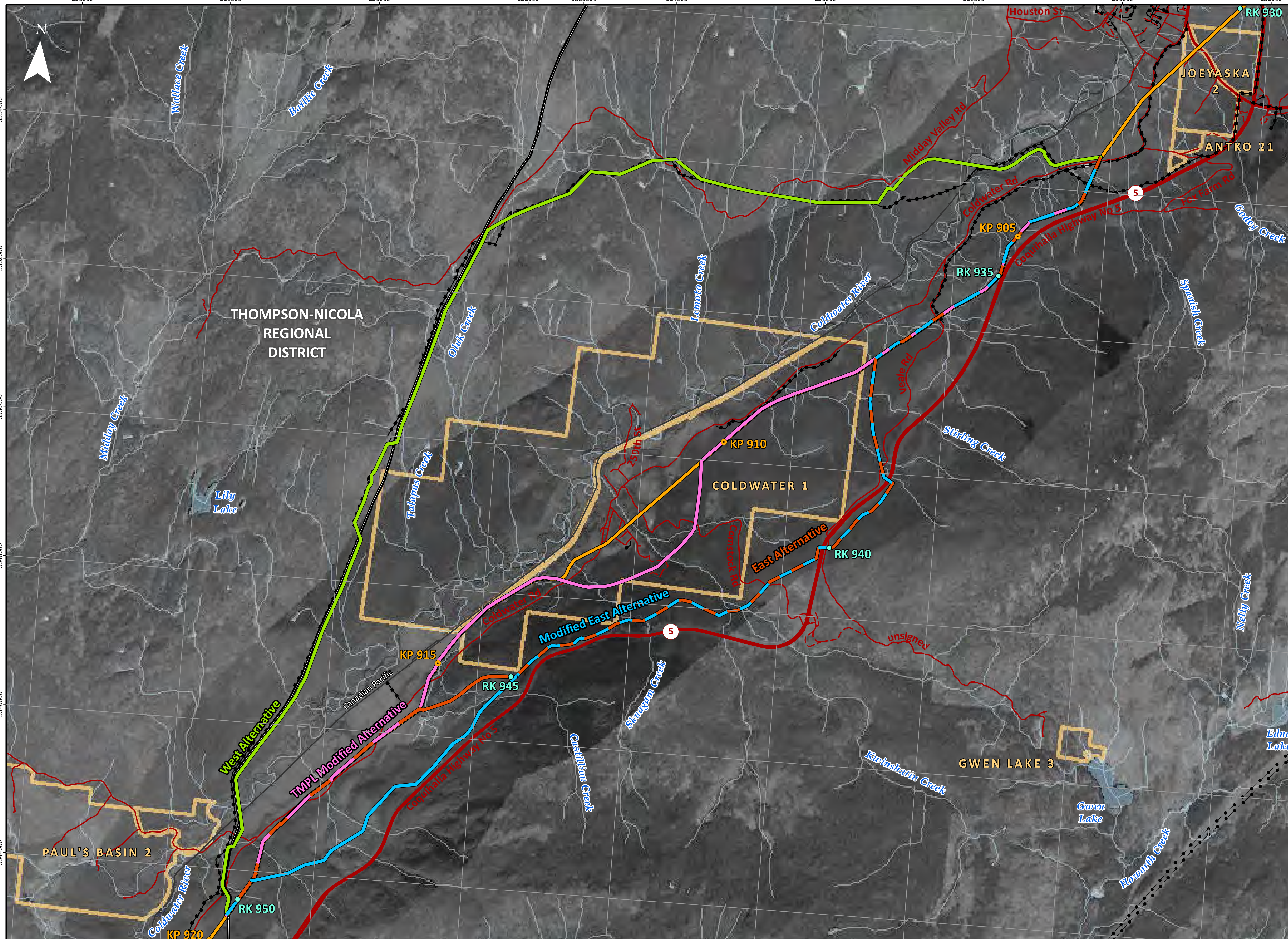

FIGURE 4.2-5

COLDWATER INDIAN RESERVE ALTERNATIVE CORRIDORS

TRANS MOUNTAIN EXPANSION PROJECT

Coldwater Indian Reserve Alternative Corridors

- TMPL Modified Alternative
- West Alternative
- East Alternative
- Modified East Alternative
- Reference Kilometre Post (RK)
- Trans Mountain Expansion Project Proposed Pipeline Corridor
- Kilometre Post (KP)
- Trans Mountain Pipeline (TMPL)
- Highway
- Paved Road
- Resource Road
- Railway
- Spectra Pipeline
- Fibre Optic Transmission System (FOTS)
- Transmission Line
- Park or Protected Area
- Waterbody
- Watercourse
- Indian Reserve

Projection: NAD 1983 UTM Zone 11N. Baseline TMPL Route Revision 0, provided by KMC, May 2012. Proposed Corridor V6 provided by UPI, August 23, 2013; Transmission Lines: BC Hydro, 2011; Transportation: IHS Inc., 2007, BC FLNRO, 2012; Geopolitical Boundaries: Natural Resources Canada, 2003, IHS Inc., 2011; First Nation Lands: Government of Canada, 2013, BC FLNRO, 2005; Hydrology: BC FLNRO, 2008; Civic Facilities: DMTI Spatial Inc. 2013; Spectra Pipelines and FOTS Lines: KMC, 2012; Imagery: Provided by KMC, 2013, NASA Geospatial Interoperability Program 2005.

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MAP NUMBER		PAGE
201308_MAP_TERA_RT_00391_REV0_05_COLDWATERIR		SHEET 1 OF 1
DATE December 2013	TERA REF. 7894	REVISION 0
SCALE 1:50,000	PAGE SIZE 11x17	DISCIPLINE RT
DRAWN SES	CHECKED TGG	DESIGN DM

0 0.5 1 1.5 2 km

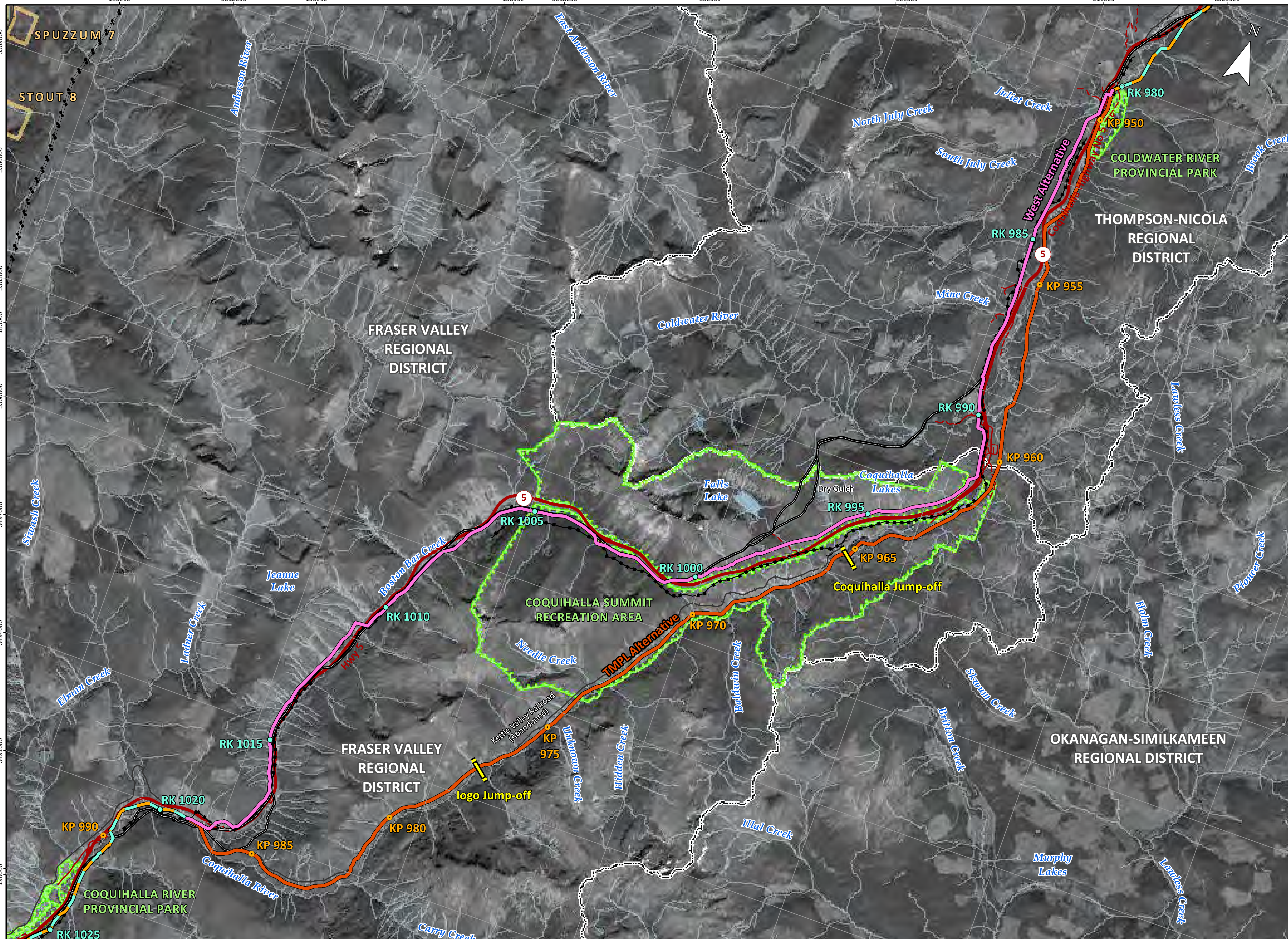
ALL LOCATIONS APPROXIMATE

201308_MAP_TERA_RT_00391_Rev0_05_ColdwaterIR.mxd

TABLE 4.2-5

EVALUATION OF ALTERNATIVE CORRIDORS - COLDWATER INDIAN RESERVE (KP 903.5 TO KP 919.5) (RK 933.1 TO RK 950.7)

Factors	TMPL Modified Alternative	West Alternative	East Alternative	Modified East Alternative
LENGTHS				
Length of pipeline corridor (km)	16.7	19.3	17.5	17.5
Length following existing TMPL right-of-way (km)	13.9	0.1	8.3	5.0
Length following other linear features (other pipelines, power lines, highways, roads, FOTS, railways, etc.) (km)	1.7	18.5	5.7	7.6
Length of "new" corridor (km)	1.1	0.7	3.5	4.9
Total parallels (km)	15.6	18.5	14.0	12.6
CROSSINGS				
No. of highway crossings (No.)	0	0	2	2
No. of road (arterial, collector, local) crossings (No.)	8	4	7	5
No. of railway crossings (No.)	0	0	0	0
Crossings of named rivers (No.)	0	2 (2 x Coldwater River)	0	0
Crossings of named creeks (No.)	5 (Stirling, Skugam, Kwinshatin, Castillion, Salem)	4 (Oluk, Salem, Lemoto x 2)	5 Stirling, Skugam, Kwinshatin, Castillion, Salem)	5 (Stirling, Skugam, Kwinshatin, Castillion, Salem)
Crossings of other watercourses (No.)	16	24	16	18
Total watercourses (No.)	21	30	21	23
GEOTECHNICAL				
Length crossing slopes > 50% on the fall line (km)	0	0	0	0
Length crossing slopes > 50% on sidehill (km)	0	0.2	0.3	0.5
Natural hazard potential (km)	High: 0 Medium: 1.4 Low: 15.3	High: 0 Medium: 2.2 Low: 17.1	High: 0 Medium: 0 Low: 17.5	High: 0 Medium: 0 Low: 17.5
Length of thin veneer of overburden or exposed bedrock (km)	0.3	4.5	3.3	4.1
HYDRAULIC ACCEPTABILITY	Yes	Yes	Yes	Yes
LAND				
Indian Reserve (km)(name)	7.0 (Coldwater IR 1)	0	0	0
Provincial Crown (km)	3.5	14.2	11.1	11.4
Private (km)	6.1	5.0	6.3	3.8
Unknown Parcels (km)	0.1	0.1	0.1	2.3
No. of private parcels (No.)	19	7	20	16
ENVIRONMENT				
Length within Coldwater River Riparian Reserve Zone (km)	0	0.6	0	0
Woodlots crossed (km)	0.2	0.7	0.2	0
Wildlife Habitat Areas for *SARA* listed species (km) (species)	0	1.6 (Williamson's Sapsucker)	0	0
Old Growth Management Area (non-legal) (km)	0.3	1.3	1.2	1.2
Designated Ungulate Winter Range (km)	3.6	13.4	11.2	13.7
Wetlands crossed (km), community forests crossed (km), and Old Growth Management Area (legal) (km)	0	0	0	0
SOCIO-ECONOMIC				
Parks and protected areas (km) (name)	0	0	0	0
Agricultural Land Reserve (km)	5.1	6.1	4.7	4.2
Community watersheds (No.)	2	0	2	2
LRMP area (km) (name)	0	0	0	0
ABORIGINAL AND STAKEHOLDER ENGAGEMENT				
Aboriginal Support	No	No major comments received to date. Consultation ongoing.	No major comments received to date. Consultation ongoing.	No major comments received to date. Consultation ongoing.
Stakeholder Support	No major comments received to date. Consultation ongoing.	No major comments received to date. Consultation ongoing.	No major comments received to date. Consultation ongoing.	No major comments received to date. Consultation ongoing.
CONSTRUCTABILITY AND COST				
Constructability	Crosses Coldwater IR 1; paralleling the existing TMPL right-of-way; skirts to the east of the more developed area.	Requires 2 Coldwater River trenchless crossings; includes Spectra right-of-way and FOTS parallel.	Skirts to east side of the Coldwater IR 1; includes 2 crossings of the Coquihalla Highway 5.	Skirts to the east side of Coldwater IR 1; includes 2 crossings of Coquihalla Highway 5.
Estimated Construction Cost ($ millions)	$31.3	$41.2	$33.2	$33.1



TRANS MOUNTAIN

FIGURE 4.2.6

COLDWATER RIVER PROVINCIAL PARK: COQUIHALLA VS. BOSTON BAR ALTERNATIVE CORRIDORS

TRANS MOUNTAIN EXPANSION PROJECT

Coldwater River Provincal Park: Coquihalla vs. Boston Bar Alternative Corridors

- TMPL Alternative
- West Alternative
- Reference Kilometre Post (RK)
- Trans Mountain Expansion Project Proposed Pipeline Corridor
- Kilometre Post (KP)
- Trans Mountain Pipeline (TMPL)
- Highway
- Paved Road
- Resource Road
- Railway
- Transmission Line
- Spectra Pipeline
- Fiber Optic Transmission System (FOTS)
- Park or Protected Area
- Waterbody
- Watercourse
- Indian Reserve
- Regional District Boundary

Projection: NAD 1983 UTM Zone 11N. Baseline TMPL Route Revision 0, provided by KMC, May 2012. Proposed Corridor V6 provided by UPI, August 23, 2013; Transmission Lines: BC Hydro, 2011; Transportation: IHS Inc., 2007, BC FLNRO, 2012; Geopolitical Boundaries: Natural Resources Canada, 2003, IHS Inc., 2011; First Nation Lands: Government of Canada, 2013, BC FLNRO, 2005; Hydrology: BC FLNRO, 2008; Civic Facilities: DMTI Spatial Inc. 2013; Spectra Pipelines and FOTS Lines: KMC, 2012; Imagery: Provided by KMC, 2013, NASA Geospatial Interoperability Program 2005.

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MAP NUMBER RT_391_		PAGE SHEET 1 OF 1
DATE December 2013	TERA REF. 7894	REVISION 0
SCALE 1:100,000	PAGE SIZE 11x17	DISCIPLINE RT
DRAWN SES	CHECKED TGG	DESIGN DM

0 1 2 3 4 km

ALL LOCATIONS APPROXIMATE

201308_MAP_TERA_RT_00391_Rev0_06_Coq_BostonBar.mxd

TABLE 4.2-6

EVALUATION OF ALTERNATIVE CORRIDORS – COLDWATER RIVER PROVINCIAL PARK – COQUIHALLA VERSUS BOSTON BAR (KP 949.1 TO KP 987.3) (RK 980.3 TO RK 1019.2)

Factors	TMPL Alternative	West Alternative
LENGTHS		
Length of pipeline corridor (km)	37.9	39.0
Length following existing TMPL right-of-way (km)	37.9	0.6
Length following other linear features (other pipelines, power lines, highways, roads, FOTS, railways, etc.) (km)	0	36.9
Length of new corridor (km)	0	1.5
Total parallels (km)	37.9	37.5
CROSSINGS		
No. of highway crossings (No.)	0	4
No. of road (arterial, collector, local) crossings (No.)	16	7
No. of railway crossings (No.)	0	0
Crossings of named rivers (No.)	16 (13 x Coquihalla River; 3 x Coldwater River)	1 (Coldwater River)
Crossings of named creeks (No.)	7 (Baldwin Creek; Norley Creek; Juliet Creek; unnamed creek; Needle Creek; Hidden Creek; Boston Bar Creek)	4 (Mine Creek; Juliet Creek; Fallslake Creek; Boston Bar Creek)
Crossings of other watercourses (No.)	39	45
Total watercourses (No.)	62	50
GEOTECHNICAL		
Length crossing slopes > 50% on the fall line (km)	0.2	0
Length crossing slopes > 50% on sidehill (km)	4.4	2.5
Natural hazard potential (km)	High: 12.5 (includes Coquihalla and Iago jump-offs) Medium: 9.0 Low: 16.3	High: 1.1 (includes Dry Gulch) Medium: 5.5 Low: 32.4
Length of thin veneer of overburden or exposed bedrock (km)	7.3	13.0
HYDRAULIC ACCEPTABILITY	Yes	Yes
LAND		
Indian Reserve (km) (name)	0	0
Provincial Crown (km)	37.8	36.5
Private (km)	0.1	0.9
Unknown Parcels (km)	0	1.6
ENVIRONMENT		
Length within Riparian Reserve Zone (km)	13.5	0.5
Old Growth Management Area (legal) (km)	0	1.7
Old Growth Management Area (non-legal) (km)	2.8	0
Designated Ungulate Winter Range (km)	2.5	0
Late winter or early winter habitat for mountain caribou (km) (Wells Gray or Groundhog), wetlands crossed (km), community forests crossed (km), woodlots crossed (km), and Wildlife Habitat Areas (km) (species)	0	0
SOCIO-ECONOMIC		
Parks and protected areas (km)(name)	13.3 (Coquihalla Summit Recreation Area) - would require impact assessment	12.7 (Coquihalla Summit Recreation Area) – would require impact assessment
Agricultural Land Reserve (km), community watersheds (No.), and LRMP area (km)(name)	0	0
ABORIGINAL AND STAKEHOLDER ENGAGEMENT		
Aboriginal Support	No major comments received to date. Consultation ongoing.	No major comments received to date. Consultation ongoing.
Stakeholder Support	General support for alternatives that reduce slope and stability risk. General support for alternatives that avoid provincial parks.	General support for alternatives that reduce the slope and stability risk. General support for alternatives that avoid provincial parks.
CONSTRUCTABILITY AND COST		
Constructability	16 river crossings; Crosses Coquihalla and Iago jump-offs in Coquihalla Canyon.	1 river crossing; West Alternative generally follows the existing Spectra gas pipeline right-of-way and FOTS alongside the Coquihalla Highway. Crosses Dry Gulch.
Estimated Construction Cost ($ millions)	$141.2	$112.2

Plate 1 Existing TMPL right-of-way (shown in yellow) surrounded by urban development within the City of Edmonton.

Plate 2 Existing TMPL right-of-way (shown in yellow) encroached by urban development through the community of Westsyde.

Plate 3 Existing FOTS right-of-way within Lac Du Bois Grasslands Protected Area.

Plate 4 Existing TMPL right-of-way within Coquihalla Canyon in foreground and proposed corridor beside Coquihalla Highway and FOTS in mid-ground.

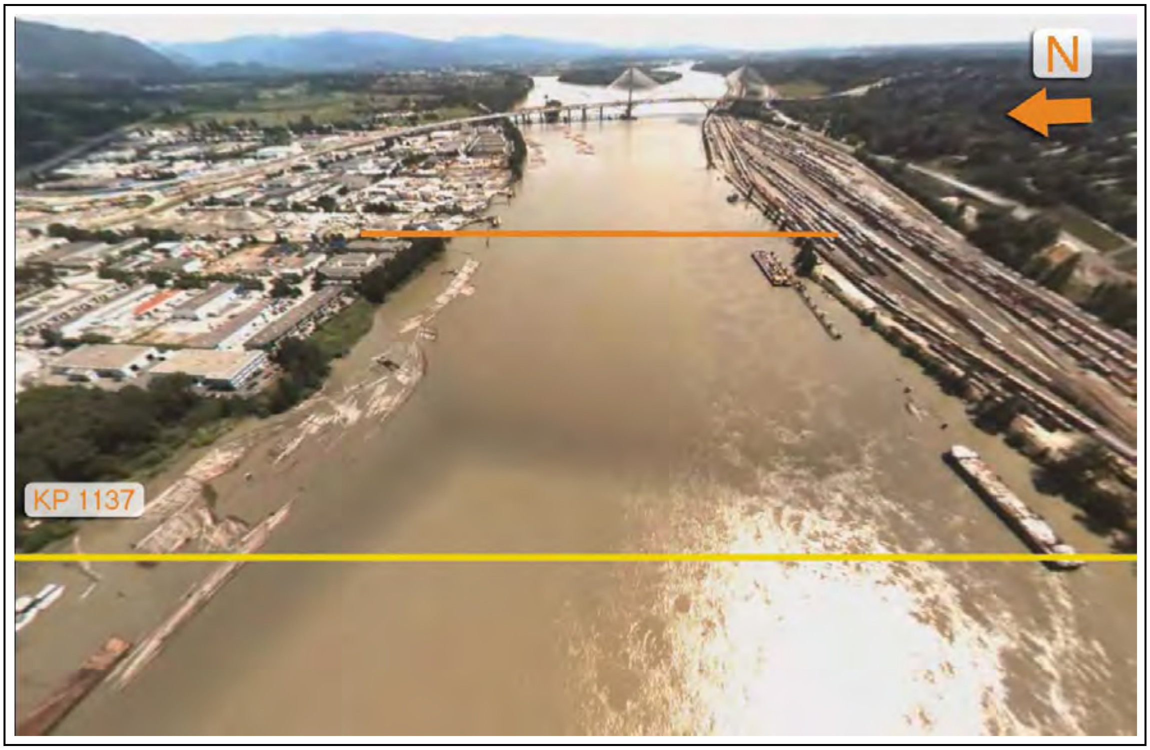

Plate 5 Overlooking the existing crossing of the Fraser River looking east with existing TMPL right-of-way (shown in yellow) in foreground, proposed pipeline corridor (shown in orange) in mid-ground and Port Mann Bridge in background.

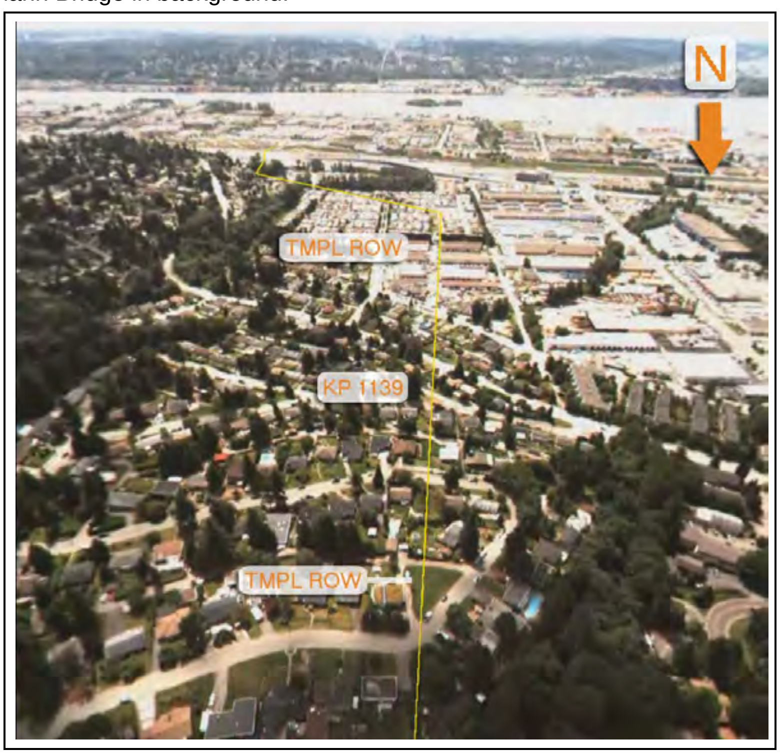

Plate 6 Looking south along the existing TMPL right-of-way (shown in yellow) encroached by urban development in the City of Coquitlam, BC.

4.3 Proposed Pipeline Corridor

Every effort has been made to follow the existing TMPL right-of-way or other existing rights-of-way as much as possible. Of a total length of 990 km, the proposed pipeline corridor follows the existing TMPL right-of-way for 662 km (67%) and the rights-of-way of other linear facilities for 220 km (22%) for a total parallel length of 882 km (89%). The remaining 108 km (11%) are on new corridor. The proposed pipeline corridor is shown on all the mapping in the remainder of this document and the preliminary Environmental Alignment Sheets provided in Volume 6E.

Note that Volumes 5A and 5B utilize preliminary results of parallel calculations, whereas the other volumes in the NEB application utilize final numbers. As a result, there is a slight discrepancy. The final percentages of TMPL parallel, other parallel and new corridor are 73%, 17% and 10%, respectively.

For purposes of this application, it was necessary to identify a proposed pipeline corridor to focus environmental and other studies. The environmental and socio-economic assessment was conducted by overlaying the proposed pipeline corridor on the project environmental setting and making predictions about environmental effects based on available information, known mitigation practices and professional judgment. It is recognized that additional landowner, stakeholder, environmental, socio-economic, geotechnical, and other information will come forward that will lead to improvements in the location of the pipeline corridor. In addition, the pipeline routing specialists are continuing to refine the proposed 150 m corridor and narrow it down to a pipeline construction right-of-way. These improvements will adopt the routing criteria, strategies and guidelines described in Volume 4A, Section 2.8 without jeopardizing pipeline safety and security. Where corridor modifications occur, additional studies will be completed to confirm predictions and implement appropriate mitigation from the EPPs. No fundamental change in the overall conclusion of no significant adverse effects is anticipated. Additional information is provided in Section 9.0 of Volumes 5A and 5B.

4.4 Permanent Facility Site Selection

4.4.1 Introduction

The TMEP is a loop of the existing 1,150 km TMPL system from Edmonton to Burnaby that has been in operation since 1953. As well as the looping of the pipeline, several new or expanded facilities (*e.g.,* pump stations, storage tanks, etc.) are required to efficiently operate the pipeline system. An overview of the general facility site selection objectives/criteria and the proposed facility sites is provided in Section 4 of Volume 2. A detailed description of the facilities associated with the TMEP is provided in Sections 3.3, 3.4 and 3.5 of Volume 4A.

New and/or expanded permanent facilities are required for the successful operations of the pipeline component of the Project.

The permanent facilities associated with the Project include the following.

- Installing 23 new sending and receiving traps (16 on TMPL and TMEP), for in-line inspection tools at 9 existing sites and one new site.
- Adding 35 new pumping units at 12 locations (*i.e.,* 11 existing and 1 new pump station sites).
- Reactivating the existing Niton Pump Station that has been maintained in a deactivated state.
- Constructing 20 new tanks located at the terminals near Edmonton (5). Sumas (1) and Burnaby (14), preceded by demolition of two existing tanks near Edmonton (1) and Burnaby (1), for a net total of 18 tanks added to the system.
- Constructing one new dock complex, with a total of three Aframax-capable berths, as well as a utility dock (for tugs, boom deployment vessels, and emergency response vessels and equipment) at Westridge Marine Terminal, followed by the deactivation and demolition of the existing berth.

This subsection describes the site selection criteria and site selection process used by the Project team to choose the sites where permanent facility sites will be located.

4.4.2 Site Selection Criteria

Edmonton, Sumas and Burnaby Terminals

The Project includes the addition of storage tanks at the existing Edmonton Terminal, Sumas Terminal and Burnaby Terminal locations. Additional booster pumps and metering facilities are also proposed for the Edmonton and Burnaby facilities. Site selection for these new facilities is primarily focused on minimizing environmental and land use disturbance by utilizing existing facility locations. The proposed expansion of the existing terminal locations is based on the following site selection criteria.

- Maximize safety of personnel and the public during construction and operations.
- Reduce environmental effects and new disturbances.
- Limit effects on terrestrial vegetation and wildlife habitat.
- Accommodate facility expansion within existing property boundaries.
- Integrate the expansion works with existing operations.
- Ensure existing infrastructure (*e.g.,* access roads) are in place and suitable for Project needs.
- Minimize issues related to undesirable topography or terrain instability.
- Avoid culturally sensitive areas.
- Avoid conflicting land uses and encroachment upon residences/communities.
- Accommodate Aboriginal community, landowner, regulatory authorities and other stakeholder feedback, to the extent feasible.

All work associated with the Project to be conducted at Edmonton, Sumas and Burnaby terminals will be conducted within the footprint of the existing industrial sites on Trans Mountain-owned lands. No new land will be acquired for the expansion of existing facilities or the installation of new facilities at the terminal locations.

Westridge Marine Terminal

The Project includes an expansion of the existing tanker loading facilities at the Westridge Marine Terminal. Site selection is primarily focused on reducing environmental and land use disturbance by utilizing existing facility locations. Expansion of the existing dock facility is based on the following criteria.

- Maximize safety of personnel and the public during construction and operations.
- Provide the highest level of navigational safety, both for vessels berthing at Westridge Marine Terminal and for other vessels transiting the inlet or at one of the four anchorages nearby.
- Provide three Aframax capable berths, allowing capacity for vessels to wait for cargo or transit windows to reduce pressure.
- Allow the existing dock to remain in service during the construction of the new dock complex, and specifically until the new Berth 1 can be commissioned.
- Reduce the overall footprint and the effect to the community views.
- Eliminate the deep-water dredging and reduce the amount of dredging for the foreshore expansion.
- Minimal storm surge effect is expected at the existing dock site. Available public information suggests that the hazard from a tsunami is very low for the area.
- Reduce environmental effects and new disturbances.

- Reduce effects to terrestrial vegetation and wildlife habitat by using existing disturbed lands to the extent feasible.
- Avoid parks and recreational areas.
- Accommodate land-based component of facility expansion within existing property boundaries.
- Proximity of existing facilities to nearby existing infrastructure (*e.g.,* access road, electric power supply).
- Avoid culturally sensitive areas.
- Avoid conflicting land uses and encroachment upon residences/communities.
- Accommodate Aboriginal community, landowner, regulatory authorities and other stakeholder feedback to the extent feasible.

Pump Stations

Pump station sites are largely selected according to the hydraulic pressure requirements of the pipelines. Pump station location was determined following selection criteria designed to respond to construction, operational, environmental and land use constraints. Factors affecting the selection of pump station sites included the pipeline diameter, pipeline operating pressures, the hydraulic and elevation profile and the type of liquid being transported (high or low viscosity). New pump stations to be located on a previously undisturbed site (*i.e.,* Black Pines) were typically provided a siting range of +2 km downstream or -1 km upstream along the existing TMPL right-of-way, centred on the hydraulic optimum. Once the optimal hydraulic points were selected, the following site selection criteria were considered in the final placement of the pump stations.

- Locate the site on existing or former pump station sites or on lands owned by Trans Mountain. Where this was not possible, the following criteria were used.
  - Consult landowners to seek voluntary agreement to acquire the necessary lands with respect to surrounding land use and constraints.
  - Reduce disturbance by utilizing previously disturbed sites, where practical.
  - Locate site near existing infrastructure (*e.g.,* access roads, power lines), to the extent feasible.
  - Locate the site within less environmentally sensitive areas, to the extent feasible.
  - Avoid areas of terrain instability.
  - Avoid wetlands and riparian areas.
  - Avoid conflicting land uses and encroachment upon residences and communities, wherever practical.
  - Avoid known archaeological, heritage and traditional land use sites.
  - Accommodate Aboriginal community, landowner and regulatory authorities and other stakeholder feedback to the extent feasible.

Trans Mountain first identified lands that had been previously disturbed for other uses. In all instances, with the exception of Black Pines Pump Station, existing sites that have been previously used as pump stations or other company uses were selected for development of new pump stations by the Project.

Mainline Block Valves

Site selection criteria for mainline block valves will include:

- engineering and operations requirements;
- meet industry codes and standards, at a minimum;
- avoid wetlands and other sensitive environmental features;
- locate in vicinity of existing access roads and power supplies, if feasible;
- avoid steep slopes, unstable terrain and poorly drained areas; and
- avoid being immediately adjacent to major watercourses.

4.4.3 Terminal Site Selection

Edmonton Terminal

All new and upgraded facilities associated with the Edmonton Terminal will be constructed on Trans Mountain-owned lands on a previously disturbed, industrial area.

Sumas Terminal

The site for the new tank to be constructed at the Sumas Terminal is located to the north of the existing tanks on Trans Mountain-owned land. The land where the new facilities will be installed has been previously disturbed. There may be a small amount of clearing required along the north fenceline of the terminal site to make space available for an access road and to relocate an existing power line.

To make space available for the new tank, an existing containment berm will be dismantled and the area graded level to support the foundation for the new tank. A new containment berm will be constructed before the new tank is put into operation. The new containment berm will be comprised of the materials from the existing berm as well as the graded materials, provided these materials are acceptable for such a use (*i.e.,* non-porous).

A power line that is currently located on the north edge of the existing cleared area may be relocated to make space available for the new tank. Electrical facilities will not be upgraded as part of this development.

Burnaby Terminal

All lands required for the new and upgraded facilities associated with the Burnaby Terminal are owned by Trans Mountain. Some onsite riparian vegetation associated with several drainage channels that traverse the facility site will need to be cleared.

Westridge Marine Terminal

All new and upgraded facilities associated with the on-shore portion of the Westridge Marine Terminal will be located within the existing disturbed area on land that is owned by Trans Mountain. Additional reclaimed foreshore lands will be required to provide the space required for the new and upgraded facilities associated with the off-shore component of the Westridge Marine Terminal.

4.4.4 Pump Station Site Selection

Edmonton Pump Station

All new and upgraded facilities associated with the Edmonton Pump Station will be constructed on Trans Mountain-owned lands within a previously disturbed, industrial area.

Gainford Pump Station

All lands required for this new pump station are owned by Trans Mountain. Some of the lands are previously undisturbed by industrial developments and remain intact with a native tree cover. The new pump station will be located to the northwest of the existing pump station facilities. The size of the station operating area associated with the Gainford Pump Station will be increased by approximately 0.6 ha on lands that are owned by Trans Mountain.

Niton Pump Station

The two deactivated pumping units associated with TMPL will be reactivated as part of TMEP. No new lands will be acquired for this aspect of the Project. All works planned for the Niton Pump Station will occur within the fenced site of the existing pump station on land that is owned by Trans Mountain. There will be no new facilities constructed at the Niton Pump Station associated with TMEP.

Wolf Pump Station

The expansion of the facilities at Wolf Pump Station will be to the west of the existing facilities on previously disturbed lands that are owned by Trans Mountain. A new pump building will be located adjacent to the existing pump building. The existing electrical infrastructure will be reused for TMEP operations. No new disturbance to previously undisturbed lands will be necessary at Wolf Pump Station.

Edson Pump Station

All land required for the planned upgrades and expansion of the Edson Pump Station is owned by Trans Mountain. All of the land required by the Project has been previously disturbed.

Hinton Pump Station

A new pump station will be built immediately adjacent to the existing Hinton Pump Station. Additional new lands will have to be acquired by Trans Mountain for the new pump station. The existing fence line will be expanded to the west by approximately 35 m, increasing the station operating area by approximately 0.3 ha.

Jasper Pump Station

All construction work to be conducted at the Jasper Pump Station will be located within the current fenced area of the existing pump station. There will be no new disturbance of previously undisturbed lands outside of the current fenced area associated with this work. Trans Mountain will not have to expand the lease they currently hold with Parks Canada.

Rearguard Pump Station

Additional new lands will have to be acquired by Trans Mountain for the development required at the Rearguard Pump Station. The existing fence line associated with this station will be expanded to the east by approximately 100 m, which will increase the station operating area by approximately 0.7 ha. The area that will be developed for this new pump station is relatively flat and has been previously disturbed.

Blue River Pump Station

All construction activities planned for the Blue River Pump Station will take place on previously disturbed lands that are owned by Trans Mountain. A new pump building will be located adjacent to the existing pump building. The existing electrical infrastructure will be reused for TMEP operations.

Blackpool Pump Station

All lands required for the planned expansion and upgrades associated with the Blackpool Pump Station are owned by Trans Mountain. All of the lands have been previously disturbed.

Darfield Pump Station

Trans Mountain will need to acquire a small amount of additional land (approximately 0.07 ha) located outside of the current fence line of the Darfield Pump Station to the north in order to accommodate the new scraper facilities to be installed at this site. The lands located to the north of the existing pump station are currently being used for agricultural purposes. Negotiations to acquire these lands by voluntary agreement are currently underway.

Black Pines Pump Station

The Black Pines Pump Station is the only new pump station location required for the Project that is not associated with a currently existing pump station. Pumping facilities for both TMPL and TMEP will be installed at Black Pines.

The general location for this pump station was selected based on the hydraulic optimum that considers the operating pressures and throughput of product in both TMPL and TMEP pipelines. The general location was identified along a 2 km length of the pipeline between KP 784 and KP 786 of the existing pipeline system. A field reconnaissance was conducted in December 2012 to further refine the location of the pump station to increase the distance from the nearest residences while keeping the station within the range of the identified hydraulic preference. The general terrain of the land was also considered during this reconnaissance to ensure the selected site was not located on steep slopes, in a wetland or close to waterbodies.

The preliminary site selected for the pump station is located at RK 811.8 (KP 784.6). This location is tree covered with mature coniferous trees (see Plate 7). The surface materials where the pump station would be located consist of a debris fan. Therefore, further geotechnical assessments will be required at this site to determine the optimum location for the station as well as to determine appropriate mitigation measures to protect the facilities from a potential debris flow during the operations phase of the Project. The current surface of the site is sloped, which would require grading to level the surface for construction and operations of the pump stations.

Plate 7 Aerial view of the proposed Black Pines Pump Station Site (May 27, 2013).

It is anticipated that an area of 150 m x 150 m will be required for the construction of the pump station and associated facilities (*e.g.,* sending/receiving traps). This area would generally be located to the west of the current Trans Mountain right-of-way, with the exception of the containment pond, which would be located east of the existing right-of-way. Final layout of the proposed pump station will be determined during detailed engineering design.

The lands that have been identified for this new pump station are currently privately owned. Trans Mountain will seek to acquire the lands needed for the construction and operation of the Black Pines Pump Station. Trans Mountain is currently negotiating with the landowners to acquire the land required for the Black Pines Pump Station.

Black Pines Power Line Route Selection Process

A search for existing power lines with a suitable voltage rating that is required for the Black Pines Pump Station was conducted after the preliminary site for the pump station was identified. A suitable existing power line was identified on the east side of Highway 5, which is to the east of the Black Pines Pump Station site (Figure 4.4-1).

A desktop assessment of existing surface encumbrances (*e.g.,* residences, farm buildings, etc.) and terrain and landscape features in the area surrounding the preliminary pump station site and the existing power line was conducted. Representatives of Trans Mountain and TERA conducted a field reconnaissance of the Black Pines area in December 2012 to verify the results of the desktop assessment.

A representative of Trans Mountain met with BC Hydro in February 2013 to discuss the potential to 'tap' into the existing power line at one of three potential locations along the line and to discuss high level routing considerations for the new power line. BC Hydro indicated that a 'tap' into this power line would be possible and that their preference would be to avoid routing the new power line across an island in the North Thompson River.

The preliminary power line route was selected to:

- reduce overall route length;
- reduce the number of bends in the line;
- avoid close proximity to residences; and
- avoid routing over an island in the North Thompson River.

With these considerations in mind, a preliminary route option was selected to the north of the island identified as a routing constraint by BC Hydro. The route crosses the North Thompson River and then turns to the south on the west side of Westsyde Road where it intersects with the north boundary of the preliminary Black Pines Pump Station site.

A route option to the south of the island in the North Thompson River was not considered due to a higher density in residences on both the east and west sides of the North Thompson River.

A representative of Trans Mountain presented the preliminary 'tap' in location and route option to BC Hydro on May 13, 2013. BC Hydro endorsed both the route and the 'tap' location on May 31, 2013.

Access Road Route Selection Process

Depending on the final site selected for the pump station, a suitable location to construct the access road intersecting with Westsyde Road will be chosen. The terrain as well as the line-of-sight along Westsyde Road will be considered when selecting the access road required for the Black Pines Pump Station. Given the close proximity of the preferred site for the Black Pines Pump Station to Westsyde Road, the access road will be short (*i.e.,* less than 100 m).

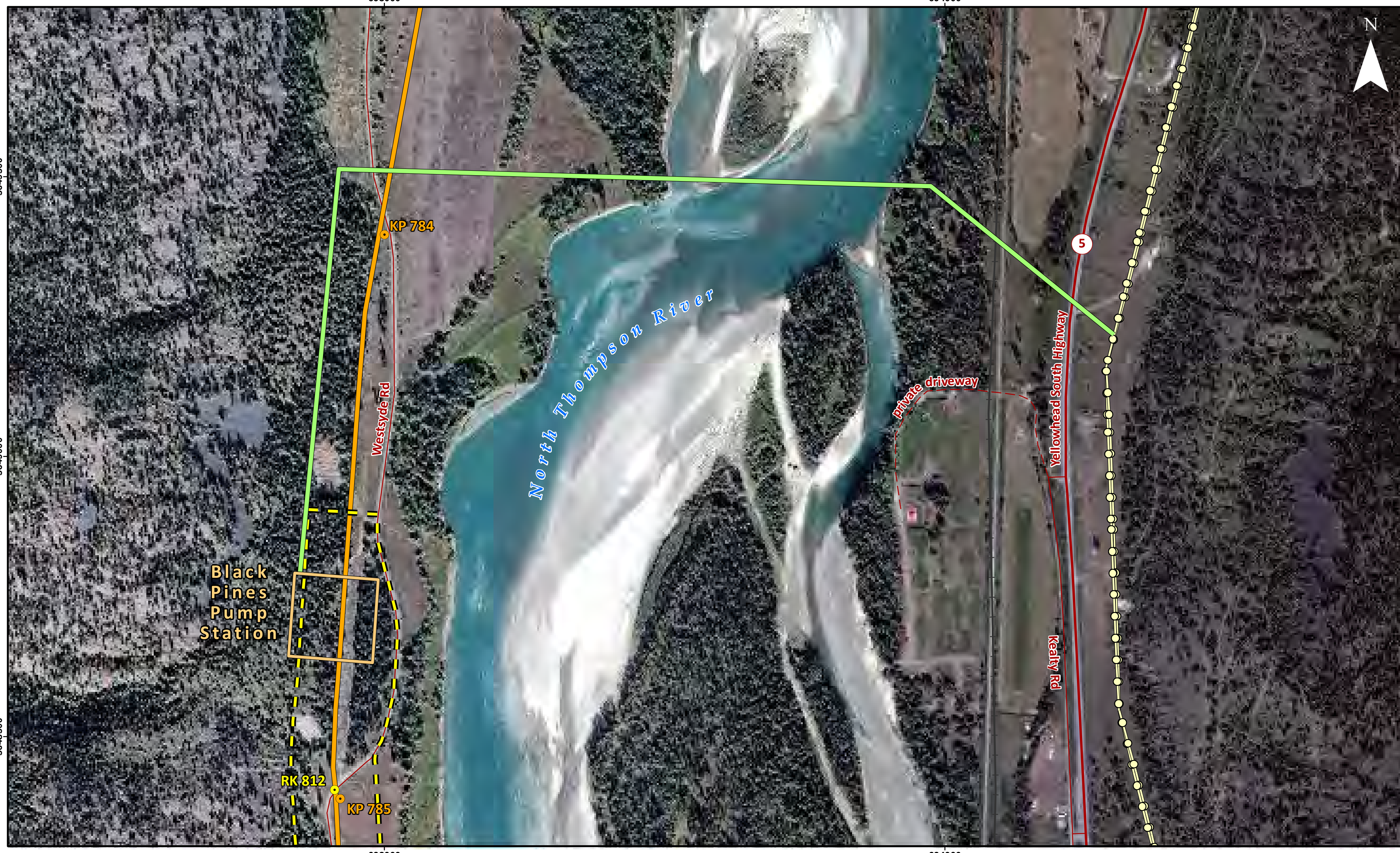

FIGURE 4.4-1

PROPOSED BLACK PINES POWER LINE ROUTE

TRANS MOUNTAIN EXPANSION PROJECT

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TRANS MOUNTAIN

SCALE: 1:10,000

0 100 200 300 400 m

ALL LOCATIONS APPROXIMATE

MAP NUMBER 201311_MAP_TERA_ESA_00493_REV0		PAGE SHEET 1 OF 1
DATE December 2013	TERA REF. 7894	REVISION 0
SCALE 1:10,000	PAGE SIZE 8.5 x 11	DISCIPLINE ESA
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Legend

- Kilometre Post (KP)
- Reference Kilometre Post (RK)
- Trans Mountain Pipeline (TMPL)
- Trans Mountain Expansion Project Proposed Pipeline Corridor
- Proposed Power Line
- Existing Power Line
- Proposed Pump Station
- Highway
- Road
- Resource Road
- Railway

Projection: NAD83 UTM Zone 10N. Routing: Baseline TMPL & Facilities: provided by KMC, 2012; Proposed Pipeline Corridor V6: provided by UPI, Aug. 23, 2013; Transportation: IHS Inc., 2013, BC Forests, Lands and Natural Resource Operations, 2012 & Natural Resources Canada, 2012; Geopolitical Boundaries: Natural Resources Canada, 2003, IHS Inc., 2011, BC FLNRO, 2007 & ESRI, 2005; First Nation Lands: Government of Canada, 2013 & IHS Inc., 2011; Hydrology: Natural Resources Canada, 2007 & BC Crown Registry and Geographic Base Branch, 2008; Colour Imagery Source: Esri, i-cubed, USDA, USGS, AEX, GeoEye, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community.

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Kamloops Pump Station

All new and upgraded facilities to be constructed at the Kamloops Pump Station associated with TMEP will be constructed on lands that are owned by Trans Mountain on previously disturbed, industrial land.

Kingsvale Pump Station

A new pump station and electrical substation will be constructed immediately adjacent to the existing Kingsvale Pump Station. The power line that currently feeds the existing pump station is undersized for the added load associated with the new pump station. Therefore, a new 138 kV power line, approximately 23.5 km in length, will also be required to provide electricity to this pump station.

The land required for the new pump station and electrical substation to be installed at Kingsvale is owned by Trans Mountain. Some new clearing and grading will be required to create a level working surface for the construction of the new facilities at Kingsvale Pump Station.

Kingsvale Power Line Route Selection Process

A search for existing power lines with suitable voltage rating as required for the Kingsvale Pump Station that are located in the vicinity of the Kingsvale Pump Station was conducted. A suitable power line exists on the east side of Highway 5A, which is to the east of the Kingsvale Pump Station site (Figure 4.4-2).

A desktop assessment of existing surface encumbrances (*e.g.,* residences, farm buildings, etc.) as well as terrain and landscape features in the area surrounding the study area between the Kingsvale Pump Station and the existing power line was conducted. Representatives of Trans Mountain and TERA conducted a field reconnaissance of the area in December 2012 to verify the results of the desktop assessment.

A representative of Trans Mountain met with BC Hydro in February 2013 to discuss the potential to 'tap' into the existing power line and to discuss high level routing considerations for the new power line. BC Hydro indicated that a 'tap' into this power line would be possible.

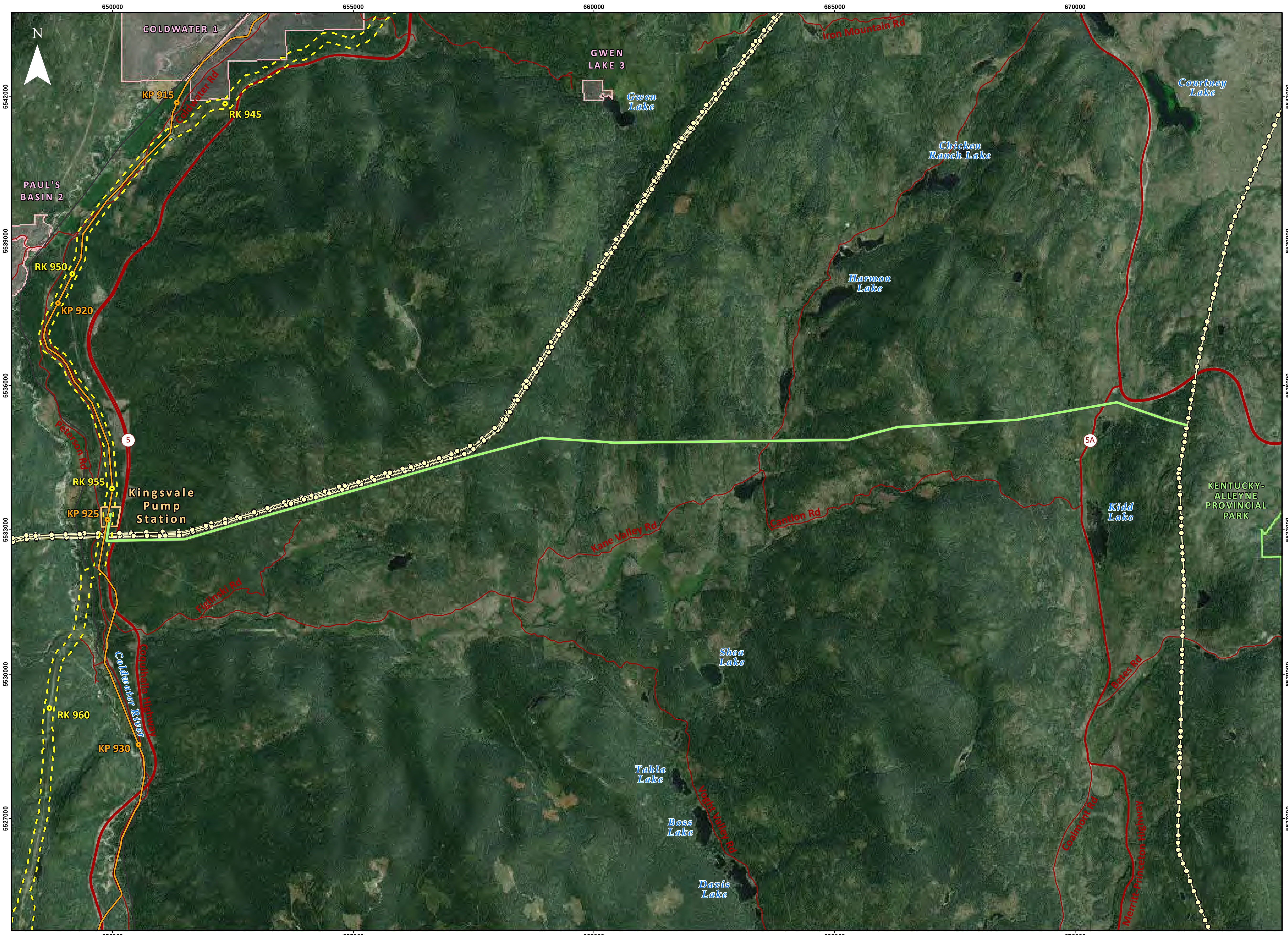
The preliminary power line route option was selected to:

- reduce overall route length;
- reduce the number of bends in the line;
- parallel existing linear features, to the extent practical; and
- avoid close proximity to residences.

With these considerations in mind, a preliminary route option was selected based on a desktop assessment of the area.

An aerial reconnaissance of the preliminary route option was conducted on May 27, 2013. Based on this reconnaissance several minor adjustments to the preliminary route alignment were made to avoid paralleling a drainage channel as well as steep sidehill terrain.

A representative of Trans Mountain presented the preliminary 'tap' in location and route options to BC Hydro on May 13, 2013. BC Hydro will have to approve the routing for the new power line since the selected route must meet their satisfaction from an operations perspective as well as future expansion considerations, if the selected route is located adjacent to the existing 500 kV transmission corridor. BC Hydro endorsed the selected route and the 'tap' location into the existing power line on May 31, 2013. However, BC Hydro has conducted an analysis to determine whether there will be an issue of induced current on the new power line required for the Kingsvale Pump Station. The result of the study indicated that there are no issues with the proposed route. The final route alignment for this power line will be selected during detailed design of the Project.



TRANS MOUNTAIN

FIGURE 4.4-2

PROPOSED KINGSVALE POWER LINE ROUTE

TRANS MOUNTAIN EXPANSION PROJECT

Kilometre Post (KP)
Trans Mountain Pipeline (TMPL)
Proposed Power Line
Trans Mountain Expansion Project Proposed Pipeline Corridor
Subject Property Facility Boundary
Highway
Paved Road
Existing Power Line
Railway
National Park / Provincial Park / Protected Area
Indian Reserve / Métis Settlement

Projection: NAD 1983 UTM Zone 10N.
Routing: Baseline TMPL & Facilities: provided by KMC, 2012; Proposed Pipeline Corridor V6: provided by UPI, Aug. 23, 2013; Transportation: IHS Inc., 2013, Natural Resources Canada, 2011; Geopolitical Boundaries: Natural Resources Canada, 2003, Altalis, 2012, IHS Inc., 2011, ESRI, 2005; First Nation Lands: Government of Canada, 2013; Parks and Protected Areas: Natural Resources Canada, 2013, Altalis, 2013, Alberta Tourism, Parks and Recreation, 2012, BC FLNRO, 2008; Hydrology: IHS Inc., 2004; Imagery Source: Esri, i-cubed, USDA, USGS, AEX, GeoEye, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community.

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Although there is no reason to believe that there are any errors associated with the data used to generate this product or in the product itself, users of these data are advised that errors in the data may be present.

MAP NUMBER 201311_MAP_TERA_ESA_00494_REV0		PAGE SHEET 1 OF 1
DATE December 2013	TERA REF. 7894	REVISION 0
SCALE 1:75,000	PAGE SIZE 11x17	DISCIPLINE ESA
DRAWN AJS	CHECKED TGG	DESIGN TGG

0 500 1,000 1,500 2,000 2,500 m

ALL LOCATIONS APPROXIMATE

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The Proposed Power Line Route

The proposed power line route extends to the northwest along an existing access road from the 'tap' in location to the existing power line. From here, the proposed route continues to the west of Highway 5A before turning to the southwest. The proposed route then turns to the northwest and continues westward until it nears the existing 500 kV transmission corridor approximately 8 km east of the Kingsvale Pump Station. The proposed route then turns to the west and parallels the existing 500 kV transmission line corridor with an offset of 70 m south of the southernmost conductor on the existing transmission line. After crossing to the west of Highway 5, the proposed route turns to the north following the existing TMPL right-of-way before it enters the lands where the new substation will be constructed within the Kingsvale Pump Station site.

Pressure Control Station

A pressure control station may be required on both TMPL and TMEP. It is likely that this facility would be installed at the Hope Pump Station if it is determined during detailed design that it is required for operations.

Existing access and electrical facilities for the Hope Pump Station will be sufficient for the construction and operation of the pressure control station.

The lands required for the pressure control station are owned by Trans Mountain.

Sumas Pump Station

There will be a new pumping unit installed on the 609.6 mm OD (NPS 24) pipeline heading south from the Sumas Pump Station into Washington State (*i.e.,* the Puget Sound line).

The land required for the new pumping unit to be installed at the existing Sumas Pump Station is owned by Trans Mountain and has been previously disturbed by industrial activity.

4.4.5 Mainline Block Valves Site Selection

Once the approximate locations of mainline block valves have been identified, using the criteria listed above in Section 4.3.2, the sites will be subject to an environmental assessment. Detailed environmental surveys (*e.g.,* soils, vegetation and wildlife) will be conducted, where warranted, to determine any potential environmental issues associated with these sites.

The evaluation of mainline block valve locations will be conducted as far in advance of their intended use, as practical, in order to allow adequate time to identify and evaluate any alternate sites. In the event that specific mitigation is warranted for a specific site, the measures developed will be documented in the Environmental As-Built Report (see Volume 6A). General provisions will be included in the contract documents that commit contractors to site protection/restoration measures at sites identified, evaluated and used during the construction program. Mitigation measures to be used at mainline block valve sites will be as described in Section 7.0 of Volume 5A and Volume 6B (Pipeline EPP). All applicable approvals for the mainline block valves will be acquired prior to use of the site or area. The level of mitigation measures applied will ensure that any residual environmental effects are reduced to a level that is not significant.

4.5 Temporary Facility Site Selection

4.5.1 Introduction

New and/or expanded temporary facilities will be required during the construction of the Project. The temporary facilities associated with TMEP will include:

- staging and stockpile sites;
- equipment storage sites;
- construction office sites;

- construction work camps (likely one in Alberta and two in BC);
- trenchless crossing work areas;
- shoo-flies/temporary access roads;
- borrow pits; and
- log decks.

This subsection describes the site selection criteria and site selection process that will used by the Project team to select the sites where temporary facility sites will be located.

4.5.2 Temporary Facility Site Selection Criteria

The following site selection criteria will be used to evaluate and select temporary facility sites and workspace.

- Selection of an optimal location for construction needs.
- Locate the facility in the vicinity of similar existing facilities to reduce environmental and land use disturbances.
- Locate temporary facilities that require the use of utilities at sites already serviced by roads and utilities.
- Avoidance, to the extent practical, of areas of native vegetation by maximizing the use of previously cleared or broken lands, or lands currently under industrial land use.
- Preferential selection of grassed areas over bush or wooded areas when temporary workspace is necessary on lands supporting native vegetation.
- Avoidance, to the extent practical, of known locations that provide site-specific habitat for wildlife species of concern or apply special mitigation (refer to Section 7.0 of Volume 5A).
- Avoidance, to the extent practical, of known sites that support vascular plant species of concern or apply special mitigation (refer to Section 7.0 of Volume 5A).
- Avoidance, to the extent practical, of steep slopes, organic soils and poorly-drained areas.
- Avoidance, to the extent practical, of known areas with heritage resource sites or apply special mitigation (refer to Section 7.0 of Volume 5B).
- Avoidance of locations adjacent to a conflicting land use where potential noise, dust or visual concerns could not be readily mitigated.
- Avoidance of parks and protected areas.
- Abide by requests of Aboriginal communities, landowners and regulatory authorities, to the extent feasible.

4.5.3 Temporary Facility Site Selection

The need for and the respective general location of these sites are the responsibility of the pipeline or facilities construction contractor. However, all temporary workspace and temporary facility site locations will require the approval of the Inspector(s) or qualified designate.

Once the location of temporary workspace or a temporary facility for use during construction has been identified, the sites will be assessed and, where appropriate, approved by the Inspector(s) or qualified designate. Detailed environmental surveys (*e.g.,* soils, vegetation and wildlife) will be conducted, where warranted, to determine any potential environmental issues.

The evaluation of potential temporary facility sites/workspace will be conducted as far in advance of its intended use, as practical, in order to allow an adequate time to chose and evaluate any alternate sites. In the event that specific mitigation is warranted for the site, the measures developed will be documented in the Environmental As-built Report (see Volume 6A). General provisions will be included in the contract documents that commit contractors to site protection/restoration measures at sites identified, evaluated and used during the construction program. Mitigation measures to be used at temporary facility sites and temporary work areas are described in Section 7.0 of Volume 5A and Volume 6B (Pipeline EPP). All applicable approvals for the temporary facility site or workspace will be acquired prior to use of the site or area. The level of mitigation applied will ensure that any residual environmental effects are reduced to a level that is not significant.

4.6 References

4.6.1 GIS Data and Mapping References

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5.0 ENVIRONMENTAL SETTING FOR THE PIPELINE

Prior to European contact, numerous Aboriginal communities settled both the plains and woodlands of Alberta. European settlement and influence began in the late 1700s with the advent of the fur trade. When the Hudson's Bay Company relinquished control of the land in 1870s, the region was opened for settlement, resulting in expansive colonization and transformation of the land for agricultural development, which became the dominant economic activity in Alberta until the discovery of oil in the Leduc field in 1947 (Government of Alberta 2012).

Prior to European contact, BC's productive coastal region was likely one of the areas most densely inhabited by First Nations in North America. European settlement began along the south coastal regions in the late 1700s, expanding rapidly inland with the discovery of gold in the Fraser River and the Cariboo Region in the 1860s. Bustling cities, roads, railways and steamships were constructed to accommodate the influx of prospectors and merchants. By the mid-1900s, major transportation developments were undertaken to accommodate growing industries such as hydro-electric power, mining and forestry, and to connect regions and communities throughout BC (Province of BC 2012). Further information on past development of the Project area is provided in Section 8.1.

The following subsections present a summary of the environmental setting of the proposed pipeline corridor for the following elements from the NEB *Filing Manual* (NEB 2013): physical and meteorological environment; soil and soil productivity; water quality and quantity; air emissions; greenhouse gas (GHG) emissions; acoustic environment; fish and fish habitat; wetlands; vegetation; wildlife and wildlife habitat; and species at risk. The environmental setting was compiled based on the following sources.

- Geotechnical, soil, groundwater, air quality, GHG, acoustic, fish, wetland, vegetation and wildlife field studies conducted for the Project (Volumes 4A and 5C).
- Existing published literature including topographic maps, aerial photography, scientific papers and reference books, as well as municipal, provincial and federal government maps, reports, interactive websites, guides, information letters, fact sheets and databases.
- Consultation and engagement with Aboriginal communities (including Aboriginal Traditional Knowledge [ATK] and Traditional Ecological Knowledge [TEK], landowners, regulatory authorities, stakeholders and the general public).

ATK is defined as knowledge that is held by, and unique to, Aboriginal peoples. TEK is a subset of ATK that is primarily concerned with the environment. ATK and TEK have been integrated into the setting in the following subsections, where applicable, from information gathered by the Aboriginal engagement team. The inclusion of ATK and TEK is essential in understanding the overall setting of the environment.

Resource material was obtained by searching libraries, internet searches and documents from regulatory authorities. References used in the preparation of the environmental setting are cited in Section 5.14. Detailed methodology for the collection of information on existing conditions, including field studies, is provided in the applicable supporting studies in Volume 5C, with the exception of the following BGC Engineering Inc. reports, which are provided in Volume 4A: Route Physiography and Hydrology; Terrain Mapping and Geohazard Inventory; Seismic Assessment Desktop Study; and Volume 5C: Acid Rock Drainage and Metal Leaching Potential Technical Report.

This section is divided into the setting for the pipeline segments (Sections 5.1 through 5.11), proposed line facilities (Section 5.12) and the existing pipeline segments to be reactivated (Section 5.13). The potential Project-related effects and mitigation are presented in Section 7.0.

The settings for each element (a technical discipline or discrete component of the biophysical or human environment identified in the NEB *Filing Manual* [NEB 2013]) discuss existing conditions within defined spatial boundaries. Element-specific spatial boundaries are described in the subsections below.

The settings for each element discuss the existing conditions for each indicator or set of indicators selected for the element. An indicator (sometimes called Valued Ecosystem Components [VECs]) is defined as a biophysical, social or economic property or variable that society considers to be important and is assessed to predict Project-related changes and focus the impact assessment on key issues. One or more indicators are selected to describe the present and predicted future condition of an element. Societal views are understood by the assessment team through published information such as management plans and engagement with regulators, the public, Aboriginal communities and other interested groups. A summary of the indicators selected for each element is provided in Table 5.0-1. The rationales for the selection of indicators are provided in Section 7.0.

TABLE 5.0-1

SELECTED INDICATORS FOR BIOPHYSICAL ELEMENTS

Element	Indicators
Physical and Meteorological Environment	• Terrain instability. • Topographic change. • Acid generating rock.
Soil and Soil Productivity	• Soil productivity. • Soil degradation. • Bedrock and stone disposal. • Soil contamination.
Water Quality and Quantity	• Surface water quality. • Surface water quantity. • Groundwater quality. • Groundwater quantity.
Air Emissions	• Primary emissions of criteria air contaminants (CACs) (particulate matter [PM], carbon monoxide [CO], nitrous oxide [N_2O] and sulphur dioxide [SO_2]) and volatile organic compounds (VOCs) (benzene, toluene, ethylbenzene and xylene [BTEX]). • Secondary smog-related products like ozone and $PM_{2.5}$. • Hydrogen sulphide (H_2S) and mercaptans emissions (odour potential). • Fugitive emissions from pump stations (discussed in Section 6.0).
GHG Emissions	• Common GHGs such as methane (CH_4), carbon dioxide (CO_2), N_2O and sulphur hexafluoride (SF_6). • Effect of Project on climate change.
Acoustic Environment	• Sound levels. • Vibrations.
Fish and Fish Habitat	• Riparian habitat. • Instream habitat. • Fish mortality or injury. • Indicator species include: – Alberta: Arctic grayling; Athabasca rainbow trout; northern pike; bull trout; burbot; and walleye; and – BC: bull trout/Dolly Varden; Chinook salmon; coho salmon; cutthroat trout; and rainbow trout/steelhead.
Wetland Loss or Alteration	• Wetland function.
Vegetation	• Vegetation communities of concern. • Plant and lichen species of concern. • Presence of infestations of provincial weed species and other invasive non-native species identified as a concern.
Wildlife and Wildlife Habitat	• Mammals: grizzly bear; moose; woodland caribou; forest furbearers; coastal riparian small mammals; and bats. • Birds: grassland/shrub-steppe birds; mature/old forest birds; early seral forest birds; riparian and wetland birds; wood warblers; short-eared owl; rusty blackbird; flammulated owl; Lewis's woodpecker; Williamson's sapsucker; western screech-owl; great blue heron; spotted owl; bald eagle; common nighthawk; northern goshawk; and olive-sided flycatcher. • Reptiles: arid habitat snakes. • Amphibians: lentic (pond-dwelling) amphibians; and lotic (stream-dwelling) amphibians.
Species at Risk	• Fish species at risk (*i.e.*, bull trout and coho salmon). • Vegetation species at risk. • Wildlife species at risk (*i.e.*, grizzly bear, woodland caribou, short-eared owl, rusty blackbird, flammulated owl, Lewis's woodpecker, Williamson's sapsucker, western screech-owl, great blue heron [*fannini* ssp.], spotted owl, common nighthawk, northern goshawk [*laingi* ssp.] and olive-sided flycatcher).

5.1 Physical and Meteorological Environment

This subsection presents a summary of the physical and meteorological environmental setting found in the Physical Environment LSA and, where appropriate, along the proposed pipeline segments. It describes the physical, geologic and meteorological conditions documented in the Physical Environment LSA and beyond to include the nearest meteorological stations. It further describes areas of geotechnical concern identified in the Physical Environment LSA. The indicators selected for this element discussed below include terrain instability, topographic change and acid generating and metal leaching rock. The rationale for the selection of indicators is provided in Section 7.2.1. In addition, the existing climate along the proposed corridor is provided. Detailed information related to the physical environment is provided in the following reports prepared by BGC Engineering Inc.: Route Physiography and Hydrology, Terrain Mapping and Geohazard Inventory, and Seismic Assessment Desktop Study of Volume 4A; and the Acid Rock Drainage and Metal Leaching Potential Technical Report and the Soils Technical Report of Volume 5C. Furthermore, the potential Project-related effects and mitigation pertaining to physical environment are discussed in Section 7.0. Issues related to meteorological environment are discussed under Changes to the Project Caused by the Environment in Section 7.10.

The Physical Environment LSA is considered the zone of influence (ZOI) likely to be affected by terrain instability during construction and operations, consisting of a 1 km wide band generally extending from the centre of the proposed pipeline corridor and facilities (*e.g.*, 500 m on both sides of the proposed pipeline corridor centre).

5.1.1 Terrain and Topography

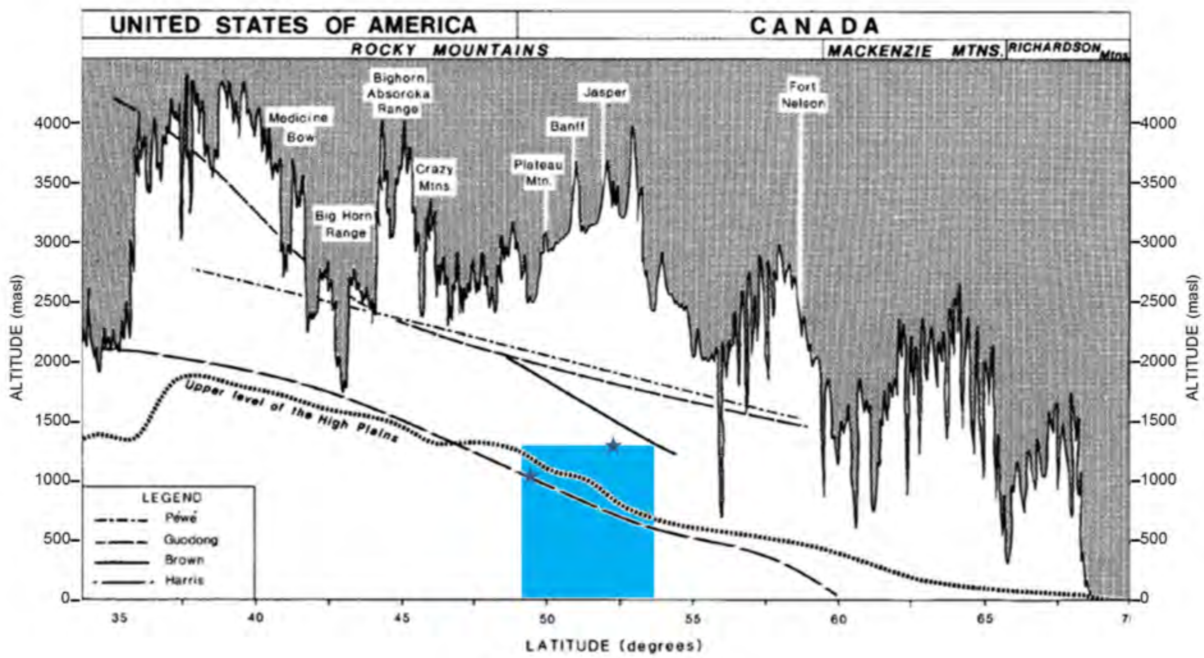
This subsection provides a summary of terrain and topographic conditions along the proposed pipeline corridor and within the Physical Environment LSA for each pipeline segment, such as physiography, bedrock, surficial geology, terrain stability (mass wasting) and wind and water erosion. In addition, a discussion of permafrost potential along the proposed pipeline corridor is provided below.

<u>Permafrost</u>

The presence or absence of permafrost is primarily temperature dependent. As such, the two primary constraints are a site's latitude and elevation. The latitude of the proposed pipeline corridor varies from 49° N near the City of Abbotsford and 53.4° N between Edson and Edmonton. Within these latitudes, the proposed pipeline corridor crosses two major mountain ranges where permafrost is known to occur at higher elevations: the Coastal Mountains; and the Rocky Mountain ranges (Harris 1986). Within these ranges, the maximum elevation of the proposed pipeline corridor is approximately 1,300 m above sea level (asl) in the Coastal Mountain range (49.6° N) and approximately 1,110 m asl in the Rocky Mountains (52.3° N).

In the 1980s, Harris summarized the distribution of permafrost based on elevation and latitude along the west coast of North America, as well as sources from other regions, as shown in Figure 5.1-1. The general trend from this figure is that at increasing latitude, the elevation boundary for permafrost presence decreases. In Figure 5.1-1, the proposed pipeline corridor is bounded within the blue box for latitude and elevation. This bounding box is located below all three lower elevation boundaries for the presence of permafrost identified for the Northern American Cordillera. Only the limits presented by Guodong (1984) fall below the elevation range of the proposed pipeline corridor; however, this data is based primarily on data from Asia and is most applicable to that geographic region.

Figure 5.1-1 Comparison of the Variation in Lower Permafrost Boundaries with Latitude for the Northern American Cordillera (Péwé, Brown and Harris) and for the Northern Hemisphere (Guodong)



Source: Harris 1986

More recently, a global permafrost distribution model was presented (Gruber 2012) that uses relationships between air temperature and the occurrence of permafrost. The model is run with high-resolution (~1 km) global elevation data and air temperatures based on the National Centre for Atmospheric Research, the National Centre for Environmental Prediction reanalysis and Climate Research Unit time series 2.0 thermal dataset for global air temperature. This data is freely available and was used within a GIS framework to determine the proximity of the proposed pipeline corridor to any potential permafrost occurrence. Based on this information, no permafrost is expected to be encountered along the proposed pipeline corridor.

Furthermore, air photos and satellite images were assessed to confirm the results from the Gruber spatial permafrost distribution model. Once more, no features were identified that would indicate the existence of permafrost along the proposed pipeline corridor.

5.1.1.1 Edmonton to Hinton Segment

The following subsections describe the physiography, bedrock, surficial geology, terrain stability (mass wasting) and wind and water erosion along the Edmonton to Hinton Segment.

<u>Physiography</u>

From east to west, the proposed pipeline corridor along the Edmonton to Hinton Segment crosses the following physiographic regions: Eastern Alberta Plains; Western Alberta Plains; Southern Alberta Uplands; and Rocky Mountains (Pettapiece 1986).

The Eastern Alberta Plains Physiographic Region (RK 0.0 to RK 128.3) is characterized by undulating plains, hummocky terrain, steep valley walls, active fluvial channels and glaciofluvial deltas (Natural Regions Committee 2006a, Pettapiece 1986). Physiographic sections crossed by the proposed pipeline corridor within this region are the Edmonton Plain (RK 0.0 to RK 5.0, RK 17.1 to RK 32.9 and RK 37.9 to RK 72.2), Cooking Lake Uplands (RK 5.0 to RK 17.1), Lac la Biche Plain – North Saskatchewan Valley

(RK 32.9 to RK 37.9) and Cherhill Uplands (RK 72.2 to RK 128.3) (Pettapiece 1986). Elevation generally rises to the west from approximately 670-800 m. Relief is generally low and arises from river incision and topographic irregularities. This area is extensively cultivated and populated to the extent that natural features may be disturbed or obscured (BGC Engineering Inc. 2013a).

The Western Alberta Plains Physiographic Region (RK 128.3 to RK 262.4) is characterized by undulating plains, less abundant hummocky terrain and incised river valleys (Natural Regions Committee 2006a, Pettapiece 1986). Within this region, the proposed pipeline corridor crosses the Drayton Plain Physiographic Section (RK 128.3 to RK 262.4) (Pettapiece 1986). Elevation increases to the west from approximately 730-980 m. Relief is low and arises from incised river valley depressions and hummocky uplands. Agricultural land use and resource exploration sites are widespread to the extent that natural features may be modified (BGC Engineering Inc. 2013a).

The Southern Alberta Uplands (RK 262.4 to RK 339.4) is characterized by hummocky terrain, rolling uplands, gently undulating terraces and incised river valleys (Natural Regions Committee 2006a, Pettapiece 1986). Within this region, the proposed pipeline corridor crosses the Western Benchlands Physiographic Section (RK 262.4 to RK 287.7) and Grande Cache Benchlands Physiographic Section (RK 287.7 to RK 339.4) (Pettapiece 1986). Elevation and relief arise from bedrock-controlled rolling to ridged hills and foothills. Elevation ranges from approximately 960-1,185 m, generally increasing to the west. Forestry and resource exploration is common in this area to the extent that natural features may be obscured (BGC Engineering Inc. 2013a).

Additional physiographic descriptions for this segment of the proposed pipeline corridor along the Edmonton to Hinton Segment are summarized by natural subregion in Table 5.1-1.

TABLE 5.1-1

PHYSIOGRAPHY OF NATURAL SUBREGIONS CROSSED BY THE EDMONTON TO HINTON SEGMENT

Natural Region	Natural Subregion	Approximate RK	Landform
Parkland	Central Parkland	RK 0 to RK 68.8	Undulating plains and hummocky uplands composed mainly of glacial till with lacustrine, fluvial and eolian inclusions.
Boreal	Dry Mixedwood	RK 68.8 to RK 145.6 RK 145.8 to RK 147.2 RK 150.7 to RK 152.1	Undulating plains and hummocky uplands composed mainly of till and considerable lacustrine deposits.
	Central Mixedwood	RK 145.6 to RK 145.8 RK 147.2 to RK 150.7 RK 152.1 to RK 169.9	Undulating plains and some hummocky uplands composed of equal proportions of till, lacustrine and fluvial deposits.
Foothills	Lower Foothills	RK 169.9 to RK 308.9 RK 311.8 to RK 319.6	Dissected plateaus and rolling uplands composed of till and considerable fluvial deposits.
Rocky Mountain	Montane	RK 308.9 to RK 311.8 RK 319.6 to RK 339.4	Valleys and foothills composed of till and considerable fluvial deposits.

Source: Natural Regions Committee 2006a

The topography along the proposed pipeline corridor is undulating to hummocky with gentle to moderate slopes. However, moderate to steep slopes may be encountered at deeply incised, major watercourse crossings, including those listed below under the terrain stability heading.

Bedrock Geology

The Eastern Alberta Plains Physiographic Region is underlain by the Horseshoe Canyon Formation and the Scollard Formation. The Horseshoe Canyon Formation (RK 0 to RK 90.6) is characterized as interbedded non-marine sandstone, siltstone, shale and numerous coal and bentonite beds (Hamblin 1998). Sandstones are soft, light-grey to greenish grey, poorly sorted and very fine to medium-grained (Hamblin 1998). Mudstones are grey-green or brown, argillaceous and bentonitic, and also carbonaceous. Units usually contain wood fragments, thin coal streaks, ironstone concretions and beds with plant and dinosaur fossils (Hamblin 1998). The Scollard Formation (RK 90.6 to RK 128.8) in the Eastern Alberta Plains consists of two units: the lower “barren” member; and the upper coal-bearing member. The lower member is characterized as thick greenish-grey shales and thin sandstones. The upper member is characterized as dark grey, bentonitic mudstones with coals (Hamblin 2010).

The Western Alberta Plains Physiographic Region is underlain by members of the Scollard and Paskapoo Formations. The Scollard Formation continues from the Eastern Alberta Plains Physiographic Region (RK 128.8 to RK 135.8) as described above. The Paskpoo Formation (RK 135.8 to RK 262.4) is a thick sequence of Palaeocene sand and siltstones. It consists of buff, medium-grained sandstone overlain by interbedded light grey soft sandy siltstone and mudstones (Dawson *et al.* 1994, Hamblin 2004). Coal seams are common in the Upper Dalehurst Member of the Paskapoo (Hamblin 2004).

The Southern Alberta Uplands Physiographic Region is underlain by the Paskapoo Formation (RK 262.4 to RK 315.5), as described above, and members of the Coalspur Formation, Brazeau Formation and Alberta Group. The Coalspur Formation (RK 315.5 to RK 322.2) of the foothills is approximately equivalent to the Scollard Formation as described above for the Eastern Alberta Plains Physiographic Region. This formation consists of the “barren” Lower Member and the coal-bearing Upper Member (Hamblin 2010). The Brazeau Formation (RK 326.1 to RK 329.9 and RK 333.1 to RK 335.9) contains interbedded greenish-grey mudstones, siltstones and fine-grained grey to greenish grey sandstone, with lesser but prominent coarser grained sandstone layers (Glass 1990). Thin coal beds, coaly shale and numerous thick bentonites occur in the upper part of the formation (Hamblin 1998). The Alberta Group (RK 329.9 to RK 339.4) is composed of dominantly dark grey, silty mudstones and a prominent middle sandstone sequence (Glass 1990).

Soil investigations and mapping along this segment were conducted in September 2006, July 2013 and from September to October 2013. Bedrock within trench depth may be encountered in shallow Bremay, shallow Dekalta, shallow Hubalta and Modeste soils. The Soils Technical Report of Volume 5C provides additional information on these soil units. The locations of these soil units along the proposed pipeline corridor are shown on the Environmental Alignment Sheets (Volume 6E).

Surficial Geology

The dominant surficial materials in the Eastern Alberta Plains Physiographic Region are thick glaciolacustrine and till sediments with lesser glaciofluvial, fluvial, colluvium, eolian and bedrock outcrops (Shetsen 1990). Glaciolacustrine and till deposits overlie discontinuous pre-glacial Saskatchewan sands and gravels as well as sedimentary bedrock (Edwards *et al.* 2006). Glaciolacustrine deposits are characterized as dark sands, silts and clays with ice-rafted stones (Shetsen 1990). Wind modification of the dried glacial lake bed produced silt and sand dunes within the Edmonton area (Edwards *et al.* 2006). Glaciofluvial deposits, both pre-glacial and post-glacial, contain gravels, sands and silts. Tills are medium to moderately fine-textured and moderately calcareous (Natural Regions Committee 2006a). Localized ice-thrust moraines near Lake Wabamun comprise deformed tills and bedrock (Edwards *et al.* 2006, Shetsen 1990). Valley slopes at water crossings are variable and may consist of exposed glaciolacustrine, till, bedrock and colluvial deposits (Shetsen 1990).

Surficial material in the Western Alberta Plains Physiographic Region are till and glaciolacustrine sediments with lesser active fluvial, glaciofluvial, deltaic, eolian and ice-thrust moraine deposits (Natural Regions Committee 2006a, Roed 1975, Shetsen 1990). Glaciolacustrine units are more common in low valleys and to the west of the physiographic region. Overburden depth is variable, but generally thins to the west and on steep slopes. Tills are variable in texture depending on the ice sheet source. The Laurentide-sourced Edson Till contains few clasts and has a silty-clay matrix with very low carbonate content (Natural Regions Committee 2006a, Roed 1970, 1975). The Cordilleran-sourced Malboro Till contains a moderate amount of clasts and has a silty, sandy-clay matrix with moderate carbonate content (Roed 1970, 1975). Glaciolacustrine deposits are characterized by laminated clays, silts and sands. Inactive eolian deposits are characterized as fine-grained sand. Glaciofluvial deltas are typically cross-bedded pebbly sands with thin clays and silt beds. Active fluvial deposits include sands and gravels with minor silts. Localized ice-thrust moraines contain deformed mixes of till and bedrock.

The dominant surficial materials in the Southern Alberta Uplands Physiographic Region are tills and peat deposits, with minor glaciofluvial, active fluvial, glaciolacustrine and bedrock outcrops (Roed 1970, 1975). Surficial material thickness is variable and is influenced by topography, but generally thins to the west. Deposits are thickest along valley bottoms and thinnest along steep slopes. Colluvial deposits may be common along incised river channels and at the base of slopes. Tills are primarily classified as Obed Till, which is characterized as being very stony with a sandy clay matrix and high carbonate content (Roed 1970). Clasts within the Obed Till can be larger than 1 m in size. Lesser amounts of Edson Till, as described above, may be encountered near the proposed pipeline corridor. Meltwater channel deposits near the Athabasca River valley are characterized as well-rounded gravels and cobbles. Glaciolacustrine sediments are laminated clays, silts and sands. Active fluvial deposits comprise sands and gravels.

A description of surficial material within each physiographic region crossed by the proposed pipeline corridor is provided in Table 5.1-2. The Soils Technical Report of Volume 5C provides additional information on surface (parent) material associated with soil units identified along the proposed pipeline corridor. The locations of these soil units along the proposed pipeline corridor are shown on the Environmental Alignment Sheets (Volume 6E).

TABLE 5.1-2

SUMMARY OF SURFICIAL MATERIAL CROSSED BY THE PROPOSED PIPELINE CORRIDOR BY PHYSIOGRAPHIC REGION

Surficial Material	Intersected Length (km) by Physiographic Region		
	Eastern Alberta Plains	Western Alberta Plains	Southern Alberta Uplands
Anthropogenic	1.4	--	--
Colluvium	0.2	--	1.9
Fluvial	1.9	2.8	0.9
Glaciofluvial	10.6	15.6	9.1
Glaciolacustrine	74.8	44.1	--
Lacustrine	0.7	61.7	--
Till	37.7	11.8	61.9
Organic	2.8	--	4.0
Total	130	136	77.8

Source: BGC Engineering Inc. 2013b

Terrain Stability

The earthquake ground shaking hazard is low on lands crossed by the proposed pipeline corridor. Peak ground acceleration (PGA) at a 1:2475 annual probability of exceedance (APE) is 0.1 g or less (BGC Engineering Inc. 2013c) Several minor earthquakes (magnitude 4 or less) have been documented along the western portion of the segment (NRCan 2013a).

Debris avalanches, rock fall and slumping may occur along incised watercourses crossed by the proposed pipeline corridor, including:

- Blackmud Creek at RK 24.2;
- Whitemud Creek at RK 28.1;
- North Saskatchewan River at RK 33.5;
- Pembina River at RK 135.0;
- Wolf Creek at RK 220.6;
- McLeod River at RK 223.9;
- Little Sundance River at RK 245.2; and
- Sundance Creek at RK 248.

No recent rock avalanches were mapped along the Edmonton to Hinton Segment (BGC Engineering Inc. 2013b). Refer to the Terrain Mapping and Geohazard Inventory of Volume 4A for more detailed and site-specific information on terrain and natural hazards along the Edmonton to Hinton Segment.

Wind and Water Erosion

Soil erosion risk is a measurement of vulnerability of the soil to erosion combined with the intensity of cultivation (Alberta Agriculture and Rural Development [AARD] 2005a). AARD generally considers soil erosion risk for the agricultural areas along the segment as low, with isolated areas of low to moderate risk (AARD 2005a). Wind erosion risk, which assesses the risk of soil degradation by wind on bare, unprotected mineral soil, is generally considered negligible to low (AARD 2005b), while water erosion risk, which assesses the risk of soil degradation by water on bare, unprotected mineral soil, ranges from low to severe (AARD 2005c).

NRCan evaluates the risk of wind erosion based on the nature of local climate and vegetation. Areas with dryer, warmer climates and with sparse vegetation cover are more vulnerable to wind erosion. NRCan considers unprotected soils along the segment near Edmonton to have high wind erosion risk with high climatic sensitivity, while wind erosion risk declines further west along the segment to low wind erosion risk with low climatic sensitivity and eventually to low or negligible risk with no climatic sensitivity (NRCan 2010a).

Soil investigations along this segment identified specific soil units highly susceptible to wind or water erosion. Soil units identified as highly susceptible to wind erosion include Carvel, Elk Point, gleyed Gabriel, Hoadley, Peace Hills, Primula, Rochester, peaty Rochester, shallow Rochester, Sundace and Winterbum. Soil units identified as highly susceptible to water erosion include Angus Ridge, Carvel, Cooking Lake, Hubalta, Malmo, Modeste, Primula and Winterburn. Refer to the Soils Technical Report of Volume 5C for additional information on these soil units. The locations of these soil units along the proposed pipeline corridor are shown on the Environmental Alignment Sheets (Volume 6E).

5.1.1.2 Hargreaves to Darfield Segment

The following subsections describe the physiography, bedrock, surficial geology, terrain stability (mass wasting) and wind and water erosion along the Hargreaves to Darfield Segment.

Physiography

From north to south, the proposed pipeline corridor along the Hargreaves to Darfield Segment crosses the following physiographic regions: Rocky Mountains; Rocky Mountain Trench; Columbia Mountains; and Interior Plateau (Holland 1976).

The Rocky Mountains Physiographic Region (RK 489.6 to RK 502.3) is characterized by structurally-controlled, moderately wide valleys surrounded by rugged, alpine mountains featuring relict glacial landforms. Mountainsides are dissected by tributary valleys and gullies (Holland 1976). Elevation generally rises along the proposed pipeline corridor from approximately 850-1,000 m. Relief is high, as the valley floor is more than 1,500 m below adjacent mountain peaks (BGC Engineering Inc. 2013a).

The Rocky Mountain Trench Physiographic Region (RK 502.3 to RK 523.7) is characterized by flat plains, active dunes, steep slopes on the margins of the trench and hummocky to undulating terrain (Holland 1976). Elevation ranges from over 1,000 m near the proposed pipeline corridor southwest of Rearguard Falls to approximately 780 m along the trench floor. Relief is nearly 2,000 m from the peaks of the mountain ranges along the trench walls to the trench floor. The trench valley is approximately 8 km wide along the proposed pipeline corridor (BGC Engineering Inc. 2013a).

The Columbia Mountains Physiographic Region (RK 523.7 to RK 612.1) is characterized by wide U-shaped main valleys, narrow hanging steeply incised tributary valleys, rugged alpine ranges, fluvial terraces, fan and relict glacial landforms. The typical north to northwestern strike of the mountain ranges and trellis-patterned drainage systems are due to the structure of the underlying metasedimentary bedrock (Demarchi 2011, Holland 1976). The proposed pipeline corridor generally parallels Highway 5 along the valley floor. Valley floor elevation generally increases from 780 m within the Rocky Mountain Trench to 880 m near the Albreda Pump Station. From the Albreda Pump Station to the Blue River Pump

Station, the valley floor elevation decreases to 670 m. The proposed pipeline corridor at times is more than 150 m above the valley floor. Relief from valley floors to adjacent peaks ranges from 1,200-1,800 m (BGC Engineering Inc. 2013a).

The Interior Plateau Physiographic Region (RK 612.1 to RK 993.8) is characterized by gentle to moderately sloping rolling uplands with rounded ridges and summits, valleys deeply dissecting the plateau, terraces, fluvial plains, fans and cones (Demarchi 2011, Holland 1976). Elevation generally decreases along the North Thompson River from 670 m to 350 m near the City of Kamloops. Local relief can be considerable in the Interior Plateau due to valley incision by large rivers, although the relief on the upper plateau itself is low (BGC Engineering Inc. 2013a).

Physiographic regions and subregions encountered by the proposed pipeline corridor along the Hargreaves to Darfield Segment are listed in Table 5.1-3.

TABLE 5.1-3

PHYSIOGRAPHIC REGIONS AND SUBREGIONS CROSSED BY THE HARGREAVES TO DARFIELD SEGMENT

Region	Subregion	Approximate RK	Landform
Rocky Mountains	Park Ranges	RK 489.6 to RK 502.3	Thick cliff-forming limestone and quartzite formations of Cambrian age form many of the mountains. Topography is extremely rugged. Mature dissection of the region has reduced inter-stream areas to narrow knife-like ridges.
Rocky Mountain Trench	Rocky Mountain Trench	RK 502.3 to RK 523.7	Along the southern half, the Rocky Mountain Trench forms a continuous, somewhat sinuous valley lying between the Columbia Mountains to the west and the Rocky Mountains to the east. This valley is occupied by the southward-flowing Canoe River and northward-flowing Fraser River. The divides between the headwaters of these rivers are low.
Columbia Mountains	Caribou Mountains	RK 523.7 to RK 542.4 RK 580 to RK 612.1	The Caribou Mountains comprise a number of longitudinal ranges trending to the northwest parallel to the strike of the underlying sedimentary rocks. Individual mountains and mountain ranges rise to high serrate peaks of heights to 3,600 m that are glacially sculptured and are separated by steep-walled glaciated valleys commonly forming a trellis pattern controlled by the underlying bedrock.
	Caribou Mountains/Monashee Mountains	RK 542.4 to RK 612.1	The high mountains of the Monashees, especially those in the northern ranges, are mostly massive and bold sharp peaks separated by deep, steep-sided valleys. Peaks above 2,400 m projected through the Pleistocene ice-sheet and were subjected to intense cirque glaciations. Lower summits were covered by ice at one stage and subsequently have been sculptured by cirque and valley glaciers to sharp peaks and sawtooth ridges. Along southern ranges at elevations below 2,100 m rounded or only moderately pointed summits prevail.
Interior Plateau	Shuswap Highland	RK 612.1 to RK 769	The Shuswap Highland consists of gentle or moderate sloping plateau areas rising from 1,500 m over 2,100 m, dissected by the Clearwater and North Thompson rivers and their tributaries into large polygonal upland tracts. The valley sides are commonly steep due to glacial erosion and the total relief is considerable while local relief in the uplands is moderate.
	Thompson Plateau	RK 736.9 to RK 769.0	The Thompson Plateau has a gently rolling upland of low relief, for the most part lying between 1,200 m and 1,500 m, but with prominences of more resistant rock rising higher. The area was occupied by Pleistocene ice and a thick mantle of drift covers bedrock over large portions. Movement of the ice over the plateau produced drumlin-like formations oriented to the south and southeast.

Source: Holland 1976

The topography along the proposed pipeline corridor ranges from gentle to moderate along valley bottoms to moderate to steep along lower slopes of incised valleys of the Fraser and North Thompson rivers and many of their tributaries.

Bedrock Geology

Bedrock lithology within the Rocky Mountain Physiographic Region is composed of the Middle Member of the Miette Group (Journeay *et al.* 2000a, Murphy 2007). This unit is composed of massive to graded, thick-bedded, feldspathic, turbitic sandstones and conglomeratic sandstones (Glass 1990).

Bedrock lithology along the eastern wall of the Rocky Mountain Trench Physiographic Region primarily consists of members of the Miette Group (Journeay *et al.* 2000a, Murphy 2007). The Upper Middle member consists of metamorphic sandstones, granule and pebble-conglomerate, siltstone and phyllite. Beneath extensive valley floor deposits, the bedrock is a mixture of: unnamed carbonates; coloured shale and dolomite; and minor quartzite (BGC Engineering Inc. 2013a).

The proposed pipeline corridor in the Columbia Mountains Physiographic Region lies within a fault-controlled valley separating the Caribou Mountains to the west and north, and the Monashee Mountains to the east and south. The dominant rock types to the west are tilted, folded and faulted sediments and metamorphic sediments of the Miette, Kaza and Horsethief Creek groups (Journeay *et al.* 2000a, Murphy 2007) and of the Shuswap Metamorphic Complex. To the east, the dominant rock types are gneisses of the Malton Gneiss Complex and metamorphic rocks of the Mica Creek Succession (Journeay *et al.* 2000a, Murphy 2007). The Miette, Kaza and Horsethief Creek groups lie within the Upper Proterozoic Windermere Supergroup. Rocks of this supergroup are dominantly coarse-grained, conglomerates and pebbly sandstones, and less common carbonates (Hein and McMechan 1994). The Miette, Kaza and Horsethief groups are composed of coarse-grained, feldspathic, pebbly sandstones and conglomerate alternating with thick argillites (clay) (Hein and McMechan 1994). The Horsethief Creek Group along the northern ridges of Mount Saint Anne predominantly contains marble (BGC Engineering Inc. 2013a).

The Shuswap Highlands Physiographic Subregion (RK 612.1 to RK 736.9) of the Interior Plateau Physiographic Region contains bedrock of the Shuswap Assemblage, Eagle Bay Assemblage and Fennel Assemblage (Journeay *et al.* 2000b,c). The Shuswap Assemblage contains gneiss and schist, with lesser amounts of amphibolite, quartzites, marbles, skarns and pegmatites. The Eagle Bay Assemblage consists predominantly of Lower Cambrian to Mississippian green schist facies, metamorphic sediments and metamorphic volcanic rocks. Within the proposed pipeline corridor, the assemblage is characterized by fine-grained sedimentary rocks, quartzite, phyllite, schist, shale, volcanic rocks, greenstone and fine-grained limestone to dolostone. The Fennel Assemblage includes the marine and sedimentary rocks of the Lower Structural Division, and the pillowed to massive metamorphic basalts of the Upper Structural Division (Journeay *et al.* 2000b).

The Thompson Plateau Physiographic Subregion (RK 736.9 to RK 769.0) of the Interior Plateau Physiographic Region is characterized predominantly by the rocks of the Quesnellia Terranne (Journeay *et al.* 2000c). The dominant bedrock units are the Kamloops Group, Harper Ranch Group, Nicola Group, unnamed olivine basalts near Brigade Hill, Ashcroft Formation, Princeton Group and Spences Bridge Group. The Kamloops Group consists of basalt and andesite breccias, tuffs and sandstones (Monger and McMillan 1989). The Harper Ranch Group consists of phyllite, volcanic sandstone, igneous rock and schist with minor carbonates. The Nicola Group consists primarily of volcanic and metamorphic sedimentary units. North of Kamloops, the Nicola Group consists of argillites, sandstones and volcaniclastic deposits (Monger and McMillan 1989). South of Kamloops, the rocks are primarily of the Eastern Volcanic Facies, which consists of alkaline breccias and tuff (Monger and McMillian 1989). West of Nicola Lake, a small portion of the Central Volcanic Facies contains intermediate pyroclastics and volcanic flows. The Ashcroft Formation consists of fine to medium-grained metamorphic sediments with minor carbonates (Monger and McMillan 1989). South of Merritt, the Nicola Group western volcanic facies consists of pyroclastics, argillites and sandstones. The Spences Bridge Group comprises undifferentiated volcanic flows and tuffs (BGC Engineering Inc. 2013a).

Soil investigations and mapping along this segment were conducted from July to August 2006 and from May to June 2013. Bedrock within trench depth may be encountered in Fox, shallow Allie, shallow Lucerne, shallow Roserim, shallow, bouldery Stukemapten and shallow Snookwa soils. The Soils Technical Report of Volume 5C provides additional information on these soil units. The locations of these soil units along the proposed pipeline corridor are shown on the Environmental Alignment Sheets (Volume 6E).

Surficial Geology

Surficial geology of the Rocky Mountain Physiographic Region includes active and inactive fluvial, colluvial, till and bedrock units. Overburden depth is variable and depends on slope angle and active geomorphic processes. Generally, the surficial material is thickest in the valley bottom and thinnest along steep bedrock slopes. No publications are available regarding the texture of the surficial materials in this section of the Rocky Mountains (BGC Engineering Inc. 2013a). Generally, tills are expected to have a sandy to silty matrix with variable clast content. Fluvial sediment is expected to contain gravel, sand and boulders. Colluvium is expected to be poorly-sorted and contain sand, gravel, blocks and some silts or clays (BGC Engineering Inc. 2013a).

The dominant surficial deposits in the Rocky Mountain Trench Physiographic Region are fluvial and glaciofluvial sediments, till, colluvium and organic material. Surficial deposits on the valley floor are very thick, whereas deposits along the valley walls may be thin. Meandering rivers rework valley deposits and poorly-drained oxbow lakes, surface depressions and wetlands are scattered across the valley floor. Glaciofluvial deposits are characterized as sandy loam to gravelly, often in rolling forms. Eolian erosion of the glaciofluvial deposits has created the active sand dunes of Jackman Flats Provincial Park. Fluvial overbank deposits are characterized as fine sandy loam to silt. Tills are characterized as sandy loam matrix with variable clast content. Organic materials may contain mossy-peat, woody-peat and silts (EBA Engineering Consultants Ltd. 2003).

The dominant surficial deposits in Columbia Mountains Physiographic Region are colluvium, till, glaciofluvial, active and inactive fluvial, organic and bedrock outcrops. Valley bottoms contain glaciofluvial and active flood plain deposits. Borehole drilling at bridge crossing locations indicates the fluvial and glaciofluvial deposits may be greater than 50 m thick south of the Albreda River confluence (Seeman and Blyth 2000). Cones and fans of tributary streams and gullies are common where they intersect larger dominant valleys. Glaciolacustrine units are common in the tributary valleys of the Thompson River valley, but are not found in the main Thompson River valley south of the confluence with the Albreda River (Seemann and Blyth 2000). Glaciofluvial terraces and fans typically lie above the active flood plain. Steep bedrock slopes along valley walls are commonly mantled by till and colluvial deposits (BGC Engineering Inc. 2013a).

The dominant surficial deposits in the Shuswap Highlands Physiographic Subregion of the Interior Plateau Physiographic Region are till, active and inactive fluvial, glaciofluvial, colluvium, bedrock outcrops and glaciolacustrine (Bednarski 2009, Fulton 1984). Till deposits mantle and blanket valley walls and upland surfaces. Colluvial deposits are common along valley slopes and in fans and cones. Fluvial plains and terraces are composed of active fluvial, glaciofluvial and glaciolacustrine deposits. Overburden thickness may be thin along steep slopes and bedrock ridges, and thickest in valley bottoms (BGC Engineering Inc. 2013a). The dominant surficial deposits of the Thompson Plateau Physiographic Subregion of the Interior Plateau Physiographic Region are active and inactive fluvial, glaciofluvial, colluvium, till, bedrock and glaciolacustrine (Bednarski 2009, Fulton 1974a,b, Tipper 1971). Similar to the Shuswap Highlands Physiographic Subregion, till deposits mantle and blanket valley walls and upland surfaces, and colluvial deposits are common along valley slopes and in fans and cones. Plains and terraces are composed of active fluvial, glaciofluvial and glaciolacustrine deposits. Overburden thickness may be thin along high valley walls and ridge tops, and thickest in valley bottoms (BGC Engineering Inc. 2013a).

A description of surficial material within each physiographic region crossed by the proposed pipeline corridor is provided in Table 5.1-4. The Soils Technical Report of Volume 5C provides additional information on surface (parent) material associated with soil units identified along the proposed pipeline corridor. The locations of these soil units along the proposed pipeline corridor are shown on the Environmental Alignment Sheets (Volume 6E).

TABLE 5.1-4

SUMMARY OF SURFICIAL MATERIAL CROSSED BY THE PROPOSED PIPELINE CORRIDOR BY PHYSIOGRAPHIC REGION

	Intersected Length (km) by Physiographic Region			
Surficial Material	Rocky Mountains	Rocky Mountain Trench	Columbia Mountains	Interior Plateau
Anthropogenic	--	--	--	4.4
Colluvium	3.0	3.9	30.8	53.1
Eolian	--	2.3	--	--
Fluvial	3.0	0.5	34.2	78.7
Glaciofluvial	3.8	7.6	13.2	65.2

TABLE 5.1-4 Cont'd

Surficial Material	Intersected Length (km) by Physiographic Region			
	Rocky Mountains	Rocky Mountain Trench	Columbia Mountains	Interior Plateau
Glaciolacustrine	--	--	--	13.6
Till	2.9	7.2	9.6	119.6
Organic	--	0.1	3.8	2.9
Bedrock	--	--	--	0.8
Total	12.7	21.6	91.6	338.3

Source: BGC Engineering Inc. 2013b

Terrain Stability

The earthquake ground shaking hazard is low on lands crossed by the proposed pipeline corridor. PGA is between 0.1 g and 0.2 g at a 1:2475 Annual Probability of Exceedance (APE) (BGC Engineering Inc. 2013c). The proposed pipeline corridor crosses zone of suspected post-glacial fault activity within the Rocky Mountain trench, where the historical earthquake record shows clusters of small to moderate magnitude (up to magnitude 6) earthquakes. The largest of these include a 6 magnitude earthquake near Valemount in 1918 and a 5.6 magnitude earthquake near Prince George in 1986 (Halchuk 2009, Lamontagne *et al.* 2007). The Seismic Assessment Desktop Study of Volume 4A provides additional information along the Hargreaves to Darfield Segment, including: surface fault rupture potential; ground-motion predictions; liquefaction potential; and seismically-induced landslide potential.

Within the Rocky Mountain Trench Physiographic Region, rock fall and debris avalanches are present on upper slopes; however, none are likely to affect the proposed pipeline corridor in the valley (BGC Engineering Inc. 2013b).

Glaciofluvial materials from approximately RK 567.0 to RK 576.0 in the Columbia Mountains Physiographic Region are dominantly composed of highly erodible medium sand with silt layers. Surface erosion and shallow debris slides are common in this area. Debris flow, debris flood and/or channel erosion hazard exists on many fans. Rock fall and debris avalanche hazards are present on many steep rock and colluvium-covered slopes throughout the region, and valley fill deposits are commonly undercut by the North Thompson River, creating unstable slopes. Several large rock avalanche and slump headscarps are present on mid to upper slopes in the region, although none are thought to be currently active. The lower slopes on the west side of the North Thompson River from RK 576.0 to RK 578.0 appear to have been actively deforming in the recent past (BGC Engineering Inc. 2013b).

Within the Interior Plateau Physiographic Region, several debris avalanches are present on steep slopes near the valley bottom of the North Thompson River. Debris flows and debris floods occur on several fans along the proposed pipeline corridor. There is potential river erosion and flooding where the proposed pipeline corridor is located on the flood plain of the North Thompson River. No recent rock avalanches were mapped along the Hargreaves to Darfield Segment (BGC Engineering Inc. 2013b).

The Terrain Mapping and Geohazard Inventory of Volume 4A provides more detailed and site-specific information on terrain and natural hazards along the Hargreaves to Darfield Segment.

Wind and Water Erosion

NRCan considers unprotected soils along the northern portion of this segment as negligible and unrated, while wind erosion risk along the southern portion of this segment has low wind erosion risk with low climatic sensitivity (NRCan 2010a).

Soil investigations along this segment identified specific soil units highly susceptible to wind or water erosion. Soil units identified as highly susceptible to wind erosion include Albreta 1, bouldery Albreta 1, Albreta 2, gleyed Albreta 2, Albreta 2 overlying gravel, Alluvium, gleyed Alluvium, Blackpool, Cayenne, disturbed Cayenne, Cranberry, Fitzwilliam, Jackman, shallow Jackman, Kwikoit 1, bouldery Kwikoit 1, disturbed Kwikoit 1, Kwikoit 2, Kwikoit 2 overlying gravel, Kwikoit 3, McNomee, Roserim, bouldery Roserim, disturbed Roserim, shallow Roserim, stony Roserim, Struthers 1, bouldery Struthers 1, disturbed Struthers 1, Struthers 2, Struthers 2 overlying gravel, Stukemapten, bouldery Stukemapten, shallow bouldery Stukemapten, Snookwa, shallow Snookwa, disturbed Snookwa, Woodley and stony Woodley. Soil units identified as highly susceptible to water erosion include Albreta 1, Allie, shallow Allie, disturbed Cayenne, Exiou, Fox, Fitzwilliam, Jackman, Kwikoit 1, Kwikoit 2, Kwikoit 2 overlying gravel, Lucerne, shallow Lucerne, stony Lucerne, Stukemapten, shallow boulder Stukemapten, Snookwa, disturbed Snookwa, shallow Snookwa, Woodley and stony Woodley. Refer to the Soils Technical Report of Volume 5C for additional information on these soil units. The locations of these soil units along the proposed pipeline corridor are shown on the Environmental Alignment Sheets (Volume 6E).

5.1.1.3 Black Pines to Hope Segment

The following subsections describe the physiography, bedrock, surficial geology, terrain stability (mass wasting) and wind and water erosion along the Black Pines to Hope Segment.

Physiography

From north to south, the proposed pipeline corridor along the Black Pines to Hope Segment crosses the Interior Plateau and Cascade Mountains physiographic regions (Holland 1976).

The Interior Plateau Physiographic Region (RK 811.8 to RK 993.8) is characterized by gentle to moderately sloping rolling uplands with rounded ridges and summits, valleys deeply dissecting the plateau, terraces, fluvial plains, fans and cones (Demarchi 2011, Holland 1976). South of Kamloops, elevation increases from 350-1,230 m before decreasing to approximately 600 m near the City of Merritt. Elevation gradually increases to 1,170 m near Coquihalla Lakes (BGC Engineering Inc. 2013a).

The Cascade Mountains Physiographic Region (RK 993.8 to RK 1043.7) is characterized by rugged mountain ranges, steeply incised tributary valleys, wide U-shaped main valleys, relict glacial landforms, terraces, fans, cones, steep slopes, fluvial plains and small basins (Demarchi 2011, Holland 1976). Elevation generally decreases from approximately 1,350 m near the Coquihalla Highway Summit to 40 m around the District of Hope. Relief in the mountainous areas of this region is high, ranging from 1,200 m near Needle Peak to nearly 1,800 m near Hope (BGC Engineering Inc. 2013a).

Physiographic regions and subregions encountered by the proposed pipeline corridor along the Black Pines to Hope Segment are listed in Table 5.1-5.

TABLE 5.1-5

PHYSIOGRAPHIC REGIONS AND SUBREGIONS CROSSED BY THE BLACK PINES TO HOPE SEGMENT

Region	Subregion	Approximate RK	Landform
Interior Plateau	Thompson Plateau	RK 811.8 to RK 993.8	The Thompson Plateau has a gently rolling upland of low relief, for the most part lying between 1,200 m and 1,500 m, but with prominences of more resistant rock rising higher. The area was occupied by Pleistocene ice and a thick mantle of drift covers bedrock over large portions. Movement of the ice over the plateau produced drumlin-like formations oriented southeasterly and southerly.
Cascade Mountains	Cascade Mountains	RK 993.8 to RK 1022.5 RK 1026.2 to RK 1043.7	The peaks and high ridges of the Cascade Mountains are serrate and exhibit the effects of intense alpine glaciation. Cirque basins are particularly noticeable on north and northeast slopes of peaks and ridges. At lower elevations between 1,800 m and 2,100 m there are rounded ridges and dome-shaped mountains which were overridden by ice at the maximum of the Cordilleran ice-sheet.
	Hozameen Range	RK 1022.5 to RK 1026.2	

Source: Holland 1976

Topography along the proposed pipeline corridor is moderate to steep as it climbs south out of the Thompson River valley onto the predominantly rolling upland terrain of the Interior Plateau Physiographic Region. South of Merritt, moderate slopes are commonly encountered along lower slopes of the Coldwater River valley and its tributaries, while steep slopes are commonly encountered along the narrow and steep Coquihalla River valley and its tributaries.

Bedrock Geology

Bedrock geology for the Interior Plateau Physiographic Region is described in Section 5.1.1.2.

The Cascade Mountains Physiographic Region is composed of folded and metamorphosed Palaeozoic and Mesozoic sedimentary and volcanic rocks intruded by granitic batholiths (Journeay *et al.* 2000c, Monger 1989). Bedrock within the Cascade Mountain Physiographic Subregion is comprised of a variety of rock types including: coarse clastics; felsic, ultramafic and mafic volcanics; mudstones, siltstones and shales; cherts; and diorite near the Coquihalla Highway Summit and Hope (BGC Engineering Inc. 2013a).

Soil investigations and mapping along this segment were conducted from late July to early September 2013. Bedrock within trench depth may be encountered in shallow Chasm, shallow Courtney, shallow Minnie, shallow Timber, shallow Tunkwa, shallow Tullee, shallow Tranquille and shallow Trapp Lake soils. The Soils Technical Report of Volume 5C provides additional information on these soil units. The locations of these soil units along the proposed pipeline corridor are shown on the Environmental Alignment Sheets (Volume 6E).

Surficial Geology

Surficial geology for the Interior Plateau Physiographic Region is described in Section 5.1.1.2.

Dominant surficial deposits within valleys of the Cascade Mountains Physiographic Region are colluvium, till, active and inactive fluvial, glaciofluvial, lacustrine, organic, anthropogenic and bedrock outcrops. Overburden thickness is variable, but is generally thickest along valley floors and thinnest along steep valley walls. Fluvial and glaciofluvial deposits generally overlie eroded till and glaciolacustrine sediments along valley floors (BGC Engineering Inc. 2013a).

A description of surficial material within each physiographic region crossed by the proposed pipeline corridor is provided in Table 5.1-1. Intersected length of surficial material for the Interior Plateau Physiographic Region is provided in Table 5.1-6. The Soils Technical Report of Volume 5C provides additional information on surface (parent) material associated with soil units identified along the proposed pipeline corridor. The locations of these soil units along the proposed pipeline corridor are shown on the Environmental Alignment Sheets (Volume 6E).

TABLE 5.1-6

SUMMARY OF SURFICIAL MATERIAL CROSSED BY THE PROPOSED PIPELINE CORRIDOR BY PHYSIOGRAPHIC REGION

Surficial Material	Intersected Length (km) by Physiographic Region
	Cascade Mountains
Anthropogenic	1.0
Colluvium	46.3
Fluvial	30.6
Glaciofluvial	6.7
Till	11.3
Organic	2.8
Bedrock	0.4
Total	99.1

Source: BGC Engineering Inc. 2013b

Terrain Stability

Earthquake ground shaking hazards increase from northeast to southwest along the Black Pines to Hope Segment. PGA at a 1:2475 APE ranges from less than 0.2 g around the City of Kamloops and the City of Merritt to almost 0.3 g at the District of Hope (BGC Engineering Inc. 2013c). This segment crosses the Fraser River-Straight Creek fault zones near Hope. The Straight Creek section, south of Hope, has some evidence for Quaternary fault activity, but no such evidence is known for the Fraser River section, and no historical seismicity is associated with either section (BGC Engineering Inc. 2013c). The earthquake record contains events with magnitudes up to 7.4 in the Coast Mountains and Cascade Ranges across northwestern Washington and southwestern BC (Halchuk 2009). The Seismic Assessment Desktop Study of Volume 4A provides additional information along the Black Pines to Hope Segment, including: surface fault rupture potential; ground-motion predictions; liquefaction potential; and seismically induced landslide potential.

Within the Interior Plateau Physiographic Region, several debris avalanches are present on steep slopes near the valley bottom of the North Thompson River. Debris flows and debris floods occur on several fans along the proposed pipeline corridor. There is potential river erosion and flooding where the proposed pipeline corridor is located on the flood plain of the North Thompson River. Between the cities of Kamloops and Merritt, the proposed pipeline corridor is located on relatively stable, rolling upland terrain. South of Merrit, the proposed pipeline corridor encounters pockets of fine-textured glaciofluvial and glaciolacustrine materials that are highly erodible and subject to gully and surface erosion, as well as shallow debris slides and slumps. Steep slopes subject to shallow debris avalanches are present where down-cutting has occurred adjacent to watercourses (BGC Engineering Inc. 2013b).

Within the Cascade Mountains Physiographic Region, snow avalanches are common along the proposed pipeline corridor through the narrow and steep Coquihalla River valley. Debris flows occur on many of the fans that infill the rounded valley floor and in steeply incised watercourses. No recent rock avalanches were mapped along the Black Pines to Hope Segment (BGC Engineering Inc. 2013b).

The Terrain Mapping and Geohazard Inventory of Volume 4A provides more detailed and site-specific information on terrain and natural hazards along the Black Pines to Hope Segment.

Wind and Water Erosion

NRCan considers unprotected soils along the northern portion of this segment around the cities of Kamloops and Merritt as having low wind erosion risk with low climatic sensitivity, while soils at other areas along this segment are considered negligible and unrated (NRCan 2010a).

Soil investigations along this segment identified specific soil units highly susceptible to wind or water erosion. Soil units identified as highly susceptible to wind erosion include Andrew, Andrew 1, Cavanaugh, shallow Courtney, Glossey 1, stony Glossey 1, Glossey 2, Glossey 2 overlying gravel, Glimpse 1, Glimpse 2, Minnie, bouldery Minnie, shallow Minnie and stony Minnie. Soil units identified as highly susceptible to water erosion include Andrew, Andrew 1, Cavanaugh, Chasm, shallow Chasm, Commonage, shallow Courtney, Glossey 1, Glossey 2, Lundbom, Minnie, bouldery Minnie, shallow Minnie, stony Minnie, McQueen, stony McQueen, Mossy, Timber, shallow Timber, stony Timber, Tunkwa, shallow Tunkwa, Tullee, shallow Tullee, Tranquille, shallow Tranquille, Trapp Lake and shallow Trapp Lake. Refer to the Soils Technical Report of Volume 5C for additional information on these soil units. The locations of these soil units along the proposed pipeline corridor are shown on the Environmental Alignment Sheets (Volume 6E).

5.1.1.4 Hope to Burnaby and Burnaby to Westridge Segments

The following subsections describe the physiography, bedrock, surficial geology, terrain stability (mass wasting) and wind and water erosion along the Hope to Burnaby Segment.

Physiography

From east to west, the proposed pipeline corridor along the Hope to Burnaby and Burnaby to Westridge segments crosses the Cascade Mountains and Georgia Depression physiographic regions (Holland 1976).

Physiography of the Cascade Mountains Physiographic Region (RK 1043.7 to RK 1091.8) is described in Section 5.1.3.1.

The Georgia Depression Physiographic Region (RK 1091.8 to RK 1179.8 and RK 0 to RK 3.6 [Burnaby to Westridge Segment]) is characterized by a flat valley floor 10-15 km wide, steep valley walls, gently rolling uplands and ridges, gently rolling to flat lowlands of terraces and plains, and deltas (Armstrong 1984, Holland 1976). Elevation along the Fraser River valley floor generally falls from 12 m near Chilliwack to sea level at its outlet to the Pacific Ocean. However, the proposed alignment diverts from the valley floor in several places and rises over prominent topographic ridges within the Lower Mainland, including Sumas Mountain (approximately 200 m) and onto the southern side of Burnaby Mountain (approximately

150 m). Relief is variable and is controlled by the distance from the alignment to the closest valley wall (BGC Engineering Inc. 2013a).

Physiographic regions and subregions encountered by the proposed pipeline corridor along the Hope to Burnaby Segment and Burnaby to Westridge Segment are listed in Table 5.1-7.

TABLE 5.1-7

PHYSIOGRAPHIC REGIONS AND SUBREGIONS CROSSED BY THE HOPE TO BURNABY AND BURNABY TO WESTRIDGE SEGMENTS

Region	Subregion	Approximate RK	Landform
Cascade Mountains	Skagit Range	RK 1043.7 to RK 1091.8	The peaks and high ridges of the Cascade Mountains are serrate and exhibit the effects of intense alpine glaciation. Cirque basins are particularly noticeable on north and northeast slopes of peaks and ridges. At lower elevations between 1,800 m and 2,100 m there are rounded ridges and dome-shaped mountains which were overridden by ice at the maximum of the Cordilleran ice-sheet.
Georgia Depression	Fraser Lowland	RK 1091.8 to RK 1179.8 RK 0 to RK 3.6 (Burnaby to Westridge Segment)	The Fraser Lowland includes the delta area of the Fraser River, an area subject to sedimentary deposition since the late Cretaceous.

Source: Holland 1976

Topography along the proposed pipeline corridor is predominantly flat as the proposed pipeline corridor extends across the Fraser River flood plain to gentle to moderately sloping east of Chilliwack and along rolling upland areas (*e.g.*, Sumas and Burnaby mountains).

Bedrock Geology

The Cascade Mountains Physiographic Region is composed of folded and metamorphosed Paleozoic and Mesozoic sedimentary and volcanic rocks intruded by granitic batholiths (Journeay *et al.* 2000c, Monger 1989). Within the Skagit Range Physiographic Subregion, bedrock is from the Bridge River, Harrison and Chilliwack terrains. These units include: orthogneiss of the Custer Gneiss; coarse clastic units of the Princeton Group; unnamed Mesozoic quartz diorite west of Hope; medium grade schist and amphibolite of Settler Schist and Broken Formation; greenshist mafic to intermediate volcanics, phyllites, and conglomerates of the Slollicum Schist; Cenozoic granodiorite of the Mount Barr Batholith; and pelites, sandstone, conglomerates and volcanics of the Chilliwack Group (BGC Engineering Inc. 2013a).

Bedrock within the Fraser Lowland Physiographic Subregion of the Georgia Depression Physiographic Region is composed primarily of Eocene clastic rocks and units of the Harrison, Bridge River and Chilliwack terranes (Journeay *et al.* 2000c). These units include: coarse-grained clastics and volcanics of the Chilliwack Group; amphibolite and gneisses of the Vedder metamorphic complex; intermediate to felsic volcanics and volcaniclastics of the Harrison Lake formation; and extensive coarse-grained clastics and rare volcanic units of the Kitsilano Formation (BGC Engineering Inc. 2013a).

During the Surrey ESA Workshop, a participant noted the possible presence of karst in the area of the proposed pipeline corridor. However, the only area where karst lands have been documented in the Lower Mainland is in the mountains southeast of the City of Chilliwack, well outside of the Physical Environment LSA (Pike *et al.* 2010).

Soil investigations and mapping along this segment were conducted from March to April 2013. Bedrock within trench depth may be encountered in shallow Cheam and shallow Cheam 1 soils. The Soils Technical Report of Volume 5C provides additional information on these soil units. The locations of these soil units along the proposed pipeline corridor are shown on the Environmental Alignment Sheets (Volume 6E).

Surficial Geology

Surficial geology for the Cascade Mountains Physiographic Region is described in Section 5.1.1.3.

The dominant surficial deposits of the Fraser Lowland Physiographic Subregion are inactive and active fluvial, lacustrine, glaciofluvial, glaciomarine, glaciolacustrine and colluvium with localized bedrock outcrops and variable anthropogenic fill. Typically, the fluvial and lacustrine deposits overlie the glaciolacustrine, glaciomarine, glaciofluvial and till deposits but these sediments may be exposed at the surface. Surficial deposits depths are variable and range from 10-300 m (Armstrong 1984).

A description of surficial material within each physiographic region crossed by the proposed pipeline corridor is provided in Table 5.1-1. Intersected length of surficial material for the Cascade Mountains Physiographic Region is provided in Table 5.1-8. The Soils Technical Report of Volume 5C provides additional information on surface (parent) material associated with soil units identified along the proposed pipeline corridor. The locations of these soil units along the proposed pipeline corridor are shown on the Environmental Alignment Sheets (Volume 6E).

TABLE 5.1-8

SUMMARY OF SURFICIAL MATERIAL CROSSED BY THE PROPOSED PIPELINE CORRIDOR BY PHYSIOGRAPHIC REGION

Surficial Material	Intersected Length (km) by Physiographic Region
	Georgia Depression
Colluvium	1.1
Fluvial	31.5
Glaciofluvial	10.2
Glaciolacustrine	0.7
Lacustrine	7.2
Till	13.6
Organic	7.9
Glaciomarine	19.4
Total	91.6

Source: BGC Engineering Inc. 2013b

Terrain Stability

Earthquake ground shaking hazard is moderate to high within the Hope to Burnaby and Burnaby to Westridge segments. PGA at a 1:2475 APE ranges from around 0.3 g near the District of Hope to 0.5 g near the Township of Langley and the City of Surrey. The Hope to Burnaby Segment either crosses or approaches two faults with suspected post-glacial activity: the Sumas and Vedder Mountain faults, both near the City of Abbotsford. Several other faults with known or suspected post-glacial activity have been documented around the Puget Sound and Georgia Basin regions, but none approach the proposed pipeline corridor (BGC Engineering Inc. 2013c). The Seismic Assessment Desktop Study of Volume 4A provides additional information along the Hope to Burnaby and Burnaby to Westridge segments, including: surface fault rupture potential; ground-motion predictions; liquefaction potential; and seismically induced landslide potential.

West of Hope to Chilliwack, the proposed pipeline corridor is bounded between steep, rocky slopes to the south and the Fraser River to the north. Debris flows occur in many of the steep watercourses along this section and could affect the proposed pipeline corridor where it crosses the fans (BGC Engineering Inc. 2013b). From RK 1078.5 to RK 1081, the proposed pipeline corridor crosses the deposit of the Cheam Rock Avalanche, a very large catastrophic landslide which occurred approximately 5,000 years ago (Orwin *et al.* 2004).

West of the City of Chilliwack, where creeks cut down through the uplands, steep ravines are formed that are subject to shallow debris avalanches. No recent rock avalanches were mapped along the Hope to Burnaby Segment and Burnaby to Westridge Segment (BGC Engineering Inc. 2013b).

The Terrain Mapping and Geohazard Inventory of Volume 4A provides more detailed and site-specific information on terrain and natural hazards along the Hope to Burnaby and Burnaby to Westridge Segments.

Wind and Water Erosion

NRCan considers unprotected soils along the eastern portion of the Hope to Burnaby Segment as negligible and unrated, while wind erosion risk along the western portion of the segment around the cities of Chilliwack and Abbotsford is considered to have moderate wind erosion risk with low climatic sensitivity (NRCan 2010a).

Soil investigations along this segment identified specific soil units highly susceptible to wind or water erosion. Soil units identified as highly susceptible to wind erosion include Cheam, shallow Cheam, Cheam 1, bouldery Cheam 1, shallow Cheam 1, Harrison, Harrison 1, Isar, Laidlaw, Sumas, Sardis and Sunshine. Soil units identified as highly susceptible to water erosion include Cheam, shallow Cheam, Cheam 1, bouldery Cheam 1, shallow Cheam 1, Harrison 1, bouldery Kenworthy, Lonzo Creek, Ryder and Whatcom. Refer to the Soils Technical Report of Volume 5C for additional information on these soil units. The locations of these soil units along the proposed pipeline corridor are shown on the Environmental Alignment Sheets (Volume 6E).

5.1.2 Acid Generating and Metal Leaching Rock

BGC Engineering Inc. investigated and characterized the potential for acid rock drainage and metal leaching along the proposed pipeline corridor. The purpose of the acid rock drainage and metal leaching assessment was to identify areas with minerals that may be harmful to the environment when exposed during pipeline construction. These minerals include those that generate acid as a result of the oxidation of iron-bearing sulphur minerals such as pyrite (FeS_2), pyrrhotite (FeS) and chalcopyrite ($CuFeS_2$), and those that can leach harmful metals to the environment. Of the sites investigated during the field program, nine were considered to contain potentially acid generating material. Of these nine sites, three were classified as potentially acid generating along the proposed pipeline corridor in the Physical Environment LSA.

Site 004 is located along the Edmonton to Hinton Segment at RK 14 and consists of a poorly sorted till with rounded sandstone clasts, coal (5-10%) and shale fragments. Orange staining of coal rich layers is pervasive. No previous documentation was found with respect to acid rock drainage, metal leaching or coal deposits for this site. The extent of the coal seams is unknown and could extend for several kilometres. The acid rock drainage potential at this site is considered to be high considering the modest sulphide-S content associated with the coal fragments within the till. There is very little neutralization potential available within the till to neutralize any acid that may be generated from the coal seams.

Site 019 is located along the Hargreaves to Darfield Segment at RK 669.5. The geology of the outcrop consists of a gossanous contact zone between chlorite schist and metasediments. This outcrop is approximately 20 m high by 50 m wide. Approximately 50% of the outcrop material is metasedimentary and only 20% is gossanous. The acid rock drainage potential at this site is considered to be high considering the high sulphide-S content. Given the low neutralization potential of the surrounding material, it is uncertain if the non-potentially acid generating rock will have the potential to neutralize all of the acid generated from the potentially acid generating material.

Site 042 is located along the Black Pines to Hope Segment at RK 987.8 and consists of a very fine-grained shale/argillite. It is 100 m wide by 4 m high. The fresh surface is black/dark grey and the weathered surface is rusty brown with drusy yellow and white secondary sulphide mineralization. Sulphides observed include disseminated pyrite and pyrite stringers (5%). This site had the highest total sulphur content of all the samples, but measured sulphide content was low, as was the leachable sulphate content. Consequently, acid rock drainage potential at this site is considered to be moderate since total sulphur is dominated by non-extractable sulphur and is not likely a concern (*i.e.*, the risk of acid rock drainage is minimal).

The Acid Rock Drainage and Metal Leaching Potential Technical Report of Volume 5C provides additional information pertaining to acid rock drainage.

5.1.3 Climate

This subsection provides a summary of regional and local climate as well as climatic and atmospheric hazards along the proposed pipeline corridor for each pipeline segment. Additional meteorological data obtained from Environment Canada stations along the proposed pipeline corridor are provided in the Air Quality and Greenhouse Gas Technical Report of Volume 5C.

5.1.3.1 Edmonton to Hinton Segment

The following subsections describe regional and local climate as well as climatic and atmospheric hazards along the Edmonton to Hinton Segment.

Regional Climate

The proposed pipeline corridor crosses the Central Parkland, Dry Mixedwood and Central Mixedwood Natural Subregions to the east and the Lower Foothills and Montane Natural Subregions to the west in the Edmonton to Hinton Segment.

The average annual temperature of the Central Parkland Natural Subregion is 2.3°C. The Dry Mixedwood Natural Subregion has the warmest summers of any of the Boreal Natural Regions with an average annual temperature of 1.1°C, while the average annual temperature of the Central Mixedwood Natural Subregion is 0.2°C. The number of frost-free days per year in the Central Parkland, Dry Mixedwood and Central Mixedwood Natural Subregions averages 102, 98 and 97 days, respectively (Natural Regions Committee 2006a).

Average annual temperature of the Lower Foothills Natural Subregion is 1.8°C, while the average annual temperature of the Montane Natural Subregion is 2.3°C. The number of frost-free days per year in the Lower Foothills and Montane Natural Subregions averages 94 and 64 days, respectively (Natural Regions Committee 2006a).

As indicated in Table 5.1-9, monthly precipitation for the five natural subregions crossed by the proposed pipeline corridor generally peaks during summer months and is lowest during late fall, winter and early spring. The Lower Foothills and Montane Natural Subregions experience similar annual monthly averages of 47 mm, with the Central Parkland, Dry Mixedwood and Central Mixedwood Natural Subregions experiencing 36 mm, 37 mm and 38 mm, respectively.

TABLE 5.1-9

AVERAGE MONTHLY PRECIPITATION (MM)

Natural Subregion	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean Monthly
Central Parkland	21.8	15.5	19.1	21.1	44.9	78.6	83.0	60.0	42.6	16.7	1.6	21.5	36
Dry Mixedwood	25.8	19.8	20.5	20.5	41.9	75.0	80.4	63.7	42.8	23.1	4.2	24.1	37
Central Mixedwood	24.3	18.2	21.6	21.9	42.2	74.9	85.2	65.1	46.9	27.5	3.6	25.0	38
Lower Foothills	30.7	22.4	25.7	26.9	57.9	99.3	107.8	80.5	57.3	26.8	4.2	28.0	47
Montane	37.5	31.0	36.6	49.8	67.7	82.1	64.7	63.1	54.9	33.0	13.2	35.1	47

Source: Natural Regions Committee 2006a

Local Climate

The meteorological data summarized in Table 5.1-10 was obtained from three Environment Canada stations along the Edmonton to Hinton Segment: the Edmonton City Centre Airport Station, located approximately 10 km northwest of RK 0.0; the Hamlet of Entwistle Station, located approximately 1.5 km north of RK 133; and the Town of Edson Station, located approximately 1.3 km south of RK 234 (Environment Canada 2013a).

TABLE 5.1-10

ENVIRONMENT CANADA TEMPERATURE AND WIND DATA ALONG THE EDMONTON TO HINTON SEGMENT

Measurement Parameter		City of Edmonton (Station 3012208)	Hamlet of Entwistle (Station 3062451)	Town of Edson (Station 3062244)
Average Annual Precipitation	Rainfall (mm)	347.8[1]	424.5[5]	415.5[7]
	Snowfall (cm)	123.5[1]	126.1[5]	160.2[7]
Highest Average Monthly Precipitation	Rainfall (mm)	93.8 (July)[1]	103.4 (July)[5]	108.4 (July)[7]
	Snowfall (cm)	24.5 (January)[1]	27.1 (January)[5]	33.1 (January)[7]
Highest Recorded Daily Precipitation	Rainfall (mm)	114 (July 31, 1953)[2]	70.4 (June 18, 1996)[5]	72.7 (July 17, 1986)[8]
	Snowfall (cm)	39.9 (November 15, 1942)[2]	51 (January 30, 1989)[5]	40.4 (November 30, 1972)[9]
Average Yearly Temperature (°C)		4.2[1]	3.5[6]	2.4[10]
Average Warmest Month (°C)		17.7 (July)[1]	16.5 (July)[6]	14.7 (July)[10]
Average Coolest Month (°C)		-10.4 (January)[1]	-11.3 (January)[6]	-10.3 (December)[10]
Highest Recorded Temperature (°C)		34.9 (June 26, 2002)[2]	35.5 (July 22, 2006)[5]	33.3 (May 26, 1986, June 3, 1970)[8]
Lowest Recorded Temperature (°C)		-48.3 (December 28, 1938)[2]	-43 (January 19, 1996)[5]	-47.3 (February 2, 1989)[8]
Average Annual Hourly Wind Speed (km/h)		11.8[1]	No data	7.5[11]
Highest Recorder Hourly Wind Speed (km/h)		72 (April 13, 1954)[3]	No data	64 (December 11, 1970, February 16, 1972, June 30, 1972)[12]
Highest Recorded Wind Gusts (km/h)		117 (June 6, 1960, September 11, 1973)[4]	No data	100 (December 11, 1970, February 16, 1972)[13]

Source: Environmental Canada 2013a

Notes:
1 Data collected from 1981 to 2004.
2 Data collected from 1937/1938 to 2004/2005.
3 Data collected from 1953 to 2004/2005.
4 Data collected from 1955 to 1993/1994.
5 Data collected from 1987-1989 to 2006/2007.
6 Data collected from 1987-1990 to 2006/2007.
7 Data collected from 1981 to 1993/1994 and 1997/1998.
8 Data collected from 1970/1971 to 1993/1994 and 1996-1998.
9 Data collected from 1970/1971 to 1993/1994 and 1997/1998.
10 Data collected from 1981 to 1993/1994 and 1996-1998.
11 Data collected from 1981 to 1992-1994.
12 Data collected from 1970/1971 to 1993/1994 and 1998/1999.
13 Data collected from 1970/1971 to 1991/1992.

Climate and Atmospheric Hazards

One major tornado was recorded in the Edmonton area on July 31, 1987. It caused 27 deaths, 600 injuries, 1,700 evacuations and $300 million in damage (NRCan 2010b). Two major hailstorms were recorded in close proximity to the Edmonton Terminal: one in 1988 that caused $48 million in damage; and one in 1901 that produced 8 cm diameter hailstones (NRCan 2010c).

5.1.3.2 Hargreaves to Darfield Segment

The following subsections describe regional and local climate as well as climatic and atmospheric hazards along the Hargreaves to Darfield Segment.

Regional Climate

The proposed pipeline corridor crosses the Interior Cedar-Hemlock (ICH) and Sub-Boreal Spruce (SBS) Biogeoclimatic (BGC) zones to the north and centre and the Interior Douglas-Fir (IDF) BGC Zone to the south along the Hargreaves to Darfield Segment.

The ICH BGC Zone has an interior, continental climate dominated by easterly moving air masses that produce cool wet winters and warm dry summers. The zone is one of the wettest in the BC interior, with a mean annual precipitation of 500-1,200 mm, 25-50% of which falls as snow. Periodic dry, high-pressure, continental air masses occasionally result in very cold winter days and very hot summer days. Mean annual temperature ranges from 2°C to 8.7°C, a range that reflects the wide latitudinal extent of the ICH. The temperature averages below 0°C for 2 to 5 months and above 10°C for 3 to 5 months of the year (Meidinger and Pojar 1991).

The SBS BGC Zone has a continental climate characterized by seasonal extremes of temperature; severe, snowy winters; relatively warm, moist and short summers; and moderate annual precipitation. In contrast to boreal climates, the sub-boreal climate is slightly less continental and, therefore, slightly warmer in January and cooler in July. Winters are shorter and the growing season is slightly longer. Mean annual temperature ranges from 1.7°C to 5°C. Average temperature is below 0°C for 4-5 months of the year, and above 10°C for 2 to 5 months. Short-term data indicate that mean annual precipitation can range from 415-1,650 mm, while data from long-term stations ranges from 440-900 mm, of which 25-50% is snow (Meidinger and Pojar 1991).

The IDF BGC Zone has a continental climate characterized by warm, dry summers, a relatively long growing season and cool winters. The main influence controlling the climate is the orographic effect created in the lee of coastal mountain ranges to the prevailing easterly flowing air. Mean annual precipitation ranges from 300-750 mm, with the exception of wetter areas where precipitation exceeds 1,000 mm. Approximately 20-50% of the precipitation falls as snow. Mean annual temperature ranges from 1.6°C to 9.5°C. The average temperature is below 0°C for 2 to 5 months and above 10°C for 3 to 5 months. Substantial moisture deficits during the growing season are common and frosts can occur at any time (Meidinger and Pojar 1991).

Local Climate

The meteorological data summarized in Table 5.1-11 was obtained from two Environment Canada stations along the Hargreaves to Darfield Segment: the Blue River Airport Station, located within 100 m of RK 612.2; and the Darfield Station, located approximately 1.8 km south of RK 769 (Environment Canada 2013a).

TABLE 5.1-11

ENVIRONMENT CANADA TEMPERATURE AND WIND DATA ALONG THE HARGREAVES TO DARFIELD SEGMENT

Measurement Parameter		Community of Blue River Airport (Station 1160899)	Darfield (Station 1162265)
Average Annual Precipitation	Rainfall (mm)	719.7[1]	372.5[1]
	Snowfall (cm)	404.4[1]	112.6[1]
Highest Average Monthly Precipitation	Rainfall (mm)	107.3 (July)[1]	54.1 (June)[1]
	Snowfall (cm)	113.5 (January)[1]	37.5 (January)[1]
Highest Recorded Daily Precipitation	Rainfall (mm)	47.4 (October 16, 2003)[2]	53.3 (August 4, 1956)[5]
	Snowfall (cm)	56.1 (January 21, 1972)[2]	33 (January 7, 1982)[5]
Average Yearly Temperature (°C)		4.8[1]	7.4[1]
Average Warmest Month (°C)		16.4 (July)[1]	19.1 (July)[1]
Average Coolest Month (°C)		-7.3 (January)[1]	-4.5 (January)[1]
Highest Recorded Temperature (°C)		37.8 (August 1, 1971)[2]	38.5 (July 19, 1979)[6]
Lowest Recorded Temperature (°C)		-44.8 (December 30, 1984)[2]	-41.1 (January 29, 1969)[6]
Average Annual Hourly Wind Speed (km/h)		2.58[3]	No Data
Highest Recorder Hourly Wind Speed (km/h)		85 (December 27, 1992)[4]	No Data
Highest Recorded Wind Gusts (km/h)		No Data	No Data

Source: Environmental Canada 2013a

Notes:
1 Data collected from 1981 to 2006/2007.
2 Data collected from 1969/1970 to 2006/2007.
3 Data collected from 1982/1983 to 2002.
4 Data collected from 1969/1970 to 2010.
5 Data collected from 1956-1958 to 2006/2007.
6 Data collected from 1962/1963 to 2006/2007.

Climate and Atmospheric Hazards

No major tornadoes or hailstorms have been recorded in the vicinity of the Hargreaves to Darfield Segment (NRCan 2010b,c).

5.1.3.3 Black Pines to Hope Segment

The following subsections describe regional and local climate as well as climatic and atmospheric hazards along the Black Pines to Hope Segment.

Regional Climate

The proposed pipeline corridor crosses the Ponderosa Pine (PP), Bunchgrass (BG) and IDF BGC zones to the north and centre and the Montane Spruce (MS), Engelmann Spruce-Subalpine Fir (ESSF), Mountain Hemlock (MH) and Coastal Western Hemlock (CWH) BGC zones to the south along the Black Pines to Hope Segment.

The climate of the PP BGC Zone is the driest and in summer, the warmest of the forested zones in BC, influenced strongly by a pronounced rainshadow effect of coastal mountain ranges. Mean annual precipitation ranges from 280-500 mm, with 15-40% falling as snowfall. Mean annual temperature ranges from 4.8°C to 10°C. Mean monthly temperature is above 10°C for 5 to 6 months and below 0°C for 2 to 5 months. Summers are very warm, with mean July temperatures of 17°C to 22°C, while winters are typically cool with light snow cover. The hot, dry summers result in considerable moisture deficits during the growing season (Meidinger and Pojar 1991).

Similar to the PP BGC Zone, the climate of the BG BGC Zone is characterized by warm to hot, arid summers and moderately cold winters with relatively little snowfall. Severe drought in this zone restricts tree establishment and grasslands dominate. The degree of aridity corresponds to the intensity of the rainshadow effect, which is most intense in the deep, incised valleys whereby temperature tends to increase with decreasing elevation. Typically, December and January are the wettest months, while a second precipitation peak occurs in June. The driest months are usually March and April (Meidinger and Pojar 1991).

The MS BGC Zone experiences a cool, continental climate characterized by cold winters and moderately short, warm summers. Mean annual temperature is 0.5°C to 4.7°C. The average temperature is below 0°C for 5 months of the year and above 10°C for 2 to 4 months. Mean annual precipitation ranges from 380-900 mm. The growing season is sufficiently warm and dry that moisture deficits can occur, particularly in the drier subzones (Meidinger and Pojar 1991).

The ESSF BGC Zone experiences a relatively cold, moist and snowy continental climate. Growing seasons are cool and short, while winters are long and cold. According to available data mostly from southeastern BC, mean annual temperatures range from -2°C to +2°C. Mean monthly temperatures are below 0°C for 5 to 7 months and above 10°C for 2 months or less. Mean annual precipitation is highly variable within the zone, with relatively dry areas of the zone receiving 400-500 mm of precipitation and wetter areas receiving up to 2,200 mm. Most (50-70%) precipitation falls as snow and maximum snowpack ranges from 1-4 m (Meidinger and Pojar 1991).

The coastal subalpine climate of the MH BGC Zone is characterized by short, cool summers and long, cool, wet winters, with heavy snow cover for several months. Mean annual temperature ranges from 0°C to 5°C. Average monthly temperature remains below 0°C for 1 to 5 months and above 10°C for 1 to 3 months. Mean annual precipitation ranges from 1,700-5,000 mm, of which 20-70% falls as snow. The deep winter snowpack is slow to withdraw, resulting in a short growing season. Spring and summer are often relatively dry, whereas fall and winter are typically very wet (Meidinger and Pojar 1991).

The CWH BGC Zone is, on average, the rainiest BGC zone in BC. The zone typically experiences cool summers (although hot dry spells can be frequent) and mild winters. Mean annual temperature ranges from 5.2°C to 10.5°C. The mean monthly temperature is above 10°C for 4 to 6 months of the year, with a mean temperature of 0.2°C in the coldest month. Mean annual precipitation ranges from 1,000-4,400 mm (and probably more in some areas), of which less than 15% falls as snow in the south portion of the zone (Meidinger and Pojar 1991).

Local Climate

The meteorological data summarized in Table 5.1-12 was obtained from two Environment Canada stations along the Black Pines to Hope Segment: the City of Kamloops Airport Station, located within 200 m of RK 846; and the District of Hope Airport Station, located approximately 400 m north of RK 1049.5 (Environment Canada 2013a).

TABLE 5.1-12

ENVIRONMENT CANADA TEMPERATURE AND WIND DATA ALONG THE BLACK PINES TO HOPE SEGMENT

Measurement Parameter		City of Kamloops Airport (Station 1163780)	District of Hope Airport (Station 1113540)
Average Annual Precipitation	Rainfall (mm)	224.3[1]	1,955.2[5]
	Snowfall (cm)	63.5[1]	103.5[5]
Highest Average Monthly Precipitation	Rainfall (mm)	31.4 (July)[1]	339 (November)[5]
	Snowfall (cm)	21.9 (December)[1]	29 (December)[5]
Highest Recorded Daily Precipitation	Rainfall (mm)	48 (August 16, 1976)[2]	173.1 (November 9, 1990)[6]
	Snowfall (cm)	33.8 (January 7, 1962)[2]	57.7 (January 12, 1975)[6]
Average Yearly Temperature (°C)		9.3[1]	10.2[5]
Average Warmest Month (°C)		21.5 (July)[1]	19 (August)[5]
Average Coolest Month (°C)		-2.8 (January)[1]	1.2 (December)[5]
Highest Recorded Temperature (°C)		40.6 (July 31, 1971)[2]	40 (July 27, 1958)[7]
Lowest Recorded Temperature (°C)		-37.2 (January 29, 1969)[2]	-24.4 (December 29, 1968)[7]
Average Annual Hourly Wind Speed (km/h)		10.3[1]	13.3[8]
Highest Recorder Hourly Wind Speed (km/h)		93 (March 30, 1975)[3]	80 (December 13, 1988)[9]
Highest Recorded Wind Gusts (km/h)		137 (March 30, 1975)[4]	156 (December 12, 1988)[10]

Source: Environmental Canada 2013a

Notes:
1 Data collected from 1981 to 2010.
2 Data collected from 1951 to 2010.
3 Data collected from 1953 to 2010.
4 Data collected from 1955/1956/1962/1966/1967 to 2010.
5 Data collected from 1981 to 1994/1995.
6 Data collected from 1934/1935 to 1994/1995.
7 Data collected from 1936/1938 to 1994/1995.
8 Data collected from 1981 to 1993/1994.
9 Data collected from 1953 to 1994/1995.
10 Data collected from 1973/1974 to 1990/1991.

Climate and Atmospheric Hazards

No major tornadoes or hailstorms have been recorded in the vicinity of the Black Pines to Hope Segment (NRCan 2010b,c).

5.1.3.4 Hope to Burnaby and Burnaby to Westridge Segments

The following subsections describe regional and local climate as well as climatic and atmospheric hazards along the Hope to Burnaby and Burnaby to Westridge segments.

Regional Climate

The entire length of the Hope to Burnaby and Burnaby to Westridge segments are located within the CWH BGC Zone discussed in Section 5.1.3.3.

Local Climate

The meteorological data summarized in Table 5.1-13 was obtained from two Environment Canada stations along the Hope to Burnaby and Burnaby to Westridge segments: the City of Chilliwack Station, located within 5 km north of RK 1095; and the City of Burnaby Simon Fraser University Station, located approximately 1 km northeast of RK 1180.2 (Environment Canada 2013a).

TABLE 5.1-13

ENVIRONMENT CANADA TEMPERATURE AND WIND DATA ALONG THE HOPE TO BURNABY AND BURNABY TO WESTRIDGE SEGMENTS

Measurement Parameter		City of Chilliwack (Station 1101530)	City of Burnaby Simon Fraser University (Station 1101158)
Average Annual Precipitation	Rainfall (mm)	1,582.2[1]	1,920.7[4]
	Snowfall (cm)	85.3[1]	89.3[4]
Highest Average Monthly Precipitation	Rainfall (mm)	272.7 (November)[1]	303.6 (November)[4]
	Snowfall (cm)	24.3 (December)[1]	29 (December)[4]
Highest Recorded Daily Precipitation	Rainfall (mm)	122.6 (December 13, 1979)[2]	171.5 (January 18, 1968)[5]
	Snowfall (cm)	66.8 (November 16, 1996)[2]	50 (December 21, 1996)[5]
Average Yearly Temperature (°C)		10.8[1]	9.6[6]
Average Warmest Month (°C)		18.8 (July)[1]	17.2 (August)[6]
Average Coolest Month (°C)		3.3 (January)[1]	2.9 (December)[6]
Highest Recorded Temperature (°C)		38 (July 21, 2006)[3]	34.5 (September 3, 1988)[5]
Lowest Recorded Temperature (°C)		-21.7 (December 29, 1968)[3]	-19.4 (December 29, 1968)[5]
Average Annual Hourly Wind Speed (km/h)		No data	No data
Highest Recorder Hourly Wind Speed (km/h)		No data	No data
Highest Recorded Wind Gusts (km/h)		No data	No data

Source: Environmental Canada 2013a

Notes:
1 Data collected from 1981/1986 to 2006/2007.
2 Data collected from 1979/1980 to 2006/2007.
3 Data collected from 1881/1896 to 2006/2007.
4 Data collected from 1981 to 2005-2007.
5 Data collected from 1965/1966 to 2006/2007.
6 Data collected from 1981/1982 to 2006/2007.

Climate and Atmospheric Hazards

No major tornadoes or hailstorms have been recorded in the vicinity of the Hope to Burnaby and Burnaby to Westridge segments (NRCan 2010b,c).

5.2 Soil and Soil Productivity

This subsection presents a summary of the soil landscapes and characteristics encountered along the proposed pipeline corridor and in the Soil LSA. The indicators selected for this element discussed below include soil productivity, soil degradation, bedrock and stone disposal, and soil contamination. The rationale for the selection of indicators is provided in Section 7.2.2. Locations of soil types encountered along the proposed pipeline corridor are identified on the Environmental Alignment Sheets (Volume 6E).

Mentiga Pedology Consultants Ltd. (Mentiga) was commissioned by TERA on behalf of Trans Mountain to conduct soil surveys within the proposed pipeline corridor where new buried pipeline is proposed. Much of the proposed pipeline corridor had been previously surveyed for Trans Mountain by Mentiga in 2006. Soil investigations in those surveys were to a depth of 1.7-2.1 m. Pertinent soils information from the previous soil surveys was utilized in this study. Additional soil investigations were conducted by Mentiga from March to October 2013. Detailed information on the known soils encountered by the proposed pipeline corridor is provided in the Soils Technical Report of Volume 5C. The potential Project-related effects and mitigation pertaining to soil and soil productivity are discussed in Section 7.2.2.

The Soil LSA is considered the ZOI likely to be affected by direct disturbance generally consisting of a 1 km wide band from the centre of the proposed pipeline corridor and facilities (*e.g.*, 500 m on both sides of the proposed pipeline corridor centre).

5.2.1 Soil Productivity

5.2.1.1 General Soil Characteristics

<u>Edmonton to Hinton Segment</u>

This segment of the proposed pipeline corridor is located in an agricultural area and primarily encounters previously disturbed soils. Chernozems and Luvisols are the dominant soil orders encountered along this segment of the proposed pipeline corridor (Natural Regions Committee 2006a).

Orthic Black Chernozems are typically associated with grasslands and open woodlands in the Central Parkland Natural Subregion. Solonetzic soils occupy approximately 15% of the central low-relief plain, in this natural subregion, with a further 20-30% of soils having Solonetzic properties. Forested areas commonly have Orthic Dark Gray Chernozem and Dark Gray Luvisolic soils. Humic and Orthic Gleysols are the most common soil types associated with wetlands (Natural Regions Committee 2006a).

Typical soils in the Dry Mixedwood Natural Subregion are Orthic Gray Luvisols under moderately well-drained aspen forests. Dark Gray Luvisols dominate in cultivated areas. Brunisols and weakly developed Gray Luvisols occur on sandy glaciofluvial or eolian deposits. Organic soils underlying wetlands are usually Terric Mesisols, while Fibric Mesisols are associated with poor fens and bogs. Peaty and Orthic Gleysols are also common wetland soils (Natural Regions Committee 2006a).

The Central Mixedwood Natural Subregion is dominated by Gray Luvisols, and Dystric and Eutric Brunisols are associated with coarse-textured sands that occupy approximately 10% of the area. Mesisols are the dominant Organic soils occurring under fens and bogs, with Terric subgroups commonly occurring. Fibric Mesisols, Fibrisols and sometimes Cryosols are associated with bogs (Natural Regions Committee 2006a).

Orthic Gray Luvisolic soils dominate the Lower Foothills Natural Subregion on the medium and fine-textured materials of the uplands. They are accompanied by Brunisolic subgroups, particularly at higher elevations. Brunisolic Gray Luvisols and Dystric Brunisols are typical of sandy terrain, and Eutric Brunisols and Regosols are often associated with calcareous, recently deposited eolian and fluvial materials. The wetland organic deposits associated with poor to rich fens are mainly Mesisols. Orthic and Peaty Gleysols often occur adjacent to wetlands and are more common in the gently undulating areas (Natural Regions Committee 2006a).

Orthic Black Chernozems are typical in the Montane Natural Subregion under grasslands with Orthic Dark Gray Chernozems becoming dominant in wooded areas. On more moist northern slopes and at higher elevations, Gray Luvisols are prevalent. Eutric Brunisols are the dominant soil in valleys on fluvial and glaciofluvial deposits. Gleysols and Organic soils are typically associated with fens (Natural Regions Committee 2006a).

<u>Hargreaves to Darfield, Black Pines to Hope, Hope to Burnaby and Burnaby to Westridge Segments</u>

The proposed pipeline corridor in BC encounters mountainous, rural, urban and agricultural areas. Luvisols and Podzols are the dominant soil orders encountered along the segments of the proposed pipeline corridor in BC (Valentine *et al.* 1978).

The Hargreaves to Darfield Segment is dominated by Lithic, Eutric Brunisolic, Humo-Ferric Podzolic and Gray Luvisolic soils. The Black Pines to Hope Segment encounters primarily Gray Luvisolic, Brown Chernozemic, Eutric Brunisolic and Humo-Ferric Podzolic soils. The Hope to Burnaby Segment is dominated by Humo-Ferric Podzolic and Humic Gleysolic soils. The Burnaby to Westridge Segment mainly consists of Humic Gleysolic soils (Valentine *et al.* 1978).

Brunisolic soils are formed under forest and generally have a brownish-coloured Bm horizon (*i.e.*, middle mineral horizon slightly altered by hydrolysis, oxidation or solution, or all three to give a change in colour or structure, or both). A Bm horizon may develop in materials of any colour, which vary in texture from gravel to clay. Brunisolic soils include some that are calcareous to the surface and very slightly weathered, and others that are strongly acid and apparently weathered. Most Brunisolic soils are well to imperfectly-drained. They occur in a wide range of climatic and vegetative environments, including Boreal Forest, mixed forest, shrubs and grass (Agriculture and Agri-Food Canada 1998).

Soils of the Podzolic order have B horizons (*i.e.*, middle mineral horizons) in which the dominant accumulated product is amorphous material composed mainly of humified organic matter. Podzolic soils typically occur in coarse to medium-textured, acid parent materials, under forest or heath vegetation in cool to very cold humid to perhumid climates. However, minor areas of Podzolic soils also occur in wet, sandy sites in areas of sub-humid climate. Other Podzolic soils have formed in parent materials that were once calcareous (Agriculture and Agri-Food Canada 1998).

Luvisolic soils generally have light-coloured, eluvial horizons and have illuvial B horizons in which silicate clay has accumulated. These soils develop characteristically in well to imperfectly-drained sites, in sandy loam to clay, base-saturated parent materials under forest vegetation in subhumid to humid, mild to very cold climates. Some Luvisolic soils also occur in acid parent materials and in forest-grassland transition zones (Agriculture and Agri-Food Canada 1998).

Chernozemic soils are typically well to imperfectly-drained and have surface horizons darkened by the accumulation of organic matter from the decomposition of serophytic or mesophytic grasses and forbs representative of grassland communities or of grassland-forest communities with associated shrubs and forbs (Agriculture and Agri-Food Canada 1998).

Soils of the Gleysolic order are defined on the basis of colour and mottling. These soils have a horizon or sub-horizon at least 10 cm thick, the upper boundary of which occurs within 50 cm of the mineral surface. Gleysolic soils have properties that indicate prolonged periods of intermittent or continuous saturation with water and reducint conditions during their genesis. In areas of subhumid climate, Gleysolic soils occur more commonly in shallow depressions and on level lowlands that are saturated with water every spring. In more humid areas, they may also occur on slopes and on undulating terrain (Agriculture and Agri-Food Canada 1998).

5.2.1.2 Specific Soil Characteristics

<u>Edmonton to Hinton Segment</u>

Soil investigations and mapping in this segment were conducted in September 2006, July 2013 and from September to October 2013. The soil investigation covers the White Area of Alberta from the Edmonton Terminal at RK 0.0 to the Edson Pump Station at RK 247.3. The area from the Edson Pump Station west to RK 339.4 was not investigated in the field (Green Area).

The following provides detailed descriptions of dominant and less common soil sub-groups encountered along this segment of the proposed pipeline corridor. In total, 31 soil units were described and mapped along the Edmonton to Hinton Segment. Further details on the results of the soil investigation are provided in the Soils Technical Report of Volume 5C.

Gray Luvisolic soils with little or no topsoil in forested areas and 10-25 cm of topsoil in cleared and developed fields are the dominant soils in imperfectly to well-drained upland positions of the landscape in the western and west central portions of the Edmonton to Hinton Segment. Orthic and Gleyed Gray Luvisols developed on till, glaciolacustrine and glaciofluvial materials occupy approximately 38% of the proposed pipeline corridor investigated in this segment. Colour differentiation between topsoils and subsoils in these soils is usually fair.

Dark Gray Luvisols and Gleyed Dark Gray Luvisols are the dominant soils in the central and east central portion of this segment and occupy approximately 15% of the proposed pipeline corridor investigated. These soils are generally moderately well to imperfectly-drained and developed on glaciofluvial veneers overlying till, loam to clay loam-textured till or clay-textured glaciolacustrine material. Topsoil thickness varies from 10-35 cm in cleared and developed fields and topsoils are easily distinguished from subsoils by colour.

Orthic Dark Gray Chernozems with 15-70 cm of topsoil and developed on pitted deltaic material occupy approximately 9% of the proposed pipeline corridor investigated in this segment and occur mainly west of the City of Edmonton towards the Town of Stony Plain. Topsoils are easily distinguished from subsoils by colour in these soils.

Orthic and Eluviated Black Chernozems with 14-54 cm of topsoil and developed on stone-free glaciolacustrine materials, slightly to moderately stony till as well as glaciofluvial sands occupy approximately 11% of the proposed pipeline corridor investigated in this segment and occur mainly in the City of Edmonton. Colour differentiation between topsoils and subsoils is excellent in these soils.

Substantial areas of poorly-drained Gleysolic soils occur along the proposed pipeline corridor in the White Area. A variety of Gleysolic soils developed on a variety of materials have been identified. Orthic Luvic Gleysols and Orthic Gleysols with little or no topsoil and developed on till or glaciolacustrine clays, as well as Orthic Humic Gleysols, Rego Humic Gleysols and Humic Luvic Gleysols with 10-50 cm of topsoil and developed on till, glaciolacustrine clays and loams or glaciofluvial sands are prominent throughout this segment. Some of the Gleysolic soils have a peaty surface (20-50 cm of surface peat). Very poorly-drained level to depressional areas are characterized by Terric Mesisols or Typic Mesisols developed on moss peat that exceeds a depth of 50 cm or 100 cm, respectively. These soils do not have a topsoil horizon, but occasionally they have been drained and cleared for agricultural purposes and have a surface horizon which should be considered topsoil and salvaged. Notable areas of Organic soils (Terric and Typic Mesisols) occur in the western and central portions of this segment. Most of the Organic soils have not been developed for agricultural purposes and remain in their native vegetation of black spruce and larch. Poorly-drained Gleysolic and Organic soils occupy approximately 18% of the proposed pipeline corridor in the White Area (10% Organic soils and 6% Gleysolic soils).

The soils along approximately 7% of the proposed pipeline were not investigated due to access restrictions. The classification of those soils is unknown at this time. These areas will be investigated in the field at a later date (see Section 9.0).

Land use along this segment of the proposed pipeline corridor investigated consists of: treed land (31.2%); hay (27.0%); cultivated land (16.6%); tame pasture (15.0%); treed-pasture (4.2%); hay-poor sod (0.8%); cleared, but not broken land (0.6%); and tame pasture-poor sod (0.4%). Other land uses of minor extent include disturbed land (usually industrial or residential land and includes a ball park in the Town of Edson), open water, major rivers and tree farms. Present land use is unknown on approximately 1.6% of the proposed pipeline corridor due to access restrictions. Present land use is shown on the Environmental Alignment Sheets (Volume 6E).

A search of the Geographic Land Information Management Planning System (GLIMPS) did not identify any soil-related Crown dispositions crossed by the Edmonton to Hinton Segment (Alberta Energy 2013).

Participants of the Wabamun and Hinton Community Workshops indicated local information on soils in the area including sandy soils in the Wabamun areas and eolian soils in the Hinton area.

Hargreaves to Darfield Segment

Soil investigations and mapping in this segment were conducted from July to August 2006 and from May to June 2013. The soil investigation covers the segment from Hargreaves (RK 489.6) to the Darfield Pump Station at RK 769.0.

The following provides detailed descriptions of dominant and less common soil sub-groups encountered along this segment of the proposed pipeline corridor. In total, 32 soil units were described and mapped along the Hargreaves to Darfield Segment. Further details on the results of the soil investigation are provided in the Soils Technical Report of Volume 5C.

Dystric and Eutric Brunisolic soils with little or no topsoil in forested areas and 10-25 cm of topsoil in cleared and developed fields are the dominant soils in imperfectly to rapidly-drained areas throughout this segment of the proposed pipeline corridor. The Dystric Brunisols (Orthic and Eluviated Dystric Brunisols) tend to dominate the northern and central portions while the Eutric Brunisols (Orthic and Eluviated Eutric Brunisols) occur mainly in the southern portion where dryer climatic conditions occur. The Dystric Brunisols occupy approximately 49% while the Eutric Brunisols make up approximately 29% of the proposed pipeline corridor in this segment. These soils are developed on till, colluvium, glaciolacustrine silts, eolian sands as well as the glaciofluvial sands and gravels.

Well to imperfectly-drained Orthic and Brunisolic Gray Luvisols with little or no topsoil in forested areas and 10-25 cm of topsoil in cleared and developed fields occupy approximately 12% of the proposed pipeline corridor in this segment. These soils have developed on some of the finer textured till deposits as well as some of the glaciolacustrine silt deposits. These soils are used much more frequently for agricultural production than the Brunisolic soils.

Land use along this segment of the proposed pipeline corridor investigated consists of: treed land (85.9%); tame pasture (6.6%); hay (4.7%); treed-pasture (1.0%); and cultivated land (0.2%). Disturbed land occupies approximately 1% of the proposed pipeline corridor, while major rivers and open water occupy approximately 0.3% and 0.2%, respectively. Present land use is shown on the Environmental Alignment Sheets (Volume 6E).

A search of the BC Integrated Land and Resource Registry (BC ILRR) did not identify any Crown dispositions that may be related to soil in the Hargreaves to Darfield Segment (BC Integrated Land Management Bureau [BC ILMB] 2013a).

Participants of the Valemount, Blue River and Clearwater Community Workshops provided the following local information on soils in the area: sand soils in the Valemount area; wet or very rocky soils in the Blue River area; and rocky/sandy soils around the Blackpool area.

Black Pines to Hope Segment

Soil investigations and mapping in this segment were conducted from late July to early September 2013. The soil investigation in this segment covers the area that has agricultural potential, namely the area between the proposed Black Pines Pump Station at RK 811.8 to the Coldwater River at RK 971. The area from the Coldwater River (RK 971) to the Hope Pump Station (RK 1044.1) mainly parallels Highway 5 and was not investigated in the field.

The following provides detailed descriptions of dominant and less common soil sub-groups encountered along this segment of the proposed pipeline corridor. In total, 26 soil units were described and mapped along the Black Pines to Hope Segment. Further details on the results of the soil investigation are provided in the Soils Technical Report of Volume 5C.

Eutric Brunisolic soils with little or no topsoil in forested areas and 10-25 cm of topsoil in cleared and developed fields are the dominant soils in imperfectly to rapidly-drained areas throughout the proposed pipeline corridor investigated in this segment. The Eutric Brunisols (Orthic and Eluviated Eutric Brunisols) tend to dominate areas where the coarser textured materials occur. The Eutric Brunisols occupy approximately 28% of the segment investigated and are developed on till or colluvial material as well as glaciofluvial sands and gravels. The Eutric Brunisols are rarely used for agricultural production.

Well to moderately-well drained Orthic Gray Luvisols with little or no topsoil (Ah or Ahe horizon) in forested areas and 10-15 cm of topsoil (Ap horizon) in cleared and developed fields occupy approximately 14% of the segment investigated. These soils are developed on loam to clay loam textured till deposits. The Luvisolic soils are rarely used for agricultural production.

Chernozemic soils with 8-38 cm of topsoil and developed on till, colluvial fans, glaciofluvial sands and gravel, glaciolacustrine material and recent fluvial sediments occupy approximately 36% of the segment investigated. The Dark Brown Chernozems have the greatest areal extent occupying approximately 19%, while the Brown Chernozems make up approximately 9% of the segment investigated. The remaining 8% consists of Black Chernozemic soils. Colour differentiation between topsoils and subsoils is poor to fair in the Brown Chernozemic soils, fair to good in the Dark Brown Chernozemic soils, and good in the Black Chernozemic soils. Many of the Chernozemic soils, especially those on grasslands, are used for agricultural production (mainly tame pasture, hay fields and grazing on native prairie).

Approximately 15% of the soils were not field investigated due to access restrictions and the classification of those soils is unknown at this time. No soil investigations were carried out in the Lac du Bois Grasslands Protected Area near the City of Kamloops which occupies approximately 9.4% of the proposed pipeline corridor between the proposed Black Pines Pump Station and the Coldwater River. Soils are anticipated to consist mainly of Brown or Dark Brown Chernozem soils in the Lac du Bois Grasslands Protected Area.

Land use along this segment of the proposed pipeline corridor consists of: treed land (52.8%); native prairie (19.6%); tame pasture (15.6%); treed-pasture (3.1%); hay (3.0%); and cultivated land (0.4%). Disturbed land makes up approximately 3% and major rivers make up approximately 0.4%. The present land use is unknown on approximately 2% of the proposed pipeline corridor in this segment. Present land use is shown on the Environmental Alignment Sheets (Volume 6E).

A search of the BC ILRR did not identify any Crown disposition that may be related to soil in the Black Pines to Hope Segment (BC ILMB 2013a).

Participants of the Kamloops Community Workshop noted that there is high erosion potential in the area from Whispering Pines to Darfield.

Hope to Burnaby Segment

Soil investigations and mapping in this segment were conducted from March to April 2013. The soil investigation in this segment covers the area between the Hope Pump Station located at RK 1044.1 in the District of Hope to the Village of Walnut Grove in southwestern BC located at RK 1151.5. The area from Walnut Grove (RK 1151.5) to Burnaby (RK 1180) consists mainly of residential and industrial lands with little or no agricultural potential and was not investigated in the field.

The following provides detailed descriptions of dominant and less common soil sub-groups encountered along this segment of the proposed pipeline corridor. In total, 30 soil units were described and mapped along the Hope to Burnaby Segment. Further details on the results of the soil investigation are provided in the Soils Technical Report of Volume 5C.

Poorly and very poorly drained Gleysols are the dominant soils occupying approximately 26% of the proposed pipeline pipeline corridor investigated in this segment. Topsoil thickness varies from 8-70 cm but most soil profiles have 20-35 cm of topsoil. Topsoils are easily distinguished from subsoils by colour in these soils. Rego Humic Gleysols are the dominant Gleysolic soils identified, but Orthic Humic Gleysols, Cumulic Humic Gleysols, Rego Gleysols and Orthic Gleysols were also identified. These soils are prominent on the Fraser River Lowlands where they are developed on recent fluvial and lacustrine deposits. These poorly drained soils are highly susceptible to soil compaction and rutting and a high water table can be expected during the winter months and after periods of prolonged, heavy precipitation.

Moderately well to rapidly drained uplands consist mainly of Orthic and Eluviated Dystric Brunisols, Orthic Humo-Ferric Podzols, and in the western portion, Luvic Humo-Ferric Podzols developed on colluvial material, colluvial-fluvial fan deposits, eolian veneers, till deposits and glaciomarine sediments. These soils have little or no topsoil in forested areas but may have up to 35 cm of topsoil in cleared and developed fields. The Dystric Brunisols and Podzols occupy approximately 22% of the proposed pipeline corridor investigated in this segment and seldom are used for agricultural production in the eastern portion but are used occasionally in the western portion for tame pasture and hay production.

Well to rapidly drained Orthic Sombric Brunisols along with minor amounts of Orthic Humo-Ferric Podzols, with 8-40 cm of desirable material, and developed on steeply sloping colluvial and colluvial-fluvial fan deposits occupy approximately 14% of the segment investigated and are confined to the eastern portion between Hope and Bridal Falls. Although the surface material is frequently very to exceedingly stony, it has a considerable higher organic matter content than the underlying subsoil. These soils are rarely used for agricultural production because of steep slopes and stony conditions.

Approximately 14% of the proposed pipeline corridor in this segment was not field investigated due to access restrictions. Soil classification in these areas is unknown at this time.

Land use along this segment of the proposed pipeline corridor consists of: treed land (38.8%); cultivated land (19.3%); tame pasture (13.7%); hay (12.1%); and treed pasture (2.5%). Disturbed land makes up approximately 10% The proposed pipeline corridor also crosses major rivers (0.1%) as well as golf courses and tree farms. The present land use is unknown on approximately 1% of the proposed pipeline corridor in this segment. Present land use is shown on the Environmental Alignment Sheets (Volume 6E).

A search of the BC ILRR did not identify any soil-related Crown dispositions crossed by the Hope to Burnaby Segment (BC ILMB 2013a).

Participants of the Chilliwack, Abbotsford, Coquitlam and Burnaby Community Workshops provided the following local information on soils in the area: naturally occurring asbestos is known to occur in soils in the Chilliwack and Abbotsford areas (particularly in the former Sumas Lake bed); and peaty soils are known to occur in the Coquitlam area.

Asbestos containing sediment is found in the Sumas River originating from a landslide in the 1930s on the Swift Creek tributary in Washington State. The landslide is composed of serpentinite rock which is rich in asbestos and heavy metals. The portion of the Sumas River flowing through the Abbotsford area has been contained within its channel by a diking system built in the 1920s and there has been no overbanking in any areas near the existing TMPL right-of-way. The risk of disturbing asbestos-rich soils in the Abbotsford area is extremely low since no sediment from the Sumas River has been deposited on farmland since the time of the landslide. The Sumas River was dredged in the early 1980s and sediments containing asbestos are stored on the river bank and capped to prevent any exposure. Any dredged sediments from recent dredging have been deposited in a secure landfill, eliminating risk of exposure to asbestos (McTavish pers. comm.).

Burnaby to Westridge Segment

Soil investigations were not conducted along this proposed pipeline segment due to the level of existing development.

A search of the BC ILRR did not identify any soil-related Crown dispositions crossed by the Hope to Burnaby Segment (BC ILMB 2013a).

5.2.1.3 Soil Capability for Agriculture

The current state of agricultural land use along the proposed pipeline corridor is discussed in detail in Section 5.4 of Volume 5B. In addition, an agricultural assessment was conducted for the Project (see the Agricultural Assessment Technical Report of Volume 5D). This subsection provides a brief summary of agriculture along the proposed pipeline corridor.

Types of agricultural operations found within in the vicinity of the proposed pipeline corridor include: livestock (in both Alberta and BC); poultry farms (located only in BC); vegetables (mainly in BC); grains and oilseeds (mainly in Alberta); nursery and floriculture operations (found only in BC); and fruits, berries and nuts (found mainly in BC).

The proposed pipeline corridor crosses several landscapes and climate zones with the following regional agricultural land use characteristics.

- Prairie climate in the City of Edmonton and surroundings with hot summers and cold winters, consisting of dry land agriculture.
- Towards the eastern Rocky Mountains, prevalence of pasture, grazing and beef production.
- In the North Thompson River Valley, forestry and some forest grazing.
- Near the City of Kamloops and towards the City of Merritt, arid conditions with upland forest and rangeland grazing. Typical agriculture is beef production, with irrigated forage production near water and intensive crop production in the valley bottom of the North Thompson River.
- In the Fraser Valley, a moderate climate favouring high density, irrigated field production and supporting intensive livestock operations.

Participants of the Abbotsford ESA Workshop raised concerns regarding soil disturbance issues and how the construction process would disturb crop growth. Further details on the Abbotsford ESA Workshop are provided in Volume 3A.

5.2.1.4 Soil Diseases

Clubroot Disease

Clubroot is a soil-borne disease caused by the plant pathogen *Plasmodiophora brassicae*, which affects canola, mustard and cole crops in the cabbage (*Brassicaceae*) family. It is considered a pest under the Alberta *Agricultural Pests Act* and was first detected in Alberta in a canola field near Edmonton in 2003 and is known to sporadically affect cole crops in the Lower Mainland of BC. Clubroot disease is spread through resting spores in the soil which can survive for up to 20 years. Symptoms will vary depending on the growth stage of the crop when infection occurs. Infection at the seedling stage can result in wilting, stunting and yellowing of plants. In later stages, infected plants will ripen prematurely and seeds will shrivel, reducing yield and quality of crop. A common physical feature and identifier of clubroot is gall formation on the roots of affected plants (AARD 2010).

Parkland and Yellowhead counties in Alberta and Fraser-Fort George, Thompson-Nicola, Fraser Valley and the Greater Vancouver Regional District (GVRD) in BC, which are traversed by the proposed pipeline corridor, were contacted to gather information on clubroot occurrences as well as to discuss any concerns or information the county/municipal/regional district representatives may have with regard to clubroot disease.

Table C2.1-1 in Appendix C of the Pipeline EPP (Volume 6B) summarizes known occurrences of clubroot in Alberta and BC. In Alberta, clubroot disease has been identified at 149 locations in Parkland County (Leskiw pers. comm.) and 3 locations in Yellowhead County (Pichette pers. comm.). In BC, clubroot disease has been found in cole crops in the Fraser Valley (Joshi pers. comm.). Generally, the risk of clubroot disease is higher along the eastern (Parkland County, Alberta) end of the proposed pipeline corridor, where there are many confirmed cases of clubroot, and in lower western BC (GVRD, BC).

Potato Cyst Nematode

Potato cyst nematodes are small invertebrate roundworms that attach themselves to the roots of host crops of the nightshade (*Solanaceae*) family (*i.e.*, potatoes, tomatoes and eggplant). They can inhibit the development of host plants, causing substantial growth retardation and, under severe outbreaks, damage to the roots and early senescence of the plants. The two common species of potato cyst nematodes found in Canada are golden nematode (*Globodera rostochiensis*) and pale potato cyst nematode (*Globodera pallida*). These soil-borne pests are primarily spread through the movement of cyst-infested soils. A potato cyst nematode infection does not result in obvious or unique symptoms. However, secondary symptoms such as reduced root system growth due to nutrient deficiencies and water stress, wilting, yellowing and reduced plant size are common indicators of what may be a cyst infection. If a severe potato cyst nematode infection is present in the crop, extensive plant death leading to yield loss can occur (Canadian Food Inspection Agency [CFIA] 2012).

Potato cyst nematodes are considered pests under Alberta's *Pest and Nuisance Control Regulation* and regulated by the CFIA under the *Plant Protection Act*. Currently, there is no legislation in place restricting access to potentially infected fields. However, if potato cyst nematode is confirmed at a given location, the CFIA may put the field under regulation. Potato cyst nematode regulated fields are monitored for access and equipment/vehicle sanitation. Furthermore, any equipment moving off a CFIA-regulated field needs a CFIA Movement Certificate.

Through landowner consultation, Trans Mountain has identified one cultivated field near the City of Spruce Grove, Alberta that may be potentially contaminated with potato cyst nematode (Worobec pers. comm.). The risk of spreading potato cyst nematode is low since the contamination is not yet confirmed and limited to a single location.

5.2.2 Soil Degradation

5.2.2.1 Edmonton to Hinton Segment

According to Coote and Pettapiece (1989), wind is not considered a major erosion agent along the proposed pipeline corridor between Edmonton (RK 0.0) and the Edson Pump Station (RK 247.3). Most of this area is mapped as having a negligible or low wind erosion risk. Water (spring snow melt and summer rainfall storm intensities and duration) is also considered an erosion agent. However, due to the relatively flat terrain over much of the proposed pipeline corridor along this segment, water is not considered a serious erosion agent either.

All sandy-textured soils are rated as having a high wind erosion hazard. This includes Elk Point, gleyed Gabriel, Hoadley, Peace Hills, Primula, Rochester, peaty Rochester, shallow Rochester and Sundance soils. Carvel and Winterburn soils vary in texture from sandy loam to silty clay loam and are rated as having a moderate-high wind erosion hazard. Soils rated as having a moderate-high or high wind erosion hazard occupy less than 17% of the proposed pipeline corridor from RK 0.0 to RK 247.3.

All soils occurring on less than 10% slopes are rated as having a slight water erosion hazard while those occurring on 10-15% slopes are rated as having a moderate water erosion hazard. Since the topography along the proposed pipeline corridor in this segment is seldom steeper than moderately rolling (> 15% slopes), water erosion of soil particles should not be of great concern. The steep slopes along the Rough Broken land unit are a concern and are rated as having a high water erosion hazard when the vegetation is disturbed. Some of the Angus Ridge, Cooking Lake, Carvel, Hubalta, Modeste, Malmo Primula and Winterburn soils also occur on strongly rolling topography and are rated as having a high water erosion hazard when the vegetation is disturbed. However, these areas are of minor extent.

Poorly-drained Haight, Kerensky, MacKay, Onoway, Rochester, Raven and Wildwood soils, as well as their peaty phases, are highly susceptible to soil compaction and rutting because these soils are generally wet most of the year. Fine-textured Bremay, shallow Bremay, Macola, Malmo and Maywood soils, although better drained than the Gleysolic soils, are also susceptible to soil compaction and rutting due to their silty clay loam surface texture. In addition, there are areas of gleyed soils (gleyed phase) which are also susceptible to soil compaction and rutting, especially when moist conditions prevail. The peat material of Devon soils is also susceptible to soil compaction. The compacted peat material may restrict future drainage through the organic material. Approximately 37% of the soils along the proposed pipeline corridor along this segment that were investigated are susceptible to soil compaction and rutting.

Due to the relatively flat terrain and the occurrence of many poorly-drained or imperfectly-drained soils along portions of the proposed pipeline corridor in this segment, soil compaction and rutting may be a concern, especially if construction occurs under moist conditions.

5.2.2.2 Hargreaves to Darfield Segment

Since many of the soils are sandy textured, many of the soils are rated as having a high or moderate to high wind erosion hazard when the protective vegetation is disturbed. The finer textured Allie, gleyed Allie, shallow Allie, gleyed Blackpool, Blackpool overlying gravel, Blue River, Cottonwood, gleyed Cottonwood, shallow Cottonwood, Exious, Fox, Lichen, Lucerne, shallow Lucerne, stony Lucerne, Mosquito, Rego Humic Gleysol, Struthers 3, Vermillion Lakes, Valemount and gleyed Valemount soils are rated as having a moderate wind erosion hazard. Soils rated as having a high or moderate to high wind erosion hazard occupy approximately 68% of the proposed pipeline corridor investigated in this segment.

Soils occurring on greater than 15% slopes are rated as having a high water erosion hazard. Slopes frequently exceed 15% in upland areas along the proposed pipeline corridor investigated in this segment; therefore, water erosion of soil particles may be a concern, especially in the northern portion where a greater amount of precipitation occurs. The Rough Broken land unit adjacent to deeply incised creeks or rivers are highly susceptible to soil erosion and slumping when the protective vegetation is removed.

Poorly and very poorly-drained soils as well as some of the imperfectly-drained soils are susceptible to compaction and rutting. Gleyed Allie, Blue River, peaty Blue River, gleyed Cottonwood, Ghita 1, Ghita 2, Mosquito, Rego Humic Gleysol, peaty Rego Humic Gleysol, Vermillion Lakes and peaty Vermillion Lakes soils are all susceptible to soil compaction and rutting. These soils occupy less than 7% of the proposed pipeline corridor investigated in this segment.

5.2.2.3 Black Pines to Hope Segment

Since many of the soils are sandy textured, many of the soils are rated as having a high or moderate to high wind erosion hazard when the protective vegetation is disturbed. The finer textured Chasm, shallow Chasm, Commonage, Flat Creek, saline Flat Creek, shallow Flat Creek, Frances, Gwenn, Lundbom,

Lundbom 1, Lac du Bois, McQueen, stony McQueen, Mossey, Timber, shallow Timber, stony Timber, Tunkwa, shallow Tunkwa, Tullee, shallow Tullee, Tranquille, shallow Tranquille, Trapp Lake, gleyed Trapp Lake and shallow Trapp Lake soils are rated as having a moderate wind erosion hazard. Soils rated as having a high or moderate to high wind erosion hazard occupy approximately 26% of the proposed pipeline corridor investigated in this segment.

Slopes frequently exceed 15% in upland areas along the proposed pipeline corridor in this segment; therefore, water erosion of soil particles may be a concern, especially in the southern portion where a greater amount of precipitation occurs. Water erosion protective measures may have to be initiated on slopes that exceed 15%. The Rough Broken land unit adjacent to deeply incised creeks or rivers are highly susceptible to soil erosion and slumping when the protective vegetation is removed.

Poorly and very poorly drained soils as well as some of the imperfectly drained soils are susceptible to soil compaction and rutting. Orthic Humic Gleysols, Typic Mesisols and gleyed Trapp Lake soils are identified as being highly susceptible to soil compaction and rutting. These soils occupy less than 1% of the proposed pipeline corridor investigated in this segment.

5.2.2.4 Hope to Burnaby Segment

Soils that have a sandy and/or gravelly surface texture are rated as having a high or moderate to high wind erosion hazard when the protective vegetation is disturbed. This includes Cheam, shallow Cheam, Cheam 1, bouldery Cheam, shallow Cheam 1, Harrison, Harrison 1, Isar, Laidlaw, Sumas, Sardis and Sunshine soils. These soils occupy approximately 30% of the proposed pipeline corridor investigated in this segment.

Slopes frequently exceed 15% in upland areas along the proposed corridor in this segment; therefore, water erosion of soil particles may be a concern, especially in the eastern portion where steeper slopes are common. Water erosion protective measures may have to be initiated on slopes that exceed 15%. The Rough Broken land unit adjacent to deeply incised creeks or rivers are highly susceptible to soil erosion and slumping when the protective vegetation is removed.

Poorly and very poorly drained soils as well as some of the imperfectly drained soils are highly susceptible to soil compaction and rutting. These soils occupy approximately 27% of the segment investigated. Due to the relatively flat terrain and the occurrence of many poorly drained soils on the Fraser River Lowlands where there is a high water table throughout the winter months, soil compaction and rutting will be a concern.

5.2.2.5 Burnaby to Westridge Segment

Soil investigations were not conducted along this proposed pipeline segment due to the level of existing development.

5.2.3 Bedrock and Stone Disposal

5.2.3.1 Edmonton to Hinton Segment

Stony Cooking Lake, shallow Rochester and shallow Rosevear soils are known to be stony at the surface. Bedrock within trench depth may be encountered in shallow Bremay, shallow Dekalta, shallow Hubalta and Modeste soils. The Soils Technical Report of Volume 5C provides additional information on these soil units. The locations of these soil units along the proposed pipeline corridor are shown on the Environmental Alignment Sheets (Volume 6E).

5.2.3.2 Hargreaves to Darfield Segment

Bouldery Albreta 1, bouldery Kwikoit 1, bouldery Roserim, bouldery Struthers 1, bouldery Stukemapten, stony Lucerne, stony Roserim and stony Woodley soils are known to be stony at the surface. Bedrock within trench depth may be encountered in Fox, shallow Allie, shallow Lucerne, shallow Roserim, shallow, bouldery Stukemapten and shallow Snookwa soils. The Soils Technical Report of Volume 5C provides additional information on these soil units. The locations of these soil units along the proposed pipeline corridor are shown on the Environmental Alignment Sheets (Volume 6E).

5.2.3.3 Black Pines to Hope Segment

Bouldery Minnie, shallow Flat Creek, stony Glossey 1, stony Minnie, stony McQueen and stony Timber soils are known to be stony at the surface. Bedrock within trench depth may be encountered in shallow Chasm, shallow Courtney, shallow Minnie, shallow Timber, shallow Tunkwa, shallow Tullee, shallow Tranquille and shallow Trapp Lake soils. The Soils Technical Report of Volume 5C provides additional information on these soil units. The locations of these soil units along the proposed pipeline corridor are shown on the Environmental Alignment Sheets (Volume 6E).

5.2.3.4 Hope to Burnaby Segment

Cheam, Cheam 1, bouldery Cheam 1, Harrison, Harrison 1 and bouldery Kenworthy soils are known to be stony at the surface. Bedrock within trench depth may be encountered in shallow Cheam and shallow Cheam 1 soils. The Soils Technical Report of Volume 5C provides additional information on these soil units. The locations of these soil units along the proposed pipeline corridor are shown on the Environmental Alignment Sheets (Volume 6E).

5.2.3.5 Burnaby to Westridge Segment

Soil investigations were not conducted along this proposed pipeline segment due to the level of existing development.

5.2.4 Soil Contamination

This subsection describes known locations of contaminated soils in the Soil LSA, including sites identified by Trans Mountain. Project-related effects and mitigation pertaining to known contaminated sites are presented in Section 7.2.2. The potential effects and mitigation related to small spills during construction are discussed in Section 7.9.

A search of the company's historical records was conducted for the Project. To address the releases, various methods were employed to the standards of the time. There are five locations where historical spills occurred that may be crossed by the proposed pipeline corridor. Soil testing will occur prior to soil disturbance (*i.e.*, construction) to ensure soil is not contaminated. If results indicate some residual contamination, the Contamination Discovery Contingency Plan (Appendix B of the Pipeline EPP of Volume 6B) will be implemented.

The likelihood of encountering contaminated soils is considered to be higher adjacent to previously-disturbed lands (*e.g.*, existing mines and roads). Possible sources of future soil contamination are limited to spot spills and leaks during construction and maintenance activities, thereby indicating an overall low potential for soil contamination along the proposed pipeline corridor.

An inventory of potentially contaminated sites related to other land users was prepared. If evidence of contamination is noted during construction, the Contamination Discovery Contingency Plan (Appendix B of the Pipeline EPP of Volume 6B) will be implemented.

5.3 Water Quality and Quantity

This subsection presents a summary of existing information and findings related to water quality and quantity, and describe the hydrological resources within the Water Quality and Quantity LSA and Aquatics RSA. The indicators selected for this element discussed below include surface water quantity, surface water quality, groundwater quality and groundwater quantity. The rationale for the selection of indicators is provided in Section 7.2.3. Locations of watercourse crossings and groundwater-related concerns along the proposed pipeline corridor are identified on the Environmental Alignment Sheets (Volume 6E). The potential Project-related effects and mitigation pertaining to water quality and quantity are discussed in Section 7.2.3. Refer to the Groundwater Technical Report of Volume 5C for additional details on the existing conditions of groundwater quantity and quality.

This setting discusses water quality and quantity within the Water Quality and Quantity LSA and the Aquatics RSA. The Water Quality and Quantity LSA is the area generally extending 100 m upstream of the centre of the proposed pipeline corridor to a minimum of 300 m downstream of the centre of the proposed pipeline corridor, as well as within 300 m of the proposed pipeline corridor, facility or trenchless crossing entrance in potentially vulnerable aquifer areas in hydraulic connection with the Footprint and in consideration of surface water drainage patterns along the pipeline corridor. The Aquatics RSA includes all watersheds directly affected by the Project and applies to surface water. The spatial boundary of the Aquatics RSA is shown on Figures 5.3-1 and 5.3-2.

5.3.1 Surface Water Quality

Surface water quality varies naturally from site to site and from year to year. There are many natural and human influences that have the ability to affect surface water quality. Increased precipitation causes elevated surface runoff, which facilitates the transport of materials from land to water. In addition to increasing sediment and turbidity levels, elevated flows brought on by increased precipitation or spring melt events can lead to greater transport and release of potential contaminants, both naturally occurring or as a result of human activity, into the water column. Conversely, water quality may appear better during low flow periods of the year or during drier years, since dry conditions cause less surface runoff and fewer contaminants coming from the land to the watercourse.

In addition to precipitation flow volume, climate and precipitation, soil type, local geology and groundwater also influence surface water quality. However, most persistent trends can be linked to human influence. Any activity that alters water quantity or affects inputs from point sources (*e.g.*, sewage outfalls) or non-point sources (*e.g.*, agricultural runoff) has the potential to influence water quality.

Certain water quality parameters such as pH, dissolved oxygen, conductivity and turbidity were obtained for many watercourses crossed by the proposed pipeline corridor during field programs conducted during 2012 and 2013 as part of the aquatics assessments for the Project (Fisheries [Alberta] Technical Report and Fisheries [British Columbia] Technical Report of Volume 5C).

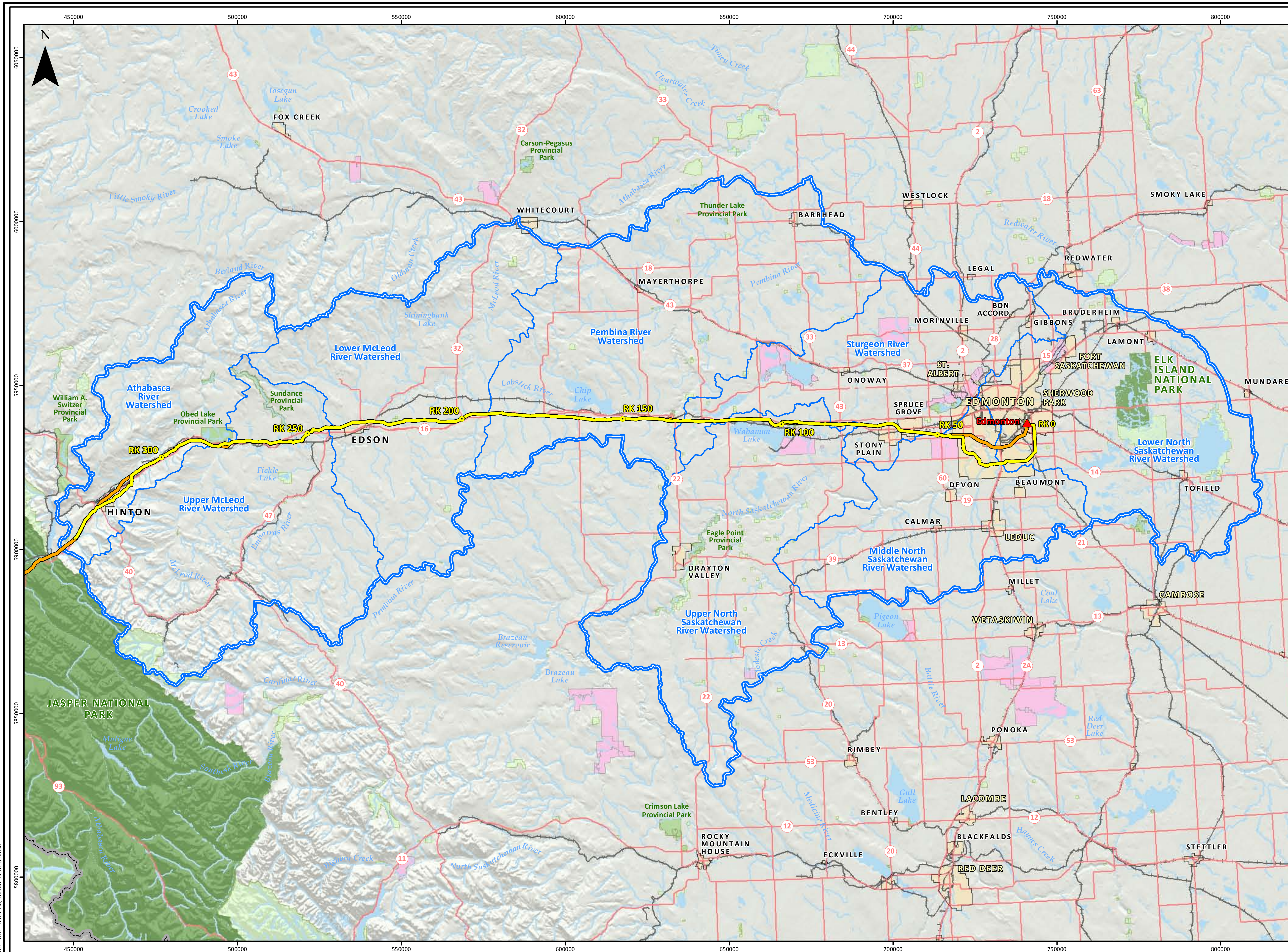
In 2012 and 2013, TEK was gathered and recorded pertaining to water quality and quantity concerns during the fisheries field program along the proposed pipeline corridor.

TRANS MOUNTAIN

FIGURE 5.3-1

AQUATICS REGIONAL STUDY AREA - ALBERTA

TRANS MOUNTAIN EXPANSION PROJECT



Legend	
●	Village / Hamlet
⊙	Reference Kilometre Post (RK)
	Trans Mountain Pipeline (TMPL)
	Trans Mountain Expansion Project Proposed Pipeline Corridor
▲	Terminal
(1)	Highway
	Railway
	Aquatics Regional Study Area Boundary
	Watershed Boundary
	City / Town / District Municipality
	Indian Reserve / Métis Settlement
	National Park
	Provincial Park
	Protected Area / Natural Area / Provincial Recreation Area / Wilderness Provincial Park / Conservancy Area
	Provincial Boundary

Projection: NAD83 UTM Zone 11N. Routing: Baseline TMPL & Facilities: provided by KMC, 2012; Proposed Pipeline Corridor V6: provided by UPI, Aug. 23, 2013; Facilities: Provided by KMC, 2012; Transportation: IHS Inc., 2013, BC Forests, Lands and Natural Resource Operations, 2012 & Natural Resources Canada, 2012; Geopolitical Boundaries: Natural Resources Canada, 2003, AltaLIS, 2013, IHS Inc., 2011, BC FLNRO, 2007 & ESRI, 2005; First Nation Lands: Government of Canada, 2013, AltaLIS, 2010 & IHS Inc., 2011; Hydrology: Natural Resources Canada, 2007 & BC Crown Registry and Geographic Base Branch, 2008; Parks and Protected Areas: Natural Resources Canada, 2012, AltaLIS, 2012 & BC FLNRO, 2008; ATS Grid: AltaLIS, 2009; Edmonton TUC: Alberta Infrstructure, 2011; Canadian Hillshade: TERA Environmental Consultants, 2008; US Hillshade: ESRI, 2009.

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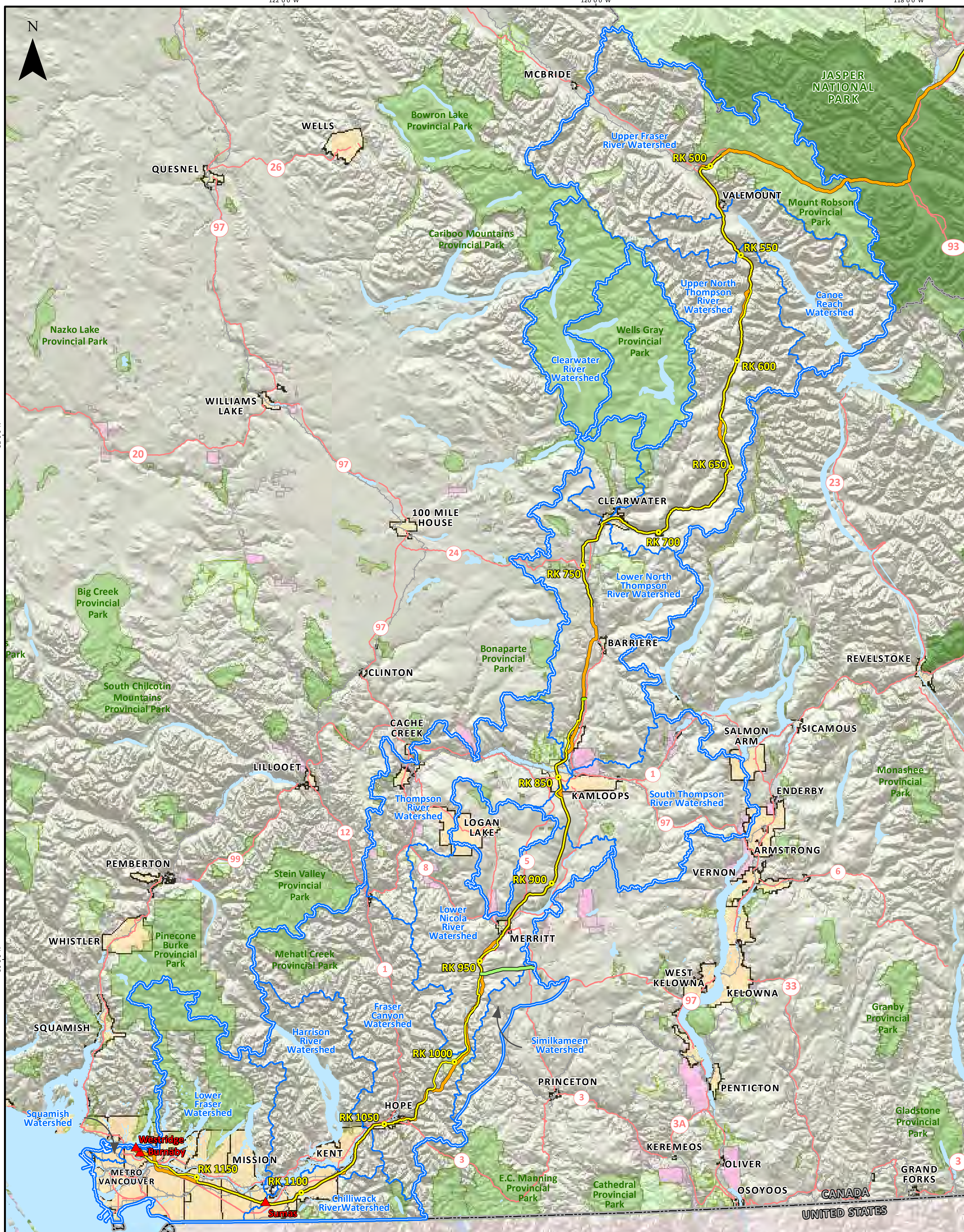
Although there is no reason to believe that there are any errors associated with the data used to generate this product or in the product itself, users of these data are advised that errors in the data may be present.

MAP NUMBER		PAGE
201309_MAP_TERA_AQ_00428_REV0_01		SHEET 1 OF 2
DATE: December 2013	TERA REF.: 7894	REVISION: 0
SCALE: 1:1,100,000	PAGE SIZE: 11x17	DISCIPLINE: AQ
DRAWN: AJS	CHECKED: TGG	DESIGN: TGG

0 10 20 30 40 km

ALL LOCATION APPROXIMATE

201309_MAP_TERA_AQ_00428_Rev0_01.mxd



- Reference Kilometre Post (RK)
- Trans Mountain Pipeline (TMPL)
- Trans Mountain Expansion Project Proposed Pipeline Corridor
- Proposed Power Line
- Terminal
- Highway
- Railway
- Fish and Fish Habitat Regional Study Area Boundary
- Watershed Boundary
- City / Town / District Municipality
- Indian Reserve / Métis Settlement
- National Park
- Provincial Park
- Protected Area / Natural Area / Provincial Recreation Area / Wilderness Provincial Park / Conservancy Area
- Provincial Boundary
- International Boundary

Projection: NAD 1983 UTM 10N. Routing:Baseline TMPL & Facilities: provided by KMC, 2012; Proposed Pipeline Corridor V6: provided by UPI, Aug. 23, 2013; Facilities: Provided by KMC, 2012; Transportation: IHS Inc., 2013, BC Forests, Lands and Natural Resource Operations, 2012 & Natural Resources Canada, 2012; Geopolitical Boundaries: Natural Resources Canada, 2003, AltaLIS, 2013, IHS Inc., 2011, BC FLNRO, 2007 & ESRI, 2005; First Nation Lands: Government of Canada, 2013, AltaLIS, 2010 & IHS Inc., 2011; Hydrology: Natural Resources Canada, 2007 & BC Crown Registry and Geographic Base Branch, 2008; Parks and Protected Areas: Natural Resources Canada, 2012, AltaLIS, 2012 & BC FLNRO, 2008; ATS Grid: AltaLIS, 2009; Edmonton TUC: Alberta Infrstructure, 2011; Canadian Hillshade: TERA Environmental Consultants, 2008; US Hillshade: ESRI, 2009; World Shaded Relief: Copyright:© 2009 ESRI

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TRANS MOUNTAIN

FIGURE 5.3-2

AQUATICS REGIONAL STUDY AREA - BRITISH COLUMBIA

TRANS MOUNTAIN EXPANSION PROJECT

MAP NUMBER		PAGE
201309_MAP_TERA_AQ_00428_REV0_02		SHEET 2 OF 2
DATE: December 2013	TERA REF.: 7894	REVISION: 0
SCALE: 1:1,600,000	PAGE SIZE: 11x17	DISCIPLINE: AQ
DRAWN: AJS	CHECKED: TGG	DESIGN: TGG

0 10 20 30 40 50 Km

ALL LOCATIONS APPROXIMATE

5.3.1.1 Edmonton to Hinton Segment

The following subsections describe the planning and management of surface water, the state of surface water quality and surface water use along the Edmonton to Hinton Segment.

Planning and Management

The proposed pipeline corridor in Alberta lies within two of Alberta's Watershed Planning and Advisory Councils (WPAC[s]) – the North Saskatchewan Watershed Alliance (NSWA) and the Athabasca Watershed Council (AWC). Designated by the Government of Alberta, the main purpose of these independent, non-profit organizations is to assess the condition of each WPAC watershed and prepare plans and solutions to address watershed issues to protect and improve water quality and ecosystem function (Alberta Environment and Sustainable Resource Development [AESRD] 2013a).

An Integrated Watershed Management Plan for the North Saskatchewan River was prepared in June 2012 (NSWA 2012). The purpose of the plan is to provide recommendations and an approach to manage the North Saskatchewan River watershed, sustain water resources for the long-term and to meet the three strategic goals of Water for Life: Alberta's Strategy for Sustainability, which are:

- safe, secure drinking water;
- healthy aquatic ecosystems; and
- reliable, quality water supplies for a sustainable economy (AESRD 2013b).

To develop its Integrated Watershed Management Plan, the NSWA prepared a State of the North Saskatchewan Watershed Report in 2005. Since then, the NSWA has prepared many technical reports and public information documents concerning the assessment of water quality, water quantity (supply and instream flow needs), groundwater, cumulative effects, climate change, economics and water use. The NSWA also prepared a Discussion Paper that summarizes the planning process conducted, the issues raised in the engagement process, the legislative and policy context for watershed management in Alberta, and the results of research and technical studies (NSWA 2013).

An Integrated Watershed Management Plan for the Athabasca River watershed is currently under development by the AWC (2012). The AWC is currently working to identify environmental issues in the watershed by compiling, analyzing and interpreting scientific and technical information into a multi-phase Athabasca State of the Watershed Report. Recommended solutions to issues identified in the various phases of the report will be compiled into the Athabasca Integrated Watershed Management Plan (AWC 2012).

Parkland County has introduced an Environmental Advisory Committee (EAC), whose mandate is to assist Council in making sound decisions regarding the environment. One of the responsibilities of the EAC is to ensure water conservation and protection (Parkland County 2013a). Yellowhead County may require industrial developers to determine how the proposed Project will retain trees and environmental features such as watercourses and wetlands. Industrial developers may also be required to prove how water and sewer servicing will be safely and cost-effectively provided (Yellowhead County 2013). A policy of Yellowhead County is to work with the Province of Alberta to support a safe and secure drinking water supply for residents through ongoing record-keeping of water supply and quality from surface and groundwater sources throughout the county. Yellowhead County will also support healthy aquatic ecosystems by participating in relevant watershed planning processes that may be initiated in the future (Yellowhead County 2013).

State of Surface Water Quality

Surface water quality risk in the Aquatics RSA ranges from a rating of 0.0-1.00 (with 1 being the highest risk and 0 being the lowest risk) (AARD 2005d). Only the east half of the proposed pipeline corridor along this segment is rated, with the highest rating of 0.76-1.00 surrounding Edmonton, with the level of risk generally decreasing further west. The dominant land use surrounding the east half of the proposed pipeline corridor along this segment is agricultural. This attributes to the higher risk ratings, since the potential exists for non-point source discharges of sediment and chemicals used in pesticides and fertilizers into surrounding surface water. Potential contributing factors also include a rise in the volume of municipal wastewater effluent, runoff from domestic lawn care products and increased soil erosion.

The Alberta River Water Quality Index was developed specifically as a way to summarize physical, chemical and biological data into a simple descriptor of water quality. The index provides a simple snapshot of annual water quality conditions in major rivers of the province. The formula used to calculate the individual sub-indices is the same as that used for the Canadian Council of Ministers of the Environment (CCME) Water Quality Index. However, the method for compiling the overall Index is tailored to Alberta.

Using CCME guidelines, AESRD sampled surface water quality at specific stations and compared against CCME and other water quality guidelines to compile an index value for water quality. AESRD monitors surface water quality at many river and lake locations each year; however, only data collected as part of the province's Long-term River Network are currently used for the index. Index values are calculated annually for each site based on data collected monthly or quarterly from April to March. Index results are reported as a number between 0 and 100, where 100 represents the best quality. Index values are calculated for the four variable groups (metals, nutrients, bacteria and pesticides). These are then averaged to produce an overall River Water Quality Index (AESRD 2013c). Table 5.3-1 provides the water quality sub-index and overall index values at select locations. Sites are chosen to represent water quality conditions up and downstream of areas of substantial human activity.

TABLE 5.3-1

WATER QUALITY SUB-INDEX AND INDEX VALUES AT SELECT LOCATIONS ALONG THE EDMONTON TO HINTON SEGMENT (2009 TO 2010)

Sample Location	Sub-Index Values (0-100)				Overall Index (Average)
	Metals	Nutrients	Bacteria	Pesticides	
Athabasca River Upstream of Hinton	100	90	100	100	98
Athabasca River at Athabasca	97	89	100	96	96
North Saskatchewan River at Devon	100	100	100	96	99
North Saskatchewan River at Pakan	97	81	86	92	89

Source: Alberta Environment (AENV) 2011

AESRD and the City of Edmonton monitor and study the water quality of the North Saskatchewan River for bacteria, nutrient and heavy metal levels as well as the health of organisms living on the river bottom. Water quality close to Edmonton is monitored at two provincial long-term monitoring sites located upstream and downstream of Fort Saskatchewan (*i.e.*, at the towns of Devon and Pakan) (Table 5.3-1). Water quality conditions at the site downstream of the City of Edmonton (Pakan) reflect urban, industrial and other effects. Specifically, water quality declines in a downstream direction due to increased loading of contaminants from non-point source runoff and effluent discharges (AENV 2007).

The proposed pipeline corridor does not cross the Athabasca River; however, many tributaries, including the McLeod and Pembina rivers, enter the Athabasca River between the two stations in Table 5.3-1. A comparison of water quality between the two Athabasca stations indicate water quality in watersheds between the two stations is of a quality as to not substantially contribute to poorer water quality upstream at the Athabasca station. Input from tributaries coursing through agricultural areas is a possible cause for the slightly lower index resulting from increased nutrient loading and pesticides (AENV 2011). For example, although dated, a 1993-1994 fall-winter water quality study of the lower Pembina River observed moderately high levels of nutrients and organic material, likely attributed to natural and anthropogenic sources (Noton 1996). Furthermore, the upper and middle reaches of the Athabasca River receive continuous discharges from several pulp mills and wastewater treatment plants in Jasper, Hinton, Whitecourt and Athabasca, point sources contributing to nutrient enrichment and declined oxygen levels during late winter (AENV 2007). Nevertheless, an index value of 96-100 indicates excellent water quality, where guidelines are almost always met.

A basin-wide survey of the Athabasca River Basin reported no widespread contamination of sediments by contaminants including dioxins and furans, polychlorinated biphenyls (PCBs), resin acids and polycyclic aromatic hydrocarbons (PAHs). Locally higher levels of sediment contamination were recorded downstream of the Town of Hinton, attributed to pulp mill effluent discharges (AENV 2007). The McLeod River has a substantial influence on the Athabasca River, with water quality of the McLeod River rated as fair. The McLeod River discharges the largest volume of water to the middle Athabasca River and contributes the largest suspended sediment and associated nutrient loads due to forestry activities, mining, agriculture, forest fires, peatlands, wetlands and other natural sources.

Water quality at the Athabasca River (at Athabasca) and North Saskatchewan River (at Devon) improved from good to excellent from the 2008 to 2009 reporting period. The long-term station at Pakan shows water quality steadily improving from an index low of 74 (fair [*i.e.*, guidelines sometimes exceeded by moderate amounts; quality occasionally departs from desirable levels]) in 2003 to 2004 and 2004 to 2005 monitoring periods, to 89 (good [*i.e.*, guidelines occasionally exceeded, but usually by small amounts; threat to quality is minimal]) in the 2008 to 2009 and 2009 to 2010 monitoring periods. As in the case of several other provincial rivers, this may have been partly influenced by a decline in precipitation. This is evidenced by stream flows that were well below the historical average. Lower flows are frequently indicative of fewer non-point source inputs to the river, which may result in fewer guideline exceedances and higher Index ratings (AENV 2011).

The Village of Wabamun is sensitive about water issues due to the CN freight train derailment in 2005. Refer to Section 7.7 of the Socio-Economic Technical Report (Volume 5D) for additional details on this incident. Since the early 1980s, AENV has sampled Wabamun Lake monthly in open water periods (May to October) and at least once during the winter. Some aspects of the lake's water quality have changed over time. Total dissolved solids and most major ion concentrations in Wabamun Lake have increased over the last 20 years. There has been a further increase in total dissolved solids and sulphate in Wabamun Lake beginning in 1999 when the Wabamun Lake Water Treatment Plant started pumping large volumes of treated water into the lake. However, plankton communities showed no major change from the early 1990s to 2001 and Wabamun Lake remains nutrient-rich (AENV 2002).

The Edmonton Waterworks System generally reports no drinking water safety concerns. In January 2013, the total chlorine residual was found to be outside of the acceptable range. The Government of Alberta worked with the provider to ensure that the public was not at risk from the drinking water (AESRD 2013d).

During the fisheries field program, TEK participants reported that water quality has been declining steadily over the past 30 years at watercourses along the proposed Edmonton to Hinton Segment, while at watercourses nearer to the Rocky Mountains, the water is still clean. This steady decline is considered by TEK participants to be due to the cumulative effects of pollution and industrial development in the region. Additional TEK related to surface water quality along the proposed Edmonton to Hinton Segment is provided in the Fisheries (Alberta) Technical Report of Volume 5C.

During the 2012 and 2013 fisheries field surveys, sampling was conducted for certain water quality parameters (*e.g.*, temperature, dissolved oxygen, pH, conductivity) at watercourse crossings identified along the proposed pipeline corridor and are documented in the Fish-Bearing Atlas for Alberta (see Appendix C of the Fisheries [Alberta] Technical Report in Volume 5C).

Surface Water Use

Drinking water sources for communities along the proposed pipeline corridor along the Edmonton to Hinton Segment are provided in Table 5.3-2.

TABLE 5.3-2

MUNICIPAL DRINKING WATER SOURCES FOR COMMUNITIES LOCATED ALONG THE PROPOSED EDMONTON TO HINTON SEGMENT

Community	Source(s)	Location Relative to Proposed Pipeline Crossing
City of Edmonton	Two water treatment plants along the North Saskatchewan River supply water to the city (EPCOR Water Services Inc. 2010).	E.L. Smith Water Treatment Plant approximately 6 km upstream. Rossdale Water Treatment Plant approximately 10 km downstream.
City of Spruce Grove	Water is supplied to the City of Spruce Grove by a pipeline from the City of Edmonton.	N/A
Town of Stony Plain	Water is supplied to the Town of Stony Plain by a pipeline from the City of Edmonton. A 3,000,000 gallon (11,360 m^3) reservoir is situated in the town and water is pumped from this into the distribution system (Alberta Community Profiles 2013).	N/A
Village of Wabamun	Currently, water is from groundwater wells located approximately 1 km south of the proposed pipeline corridor. However, a water supply pipeline is under construction as of October 2013 from the Town of Stony Plain (During pers. comm.).	N/A
Hamlet of Entwistle	Entwistle primarily utilizes the sandstone aquifer of the Paskapoo formation for its water needs (Parkland County 2012).	N/A
Hamlet of Evansburg	Evansburg receives water supply from three wells located 4 km south of the water treatment plant at S1/2 13-53-8 W5M (Yellowhead County 2003).	N/A
Hamlet of Wildwood	Groundwater.	N/A
Town of Edson	Edson's potable water source is the groundwater resources in aquifers which lie beneath the town. As the town has grown, the aquifers have been slowly declining and have been exploring methods to augment the town's water supply either by artificially recharging the aquifers or building a water treatment plant that will draw from the McLeod River (Yellowhead County 2007).	N/A
Town of Hinton	Athabasca River (information from Hinton Community Workshop).	Approximately 2 km north.

To account for the variable downstream extent of the Water Quality and Quantity LSA, surface water licences were identified within a conservative downstream length of 5 km from pipeline crossings. Due to the large number of surface water licences in Alberta, providing details for every licence identified such as location, status and purpose, was considered impractical. Alternatively, for the purposes of this ESA, a descriptive approach of identifying surface water licences based on approximate observations of the available data is provided.

Based on examination of the AESRD surface water licence online database, there are several hundred approvals, licences, registrations, authorizations, permits and/or certificates issued under the *Water Act* and Alberta *Environmental Protection and Enhancement Act* within 5 km downstream of watercourses crossed by the proposed pipeline corridor along this segment (Government of Alberta 2013a). Many licences were for past temporary use and, consequently, are either expired or no longer active (*e.g.*, for hydrostatic testing). In the Edmonton area, presently active licences within 5 km were issued for public activities (*e.g.*, watermains), construction activities and industry operations. West of Edmonton, licences are issued for the aforementioned uses as well as for agricultural purposes (*e.g.*, irrigation); however, the frequency of water licences generally decreases heading further west of Edmonton. Surface water points of diversion within 5 km of pipeline crossings that are currently in use could not specifically be identified in Alberta for this ESA due to a lack of usable data and/or specific details.

5.3.1.2 Hargreaves to Darfield Segment

The following subsections describe the planning and management of surface water, the state of surface water quality and surface water use along the Hargreaves to Darfield Segment.

Planning and Management

The proposed pipeline corridor traverses the upper Fraser River Basin from RK 489.6 to RK 527.9 and RK 547.7 to RK 769. The Fraser Basin Council (FBC) is a collaboration of four orders of government (federal, provincial, local and Aboriginal communities), along with those from the private sector and the general public that are brought together to advance sustainability in the Fraser Basin. The FBC is available to assist public, private and non-profit organizations with their sustainability challenges. The FBC is facilitating several regional initiatives to improve the health of watersheds including helping advance a Collaborative Watershed Governance Initiative (CWGI) for the sustainable management of BC's watersheds (FBC 2013).

The proposed pipeline corridor traverses the Columbia River Basin from RK 527.9 to RK 547.7. The Columbia Basin Trust (CBT) was created in 1995 to support efforts by the people of the basin to create social, economic and environmental well-being in the Canadian portion of the Columbia River Basin. The CBT works with the people that live in the basin to develop and deliver programs and initiatives that respond to their needs and supports communities. The CBT has created an Environmental Strategic Plan that was developed in response to the concerns of the people of the basin. Objectives and goals in the Environmental Strategic Plan include providing resources to projects, programs and collaborative efforts, supporting positive environmental action within the basin and promoting an understanding of organizational activities which reduce environmental effects in the basin (CBT 2009).

The Hargreaves to Darfield Segment is located within the Thompson-Nicola Regional District (TNRD) which has in place a Regional Growth Strategy where one of its mandates is to protect and enhance the quality and quantity of the water of the region's lakes, rivers, streams and groundwater sources (TNRD 2013). One other principle identified in this strategy is to develop policies and legislation to identify, conserve and protect the natural environment, including mapping of sensitive ecosystems and designating development permit areas.

State of Surface Water Quality

In general, the Fraser River tends to be turbid at its headwaters due to glacial flour and insoluble silts and clays from bedrock dissolution. Water quality reports are available for the Fraser River at Red Pass (located below Moose Lake in the headwaters of the Fraser River) which is the first of five long-term monitoring stations on the Fraser River. These reports represent ambient conditions that can be compared with water quality at downstream sites. Water quality concerns include increases in total metals which appear to be a result of increasing turbidity due to natural erosion processes, as well as an increase in conductivity and hardness. However, levels have remained stable since 1992 and an increase in nickel concentrations has been reduced in recent years, remaining well below guideline levels for aquatic life. Overall, the water quality of the Fraser River at the Red Pass site is ranked as good to excellent (BC Ministry of Environment [MOE] 2007a).

BC developed a Water Quality Index in 1995 that uses CCME guidelines. Variables that were measured at selected sites across BC included physical characteristics, nutrients, metals, major ions and other compounds such as pesticides. From 2002 to 2004, the Fraser River at Red Pass sampling site was ranked as excellent – the highest ranking of the 31 sites (BC MOE 2007b). From 1985 to 2004, this site has showed improved water quality due to the removal of lead from gasoline; however, it has also showed increased levels of nickel and manganese due to natural erosion and surface runoff from highways, respectively (BC MOE 2007b).

The BC MOE's Thompson Region developed a watershed prioritization matrix to identify watersheds within the region at highest risk of anthropogenic effects on water quality and its designated users. Watershed attributes with potential to affect water quality conditions that were considered in the risk rankings included a number of natural watershed characteristics (*e.g.*, watershed slope and drainage density) and human land uses (*e.g.*, road density, forest harvesting and agriculture). Of the watersheds tested, the headwaters of the North Thompson River to Clearwater and from Clearwater to Barriere were the watershed units relevant to the proposed pipeline segment. Both of these watershed units were ranked within the top ten watershed units at high risk of anthropogenic effects on water quality and water users due to urbanization, agriculture, mining, and road and stream crossing densities compared to other watershed units within the Thompson Region (BC MOE 2011a).

During the fisheries field program, TEK participants reported that water quality is steadily declining due to increased agriculture and logging activities. Participants felt that water temperatures are rising, in general, due to climate change. Additional TEK related to surface water quality along the proposed Hargreaves to Darfield Segment is provided in the Fisheries (British Columbia) Technical Report of Volume 5C.

During the 2012 and 2013 fisheries field surveys, sampling was conducted for certain water quality parameters (*e.g.*, temperature, dissolved oxygen, pH, conductivity) at watercourse crossings identified along the proposed pipeline corridor and are documented in the Fish-Bearing Atlas for BC (see Appendix B of the Fisheries [British Columbia] Technical Report in Volume 5C).

Surface Water Use

The BC Ministry of Health is responsible for overseeing the implementation of the *Drinking Water Protection Act* and *Drinking Water Protection Regulation*. The Village of Valemount gets its drinking water from Swift Creek and is considering groundwater wells as a potential future supply option. During 2002/2003, Swift Creek drinking water quality was good overall with water soluble contaminants present at concentrations well below drinking water guidelines (BC MOE 2004).

The proposed pipeline corridor does not intersect any community watersheds and there are no community watersheds within 2 km downstream of any watercourse crossings. The Valemount Community Watershed is located approximately 2 km upstream from the proposed crossing of Swift Creek at RK 522.5, while the Avola Community Watershed is located approximately 500 m upstream of the proposed crossing of Avola Creek at RK 656.1 (BC MOE 2009a).

Table 5.3-3 identifies municipal drinking water sources for communities along the Hargreaves to Darfield Segment.

TABLE 5.3-3

MUNICIPAL DRINKING WATER SOURCES FOR COMMUNITIES LOCATED ALONG THE PROPOSED HARGREAVES TO DARFIELD SEGMENT

Community	Source(s)	Location Relative to Proposed Pipeline Crossing
Village of Valemount	Swift Creek (information from Valemount Community Workshop).	Approximately 2 km upstream of the proposed watercourse crossing.
Community of Blue River	Groundwater (information from Blue River Open House).	N/A (refer to Section 5.3.3.2 for additional information).
Community of Avola	Avola Creek.	Approximately 630 m upstream of the proposed watercourse crossing.
Community of Vavenby	North Thompson River.	Approximately 680 m south of the proposed pipeline corridor.
District of Clearwater	Both groundwater and surface water (Hascheak Creek).	Hascheak Creek source located approximately 1 km upstream from the North Thompson River on opposite side of proposed pipeline corridor.

There are approximately 143 registered surface water points of diversion identified within 5 km downstream of proposed pipeline crossings (BC Ministry of Forests, Lands and Natural Resource Operations [MFLNRO] 2010). The surface water licences are primarily for domestic and irrigation purposes, although other purposes include stockwatering, land improvement, conservation, watering, water works, fire protection, processing and work camps. A list of the water licences registered with BC MFLNRO within 5 km downstream of the watercourses crossed by the proposed pipeline corridor is provided in Appendix 5.1 (located at the end of Section 5.0).

5.3.1.3 Black Pines to Hope Segment

The following subsections describe the planning and management of surface water, the state of surface water quality and surface water use along the Black Pines to Hope Segment.

Planning and Management

The Black Pines to Hope Segment lies entirely within the Fraser River Basin. As mentioned above, the FBC is available to assist public, private and non-profit organizations with their sustainability challenges. The FBC is facilitating several regional initiatives to improve the health of watersheds including helping advance a CWGI for the sustainable management of BC's watersheds (FBC 2013). Within the Fraser River Basin, the proposed pipeline corridor is located within the Thompson Region and Fraser Valley. In the Thompson Region, the FBC supports projects to advance the social, economic and environmental health of the region.

State of Surface Water Quality

Water quality was monitored at the North Thompson River at North Kamloops by BC MOE from 1985 to 1995 (BC Ministry of Environment, Lands and Parks [MELP] 1997). The Clearwater Sewage Treatment Plant discharges to the ground near the North Thompson River. There are no known sources of metals and no active mines in the North Thompson watershed. However, agriculture, urbanization and forestry have impacted the watershed. Levels of aluminum, copper, iron and zinc exceeding guidelines for aquatic life or drinking water were observed in winter and fall, in association with low levels of non-filterable residue. Levels appeared to be naturally high in the North Thompson River, since higher values during low flows have occasionally occurred since monitoring began in 1987, and since there were no considerable industrial discharges into the river. Variables exceeding guidelines at times during spring freshet were aluminum, chromium, copper, iron, manganese and titanium. Overall, guidelines were consistently met for most of the sampled variables and no considerable environmental trends were found (BC MELP 1997).

The North Thompson River from Barriere to Kamloops was within the top three watershed units within the Thompson Region that are at a high risk of anthropogenic effects on water quality and its users due to high road density, stream crossing density, urban and agriculture scores (BC MOE 2011a). The Thompson and Nicola rivers ranked within the top ten watershed units at high risk of anthropogenic effects on water quality (BC MOE 2011a).

Water quality reports are available for the Fraser River at Hope, which is the monitoring station furthest downstream from the proposed pipeline corridor along this segment. Levels of most metals fluctuated with turbidity levels, which in turn corresponded to increased flows. High metal concentrations at those times that exceeded guidelines or site-specific water quality objectives would not be biologically available and, therefore, were of little concern. Other water quality values seemed to fluctuate through the year according to the specific conductivity of the water, but were below guideline values and had no other trends (BC MOE 2007c). The Fraser River at Hope Station showed good water quality from 2002 to 2004 according to the BC Water Quality Index (BC MOE 2007b). From 1979 to 2004, this station has also shown improved water quality due to improved waste abatement at pulp mills (BC MOE 2007b).

TEK related to surface water along the proposed Black Pines to Hope Segment is provided in the Fisheries (British Columbia) Technical Report of Volume 5C.

During the 2012 and 2013 fisheries field surveys, sampling was conducted for certain water quality parameters (*e.g.*, temperature, dissolved oxygen, pH, conductivity) at watercourse crossings identified along the proposed pipeline corridor and are documented in the Fish-Bearing Atlas for BC (see Appendix B of the Fisheries [British Columbia] Technical Report in Volume 5C).

Surface Water Use

The South Thompson River provides the main source of drinking water for the City of Kamloops. The intake is located approximately 8.5 km upstream from the proposed crossing of the Thompson River. The main source of drinking water for the City of Merritt and District of Hope is groundwater (refer to Section 5.3.3.3 for additional information).

The proposed pipeline corridor intersects three community watersheds. The proposed pipeline corridor crosses the Kwinshatin Community Watershed from RK 939.4 to RK 942.7 and the Skuagam Community Watershed from RK 942.7 to RK 943.8, both of which serve the Coldwater 1 Indian Reserve. The intake locations of the Kwinshatin and Skuagam community watersheds are located approximately 1.1 km and 800 m northwest of the proposed pipeline corridor at Kwinshatin and Skuagam creeks, respectively. Both watercourses are crossed by the proposed pipeline corridor. The proposed pipeline corridor east of Hope intersects the Kopp Creek Community Watershed from RK 1039.2 to RK 1039.8. The intake location of the Kopp Community Watershed is located approximately 400 m northwest of the proposed pipeline corridor at Kopp Creek, which is not crossed by the proposed pipeline corridor. The proposed pipeline corridor does not intersect any other community watersheds and there are no community watersheds within 2 km downstream of any watercourse crossings (BC MOE 2009a).

There are approximately 386 registered surface water points of diversion identified within 5 km downstream of proposed pipeline crossings (BC MFLNRO 2010). The surface water licences are primarily for domestic and irrigation purposes, although other purposes include stockwatering, waterworks, storage and conservation. A list of the water licences registered with BC MFLNRO within 5 km downstream of the watercourses crossed by the proposed pipeline corridor is provided in Appendix 5.1.

5.3.1.4 Hope to Burnaby Segment

The following subsections describe the planning and management of surface water, the state of surface water quality and surface water use along the Hope to Burnaby Segment.

Planning and Management

The Hope to Burnaby Segment is located within the Fraser River Basin. The lower Fraser River courses through the Fraser Valley Regional District (FVRD) and Metro Vancouver, and is central to supporting agriculture, recreation, tourism, forestry, fishing, transportation and natural ecosystems. The FBC is bringing together all orders of government, along with private and non-profit sector leaders, each with an interest in the Fraser River or a responsibility for some aspect of its management, to form the Lower Fraser Collaborative Initiative which will help plan a sustainable future for the lower Fraser River (FBC 2013).

The key objectives of Metro Vancouver's drinking water treatment facilities are: protecting the source (watersheds); treating water at the source and disinfecting at further points in the distribution system; cleaning and maintaining the distribution system; and monitoring water quality at all stages. Population growth will place demands not only on water supply, but also on water infrastructure if not carefully planned. Metro Vancouver developed the Drinking Water Management Plan to ensure the region's water needs are met sustainably. The goals of the Drinking Water Management Plan include providing clean, safe drinking water, ensuring the sustainable use of water resources and ensuring a sufficient supply of water (Metro Vancouver 2011a). Metro Vancouver is conducting ongoing projects on source watersheds and water distribution systems to maintain the quality of the region's drinking water as well as meet the needs of an expected population increase of 800,000 people leading up to 2025. The Seymour and Capilano watersheds supply up to 70% of the Lower Mainland's drinking water. Construction of new water supply and treatment facilities for these water sources is underway in the Lower Seymour Conservation Reserve and at Capilano River Regional Park (Metro Vancouver 2013a).

State of Surface Water Quality

Water quality data from 1979 to 1982 from the Sumas River, a tributary to the Chilliwack/Vedder River, showed that the Sumas River had good water quality except for phosphorus, fecal coliforms and asbestos (BC MOE 1985). Although phosphorus values in its lower reaches were typical of low productivity streams, higher phosphorus values and likely higher productivity existed in its upper reaches. In addition, fecal coliform values were generally high throughout the Sumas River, exceeding working water quality criteria for primary contact recreation. Naturally occurring asbestos values in the river were higher than found in most other water in North America. These high levels have been associated with high metal-levels, as well as toxicity problems to plants in flooded areas where sediments had been deposited.

Metro Vancouver's drinking water comes from reservoirs in three watersheds, namely Capilano, Seymour and Coquitlam. Metro Vancouver is committed to delivering and maintaining the best drinking water possible and protecting these three watersheds is crucial to ensuring high quality drinking water. Some of Metro Vancouver's water quality concerns include turbidity due to heavy rainfall, parasites from animals, bacteria growth due to chlorine depletes, acidity in the water causing corrosion of pipes and chlorination disinfection by-products.

Metro Vancouver's closed watershed policy provides a barrier against water contamination from human sources (Metro Vancouver 2013b). To ensure the safety of the water, Metro Vancouver conducts daily tests and takes precautions in anticipation of events that can cause high turbidity levels (Metro Vancouver 2013a). In addition, to ensure drinking water meets provincial legislation and federal guidelines, Metro Vancouver has developed a Drinking Water Treatment Program that includes primary and secondary disinfection. In 2012, the turbidity levels of the delivered water easily met the requirements of the *Guidelines for Canadian Drinking Water Quality* (Metro Vancouver 2012a). Bacteriological water quality was good in the member municipalities. Of approximately 21,000 municipal samples collected for testing in 2012, 99.9% were free of coliforms, a figure which was similar to 2011 (99.9%). In 2012, no *E.coli* was detected (Metro Vancouver 2012a).

TEK related to surface water quality along the Hope to Burnaby Segment is provided in the Fisheries (British Columbia) Technical Report of Volume 5C.

During the 2012 and 2013 fisheries field surveys, sampling was conducted for certain water quality parameters (*e.g.*, temperature, dissolved oxygen, pH, conductivity) at watercourse crossings identified along the proposed pipeline corridor and are documented in the Fish-Bearing Atlas for BC (see Appendix B of the Fisheries [British Columbia] Technical Report in Volume 5C).

Integrated Stormwater Management

In recognition of the increased pressures on local watersheds from existing land uses and expanding development, many municipalities in Metro Vancouver have prepared Integrated Stormwater Management Plans (ISMPs). The purpose of ISMPs is to examine the linkages between drainage servicing, land use planning and environmental protection in order to support the growth of a community in a way that maintains or ideally enhances the overall health of a watershed. There are many ISMPs in various stages of development; however, only three ISMPs have been identified that are crossed by the proposed pipeline corridor: Clayburn Creek in the City of Abbotsford; and Como and Nelson creeks in the City of Coquitlam.

Clayburn Creek (crossed by the proposed pipeline corridor at RK 1090.5 and RK 1091.5) is a relatively healthy watershed. However, sedimentation within the middle and upper reaches of Clayburn Creek is a major water quality concern, resulting predominantly from new development. Sampling conducted at Stony Creek and Poignant Creek (tributaries of Clayburn Creek) from 1997-2001 and in 2009 at Stoney Creek found elevated levels of fecal coliform likely attributed to hobby farms, failing septic fields in the Straiton community and at nearby cow pastures. Metal levels in sediment sampled from near the lowland-upland transition of the watershed were generally lower than at upper watershed sites; however, arsenic levels were slightly above BC MOE *Interim Sediment Quality Guidelines* (ISQGs) in Stoney Creek (near Stoney Creek Park) and nickel levels were above ISQGs in the lower part of Poignant Creek and at the Clayburn Creek lowland sampling site. Elevated arsenic levels are likely natural while the nickel levels, particularly at the lowland sampling site on Clayburn Creek, may represent contamination from human sources (Kerr Wood Leidal Associates Ltd. [Kerr Wood Leidal] 2012).

Benthic invertebrates (streambed insects) are useful indicators of stream condition and can be monitored over time to track changes instream or watershed health. As described in the Clayburn Creek ISMP, eight different sites in the watershed were sampled for invertebrates. Overall, the Clayburn Watershed had a health rating of fair (Kerr Wood Leidal 2012).

Como Creek is crossed by the proposed pipeline corridor at RK 1141.3. The main purpose of the Como Creek ISMP is to address drainage problems, particularly the chronic flooding in the lower reaches, which results in periodic property damage and road closures, as well as rapid watercourse erosion and instability. In addition, high flows and flooding tends to exacerbate existing influences on water quality resulting from pollutant runoff associated with high density development and waste discharge from industrial/commercial land uses. No specific sampling or monitoring information that may otherwise provide an indication of the state of water quality in the watershed is provided in the Como Creek ISMP (CH2M Hill Inc. 2002). Much has evolved since this ISMP was developed and updates to the plan are currently underway (City of Coquitlam 2013).

The watershed of Nelson Creek is crossed by the proposed pipeline corridor; however, Nelson Creek is not crossed. The watershed of Nelson Creek contains a high level of urban development with land uses ranging from residential in the upper reaches to commercial in the lower reaches. The health of the watershed is generally ranked poor, with water quality impacts resulting from elevated fecal coliforms, nutrients and some metals, as well as from total suspended solids (TSS) resulting from increased stream channel erosion. A water quality sampling program was conducted for the ISMP to assess baseline conditions. TSS levels and nitrogen concentrations were below provincial guidelines in all samples, while individual values for *E. coli* exceeded guidelines in all samples. Phosphorous concentrations generally decreased between upstream and downstream sampling sites, suggesting high concentrations in the upper watershed are diluted with other sources of water downstream and were higher in wet weather. Most metal parameters met BC water quality guidelines, with the exception of cadmium, copper and zinc (CH2M Hill Inc. 2010).

The City of Burnaby and AECOM are collaborating to develop an ISMP for the watershed of Eagle Creek in order to better manage land development and support environmental protection, preservation and enhancement of Eagle Creek and its tributaries. During an external stakeholder workshop for the Eagle Creek ISMP, recent studies conducted to provide an indication of the current state of water quality and quantity were summarized. Some key observations were the presence of low base flows in the late summer period, presence of iron oxide (likely naturally occurring) and downstream sedimentation, including at the Burnaby Lake inflow. The Eagle Creek ISMP will aim to address issues such as minimizing erosion and resulting problems with sedimentation in the lake, habitat enhancements, improving water quality in the stream and reducing pollution (Hill, Phang pers. comm.). The Eagle Creek ISMP is expected to be released in 2014.

Surface Water Use

The main sources of drinking water for municipalities in the Lower Mainland, including the Township of Langley and cities of Abbotsford, Surrey, Coquitlam and Burnaby, is provided by the Capilano, Seymour and Coquitlam mountain reservoirs operated by Metro Vancouver. Water is conveyed from these reservoirs by regional water mains to member municipalities for distribution to homes, businesses and industry. The Township of Langley also receives some drinking water from municipal wells. The City of Chilliwack receives most of its drinking water from municipal wells as well, specifically the Sardis Aquifer (refer to Section 5.3.3.4 for additional information).

The proposed pipeline corridor does not intersect any community watersheds along this segment and there are no community watersheds within 2 km downstream of any watercourse crossings. The Nevin Community Watershed is located approximately 1.3 km upstream from the proposed crossing of Nevin Creek at RK 1083.4, while the Dunville Community Watershed is located approximately 1.2 km upstream of the proposed crossing of Dunville Creek at RK 1083.9 (BC MOE 2009a).

There are approximately 220 registered surface water points of diversion identified within 5 km downstream of proposed pipeline crossings (BC MFLNRO 2010). The surface water licences are primarily for domestic and irrigation purposes, although other purposes include stockwatering, conservation, land improvement and sewage disposal. A list of the water licences registered with BC MFLNRO within 5 km downstream of the watercourses crossed by the proposed pipeline corridor is provided in Appendix 5.1.

5.3.1.5 Burnaby to Westridge Segment

The following subsections describe the planning and management of surface water, the state of surface water quality and surface water use along the Burnaby to Westridge Segment.

Planning and Management

The Burnaby to Westridge Segment is located within the Greater Vancouver Sea to Sky Region within the Fraser River Basin. Refer to Section 5.3.4.2 for additional information.

State of Surface Water Quality

Refer to Section 5.3.4.2 for information on the state of surface water quality in Metro Vancouver.

Surface Water Use

The City of Burnaby obtains most of its drinking water from the Capilano and Seymour reservoirs, which are operated by Metro Vancouver. The proposed pipeline corridor does not intersect any community watersheds and there are no community watersheds within 2 km downstream of any watercourse crossings (BC MOE 2009a). No registered surface water points of diversion were identified within 5 km downstream of proposed pipeline crossings (BC MFLNRO 2010).

5.3.2 Surface Water Quantity

Drainage basins, watersheds and watercourses crossed by the proposed pipeline corridor were identified and characterized through a combination of desktop analysis and field programs conducted during 2012 and 2013 as part of the aquatics assessments for the Project (Fisheries [Alberta] Technical Report and Fisheries [British Columbia] Technical Report of Volume 5C).

Surface water quantity also varies naturally from site to site and from year to year depending on, among other factors, precipitation levels and patterns, temperature and land use. To understand the range of flows at major watercourse crossings, historical data was obtained from Environment Canada hydrometric monitoring stations, which provide a long-term record of stream flow information of watercourses at specific locations. Additional streamflow data for small and large watercourses crossed by the proposed pipeline corridor, including seasonal and peak flow estimates and average monthly runoff depth, are provided in the Route Physiography and Hydrology Report prepared by BGC Engineering Inc. (Volume 4A).

5.3.2.1 Edmonton to Hinton Segment

The proposed pipeline corridor along the Edmonton to Hinton Segment crosses the Lower, Middle and Upper North Saskatchewan River watersheds and the Sturgeon River watershed, comprising the area from the City of Edmonton to the Hamlet of Evansburg, and form part of the North Saskatchewan River basin. The proposed pipeline corridor then crosses the Pembina River, Upper and Lower McLeod River and the Athabasca River watersheds to the west from the Hamlet of Evansburg to the interprovincial border near the Town of Hinton, which form part of the Athabasca River basin (AESRD 2013e). There are approximately 202 potential watercourse crossings identified along the proposed pipeline corridor along this segment. Larger watercourses crossed by the proposed pipeline corridor include the North Saskatchewan River (RK 33.5), Pembina River (RK 135.0) and McLeod River (RK 223.9), the latter two of which are tributaries of the Athabasca River. A summary of watercourse crossings in the North Saskatchewan River basin and Athabasca River basin along the proposed pipeline corridor for the Edmonton to Hinton Segment is provided in Section 5.7 Fish and Fish Habitat.

The North Saskatchewan River originates in Banff National Park of Alberta and flows east 1,287 km to join the South Saskatchewan River, forming the Saskatchewan River, which eventually drains into Hudson Bay via the Nelson River. Both the Pembina and McLeod rivers originate in the foothills of the Rocky Mountains of Alberta east of Jasper National Park, flowing for several hundred kilometres before entering the Athabasca River in central Alberta, which ultimately discharges into the Arctic Ocean via the Mackenzie River.

The proposed pipeline corridor crosses an Environmentally Significant Area (690) of national importance for riparian areas at SW 3 and NW 3-52-25 W4M and NE 4-52-25 W4M (RK 32.5 to RK 34.9). This Environmentally Significant Area extends the length of the North Saskatchewan River to the Saskatchewan border (Alberta Tourism, Parks and Recreation [ATPR] 2009). ATPR defines Environmentally Significant Areas as being important to the long-term maintenance of biological diversity, soil, water or other natural processes, at multiple spatial scales and/or areas that contain rare or unique elements or that include elements that may require special management consideration due to their conservation needs. However, ATPR also states that Environmentally Significant Areas do not represent government policy and do not necessarily require legal protection. They are intended to be an information tool to help inform land use planning and policy at local, regional and provincial scales.

No designated or nominated Canadian Heritage Rivers are crossed by the proposed pipeline corridor along this segment (Canadian Heritage Rivers System 2011a). The proposed pipeline corridor does not cross any of the 13 designated irrigation districts in Alberta (AARD 2011).

The North Saskatchewan River Basin has 20-30% of its natural flow that may be diverted under terms of licenced allocation, while only 2-5% of natural flow may be diverted from the Athabasca River Basin (AENV 2010). Flow averages from 2003 to 2012 were recorded at the Pembina River near the Hamlet of Entwistle and the North Saskatchewan River in the City of Edmonton. Flow averages for the Pembina River are documented as being Normal in all months, while the North Saskatchewan River is Below Normal from May to September and Above Normal from October to April (AESRD 2012a).

Hydrostatic test water for the Edmonton to Hinton Segment is expected to be withdrawn from the North Saskatchewan River, Pembina River and McLeod River. An estimated 81,000 m^3 of water will be needed to conduct hydrostatic testing of the proposed pipeline along this segment. Water used for hydrostatic testing will be released within the same drainage basin from where it was withdrawn.

<u>Historical Streamflow</u>

The Water Survey of Canada maintains a hydrometric station on the North Saskatchewan River at Edmonton, Alberta (Station No. 05DF001) (Environment Canada 2013b). This station is approximately 20 km downstream of the proposed crossing at RK 33.5. Discharge at this station has been recorded every year since 1911. The annual high flow event typically occurs from May to July and flows gradually decline through late summer and fall. Figure 5.3-3 shows that mean monthly flows are lowest in February at 68.7 m^3/s and mean flows are highest during the late spring freshet with a peak in July at 483 m^3/s (Environment Canada 2013b). Data for this watercourse are presented in Figure 5.3-3 and Table 5.3-4 and includes maximum, minimum and mean monthly discharges. Since this station records flow information downstream of the proposed crossing, discharge at the time of construction may be slightly less than the recorded mean discharge resulting from small tributaries (*e.g.*, Whitemud Creek) located between the station and the proposed watercourse crossing.

Figure 5.3-3 Historical Mean Monthly Streamflow (m^3/s) Summary for the North Saskatchewan River at Edmonton, Alberta (Station 05DF001)

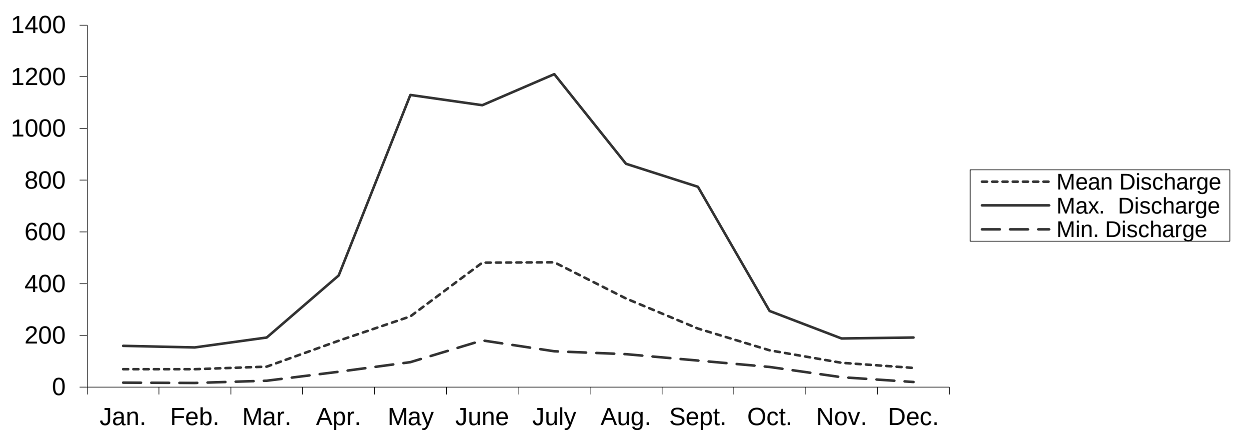


TABLE 5.3-4

HISTORICAL MEAN MONTHLY STREAMFLOW (m^3/s) SUMMARY FOR THE NORTH SASKATCHEWAN RIVER AT EDMONTON, ALBERTA (STATION 05DF001)

Discharge	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Mean Discharge	69.4	68.7	79.0	179.0	273.0	481.0	483.0	342.0	226.0	142.0	93.6	73.9
Max. Discharge	160.0	153.0	192.0	432.0	1,130.0	1,090.0	1,210.0	864.0	774.0	294.0	188.0	192.0
Min. Discharge	16.7	16.4	24.6	58.9	96.6	181.0	138.0	127.0	103.0	78.1	38.0	19.6
Years of Streamflow Record:	1911 to 2010											
Maximum Daily Discharge:	4,640 m^3/s on June 29, 1915											
Minimum Daily Discharge:	6.23 m^3/s on January 1, 1940											
Effective Drainage Area:	27,100 km^2											

Source: Environment Canada 2013b

The Water Survey of Canada maintains a hydrometric station on the Pembina River near Entwistle, Alberta (Station No. 07BB002) (Environment Canada 2013c). This station is approximately 2 km downstream of the proposed crossing at RK 135.0. Discharge at this station has been recorded for approximately 66 years between 1914 and 2010. The annual high flow event typically occurs from May to July and flows gradually decline through late summer and fall. Figure 5.3-4 shows that mean monthly flows are lowest in February at 2.31 m³/s and mean flows are highest during the spring freshet with a peak in May at 48.9 m³/s (Environment Canada 2013c). Data for this watercourse are presented in Figure 5.3-4 and Table 5.3-5 and includes maximum, minimum and mean monthly discharges. Since no tributaries of considerable volume are located between this station and the proposed crossing located upstream, discharge at the time of construction should be similar to the recorded mean discharge at the station.

Figure 5.3-4 Historical Mean Monthly Streamflow (m³/s) Summary for the Pembina River Near Entwistle, Alberta (Station 07BB002)

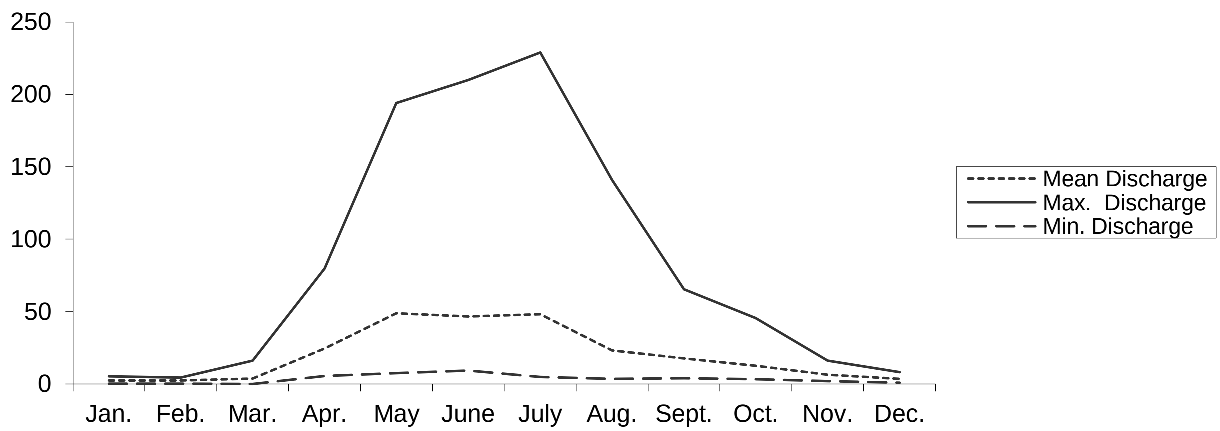


TABLE 5.3-5

HISTORICAL MEAN MONTHLY STREAMFLOW (m³/s) SUMMARY FOR THE PEMBINA RIVER NEAR ENTWISTLE, ALBERTA (STATION 07BB002)

Discharge	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Mean Discharge	2.41	2.31	3.83	24.4	48.9	46.6	48.1	23.1	17.7	12.5	6.33	3.57
Max. Discharge	5.33	4.45	16.0	79.8	194.0	210	229.0	141.0	65.4	45.6	16.0	8.1
Min. Discharge	0.276	0.082	0.028	5.53	7.54	9.18	4.89	3.5	3.95	3.37	1.93	0.841
Years of Streamflow Record:	1914 to 1923 and 1954 to 2010											
Maximum Daily Discharge:	1,180 m³/s on July 20, 1986											
Minimum Daily Discharge:	0.000 m³/s on February 13, 1922 and January 16, 1923											
Effective Drainage Area:	4,330 km²											

Source: Environment Canada 2013c

The Water Survey of Canada maintains a hydrometric station on the McLeod River near Rosevear, Alberta (Station No. 07AG007) (Environment Canada 2013d). This station is approximately 24 km downstream of the proposed crossing at RK 223.9. Discharge at this station has been recorded every year since 1984. The annual high flow event typically occurs from May to July and flows gradually decline through late summer and fall. Figure 5.3-5 shows that mean monthly flows are lowest in February at 6.29 m³/s and mean flows are highest during the spring freshet with a peak in June at 96.4 m³/s (Environment Canada 2013d). Data for this watercourse are presented in Figure 5.3-5 and Table 5.3-6 and includes maximum, minimum and mean monthly discharges. Since this station records flow information downstream of the proposed crossing, discharge at the time of construction may be slightly less than the recorded mean discharge resulting from smaller tributaries (*e.g.*, Edson River) located between the station and the proposed watercourse crossing.

Figure 5.3-5 Historical Mean Monthly Streamflow (m^3/s) Summary for the McLeod River Near Rosevear, Alberta (Station 07AG007)

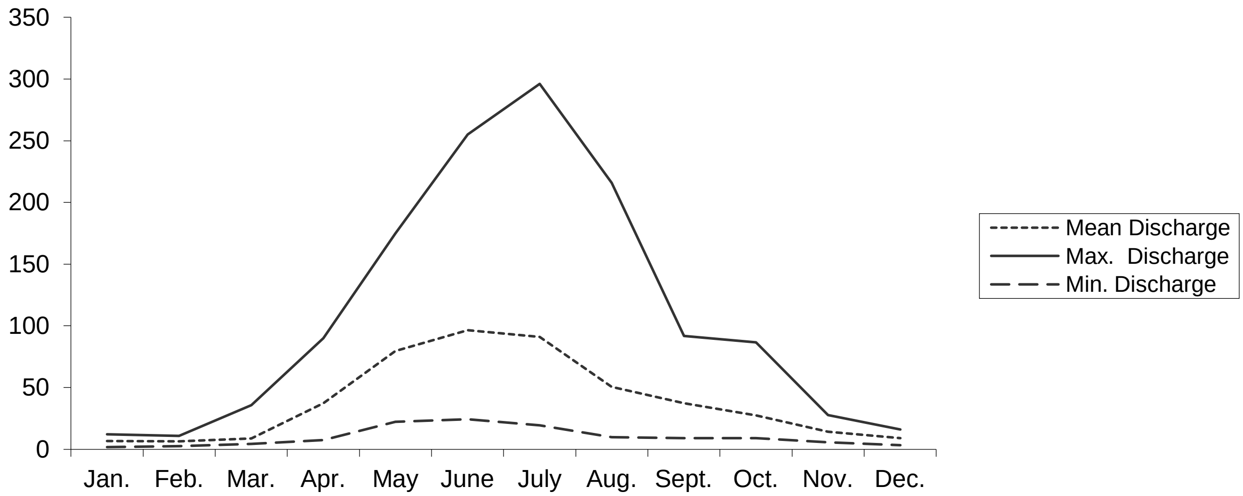


TABLE 5.3-6

HISTORICAL MEAN MONTHLY STREAMFLOW (m^3/s) SUMMARY FOR THE MCLEOD RIVER NEAR ROSEVEAR, ALBERTA (STATION 07AG007)

Discharge	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Mean Discharge	6.65	6.29	8.79	37.4	79.5	96.4	91.0	50.6	37.4	27.5	14.1	8.91
Max. Discharge	12.2	10.8	35.7	90.0	175.0	255.0	296.0	216.0	91.7	86.6	27.8	16.0
Min. Discharge	1.81	2.58	4.31	7.32	22.3	24.2	19.5	9.76	8.9	8.93	5.7	3.28
Years of Streamflow Record:	1984 to 2011											
Maximum Daily Discharge:	1,790 m^3/s on July 19, 1986											
Minimum Daily Discharge:	1.60 m^3/s on January 7, 2004											
Effective Drainage Area:	7,080 km^2											

Source: Environment Canada 2013d

5.3.2.2 Hargreaves to Darfield Segment

From north to south, the proposed pipeline corridor crosses the Upper Fraser River, Canoe Reach, Upper North Thompson River, Clearwater River and Lower North Thompson River watersheds. The Canoe Reach watershed is part of the Columbia River Basin, while the remaining watersheds form part of the Fraser River Basin (BC ILMB 2013b). There are approximately 349 potential watercourse crossings identified along the proposed pipeline corridor along this segment. Larger watercourses crossed include the upper Fraser River (RK 499.7), Canoe River (RK 531.3), North Thompson River (RK 581.2, RK 619.9 and RK 651.7), Blue River (RK 613.8), Raft River (RK 717.7) and Clearwater River (RK 725.5). A summary of watercourse crossings in the Fraser River Basin and Columbia River Basin along the proposed pipeline corridor for the Hargreaves to Darfield Segment is provided in Section 5.7 Fish and Fish Habitat.

The Fraser River originates in Mount Robson Provincial Park of BC, flowing northwest to Prince George before bending south to the Lower Mainland where it enters the Pacific Ocean after 1,370 km. The Canoe River originates from the Caribou Mountains southwest of the Village of Valemount, BC, and is the only major watercourse crossing within the Columbia River Basin. The Canoe River drains into Kinbasket Lake, a narrow reservoir approximately 190 km long created by the Mica Dam.

The proposed pipeline corridor follows the valley bottom of the North Thompson River for most of its length, crossing the watercourse at three locations. The North Thompson River originates in the Caribou Mountains just outside the east boundary of Wells Gray Provincial Park. The river flows east toward Highway 5, where it bends south, paralleled by the highway and existing TMPL right-of-way for most of its length, until converging with the South Thompson River at the City of Kamloops, BC. The headwaters of the Blue, Raft and Clearwater rivers in the Caribou Mountains are tributaries of the North Thompson River.

The entire length of the Fraser River, from its origins in Mount Robson Provincial Park, to its outflow into the Pacific Ocean at Vancouver, is designated both as a Canadian Heritage River by the Canadian Heritage Rivers System and a BC Heritage River by the BC MOE (BC MOE 2011b, Canadian Heritage Rivers System 2011a). No other designated or nominated Canadian or BC Heritage Rivers are crossed by this segment (BC MOE 2011c, Canadian Heritage Rivers System 2011a).

Surface water allocation in the Province of BC is calculated as overall volume of water for various consumptive and non-consumptive purposes within the entire province (BC MOE 2013a). Although water allocation plans were prepared for specific watercourses in the southern interior and Vancouver Island, no such plans were available for watercourses crossed by the proposed pipeline corridor (BC MOE 2013b).

Hydrostatic test water for the proposed pipeline segment is expected to be withdrawn from the Fraser River, Canoe River and North Thompson River. An estimated 90,000 m^3 of water will be needed to conduct hydrostatic testing of the proposed pipeline along the Hargreaves to Darfield Segment. Water used for hydrostatic testing will be released within the same drainage basin from where it was withdrawn.

Historical Streamflow

The Water Survey of Canada maintains a hydrometric station on the Fraser River at Red Pass, BC (Station No. 08KA007) (Environment Canada 2013e). This station is approximately 27 km upstream of the proposed crossing at RK 499.7. Discharge at this station has been recorded every year since 1955. The annual high flow event typically occurs from June to August and flows gradually decline through late summer and fall. Figure 5.3-6 shows that mean monthly flows are lowest in March at 5.32 m^3/s and mean flows are highest during the spring freshet with a peak in June at 152 m^3/s (Environment Canada 2013e). Data for this watercourse are presented in Figure 5.3-6 and Table 5.3-7 and includes maximum, minimum and mean monthly discharges. Since this station records flow information upstream of the proposed crossing, discharge at the time of construction may be more than the recorded mean discharge resulting from smaller tributaries (*e.g.*, Robson River, Swift Current Creek) located between the station and the proposed watercourse crossing.

Figure 5.3-6 Historical Mean Monthly Streamflow (m^3/s) Summary for the Fraser River at Red Pass, BC (Station 08KA007)

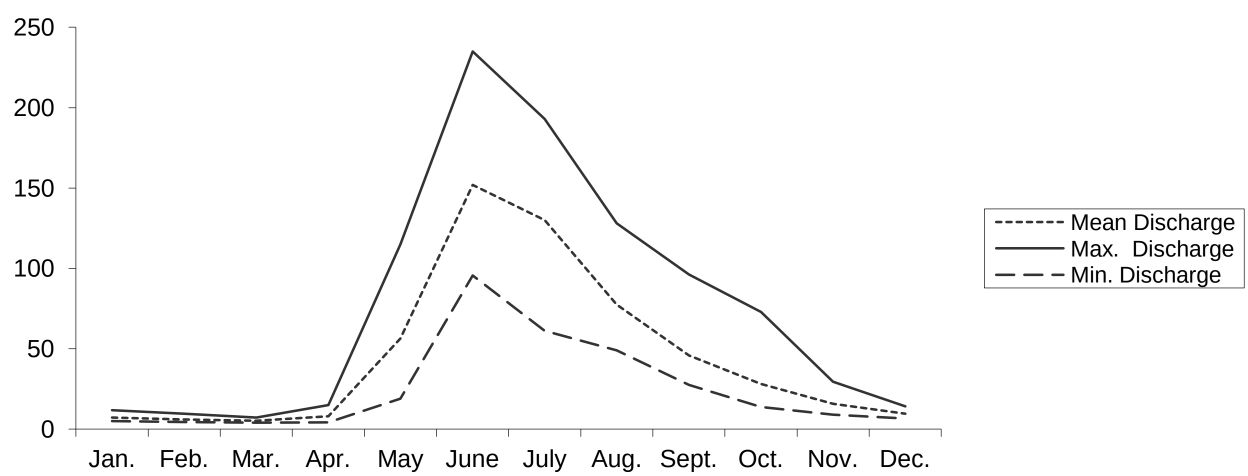


TABLE 5.3-7

HISTORICAL MEAN MONTHLY STREAMFLOW (m^3/s) SUMMARY FOR THE FRASER RIVER AT RED PASS, BC (STATION 08KA007)

Discharge	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Mean Discharge	7.24	5.98	5.32	7.94	56.4	152.0	130.0	77.4	45.9	28.1	15.7	9.67
Max. Discharge	11.8	9.58	7.28	14.9	115.0	235.0	193.0	128.0	96.2	73.0	29.5	14.2
Min. Discharge	5.11	4.46	4.06	4.23	19.0	95.6	61.2	49.0	27.5	13.9	9.06	6.69
Years of Streamflow Record:	1955 to 2010											
Maximum Daily Discharge:	402 m^3/s on June 12, 1972											
Minimum Daily Discharge:	3.51 m^3/s on March 30, 1962											
Gross Drainage Area:	1,710 km^2											

Source: Environment Canada 2013e

The Water Survey of Canada maintains a hydrometric station on the Clearwater River near Clearwater Station, BC (Station No. 08LA001) (Environment Canada 2013f). This station is located approximately 2 km upstream of the proposed crossing at RK 725.5. Discharge at this station has been recorded for approximately 73 years between 1914 and 2010. The annual high flow event typically occurs from June to August and flows gradually decline through late summer and fall. Figure 5.3-7 shows that mean monthly flows are lowest in February at 45.3 m^3/s and mean flows are highest during the spring freshet with a peak in June at 714 m^3/s (Environment Canada 2013f). Data for this watercourse are presented in Figure 5.3-7 and Table 5.3-8 and includes maximum, minimum and mean monthly discharges. Although this station records flow information upstream of the proposed crossing, discharge at the time of construction should be similar as the recorded mean discharge since there are only minor tributaries (*e.g.*, Brookfield Creek) located between the station and the proposed watercourse crossing.

Figure 5.3-7 Historical Mean Monthly Streamflow (m^3/s) Summary for the Clearwater River Near Clearwater Station, BC (Station 08LA001)

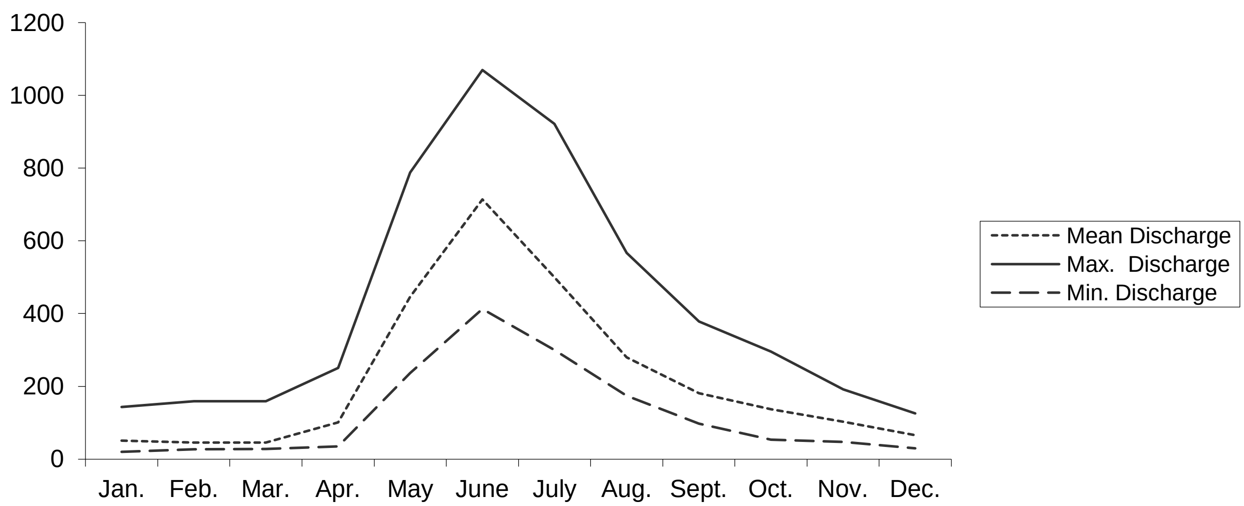


TABLE 5.3-8

HISTORICAL MEAN MONTHLY STREAMFLOW (m^3/s) SUMMARY FOR THE CLEARWATER RIVER NEAR CLEARWATER STATION, BC (STATION 08LA001)

Discharge	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Mean Discharge	50.9	45.3	45.6	101.0	446.0	714.0	500.0	280.0	181.0	137.0	103.0	65.3
Max. Discharge	143.0	159.0	159.0	251.0	788.0	1,070.0	922.0	567.0	378.0	296.0	192.0	126.0
Min. Discharge	20.2	27.0	27.7	34.6	237.0	413.0	300.0	174.0	97.2	53.2	47.3	29.9
Years of Streamflow Record:	1914 to 1919, 1921 to 1928 and 1950 to 2010											
Maximum Daily Discharge:	1,420 m^3/s on June 30, 1923											
Minimum Daily Discharge:	19.5 m^3/s on January 12, 1953											
Gross Drainage Area:	10,300 km^2											

Source: Environment Canada 2013f

The Water Survey of Canada maintains a hydrometric station on the North Thompson River at Birch Island, BC (Station No. 08LB047) (Environment Canada 2013g). This station is located approximately 65 km downstream of the southern-most proposed crossing of the North Thompson River at RK 651.7. Discharge at this station has been recorded every year since 1960. The annual high flow event typically occurs from May to July and flows gradually decline through late summer and fall. Figure 5.3-8 shows that mean monthly flows are lowest in February at 28.1 m^3/s and mean flows are highest during the spring freshet with a peak in June at 444 m^3/s (Environment Canada 2013g). Data for this watercourse are presented in Figure 5.3-8 and Table 5.3-9 and includes maximum, minimum and mean monthly discharges. Since this station records flow information well downstream of the proposed crossing, discharge at the time of construction may be less than the recorded mean discharge as a result of numerous smaller tributaries (*e.g.*, Mad River, Chuck Creek, Montana Creek, Hornet Creek, Cornet Creek, Otter Creek, Ivy Creek, Avola Creek) located between the station and the proposed watercourse crossing.

Figure 5.3-8 Historical Mean Monthly Streamflow (m^3/s) Summary for the North Thompson River at Birch Island, BC (Station 08LB047)

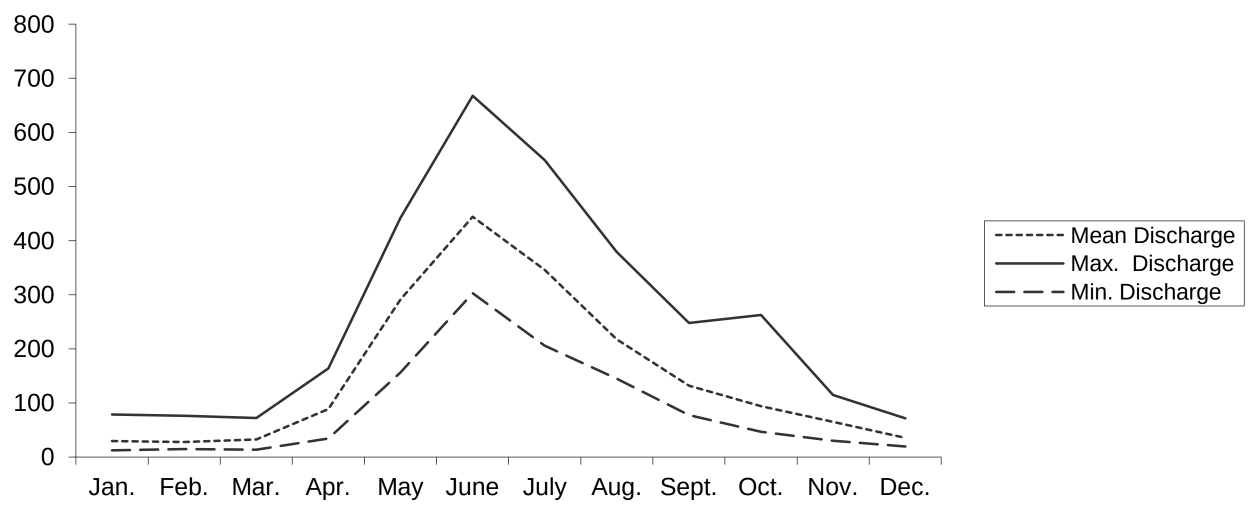


TABLE 5.3-9

HISTORICAL MEAN MONTHLY STREAMFLOW (m^3/s) SUMMARY FOR THE NORTH THOMPSON RIVER AT BIRCH ISLAND, BC (STATION 08LB047)

Discharge	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Mean Discharge	29.9	28.1	32.8	88.9	291.0	444.0	346.0	218.0	132.0	94.4	65.4	35.9
Max. Discharge	79.1	76.6	72.4	164.0	442.0	668.0	549.0	379.0	248.0	263.0	115.0	71.7
Min. Discharge	12.4	14.7	13.9	34.2	156.0	303.0	206.0	145.0	77.9	46.9	30.2	19.6
Years of Streamflow Record:	1960 to 2010											
Maximum Daily Discharge:	956 m^3/s on June 30, 1984											
Minimum Daily Discharge:	10.7 m^3/s on January 28, 1988											
Gross Drainage Area:	4,490 km^2											

Source: Environment Canada 2013g

5.3.2.3 Black Pines to Hope Segment

Located entirely within the Fraser River Basin, from north to south, the proposed pipeline corridor crosses the Lower North Thompson River, Thompson River, South Thompson River, Thompson River, Lower Nicola River and Fraser Canyon watersheds. There are approximately 318 potential watercourse crossings identified along the proposed pipeline corridor for this segment. Larger watercourses crossed include the Thompson River (RK 846.8), Nicola River (RK 928), Coldwater River (RK 957.9, RK 970.3, RK 980 and RK 990) and Coquihalla River (RK 1021.8, RK 1026.5, RK 1028.6, RK 1032.6 and RK 1043.2). A summary of watercourse crossings in the Fraser River Basin along the proposed pipeline corridor for the Black Pines to Hope Segment is provided in Section 5.7 Fish and Fish Habitat.

The Thompson River forms at the confluence of the North and South Thompson rivers at Kamloops, BC. The Thompson River flows into Kamloops Lake approximately 5 km downstream of the proposed crossing, continuing on until joining the Fraser River at the Village of Lytton, BC. The headwaters of the Nicola River originate from the Thompson Plateau west of Kelowna, BC, flowing west through the City of Merritt, at the proposed crossing, before heading northwest until its confluence with the Thompson River at the Community of Spences Bridge. The Coldwater River is a major tributary of the Nicola River, converging several kilometres downstream of the proposed crossing of the Nicola River. Coldwater River generally flows in a northerly direction, originating from the Coquihalla Pass in the Coast Mountains. The proposed pipeline corridor crosses the river at four locations as it winds up the valley, until it reaches the summit of the pass and begins descending down the valley of the Coquihalla River, crossing at five locations before its confluence with the Fraser River near Hope.

No designated or nominated Canadian or BC Heritage Rivers are crossed by the proposed pipeline corridor along this segment (BC MOE 2011c, Canadian Heritage Rivers System 2011a).

Hydrostatic test water for the Black Pines to Hope Segment is expected to be withdrawn from the Thompson River, Coldwater River and Coquihalla River. An estimated 95,000 m^3 of water will be needed to conduct hydrostatic testing of the proposed pipeline along this segment. Water used for hydrostatic testing will be released within the same drainage basin from where it was withdrawn.

<u>Historical Streamflow</u>

The Water Survey of Canada maintains a hydrometric station on the Thompson River at Kamloops, BC (Station No. 08LF023) (Environment Canada 2013h). This station is located approximately 5 km upstream of the proposed crossing at RK 846.8. Water level at this station has been recorded for most months of every year since 1911. Unlike other hydrometric data presented within this subsection that records volume, this station measures water level in metres. The annual high flow event typically occurs from May to July and water levels gradually decline through late summer and fall. Figure 5.3-9 shows that mean monthly water levels are lowest in March at 3.4 m and mean water levels are highest during the spring freshet with a peak in June at 7.1 m (Environment Canada 2013h). Data for this watercourse are presented in Figure 5.3-9 and Table 5.3-10 and includes maximum, minimum and mean monthly water levels. Since no tributaries of considerable volume are located between this station and the proposed crossing located downstream, water level at the time of construction should be similar to the recorded mean water level at the station.

Figure 5.3-9 Historical Mean Monthly Water Level (m) Summary for the Thompson River at Kamloops, BC (Station 08LF023)

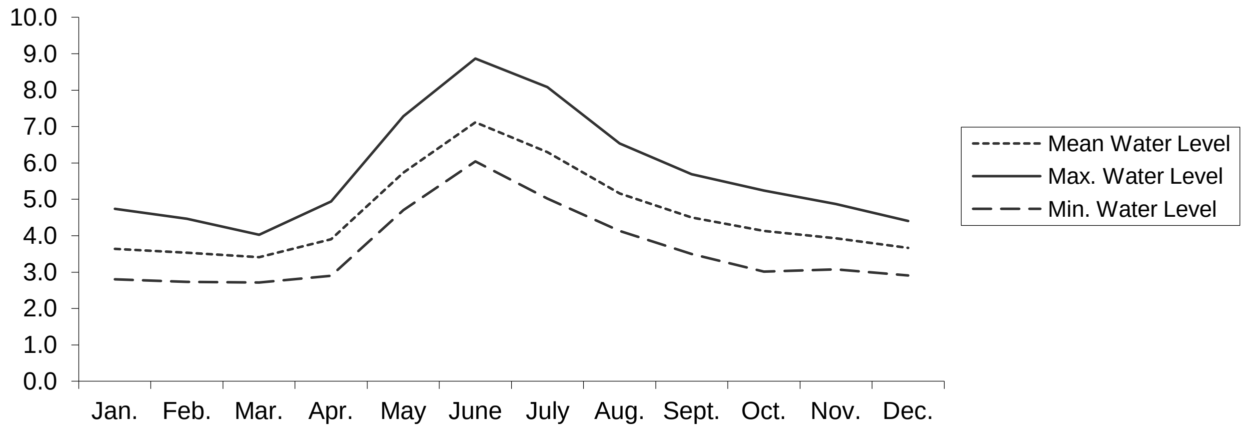


TABLE 5.3-10

HISTORICAL MEAN MONTHLY WATER LEVEL (m) SUMMARY FOR THE THOMPSON RIVER AT KAMLOOPS, BC (STATION 08LF023)

Discharge	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Mean Water Level	3.6	3.5	3.4	3.9	5.7	7.1	6.3	5.2	4.5	4.1	3.9	3.7
Max. Water Level	4.7	4.5	4.0	4.9	7.3	8.9	8.1	6.5	5.7	5.2	4.9	4.4
Min. Water Level	2.8	2.7	2.7	2.9	4.7	6.0	5.0	4.1	3.5	3.0	3.1	2.9
Years of Streamflow Record:	1911 to 2011											
Maximum Daily Water Level:	9.876 m on June 14, 1972											
Minimum Daily Water Level:	2.623 m on March 12, 2003 and March 1, 2010											
Gross Drainage Area:	37,800 km^2											

Source: Environment Canada 2013h

The Water Survey of Canada maintains a hydrometric station on the Coquihalla River near Hope, BC (Station No. 08MF003) (Environment Canada 2013i). This station is located within 1 km of the proposed crossing at RK 1043.2. Discharge at this station has been recorded for approximately 36 years sporadically between 1911 and 1983. The annual high flow event typically occurs during May and June and flows abruptly decline during summer, increase during fall and early winter and decline slightly in late winter. Figure 5.3-10 that mean monthly flows are lowest in August at 12 m^3/s and mean flows are highest during the spring freshet with a peak in June at 78.5 m^3/s (Environment Canada 2013i). Data for this watercourse are presented in Figure 5.3-10 and Table 5.3-11 and includes maximum, minimum and mean monthly discharges. Since no tributaries of considerable volume are located between this station and the proposed crossing located downstream, discharge at the time of construction should be similar to the recorded mean discharge at the station.

Figure 5.3-10 Historical Mean Monthly Streamflow (m^3/s) Summary for the Coquihalla River Near Hope, BC (Station 08MF003)

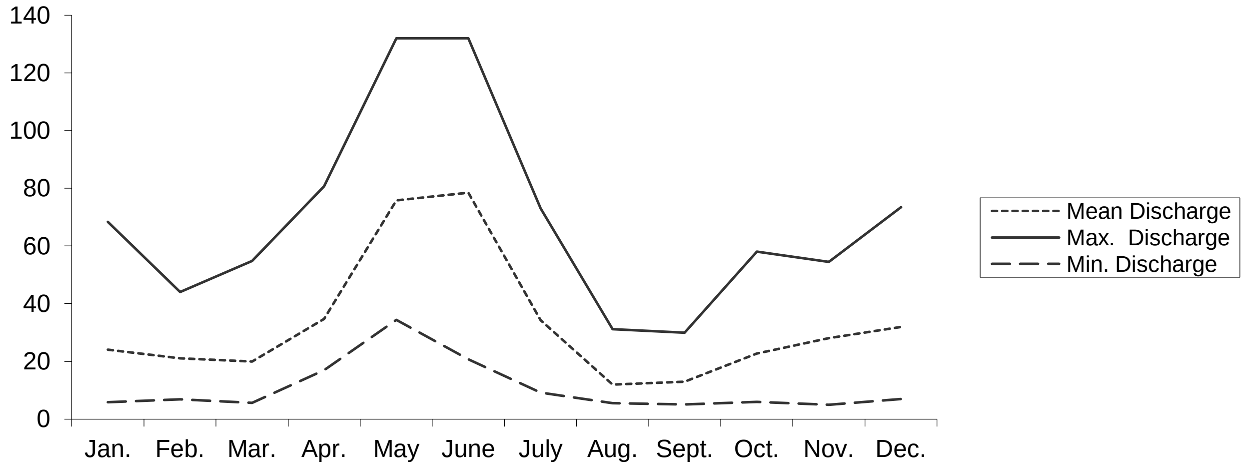


TABLE 5.3-11

HISTORICAL MEAN MONTHLY STREAMFLOW (m^3/s) SUMMARY FOR THE COQUIHALLA RIVER NEAR HOPE, BC (STATION 08MF003)

Discharge	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Mean Discharge	24.1	21.1	19.9	34.7	75.8	78.5	34.3	12.0	13.0	22.7	28.1	31.9
Max. Discharge	68.4	44.1	54.8	80.7	132.0	132.0	73.1	31.2	29.9	58.0	54.5	73.5
Min. Discharge	5.87	6.86	5.59	17.0	34.4	20.7	9.19	5.49	5.03	5.92	4.95	6.92
Years of Streamflow Record:	1911 to 1922 and 1957 to 1983											
Maximum Daily Discharge:	490 m^3/s on December 26, 1980											
Minimum Daily Discharge:	2.55 m^3/s on September 26, 1917											
Gross Drainage Area:	741 km^2											

Source: Environment Canada 2013i

5.3.2.4 Hope to Burnaby Segment

Located entirely within the Fraser River Basin, from east to west, the proposed pipeline corridor crosses the Fraser Canyon, Harrison River, Chilliwack River and Lower Fraser watersheds. There are approximately 131 potential watercourse crossings identified along the proposed pipeline corridor for this segment. Larger watercourses crossed include the Chilliwack River (RK 1102.3), Sumas River (RK 1114.6), Salmon River (RK 1147.4) and lower Fraser River (RK 1168.9). A summary of watercourse crossings in the Fraser River Basin along the proposed pipeline corridor for the Hope to Burnaby Segment is provided in Section 5.7 Fish and Fish Habitat.

Both the Chilliwack and Sumas rivers originate in Washington State. Flowing northwest across the Canada/US border, the Vedder River joins the Sumas River approximately 8 km downstream of the proposed crossing. The Sumas River continues from the confluence for approximately 3 km before converging with the lower Fraser River. The lower Fraser River is the largest watercourse crossing along the entire length of the proposed pipeline corridor. The Fraser River drains into the Strait of Georgia approximately 30 km downstream of the proposed crossing.

The entire length of the Fraser River, from its origins in Mount Robson Provincial Park, to its outflow into the Pacific Ocean at Vancouver, is designated both as a Canadian Heritage River by the Canadian Heritage Rivers System and a BC Heritage River by the BC MOE (BC MOE 2011b, Canadian Heritage

Rivers System 2011a). No other designated or nominated Canadian or BC Heritage Rivers are crossed by this proposed pipeline segment (BC MOE 2011c, Canadian Heritage Rivers System 2011a).

Hydrostatic test water for the Hope to Burnaby Segment is expected to be withdrawn from the Coquihalla River, Sumas River and Fraser River. An estimated 50,000 m^3 of water will be needed to conduct hydrostatic testing of the proposed pipeline along this segment. Water used for hydrostatic testing will be released within the same drainage basin from where it was withdrawn.

Historical Streamflow

The Water Survey of Canada maintains a hydrometric station on the lower Fraser River at Mission, BC (Station No. 08MH024) (Environment Canada 2013j). This station is located approximately 47 km upstream of the proposed crossing at RK 1168.9. Discharge at this station has been recorded for 32 years since 1965; however, continuous monitoring has only been recorded from 1965 to 1992. The annual high flow event typically occurs from May to July and flows gradually decline through late summer and fall. Figure 5.3-11 shows that mean monthly flows are lowest in February at 1,400 m^3/s and mean flows are highest during the spring freshet with a peak in June at 8,110 m^3/s (Environment Canada 2013j). Data for this watercourse are presented in Figure 5.3-11 and Table 5.3-12 and includes maximum, minimum and mean monthly discharges. Since this station records flow information well upstream of the proposed crossing, discharge at the time of construction will be more than the recorded mean discharge as a result of numerous smaller tributaries (*e.g.*, Pitt River, Stave River) located between the station and the proposed watercourse crossing.

Figure 5.3-11 Historical Mean Monthly Streamflow (m^3/s) Summary for the Lower Fraser River at Mission, BC (Station 08MH024)

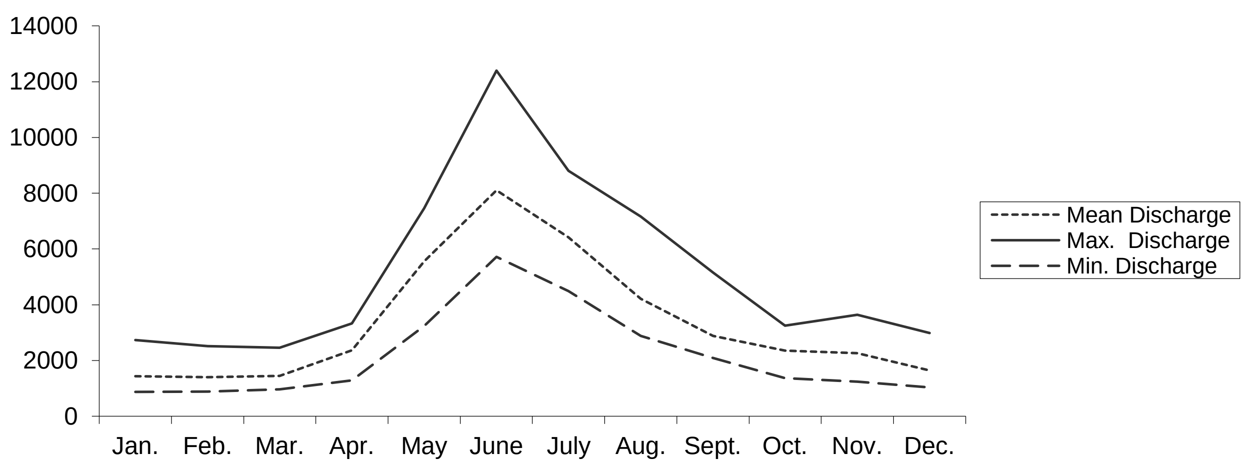


TABLE 5.3-12

HISTORICAL MEAN MONTHLY STREAMFLOW (m^3/s) SUMMARY FOR THE LOWER FRASER RIVER AT MISSION, BC (STATION 08MH024)

Discharge	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Mean Discharge	1,440	1,400	1,450	2,370	5,560	8,110	6,420	4,220	2,890	2,360	2,270	1,640
Max. Discharge	2,730	2,520	2,460	3,330	7,460	1,2400	8,810	7,170	5,160	3,250	3,640	2,990
Min. Discharge	881	889	973	1,290	3,240	5,720	4,490	2,880	2,090	1,370	1,240	1,040
Years of Streamflow Record:	1965 to 1992											
Maximum Daily Discharge:	13,500 m^3/s on June 22, 1967											
Minimum Daily Discharge:	648 m^3/s on February 15, 1980											
Gross Drainage Area:	228,000 km^2											

Source: Environment Canada 2013j

5.3.2.5 Burnaby to Westridge Segment

The proposed Segment crosses the Lower Fraser River Watershed within the Fraser River Basin. There is one potential watercourse crossing identified along the proposed pipeline corridor for the Burnaby to Westridge Segment at RK 1182.5.

Historical Streamflow

No hydrometric monitoring stations are identified at watercourses crossed by the Burnaby to Westridge Segment.

5.3.3 Groundwater Quality and Quantity

Groundwater Quality

Groundwater quality depends on the source of the water and the material through which it flows (*e.g.*, sulphate containing clay till, clean sand and gravel), as well as whether the groundwater encounters contamination. Both natural and human influences can affect groundwater quality. Surface water that recharges into the ground can affect groundwater quality; as conversely, groundwater may affect surface water quality. The effects to groundwater quality may be point-source such as a spill or may be much broader in scale such as glacial tills, the time scales over which the effect to groundwater quality varies.

Groundwater Quantity

The flow of groundwater is controlled by gravity and the physical characteristics of the materials through which it flows. Groundwater flow patterns can be affected as a result of natural (*e.g.*, surface water flooding) or human influences (*e.g.*, dewatering, construction of reservoirs).

In the following subsections describing the BC pipeline segments, the term vulnerability in describing aquifers is based on the definition provided by Berardinucci and Ronneseth (2002). They defined the vulnerability of an aquifer as the potential for an aquifer to be degraded. The vulnerability was determined based on:

- depth to the water table – the shallower the water table the greater the vulnerability;
- permeability of materials above the aquifer – the more permeable the sediments the higher the vulnerability; and
- thickness and extent of confining sediments – the less areally extensive and the thinner the confining sediments, the greater the vulnerability.

Tables describing the potential groundwater issues noted for each of the segments are included in the following subsections. A description of the types of potential groundwater issues and why they are a concern is provided in Table 5.3-13.

TABLE 5.3-13

DESCRIPTION OF POTENTIAL GROUNDWATER-RELATED ISSUES ALONG THE PROPOSED PIPELINE CORRIDOR

Potential Type of Groundwater Issue	Description
Creek crossings/deeply incised creek crossings	Related to the increased potential for a trenchless crossing or open cut to compromise the integrity of a confining unit that isolates an underlying productive aquifer (especially in valley bottom). A breach of the confining unit during pipeline construction activities may result in uncontrollable artesian flow at the entry or exit point of the trenchless crossing, or along the alignment in the open cut. This condition may lead to the development of saturated surface conditions and permanent wet conditions in the discharge areas. In addition, loss of circulation that could occur during trenchless crossing may result in drilling fluids entering the creek bed or discharging to surface along the valley slope.
River proximity or crossing/fluvial materials/colluvium in stream	The proposed pipeline corridor lies within alluvial deposits located in proximity to a surface water body. Possible direct hydraulic connection to the surface water body through saturated, coarse-grained alluvial deposits. The saturated alluvial deposits become a direct pathway for pipeline releases to enter the surface water body.

TABLE 5.3-13 Cont'd

Potential Type of Groundwater Issue	Description
Shallow groundwater	Related to the increased potential to experience groundwater discharge in the open excavations by intersecting the water table or comprising the integrity of a shallow confining unit. Groundwater discharging to the pipeline ditch may then be redirected through the higher permeability backfill material, discharging as a new spring at lower elevations.
Shallow well	Related to the increased potential to alter groundwater flow by open excavations, trenchless crossings that intersect the water table or comprising the integrity of a shallow confining unit. Shallow wells completed in this environment may be compromised by the change in the flow system caused by the pipeline construction activity. Shallow wells may be more vulnerable to groundwater impacts caused by pipeline spills.
Spring	Flowing (artesian) conditions indicate increased potential to experience groundwater discharge in the open excavations by intersecting the water table or comprising the integrity of a shallow confining unit. A change in the natural flow system caused by pipeline construction activities may affect natural spring flow.
Unconfined aquifer	Related to the increased potential to alter groundwater flow by open excavations below the water table. A change in the natural flow system caused by pipeline construction activities may affect natural spring flow and shallow wells completed in this environment.
Contaminated shallow aquifer	Existing contamination of unknown extent. Increased potential to alter groundwater flow by open excavations below the water table, leading to redistribution of existing subsurface contamination.

5.3.3.1 Edmonton to Hinton Segment

Ground elevations along the proposed pipeline corridor of the Edmonton to Hinton Segment ascend from approximately 700 m asl near Edmonton to approximately 900 m asl along the western edge of Parkland County. From Parkland County, the proposed pipeline corridor passes into Yellowhead County in west central Alberta and ground elevations increase to approximately 1,400 m asl at Hinton.

Approximately 202 surface water crossings were identified along the proposed pipeline corridor in this segment. Of these, six are being investigated as potential horizontal directional drill (HDD) crossings.

Deeply incised, major watercourse crossings occur at:

- North Saskatchewan River at RK 33.5;
- Pembina River at RK 135.0;
- Wolf Creek at RK 220.6; and
- McLeod River at RK 223.9.

The surficial geology along the proposed pipeline corridor through Parkland and Yellowhead counties is variable, but typically comprises glacial to lacustrine clay deposits that overlie bedrock. Occasional alluvial and fluvial deposits also are mapped along the proposed pipeline corridor (Roed 1970, Shetsen 2002). Unconsolidated deposits are generally reported to be greater than 20 m thick up to approximately RK 128, less than 20 m thick up to RK 226.3, greater than 20-30 m thick from RK 226 to RK 238 and then shallower (less than approximately 10 m thick) to RK 247.

Sand and gravel deposits typically have the highest permeability; these deposits accumulate in fluvial and glaciofluvial depositional environments, following the existing stream and river valleys. Some buried channels have been identified along the proposed pipeline corridor; however, the depth of burial is considered too deep to be disturbed by pipeline construction (1.8-3 m). Silt, sand with clay and gravel with clay deposits tend to have more moderate permeability and may also be found in glaciofluvial and alluvial deposits.

Lacustrine clay and glacial till deposits typically represent low permeability materials that confine the deeper-seated aquifers. Glaciofluvial and alluvial deposits characterized by a clayey matrix can also provide effective barriers to vertical and horizontal groundwater flow. Most water wells extend to bedrock and are completed in regional fractured sandstone units defined as domestic use aquifers. These aquifers are generally confined by low permeability overburden materials and low permeability bedrock shale units. Water wells completed in unconsolidated over burden deposits are usually exploiting local aquifers.

Regional groundwater contamination risk mapping has been interpreted from surficial geology descriptions along the Edmonton to Hinton Segment (Hydrogeological Consultants Ltd. [HCL] 1998, 2004). The risk is high when the near-surface materials are permeable; the risk is low when the near-surface materials are less permeable.

Edmonton obtains its water supply from the North Saskatchewan River. The City of Spruce Grove (approximately RK 58) and the Town of Stony Plain (approximately RK 65) are serviced via a water main from Edmonton. The groundwater contamination risk mapping shows that conditions are generally moderate to high risk of contamination immediately west of Edmonton through to approximately RK 119. The risk of potential contamination becomes generally lower risk with patches of higher risk though to the western border of Parkland County. Of note, Wabamun Lake area is mapped as being at a higher risk of groundwater contamination (HCL 1998). The Village of Wabamun (approximately RK 97) has switched to using groundwater from Wabamun Lake Provincial Park. A pipeline to supply water to the Village of Wabamun from the Town of Stony Plain is currently under construction (During pers. comm.).

In addition, the hamlets of Entwistle (approximately RK 134), Evansburg (approximately RK 136) and Wildwood (approximately RK 150) depend on groundwater.

Aquifers located in Alberta have not been defined in a systematic fashion. The Alberta Geological Survey has identified the Haynes and Sunchild members of the bedrock Paskapoo Formation as aquifers. Possible aquifers in unconsolidated materials along the proposed pipeline corridor in the Edmonton to Hinton Segment were identified as part of this Project. This identification was based on HCL's assessment of areas at risk to groundwater contamination (HCL 1998, 2004), the presence of sand and gravel aggregate, near surface sand and gravel, and the utilization of groundwater through the presence water wells. Table 5.3.14 below lists possible aquifers crossed by the Edmonton to Hinton Segment. The aquifers are presented on the maps for each segment in Appendix A of the Groundwater Technical Report of Volume 5C.

TABLE 5.3-14

POSSIBLE AQUIFERS IN THE EDMONTON TO HINTON SEGMENT

RK	Possible Aquifer Type	Name or Material
RK 33.8 to RK 33.9	Buried valley aquifer (Thalweg)	(none)
RK 36.4 to RK 57.6	Unconsolidated	sand and gravel
RK 62.1 to RK 65.8	Unconsolidated	sand and gravel
RK 67.6 to RK 67.7	Buried valley aquifer (Thalweg)	Drayton
RK 69.2 to RK 79.3	Unconsolidated	sand and gravel
RK 83.2 to RK 85	Unconsolidated	sand and gravel
RK 86.5 to RK 89.8	Unconsolidated	sand and gravel
RK 91.4 to RK 92.8	Unconsolidated	sand and gravel
RK 94.7 to RK 96	Unconsolidated	sand and gravel
RK 97.7 to RK 100.2	Unconsolidated	sand and gravel
RK 103.3 to RK 111.6	Unconsolidated	sand and gravel
RK 112.9 to RK 117.6	Unconsolidated	sand and gravel
RK 121.5 to RK 123.5	Unconsolidated	sand and gravel
RK 121.6 to RK 121.7	Buried valley aquifer (Thalweg)	Onoway
RK 125 to RK 125.4	Unconsolidated	sand and gravel
RK 129.5 to RK 133.9	Unconsolidated	sand and gravel
RK 162.9 to RK 165.3	Unconsolidated	sand and gravel
RK 170.3 to RK 174.1	Unconsolidated	sand and gravel
RK 176.5 to RK 189.4	Bedrock	Sunchild member
RK 184.8 to RK 199.3	Bedrock	Haynes member
RK 185 to RK 186.3	Unconsolidated	sand and gravel
RK 195.3 to RK 198.8	Bedrock	Sunchild member
RK 198.3 to RK 200.2	Unconsolidated	sand and gravel
RK 205 to RK 218.8	Bedrock	Haynes member

TABLE 5.3-14 Cont'd

RK	Possible Aquifer Type	Name or Material
RK 211.8 to RK 216.8	Unconsolidated	sand and gravel
RK 217.7 to RK 222.3	Unconsolidated	sand and gravel
RK 221.9 to RK 224.4	Bedrock	Sunchild member
RK 227.3 to RK 230.1	Unconsolidated (plus Thalweg)	sand and gravel and Edson
RK 231.5 to RK 339.44	Unconsolidated	sand and gravel
RK 256.5 to RK 261.5	Bedrock	Sunchild member
RK 259.9 to RK 283.4	Bedrock	Haynes member
RK 270.9 to RK 280.1	Bedrock	Sunchild member
RK 285 to RK 299.4	Bedrock	Sunchild member

The eastern half of Yellowhead County has a predominantly low risk of contamination grading to moderate or higher risk near the Town of Edson. Between Edson and Hinton, the regional mapping shows that the risk of groundwater contamination is generally high (HCL 2004). Surficial geology mapping through sections of Yellowhead County have identified the presence of organic deposits (muskeg), which may indicate shallow perched groundwater conditions.

The Town of Edson (RK 230) is supplied by groundwater from 10 municipal supply water wells, 2 of which are 80 m (ID No. 481637; currently not in use) and 300 m (ID# 483171; in use) south of the proposed pipeline corridor, while the Town of Hinton relies on the Athabasca River as its water supply source. The rural areas between Edson and Hinton predominantly use groundwater for drinking water and other water use purposes. The well density is considered moderate along the proposed pipeline corridor in the Edmonton to Hinton Segment. Typically, there are very few wells in close proximity of the proposed pipeline corridor.

Potential groundwater-related issues raised as part of the desktop study and subsequent field work for the Edmonton to Hinton Segment is summarized in Table 5.3-15.

TABLE 5.3-15

POTENTIAL GROUNDWATER-RELATED ISSUES IN THE EDMONTON TO HINTON SEGMENT

Location	Potential Groundwater-Related Issue	Summary of Issue	Summary for Field Visited Sites
RK 17.9	Well 85713 - Could have potential groundwater issue, bored stock well, total depth = 14.3 m and water level = 3.2 m below ground level (bgl). Regional geology indicates ice-contacted fluvial deposits.	Shallow well, colluvium	--
RK 24.1 to RK 24.4	Deep Blackmud Creek crossing - colluvial deposits.	Colluvium in stream	--
RK 28.0 to RK 28.2	Deep Whitemud Creek crossing - colluvial deposits.	Colluvium in stream	--
RK 34.4 to RK 34.6	North Saskatchewan River Crossing - colluvial and fluvial deposits.	Colluvium in stream	--
RK 36.8 to RK 37.1	Deep unnamed creek crossing - colluvial deposits.	Colluvium in stream	--
RK 39.6	Well 2093324 - Could have potential groundwater issue, stock well, total depth = 14.3 m and water level = 3.1 m bgl. Regional geology indicates lacustrine deposits.	Shallow well	--
RK 41.6	Well 75019 - total depth = 9.1 m for domestic use. Well 75018 - total depth = 14.0 m for domestic/stock. Potential groundwater because of depth and possible water level.	Shallow well	--
RK 50.9	12 well records related to water table test site near here. Other wells do not indicate groundwater issue; however, the reason for water table test site may cause concern.	Shallow well	--
RK 56.9	Well 81074 - potential groundwater issue. Hand dug domestic/stock use with total depth = 11.6 m and water level = 6.1 m. Just outside 150 m corridor so need to verify location (accuracy only to nearest 400 m). Lacustrine deposits may eliminate concern.	Shallow well	--

TABLE 5.3-15 Cont'd

Location	Potential Groundwater-Related Issue	Summary of Issue	Summary for Field Visited Sites
RK 89.2	Well 459883 - could have potential groundwater issue, bored stock well total depth = 10.4 m and water level = 0.3 m bgl. Shallow ephemeral unknown creek no groundwater concern.	Shallow well	--
RK 90.2	Well 459880 - could have potential groundwater issue, bored stock well total depth = 8.53 m and water level = 1.21 m bgl. Shallow ephemeral unknown creek no groundwater concern.	Shallow well	--
RK 134.9 to RK 135.6	Pembina River Crossing - fluvial deposits.	Colluvium in stream	Steep banks, shallow groundwater likely; 5-10 m overburden over sandstone bedrock.
RK 171.4 to RK 171.5	Lake Crossing - glacial sediments but top of bedrock 7.1 m - potential groundwater concerns.	Shallow well	--
RK 185.3	Shallow Lobstick River crossing - fluvial deposits may cause potential groundwater issue.	Colluvium in stream	--
RK 220.6	Wolf Creek crossing in fluvial deposits - potential groundwater concern.	Colluvium in stream	Poorly-drained; glaciolacustrine silty clayey till.
RK 223.7 to RK 224.1	McLeod River crossing in fluvial deposits - potential groundwater concern.	Colluvium in stream	Shallow groundwater; glaciolacustrine silty clayey till; bedded sandstone.
RK 224.7 to RK 225	Fluvial deposits near the McLeod River.	Colluvium in stream	--
RK 309.1 to RK 311.1	Trail Creek and unknown ephemeral creek crossing in fluvial/alluvium deposits. Full section passes near Athabasca River.	Colluvium in stream	Shallow groundwater: Seepage from glaciofluvial sand and gravel on top of siltstone in river bank exposure.
RK 319.8 to RK 320.1	Hardisty Creek crossing in till near fluvial deposits - potential groundwater concern (approximately 20 m elevation change).	Colluvium in stream	--
RK 327.5 to RK 327.7	Shallow Maskuta Creek crossing in fluvial sediments - most wells deep, but there is spring in area - potential concern.	Colluvium in stream, spring	--
RK 329.5	Shallow wells in glaciofluvial sediments with no confining layers - potential groundwater concern, would have to confirm locations.	Shallow well	--
RK 337.2 to RK 337.5	Two shallow unknown creek crossings in fluvial sediments. Well 485176 in fluvial sediments with no confining layers - potential groundwater concern.	Colluvium in stream	--

More detailed information is provided in Appendix B in the Groundwater Technical Report of Volume 5C.

5.3.3.2 Hargreaves to Darfield Segment

Ground elevations along the proposed pipeline corridor of the Hargreaves to Darfield Segment descend from over 900 m asl near RK 490.0 to approximately 450 m asl at RK 769.0. Groundwater flows generally follow local topography with recharge occurring either directly over the aquifers or from the valley walls (mountain sides) and discharge feeding the local river systems or flowing within fluvial sediments down the valley base.

Approximately 350 surface water crossings were identified along the proposed pipeline corridor in this segment. Of these, eight are being investigated as potential HDD crossings.

Watercourses recommended as potential HDD crossings are summarized below:

- North Thompson River at RK 581.2;
- Blue River at RK 613.8;
- Unnamed channel at RK 619.8;
- Multiple North Thompson River crossings at RK 619.9 and RK 651.6;
- Raft River at RK 717.7;

- Clearwater River at RK 725.5; and
- Mann Creek at RK 735.0.

Maps showing surficial geology from RK 489.7 to RK 636 were considered to be poor quality due to the small scale. From RK 636, however, regional mapping appears underlain by colluvium up to RK 639, which transitions to glacial till bordering fluvial deposits along major drainages. The proposed pipeline corridor passes over predominantly fluvial and glaciofluvial deposits from RK 648 to RK 769 (Fulton 1986, Gough 1987, Tipper 1971). The proposed pipeline corridor intersects short sections of mapped glacial till, colluviums and bedrock through this area; however, most of the well logs reviewed indicated the presence of sand and gravel overlying or bedrock mapped as surface outcrop (BC MOE 2013c).

Additional description of surficial geology for this segment is described in Section 5.1.1.2.

No aquifers have been mapped from RK 490 to RK 524 (from Hargreaves to Valemount). In general, groundwater level depths from RK 490 to RK 524, where reported, are considered moderate (> 6 m bgl), to deep (> 30 m bgl). Few wells are located in the Water Quantity and Quality LSA in this segment. The Valemount Aquifer (#799) is mapped as a glaciofluvial sand and gravel deposit between approximately RK 516 and RK 524.1. This aquifer has been classified in the BC provincial aquifer classification system as having relatively low demand, low vulnerability and a moderate productivity. The average well depth through the area is greater than 28 m bgl. A second glaciofluvial sand and gravel deposit is mapped within the Valemount area, the South Valemount Aquifer (#800) from RK 526 to RK 530. This aquifer is classified as having low demand, low productivity and a moderate vulnerability. The average well depth through this aquifer is greater than approximately 50 m bgl (BC MOE 2013c).

Potentially shallow groundwater areas are noted at a few locations between the Village of Valemount and Community of Blue River (particularly around Blue River), although information on groundwater depths is limited because of the lack of wells in the area (BC MOE 2013c). Aquifer #825 is described as a glaciofluvial sand and gravel deposit mapped near the Community of Blue River. It intersects the proposed pipeline corridor from RK 611.8 to RK 617.5. It is classified as a low demand, moderate productivity and highly vulnerable aquifer (BC MOE 2013c). No aquifers have been mapped between the communities of Blue River and Vavenby, though available information suggests there may be shallow groundwater present along the proposed pipeline corridor. Aquifer #807 is a glaciofluvial sand and gravel deposit extending from the Community of Vavenby to the District of Clearwater. The proposed pipeline corridor intersects Aquifer #807 from RK 698 to RK 717.6. The aquifer is classified as having moderate demand, productivity and vulnerability. Reported well depths are generally deep (> 30 m bgl) and water depths vary from shallow to deep (BC MOE 2013c).

Aquifer #773 is encountered from RK 717.6 to RK 719.4. This aquifer is defined as a glaciofluvial sand and gravel deposit with high demand, moderate productivity and low vulnerability (BC MOE 2013c). The water well density increases substantially around the District of Clearwater. Within the District of Clearwater, the south side of the proposed pipeline corridor encounters Aquifer #772 (a bedrock aquifer with moderate productivity, moderate vulnerability and low demand) and Aquifer #770, described as a sand and gravel deposit with high productivity, demand and vulnerability at RK 723.1. Aquifer #770 transitions to Aquifer #769, described as a sand and gravel deposit with moderate productivity, moderate demand and high vulnerability for a short section of the proposed pipeline corridor. No aquifers are mapped along the proposed pipeline corridor from RK 729.5 to RK 769.0. Reported water levels near the District of Clearwater range from shallow (< 5 m bgl) to moderate (5-30 m bgl) (BC MOE 2013c).

Aquifer #296 has been mapped as an alluvium and alluvial fan (fan shaped deposit of sediment built up by moving water) sand and gravel deposit between RK 748.5 and RK 756.8. The aquifer has low demand and moderate productivity and vulnerability. Aquifer #293 is a second alluvium and alluvial fan sand and gravel deposit mapped south of Clearwater (RK 756.8 to approximately RK 769) (BC MOE 2013c).

There are no community-owned drinking water supply wells in the Village of Valemount, communities of Albreda (RK 545.3), Avola (RK 652.7) and Vavenby (RK 695.7), the District of Clearwater (RK 714.7), Blackpool (RK 726.5) or the Community of Darfield (RK 765). The Community of Blue River (approximately RK 614) is supplied by groundwater (Hughes, Madden pers. comm.); however, the source wells are mapped over 1 km from the proposed pipeline corridor. North Thompson River Provincial Park is supplied by two water wells that are located in proximity to the proposed pipeline corridor. The rural areas between the District of Clearwater and North Thompson River Park are predominantly supplied by groundwater for drinking water and other water use purposes (BC MOE 2013c).

Potential groundwater-related issues raised as part of the desktop study and subsequent field work for the Hargreaves to Darfield Segment are summarized in Table 5.3-16.

TABLE 5.3-16

POTENTIAL GROUNDWATER-RELATED ISSUES IN THE HARGREAVES TO DARFIELD SEGMENT

Location	Potential Groundwater-Related Issue	Summary of Issue	Summary for Field Visited Sites
RK 514.4	Creek crossing.	Creek crossing	--
RK 515.9	Creek crossing.	Creek crossing	--
RK 517.8	Creek crossing.	Creek crossing	--
RK 522.6	Creek crossing, potential shallow groundwater in terrace, unconfined.	Groundwater shallow	Well-drained glaciofluvial sand and gravel.
RK 523.6	Creek and marsh crossing.	Creek crossing	--
RK 531.2	Canoe River crossing; groundwater at or above river level.	Groundwater shallow	Well-drained, sandstone bedrock.
RK 533	Generally swampy area, shallow groundwater.	Groundwater shallow	--
RK 534.4	Creek crossing.	Creek crossing	--
RK 545.8 to RK 545.9	Shallow groundwater.	Groundwater shallow	--
RK 559	Stream crossing, groundwater in alluvium.	Colluvium in stream	--
RK 559	Groundwater in alluvium.	Colluvium in stream	--
RK 561.2	Deep creek crossing.	Deeply incised creek	--
RK 563.4 to RK 563.5	Deep creek crossing.	Deeply incised creek	--
RK 565.9	Deep creek crossing.	Deeply incised creek	--
RK 567.6	Deep creek crossing.	Deeply incised creek	--
RK 571.9	Deep creek crossing.	Deeply incised creek	--
RK 573.5	Creek crossing.	Creek crossing	--
RK 576.3	Creek crossing.	Creek crossing	--
RK 580.3	Deep creek crossing.	Deeply incised creek	Shallow groundwater, well-drained; groundwater seep from bedrock.
RK 581.1	North Thompson River crossing.	River	--
RK 590.3	Creek crossing.	Creek crossing	--
RK 592.9 to RK 593	Creek crossing, alluvial fan.	Colluvium in stream	--
RK 600.2 to RK 600.3	Thunder River crossing.	River	--
RK 611.7 to RK 611.8	Creek crossing, very close to North Thompson River.	Creek crossing	--
RK 613.7	Sand deposits hosting water table aquifer may be used locally - potentially sensitive to contamination.	Groundwater shallow	Shallow groundwater, well-drained, fluvial sand and gravel.
RK 613.8	Blue River crossing.	River	--
RK 619.9	North Thompson River crossing, alluvial terrace high groundwater.	Colluvium in stream	--
RK 621 to RK 622.9	Pipeline corridor close to river in alluvial terrace.	Colluvium in stream	--
RK 622.9 to RK 625.4	Pipeline corridor close to North Thompson River in alluvial terrace, highly sensitive area.	Colluvium in stream	--
RK 625.4 to RK 626.9	Pipeline corridor close to North Thompson River in alluvial terrace, sensitive area.	Colluvium in stream	--
RK 626.6	Froth Creek crossing, potentially seasonal high flow.	Creek crossing	--
RK 634	Very deep creek crossing, may be sensitive to groundwater.	Deeply incised creek	--
RK 638.7	Finn Creek crossing, sand and boulders aquifer, high groundwater level.	Groundwater shallow	--
RK 642 to RK 643.5	Close to braided North Thompson River crossing.	Colluvium in stream	--
RK 645.3 to RK 645.8	Close to North Thompson River crossing.	Colluvium in stream	Poorly-drained, metamorphic bedrock.
RK 646.8 to RK 648.2	Close to North Thompson River crossing.	Colluvium in stream	--
RK 649	Tumtum Creek crossing; alluvial fan.	Colluvium in stream	--
RK 651.3 to RK 651.8	North Thompson River crossing; alluvial terraces.	Colluvium in stream	Shallow groundwater, poorly-drained, fractured metamorphic bedrock.
RK 659.8 to RK 660.7	Very close to North Thompson River in alluvial (?)[1] deposits.	Colluvium in stream	--
RK 663.2 to RK 663.5	Creek bed.	Creek crossing	--

TABLE 5.3-16 Cont'd

Location	Potential Groundwater-Related Issue	Summary of Issue	Summary for Field Visited Sites
RK 668.4 to RK 668.9	Very close to North Thompson River.	Colluvium in stream	--
RK 669 to RK 671.2	Very close to North Thompson River.	Colluvium in stream	--
RK 682.8 to RK 684.2	Close to North Thompson River.	Colluvium in stream	--
RK 706	Wells in proposed pipeline corridor, depth from 20-60 m, aquifer somewhat protected by fine material, low rates.	Shallow well	Glaciofluvial cobbles.
RK 709.6	Close to river, alluvial material (?)[1].	Colluvium in stream	--
RK 711.5	Well in proposed pipeline corridor, close to 50 m dry gravel(?)[1], then water-bearing gravel.	Shallow well	--
RK 713.4	Wells in proposed pipeline corridor, appears as low sensitivity.	Shallow well	--
RK 715.6	River deposits.	Colluvium in stream	--
RK 717.5	Wells in proposed pipeline corridor, low rate to dry(?)[1] somewhat protected by clay and till layers.	Shallow well	Shallow groundwater seepage, glaciofluvial materials to 10 m thick.
RK 725.6 to RK 725.7	Clearwater River crossing, wells in proposed pipeline corridor 30-40 m deep, poorly protected by dirty sand/gravel.	Shallow well	Water well at higher elevation has groundwater depth of approximately 40 m bgl (well is likely 40 m above river), well-drained, likely glaciofluvial, shallow groundwater a possibility.
RK 728.8 to RK 729.5	Blackpool community, shallow wells 6-12 m, water table unprotected aquifer.	Shallow well	--
RK 731 to RK 731.6	Shallow wells 12 m deep, unprotected water table aquifer.	Shallow well	--
RK 734.9 to RK 735.1	Mann Creek crossing, apparently alluvial terrace shallow, water table aquifer.	Colluvium in stream	--
RK 740.7 to RK 740.8	Very close to Lake Lemieux, check geology for material permeability.	Colluvium in stream	--

Note: 1 (?) indicates some uncertainty in the interpretation of imagery and well data.

More detailed information is provided in Appendix B in the Groundwater Technical Report of Volume 5C.

5.3.3.3 Black Pines to Hope Segment

Ground elevations along the proposed pipeline corridor of the Black Pines to Hope Segment increase from approximately 350 m asl at RK 813 to approximately 1,240 m asl at the Coquihalla Summit at RK 1004, then decrease to approximately 60 m asl in the District of Hope at RK 1045.4. Groundwater flows generally follow local topography with recharge occurring either directly over the aquifers or from the valley walls (mountain sides) and discharge feeding the local river systems or flowing within fluvial sediments down the valley base. Portions of the proposed pipeline corridor along the Coquihalla Highway are heavily confined by steep mountain approaches on both sides of the pass.

Approximately 315 surface water crossings were identified along the proposed pipeline corridor in this segment. Of these, seven are being investigated as potential HDD crossings.

Major watercourse crossings are summarized below:

- Thompson River at RK 846.8;
- Nicola River at RK 928.0;
- multiple Coldwater River crossings at RK 957.9, RK 970.3, RK 980.0 and RK 990.0; and
- Coquihalla River at RK 1043.2.

Regional surficial geology mapping by Young (1983) from RK 813 to RK 847.5 is mostly fluvial or glaciofluvial with occasional areas described as colluvium. South of Kamloops (RK 848), the proposed pipeline corridor enters into an area dominated by glacial till and where fluvial or glaciofluvial deposits are only occasionally encountered at stream crossings. From RK 892.6 to RK 934.2, the proposed pipeline corridor crosses glacial till, colluvium, glaciofluvial, fluvial and lacustrine deposits intermittently. Glacial till is the dominant surficial deposit from RK 934.6 to RK 958.8 (Fulton 1986), after which no surficial geology information is available through to the end of this segment. Additional description of surficial geology for this segment is described in Section 5.1.1.3.

Aquifer #283 is mapped in the proposed pipeline corridor from RK 812 to RK 821. This aquifer is described as a modern alluvial fan sand and gravel deposit. It reportedly has low demand and moderate productivity and vulnerability. Water wells reported in the area are generally deep (> 60 m bgl) and water depths are considered to be moderate until RK 820 where shallow water depths are reported. Aquifer #282, an alluvial sand and gravel deposit with moderate demand, moderate productivity and high vulnerability is encountered by the proposed pipeline corridor north of the Thompson River in the Kamloops area from RK 844.7 to RK 846.6. South of the Thompson River, the proposed pipeline corridor crosses a short section of Aquifer #284, an alluvial sand and gravel deposit with similar characteristics as Aquifer #282 (BC MOE 2013c).

Bedrock Aquifer #276 is crossed by the proposed pipeline corridor from RK 851.8 to RK 857.3; this aquifer is classified as having low demand, low productivity and moderate vulnerability. Perched shallow groundwater may be encountered near local surficial water bodies. No aquifers have been mapped from RK 857 to RK 865.7. A second bedrock aquifer, Aquifer #274, is encountered at RK 865.7. Aquifer #274 has similar characteristics as Aquifer #276. No aquifers have been mapped from RK 871.8 to RK 931.1 and little hydrogeological information is available due to the scarcity of water wells. Near the City of Merritt, the proposed pipeline corridor crosses Aquifer #75, described as a sand and gravel deposit with moderate demand, moderate productivity and low vulnerability from RK 931.1 to RK 932.7. Well depths in this area are deep and the groundwater levels are generally variable. No aquifers have been mapped from RK 932.7 to RK 1041.9 (Merritt to Hope). The proposed pipeline corridor crosses Aquifer #1005 from RK 1041.9 to RK 1043.1 as it enters Hope. This aquifer is described as a sand and gravel deposit with moderate demand, moderate productivity and moderate vulnerability. It is underlain by Aquifer #1009, a bedrock aquifer with moderate demand, moderate productivity, but reportedly high vulnerability. Water levels range from shallow to deep in this area. West of RK 1042.9, Aquifer #1007, a sand and gravel deposit with low demand, high productivity and high vulnerability, is mapped within the Water Quantity and Quality LSA.

Well densities are considered high in proximity to the proposed pipeline corridor in the Kamloops, Merritt and Hope areas (BC MOE 2013c). The Kamloops Airport and School District 24 operate drinking water systems in proximity (approximately 400 m and 100 m respectively) to the proposed pipeline corridor. A District of Hope community well and two drinking water system wells are identified in Aquifer #1005 potentially within the proposed pipeline corridor. Spectra Energy Corporation operates a water supply system well near RK 952.8 that lies within 200 m of the proposed pipeline corridor. The Coldwater First Nation's water supply wells are identified in proximity to the existing pipeline corridor and are approximately 1,220 m from RK 642.5 of the proposed pipeline corridor.

Potential groundwater-related issues raised as part of the desktop study and subsequent field work for the Black Pines to Hope Segment is summarized in Table 5.3-17.

TABLE 5.3-17

POTENTIAL GROUNDWATER-RELATED ISSUES IN THE BLACK PINES TO HOPE SEGMENT

Location	Potential Groundwater-Related Issue	Summary of Issue	Summary for Field Visited Sites
RK 844.8 to RK 845.8	North Thompson River terraces, shallow aquifer contaminated by the Kamloops Pump Station.	Contaminations - shallow aquifer	Likely fluvial compact fine clay gravel cobbles; monitoring wells near the Kamloops Pump Station.
RK 846.5 to RK 847.5	North Thompson River crossing, including river terrace with shallow groundwater.	Groundwater shallow	--
RK 858.3 to RK 858.5	Ravine crossing, shallow groundwater.	Groundwater shallow	--
RK 869.7 to RK 870.1	Proposed pipeline corridor encroaching Menanteau Lake; wetland, shallow groundwater.	Groundwater shallow	--
RK 881.7	Very close to Anderson Lake; high groundwater table and connection to lake.	Groundwater shallow	--
RK 910.1	Encroaching wetland.	Creek crossing	--

TABLE 5.3-17 Cont'd

Location	Potential Groundwater-Related Issue	Summary of Issue	Summary for Field Visited Sites
RK 927.8 to RK 928	Nicola River crossing and alluvial terraces; groundwater shallow and connected to river.	Colluvium in stream	Shallow groundwater; poorly-drained, wet.
RK 956.2	Shallow well; aquifer confined but not deep.	Shallow well	Shallow groundwater, well-drained.
RK 957.8 to RK 957.9	Coldwater River crossing; possible terraces with shallow groundwater.	Groundwater shallow	--
RK 963.1 to RK 963.6	Very close to Fig Lake; possible shallow groundwater.	Groundwater shallow	--
RK 970.2 to RK 970.3	Coldwater River crossing and in close proximity to the river.	Colluvium in stream	High electrical conductivity suggests shallow groundwater, well-drained steep till slope failing, 5 m hard till sand and gravel, volcanic bedrock.
RK 980 to RK 980.1	Coldwater River crossing.	River	Shallow groundwater - possible spring in rip-rap, fluvial to glaciofluvial.
RK 1021.8	Coquihalla River crossing, shallow groundwater in alluvial terraces.	Groundwater shallow, colluvium in stream	Shallow groundwater, well-drained glaciofluvial (gravel pit).
RK 1022.9	Dewdney Creek crossing, shallow water in alluvial deposits.	Groundwater shallow	--
RK 1026.5	Coquihalla River crossing.	River	--
RK 1028.6 to RK 1028.7	Coquihalla River crossing, shallow groundwater in alluvium.	Groundwater shallow	--
RK 1032.6	Coquihalla River crossing, shallow groundwater in alluvium.	Groundwater shallow	--
RK 1040.1	Well in the proposed pipeline corridor, shallow and unconfined (unnamed) aquifer.	Shallow well	--
RK 1040.6	Well in the proposed pipeline corridor, shallow (unnamed) aquifers poorly confined and/or not confined.	Shallow well	--
RK 1042.2 to RK 1043.3	Shallow (within 20 m) unconfined (unnamed) aquifer and at end point Coquihalla River crossing.	Unconfined aquifer	Shallow groundwater, well-drained glaciofluvial (gravel pit).

More detailed information is provided in Appendix B in the Groundwater Technical Report of Volume 5C.

5.3.3.4 Hope to Burnaby Segment

Ground elevations along the proposed pipeline corridor of the Hope to Burnaby Segment transition from approximately 60 m asl near the District of Hope to approximately 175 m asl near the City of Burnaby. Groundwater flows will generally follow local topography with recharge occurring directly over the aquifers and discharge feeding the local river systems.

Approximately 131 surface water crossings were identified along the proposed pipeline corridor in this segment. Of these, five have been proposed as potential HDD crossings.

Major watercourse crossings are summarized below:

- Chilliwack/Vedder River at RK 1102.1; 1102.3 and 1102.4;
- Sumas River at RK 1114.6; and
- Fraser River at RK 1168.9.

No surficial geology mapping is available between Hope and Bridal Falls. Regional surficial geology mapping by Armstrong (1980) extends west of Bridal Falls. Armstrong (1980) describes the surficial geology west of Bridal Falls (RK 1079.4 to RK 1085.9) as complex, consisting of Salish bog, swamp and shallow lake deposits consisting of either lowland peat, organic silt loam and silty clay loam (0.3-10 m thick) overlying Fraser River overbank and channel deposits, sandy loam, loamy silt or Salish slope deposits consisting of fan and landslide sand and gravel up to 10 m thick. The surficial geology from RK 1079.4 to RK 1085.9 is summarized in Table 5.3-18. Additional description of surficial geology for this segment is described in Section 5.1.1.4.

TABLE 5.3-18

SURFICIAL GEOLOGY FROM RK 1079.4 TO RK 1085.9

RK Range	Surficial Sediment Description
RK 1079.4 to RK 1080.7	Bog swamp deposits 0.4–10 m thick
RK 1080.8 to RK 1081.5	Slope deposits (sand and gravel) to 10 m thick
RK 1081.6 to RK 1082.2	Channel and overbank deposits (sand and gravel)
RK 1082.2 to RK 1083.3	Slope deposits (sand and gravel) to 10 m thick
RK 1083.3 to RK 1083.9	Bog swamp deposits 0.4-10 m thick
RK 1083.9 to RK 1084.6	Slope deposits (sand and gravel) to 10 m thick
RK 1084.6 to RK 1084.8	Bog swamp deposits 0.4–10 m thick
RK 1084.8 to RK 1085.9	Slope deposits (sand and gravel) to 10 m thick

Source: Armstrong 1980

From RK 1085.9 to RK 1093.9, the material encountered consists of either channel and overbank sediments consisting of silty clay loam or Salish bog, swamp or shallow lake deposits of lowland peat and organic silt loam (Armstrong 1980). From RK 1093.9 to RK 1100.4, the material encountered consists of mountain stream channel and flood plain sediments composed of sand and gravel deposited by the Chilliwack River in Sumas Valley up to 15 m thick (Armstrong 1980). From RK 1100.4 to RK 1108.4, the surficial material consists of stream deposits of sand and gravel up to 15 m thick (Armstrong 1961). From RK 1108.4 to RK 1114.4 (western edge of Sumas Mountain), the proposed pipeline corridor encounters lacustrine deposits consisting of sand up to 4.5 m overlying silt, clayey silt and silty clay (Armstrong 1961). From RK 1114.4 to RK 1121.2, the near surface materials consist of bedrock exposed at Sumas Mountain.

The surficial sediments encountered from RK 1121.2 to RK 1138.2 are variable as shown in Table 5.3-19.

TABLE 5.3-19

SURFICIAL GEOLOGY FROM RK 1121.2 TO RK 1138.2

RK Range	Surficial Sediment Description
RK 1121.1 to RK 1121.7	Slopewash sand to 3 m thick resting on silty clay and clayey silt.
RK 1121.7 to RK 1123.3	Fraser flood plain silty clay and clayey silt up to 9 m thick and overlying sand.
RK 1123.3 to RK 1124.1	Salish swamp deposits (lowland peat) up to 10.6 m thick in most places resting on silty clay and in some places overlying sand and sandy silt.
RK 1124.1 to RK 1128.2	Fraser flood plain silty clay and clayey silt up to 9 m thick and overlying sand.
RK 1128.2 to RK 1129.2	Salish swamp deposits (lowland peat) up to 10.6 m thick in most places resting on silty clay and in some places overlying sand and sandy silt.
RK 1129.2 to RK 1130.1	Glaciolacustrine deposits of silt, clayey silt, silty clay, fine sand and minor coarse sand and gravel.
RK 1130.1 to RK 1130.9	Abbotsford outwash, ice contact, gravel, sand and lenses of till.
RK 1130.9 to RK 1133.4	Glacial Sumas sandy till from less than 1.5 m to 10.6 m thick.
RK 1133.4 to RK 1137.9	Fort Langley Formation (Whatcom) glaciomarine deposits of stony clayey silt and silty clay, clay, silt and sand from 7.6 m to 91.4 m thick.
RK 1137.9 to RK 1138.2	Huntingdon Gravel consisting of gravel and sand up to 30.5 m thick underlying either Sumas till or Whatcom glaciomarine deposits.

Source: Armstrong 1961

West of RK 1140.4, the surficial geology mapping was completed by Armstrong and Hicock (1980). From RK 1140.4 to RK 1145.4, the glaciomarine sediments are referred to as the Fort Langley Formation, which on the older maps was called the Whatcom glaciomarine deposits (Armstrong 1961). The surficial geology from RK 1138.2 to RK 1168.6 (Fraser River Crossing) is described in Table 5.3-20.

TABLE 5.3-20

SURFICIAL GEOLOGY FROM RK 1138.2 TO RK 1168.6

RK Range(s)	Surficial Sediment Description
RK 1138.2 to RK 1144.8	Fort Langley Formation (Whatcom) glacio-marine deposits of stony clayey silt and silty clay, clay, silt and sand from 7.6-91.4 m thick.
RK 1144.8 to RK 1146.3	Salish swamp deposits (lowland peat) up to 10.6 m thick in most places resting on silty clay and in some places overlying sand and sandy silt.
RK 1146.3 to RK 1148.4	Capilano sediments – marine silt loam to clay loam with minor sand and silt and stones to 18.3 m thick.
RK 1148.4 to RK 1150.4	Fraser River deposits – overbank sandy to silt loam to 2 m thick overlying 15 m or more of deltaic channel till (sandy to silt loam).
RK 1150.4 to RK 1151.4; RK 1152.4 to RK 1153.4	Fort Langley Formation - marine silty clay to fine sand. From RK 1151.4 to RK 1152.4 and from RK 1153.4 to RK 1154.4 consists of lowland peat up to 14 m thick overlying Fraser River sediment sandy to silt loam.
RK 1154.4 to RK 1157.6	Sumas drift – proglacial deltaic gravel and sand up to 40 m thick.
RK 1157.6 to RK 1160.1	Capilano sediments mainly marine silt loam to clay loam up to 60 m thick.
RK 1160.1 to RK 1163.6	Salish sediments - lowland peat up to 14 m thick overlying Fraser River sediment sandy to silt loam.
RK 1163.6 to RK 1168.4	Pre-Vashon Quadra fluvial channel fill and marine interbedded fine sand to clayey silt. From RK 1166.4 to RK 1166.4.7 consists of lowland peat up to 14 m thick overlying Fraser River sediment sandy to silt loam.
RK 1168.4 to RK 1168.6	Lowland peat up to 14 m thick overlying Fraser River sediment sandy to silt loam.

Source: Armstrong and Hicock 1980

North of the Fraser River crossing at RK 1168.8, the surficial geology consists of Tertiary bedrock overlain by Vashon Till (Armstrong and Hicock 1980). However, where the proposed pipeline corridor follows valley bottoms, the surficial geology shows much variation, as outlined in Table 5.3-21 below.

TABLE 5.3-21

SURFICIAL GEOLOGY FROM RK 1168.4 TO RK 1176.4

RK Range	Surficial Sediment Description
RK 1168.4.8 to RK 1173	Fraser River overbank deposits of sandy to silt clay loam up to 2 m thick overlying 15 m or more deltaic and channel till sandy to silt loam.
RK 1173 to RK 1173.4	Lowland peat up to 14 m thick overlying Fraser River sediment sandy to silt loam (small amount of Pre-Vashon Quadra fine sand to clayey silt at RK 1173.4).
RK 1173.4 to RK 1176.4	Marine shore and fluvial sand up to 8 m thick.
RK 1176.4 to RK 1179	Vashon Drift and Capilano sediments generally < 8 m thick (from RK 1176.5 to RK 1177.0 consists of marine shore and fluvial sand).
RK 1179 to RK 1179.7 (Burnaby Terminal)	Capilano Sediments – raised beach deposits consisting of poorly-sorted sand to gravel 1-8 m thick.

Source: Armstrong and Hicock 1980

Aquifer #1 is mapped in the Hope area from approximately RK 1045.4 to RK 1051.4. This aquifer is described as a Fraser River Sediments sand and gravel deposit. It reportedly has moderate demand, high productivity and high vulnerability. Water levels reported on records completed for local water wells appear to be shallow to moderate in depth, averaging around 8 m bgl. Aquifer #3 is located immediately south of Hope from approximately RK 1054.5 to RK 1064.5. This aquifer is also a Fraser River sand and gravel deposit with similar characteristics as Aquifer #1 (BC MOE 2013c).

Aquifer #6 extends from RK 1077.2 to RK 1094. This sand and gravel deposit is identified as the Chilliwack-Rosedale Aquifer and is classified as having a low demand, high productivity and high vulnerability. The proposed pipeline corridor is in proximity (approximately 300 m) to several probable drinking water systems with wells in this aquifer including the Tzeachten Indian Reserve (BC MOE 2013c).

Aquifer #8, the Vedder River Fan Aquifer, is located at approximately RK 1094 and is also known locally as the Sardis Aquifer. The Vedder River Fan Aquifer is described as a sand and gravel deposit with high demand, productivity and vulnerability. The City of Chilliwack community wells are located within this aquifer and the mapped well capture zones cross the pipeline proposed pipeline corridor. The proposed pipeline corridor crosses the Vedder River at RK 1102.2 and continues west through Aquifer #8. The Yarrow Waterworks District wells are located within Aquifer #8 on the south side of the Vedder River, more than 800 m from the proposed pipeline corridor. The proposed pipeline corridor continues to overlie Aquifer #8 through to Aquifer #21, the Sumas Prairie Aquifer in Abbotsford. Aquifer #21 is described as a sand and gravel deposit with moderate demand, productivity and vulnerability. No aquifers are mapped from RK 1114.4.2 to RK 1121.1 (BC MOE 2013c).

The proposed pipeline corridor passes briefly across a series of saturated sand and gravel deposits defined as aquifers between the cities of Abbotsford and Surrey (BC MOE 2013c).

1. Aquifer #22 extends from RK 1121.1 to RK 1129.9 and is a regionally extensive, sand and gravel deposit classified as having low demand, low moderate productivity and low vulnerability. Water levels in this aquifer range from shallow to moderate depth. The Stó:lō Nation and another potential drinking water system are located near RK 1127.6.
2. Aquifer #16 extends from RK 1129.9 to RK 1130.9 and is a Sumas Drift sand and gravel deposit with low demand, low to moderate productivity and high vulnerability. Water levels in this aquifer range from shallow to moderate depth. There is a high density of wells in proximity to the proposed pipeline corridor in this area.
3. Aquifer #27 extends from RK 1130.6 to RK 1132.4 and is mapped as a Fort Langley Formation sand and gravel deposit with high demand, high productivity and low vulnerability. Water levels in this aquifer range from moderate to deep. There is a high density of wells in proximity to the proposed pipeline corridor in this area.
4. Aquifer #29 does not cross the proposed pipeline corridor, but is located within the Water Quantity and Quality LSA. This aquifer is described as a Fort Langley Formation sand and gravel deposit with low demand, low vulnerability and moderate productivity. Water levels in this aquifer range from moderate to deep. There is a high density of wells in proximity to the proposed pipeline corridor in this area.
5. Aquifer #30 extends from RK 1132.4.5 to RK 1133.4.5 and is mapped as a Fort Langley Formation sand and gravel deposit with low demand, moderate productivity and high vulnerability. Water levels in this aquifer range from moderate to deep. There is a high density of wells in proximity to the proposed pipeline corridor in this area.
6. The proposed pipeline corridor crosses back over Aquifer #27 at RK 1135.7.
7. Aquifer #32 extends from RK 1138 to RK 1138.9 and is described as a sand and gravel deposit with moderate demand, moderate productivity and low vulnerability. Water levels in this aquifer range from moderate to deep. There is a high density of wells in proximity to the proposed pipeline corridor in this area.
8. Aquifers #35 (Hopington) and #36 do not cross the proposed pipeline corridor, but are located within the Water Quantity and Quality LSA. Both aquifers are described as sand and gravel deposit with high vulnerability. The Hopington Aquifer has been identified as in intensive use for water supply with declining water levels and increasing nitrate concentrations.
9. Aquifer #58 (Nicomeki-Serpentine) extends from RK 1145.4 to RK 1159.7 and is a sand and gravel deposit with moderate demand, moderate productivity and low vulnerability. Several potential drinking water systems owned by the Township of Langley and a Langley school, among others, were identified. Water levels in this aquifer range from shallow to moderate depths. There is a high density of wells in proximity to the proposed pipeline corridor in this area.
10. Aquifers #59 and #60 also underlie the proposed pipeline corridor through this segment. Both aquifers are classified as low vulnerability.
11. Aquifer #61 extends from RK 1163.4 to RK 1165.4 and from RK 1167.8 to RK 1168.4, and is described as a Quadra Sand aquifer with low demand, low vulnerability and high productivity. Water levels in this aquifer range from shallow to moderate depths. There is a high density of wells in proximity to the proposed pipeline corridor in this area including potential drinking water system wells owned by Mountford, Corporation of Surrey, the GVRD and numerous commercial/industrial names.
12. Aquifer #48 underlies the proposed pipeline corridor from RK 1165.4 to RK 1167.8 and from RK 1166.4 to the Fraser River at RK 1168.6. This aquifer is described as a sand and gravel deposit

with low demand and moderate productivity and vulnerability. Few water wells are located in this area.

13. Aquifer #46 extends from RK 1169.1 close to the Fraser River to RK 1173.2 and is described as a sand and gravel deposit with low demand, moderate productivity and high vulnerability. Few water wells are located in this area.
14. Aquifer #49 extends from RK 1173.2 to RK 1179.4 at the southern edge of the Burnaby Terminal and is described as a sand and gravel deposit with low demand and moderate vulnerability. Burnaby is supplied by GVRD water from a remote surface water source and few wells are identified in the area.

Potential groundwater-related issues raised as part of the desktop study and subsequent field work for the Hope to Burnaby Segment is summarized in Table 5.3-22.

TABLE 5.3-22

POTENTIAL GROUNDWATER-RELATED ISSUES IN THE HOPE TO BURNABY SEGMENT

Location	Potential Groundwater-Related Issue	Summary of Issue	Summary for Field Visited Sites
RK 1047.6	Shallow (within 20 m) unconfined aquifer. RK in the mid-point of well field.	Unconfined aquifer	--
RK 1049.3 to RK 1051.6	Shallow (within 30 m) unconfined aquifer. Wells in the proposed pipeline corridor.	Unconfined aquifer	--
RK 1054.6 to RK 1062.8	Poorly confined to unconfined, shallow (within 10 m) aquifer along the corridor; high production rates up to 800 gallons per minute (pgm); 2 creek crossings.	Unconfined aquifer	Well-drained, moderate to high permeability, shallow groundwater, surface seepage, coarse sand and silt; domestic well noted.
RK 1057.6	Two wells within the proposed pipeline corridor, somewhat confined, no particular concerns.	Shallow well	--
RK 1062.8 to RK 1065.1	Poorly confined to unconfined aquifer within 20 m, high production rates likely.	Unconfined aquifer	--
RK 1077.3 to RK 1089.9	Potentially confined aquifer, 20-30 m thick. A few wells identified. Low to medium concerns.	Unconfined aquifer	--
RK 1080.1 to RK 1083.1	Entire length of corridor over an unconfined, prolific aquifer; 20-30 m thick. Numerous wells identified.	Unconfined aquifer	--
RK 1089.9 to RK 1094.2	Shallow sandy aquifer, top at 8-10 m, mostly unconfined, high rates. Entire area should be classified sensitive.	Unconfined aquifer	--
RK 1094.2 to RK 1094.9	Chilliwack/Vedder Aquifer; sensitive zone.	Unconfined aquifer	New subdivision - could have wells, coarse, sandy till, cobbles.
RK 1094.9 to RK 1097.9	Shallow sandy aquifer, top at 810 m, mostly unconfined, expected high production rates. Entire area should be classified sensitive; no wells marked in corridor.	Unconfined aquifer	--
RK 1097.9 to RK 1101.1	Chilliwack/Vedder Aquifer; sensitive zone.	Unconfined aquifer	--
RK 1101.2 to RK 1104.7	Chilliwack/Vedder Aquifer; sensitive zone, no confining layers, shallow; Chilliwack/Vedder River crossing at RK 1102.6.	Unconfined aquifer	--
RK 1104.7 to RK 1107.5	Chilliwack/Vedder Aquifer; sensitive zone, no confining layers, shallow.	Unconfined aquifer	--
RK 1114.6 to RK 1114.7	Sumas River crossing.	River	--
RK 1147.4	Wells in the proposed pipeline corridor; deeper confined aquifer at 60+ m bgl. Salmon River crossing at RK 1147.8.	Shallow well	--
RK 1159	Numerous wells in the corridor; some dry, some 120 m deep, some very shallow (< 20 m). High to medium sensitivity.	Shallow well	--
RK 1168.6 to RK 1169.3	Fraser River crossing.	River	--

More detailed information is provided in Appendix B in the Groundwater Technical Report of Volume 5C.

5.3.3.5 Burnaby to Westridge Segment

No surface water crossings have been identified along the proposed pipeline corridor and no trenchless crossings are proposed through this segment.

Ground elevations decrease from approximately 175 m asl at Burnaby to 0 m asl at the Westridge Marine Terminal. Groundwater flows generally follow local topography with recharge occurring directly over the aquifers and discharge feeding the local river systems and Burrard Inlet.

Regional surficial geology for the Burnaby to Westridge Segment is summarized in Table 5.3-23.

TABLE 5.3-23

SURFICIAL GEOLOGY FROM RK 0 to RK 3.6
ALONG THE BURNABY TO WESTRIDGE SEGMENT

RK Range	Surficial Sediment Description
RK 0 to RK 1	Capilano Sediments – raised beach deposits consisting of poorly sorted sand to gravel 1-8 m thick.
RK 1 to RK 2.8	Vashon Drift and Capilano sediments generally < 8 m thick but up to 25 m thick of till and interbeds of glaciofluvial sand to gravel.
RK 2.8 to RK 3.6 (Westridge Marine Terminal)	Undivided pre-Vashon till, glaciofluvial and marine sediments.

Source: Armstrong and Hicock 1980

Additional description of surficial geology for this segment is described in Section 5.1.1.5.

Aquifer #49 is mapped in the Burnaby area from RK 1.7 to RK 3.5. This aquifer is described as a Quadra Sands deposit with low demand, moderate productivity and vulnerability. Burnaby is supplied by GVRD water from a remote surface water source and few wells are identified in the area.

No additional aquifers are identified between RK 3.5 and the Westridge Marine Terminal at RK 3.6. More detailed information is provided in Appendix B in the Groundwater Technical Report of Volume 5C.

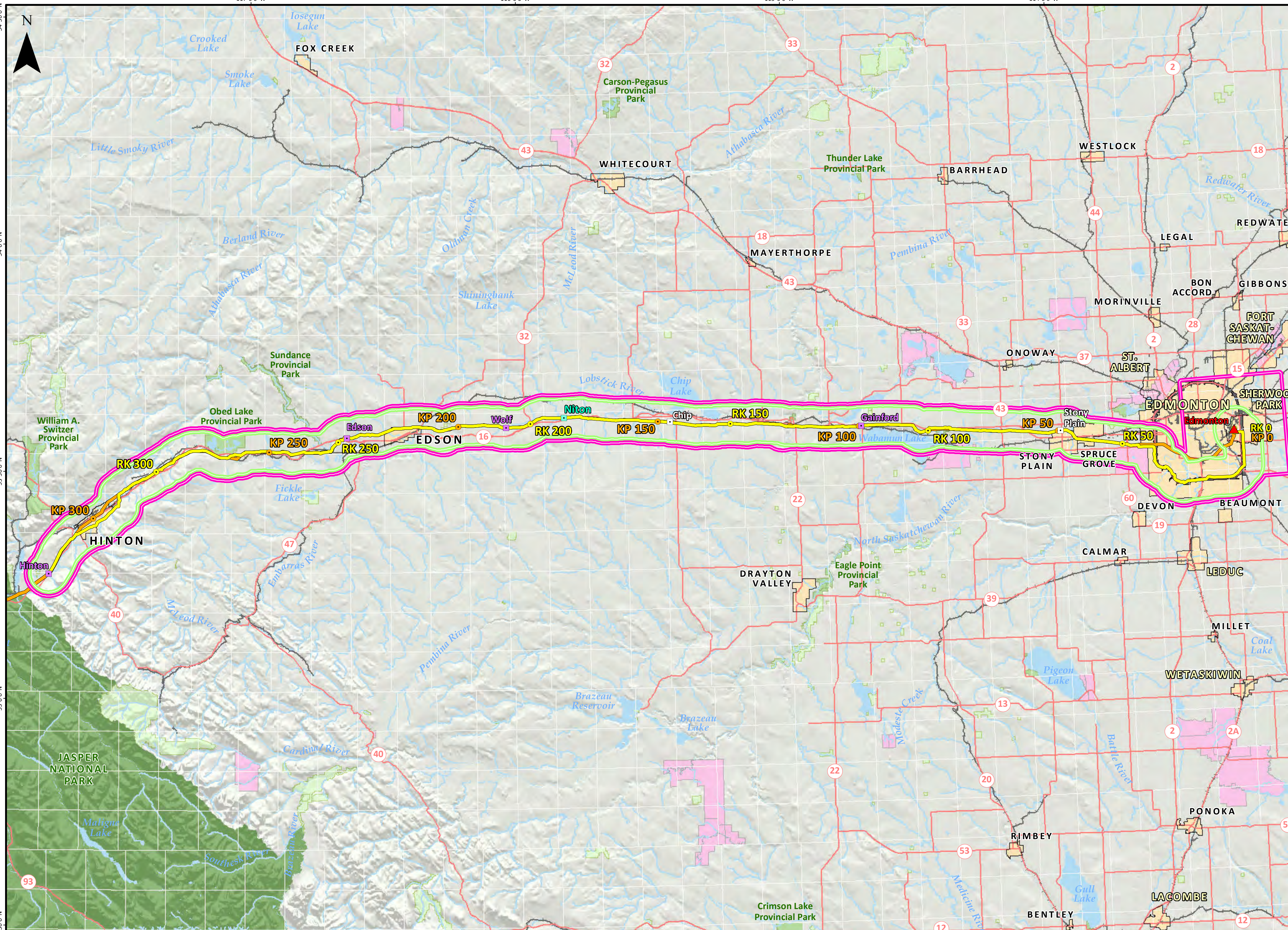
5.4 Air Emissions

This subsection discusses the existing air quality conditions along the proposed pipeline corridor. The indicators selected for this element discussed below include:

- primary emissions of CACs (PM, CO, NO_2 and SO_2) and VOCs (BTEX);
- secondary smog-related products (ozone and $PM_{2.5}$);
- H_2S and mercaptans (odour potential); and
- fugitive emissions from pump stations (discussed in Section 6.0).

The rationale for the selection of indicators is provided in Section 7.2.4. The potential Project-related effects and mitigation pertaining to air emissions arising from construction and operation of the proposed pipeline are discussed in Section 7.2.4. Refer to the Pipeline and Facilities Air Quality and Greenhouse Gas Technical Report of Volume 5C for additional details on the existing ambient air quality conditions.

This setting discusses the existing ambient air quality conditions within the Air Quality RSA, which is the area where the direct and indirect influences of other activities could overlap with the Project-specific effects from the pipeline and cause cumulative effects on the air quality indicators. The Air Quality RSA consists of a 5 km wide band generally extending from the Footprint (*e.g.*, 2.5 km on both sides of the Footprint). The spatial boundaries of the Air Quality RSA are shown on Figures 5.4-1 to 5.4-4, along with the spatial boundaries of the Acoustic Environment RSA (Section 5.6).



TRANS MOUNTAIN

FIGURE 5.4-1

AIR QUALITY AND ACOUSTIC ENVIRONMENT STUDY AREA BOUNDARIES - EDMONTON TO HINTON

TRANS MOUNTAIN EXPANSION PROJECT

- Village / Hamlet
- Kilometre Post (KP)
- Reference Kilometre Post (RK)
- Trans Mountain Pipeline (TMPL)
- Trans Mountain Expansion Project Proposed Pipeline Corridor
- Terminal
- Pump Station (Pump Addition, Station Modifications and/or Scraper Facilities)
- New Pump Station (Proposed)
- Pump Station (Reactivated)
- Existing Pump Station
- Highway
- Railway
- Air Quality RSA
- Acoustic Environment RSA
- City / Town / District Municipality
- Indian Reserve / Métis Settlement
- Transportation and Utility Corridor (TUC)
- National Park
- Provincial Park
- Protected Area / Natural Area / Provincial Recreation Area / Wilderness Provincial Park / Conservancy Area
- Provincial Boundary

Projection: NAD83 UTM Zone 11N. Routing: Baseline TMPL & Facilities: provided by KMC, 2012; Proposed Pipeline Corridor V6: provided by UPI, Aug. 23, 2013; Transportation: IHS Inc., 2013, BC Forests, Lands and Natural Resource Operations, 2012 & Natural Resources Canada, 2012; Geopolitical Boundaries: Natural Resources Canada, 2003, AltaLIS, 2013, IHS Inc., 2011, BC FLNRO, 2007 & ESRI, 2005; First Nation Lands: Government of Canada, 2013, AltaLIS, 2010 & IHS Inc., 2011; Hydrology: Natural Resources Canada, 2007 & BC Crown Registry and Geographic Base Branch, 2008; Parks and Protected Areas: Natural Resources Canada, 2012, AltaLIS, 2012 & BC FLNRO, 2008; ATS Grid: AltaLIS, 2009; Edmonton TUC: Alberta Infrstructure, 2011; Canadian Hillshade: TERA Environmental Consultants, 2008; US Hillshade: ESRI, 2009.

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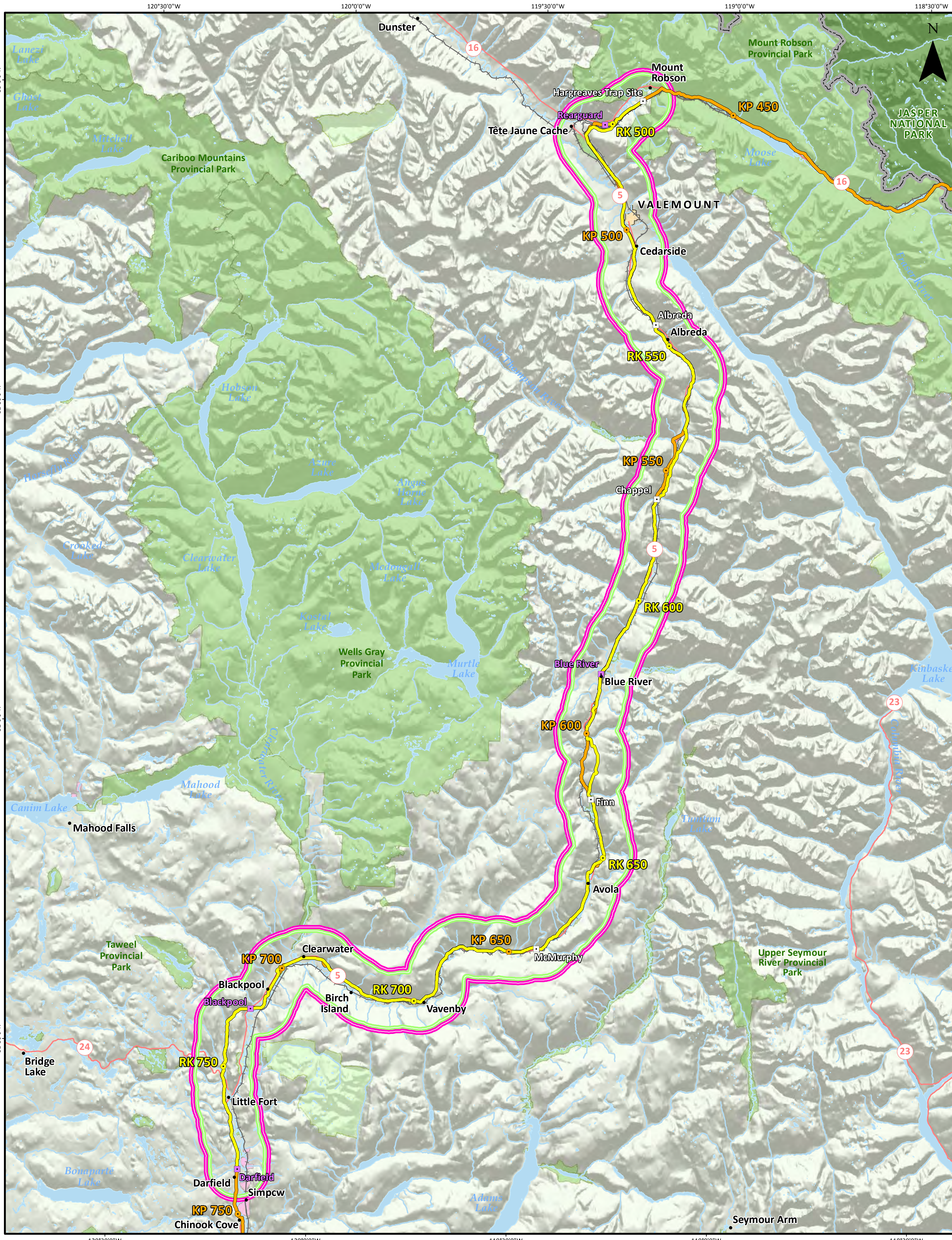

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Symbol	Legend	Symbol	Legend	Symbol	Legend
•	Village / Hamlet		New Pump Station (Proposed)		City / Town / District Municipality
	Kilometre Post (KP)		Pump Station (Reactivated)		Indian Reserve / Métis Settlement
	Reference Kilometre Post (RK)		Existing Pump Station		National Park
	Existing Trans Mountain Pipeline		Highway		Provincial Park
	Trans Mountain Expansion Project Proposed Pipeline Corridor		Railway		Protected Area / Natural Area / Provincial Recreation Area / Wilderness Provincial Park / Conservancy Area
	Terminal		Air Quality RSA		Provincial Boundary
	Pump Station (Pump Addition, Station Modifications and/or Scraper Facilities)		Acoustic Environment RSA		

Projection: NAD 1983 UTM 11N. Routing: Baseline TMPL & Facilities: provided by KMC, 2012; Proposed Pipeline Corridor V6: provided by UPI, Aug. 23, 2013; Transportation: IHS Inc., 2013, BC Forests, Lands and Natural Resource Operations, 2012 & Natural Resources Canada, 2012; Geopolitical Boundaries: Natural Resources Canada, 2003, AltaLIS, 2013, IHS Inc., 2011, BC FLNRO, 2007 & ESRI, 2005; First Nation Lands: Government of Canada, 2013, AltaLIS, 2010 & IHS Inc., 2011; Hydrology: Natural Resources Canada, 2007 & BC Crown Registry and Geographic Base Branch, 2008; Parks and Protected Areas: Natural Resources Canada, 2012, AltaLIS, 2012 & BC FLNRO, 2008; ATS Grid: AltaLIS, 2009; Edmonton TUC: Alberta Infrastructure, 2011; Canadian Hillshade: TERA Environmental Consultants, 2008; US Hillshade: ESRI, 2009.

TRANS MOUNTAIN

FIGURE 5.4-2

AIR QUALITY AND ACOUSTIC ENVIRONMENT STUDY AREA BOUNDARIES - HARGREAVES TO DARFIELD

TRANS MOUNTAIN EXPANSION PROJECT

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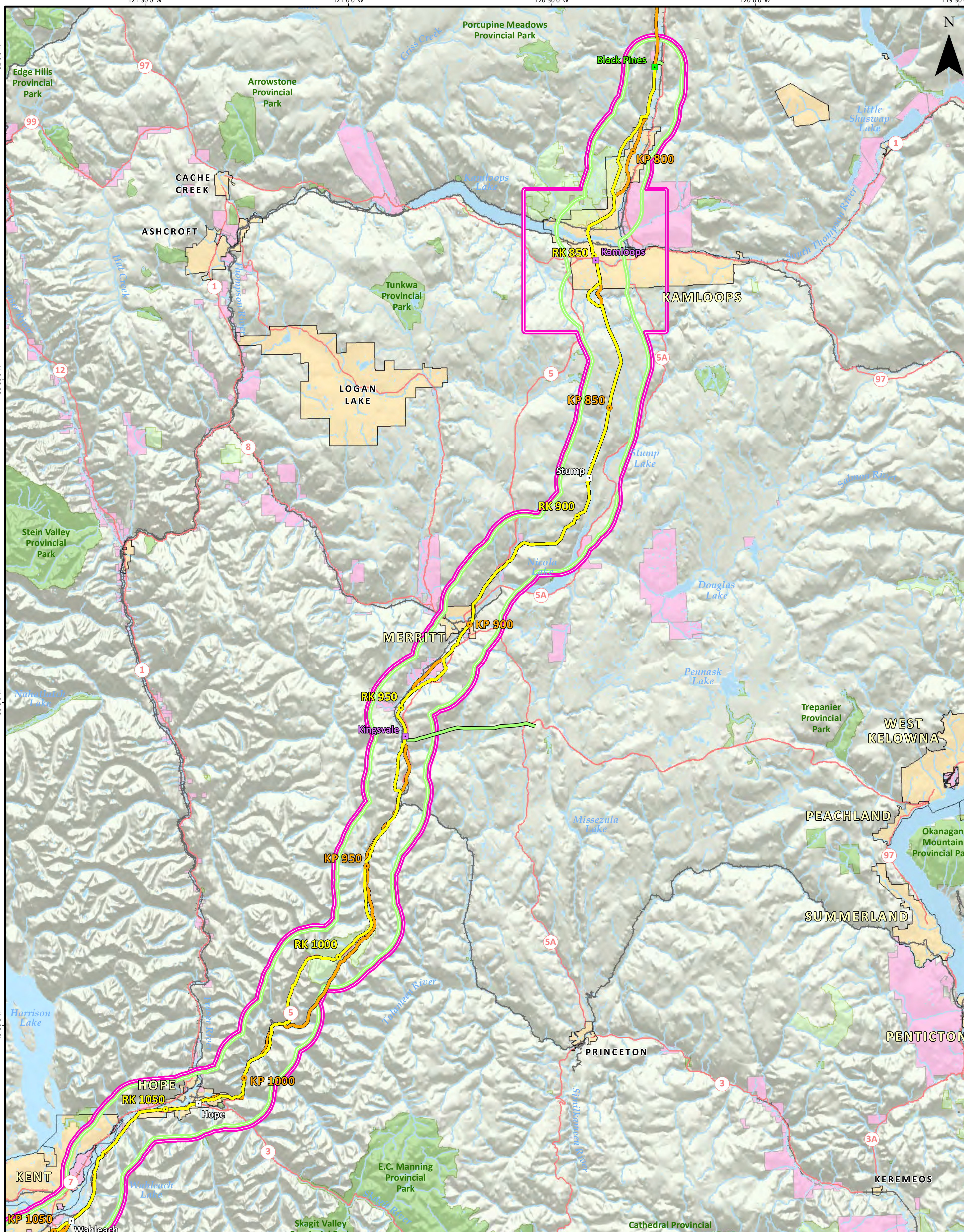

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Legend		
Village / Hamlet	New Pump Station (Proposed)	City / Town / District Municipality
Kilometre Post (KP)	Pump Station (Reactivated)	Indian Reserve / Métis Settlement
Reference Kilometre Post (RK)	Existing Pump Station	National Park
Trans Mountain Pipeline (TMPL)	Highway	Provincial Park
Trans Mountain Expansion Project Proposed Pipeline Corridor	Railway	Protected Area / Natural Area / Provincial Recreation Area / Wilderness Provincial Park / Conservancy Area
Proposed Power Line	Air Quality RSA	Provincial Boundary
Terminal	Acoustic Environment RSA	
Pump Station (Pump Addition, Station Modifications and/or Scraper Facilities)		

Projection: NAD 1983 UTM 11N. Routing: Baseline TMPL & Facilities: provided by KMC, 2012; Proposed Pipeline Corridor V6: provided by UPI, Aug. 23, 2013; Transportation: IHS Inc., 2013, BC Forests, Lands and Natural Resource Operations, 2012 & Natural Resources Canada, 2012; Geopolitical Boundaries: Natural Resources Canada, 2003, AltaLIS, 2013, IHS Inc., 2011, BC FLNRO, 2007 & ESRI, 2005; First Nation Lands: Government of Canada, 2013, AltaLIS, 2010 & IHS Inc., 2011; Hydrology: Natural Resources Canada, 2007 & BC Crown Registry and Geographic Base Branch, 2008; Parks and Protected Areas: Natural Resources Canada, 2012, AltaLIS, 2012 & BC FLNRO, 2008; ATS Grid: AltaLIS, 2009; Edmonton TUC: Alberta Infrstructure, 2011; Canadian Hillshade: TERA Environmental Consultants, 2008; US Hillshade: ESRI, 2009.

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TRANS MOUNTAIN

FIGURE 5.4-3

AIR QUALITY AND ACOUSTIC ENVIRONMENT STUDY AREA BOUNDARIES - BLACK PINES TO HOPE

TRANS MOUNTAIN EXPANSION PROJECT

MAP NUMBER			PAGE
201310_MAP_TERA_AIR_00472_03_REV0			SHEET 3 OF 4
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ALL LOCATIONS APPROXIMATE

TRANS MOUNTAIN

FIGURE 5.4-4

AIR QUALITY AND ACOUSTIC ENVIRONMENT STUDY AREA BOUNDARIES HOPE TO WESTRIDGE

TRANS MOUNTAIN EXPANSION PROJECT

- Kilometre Post (KP)
- Reference Kilometre Post (RK)
- Trans Mountain Pipeline (TMPL)
- Trans Mountain Expansion Project Proposed Pipeline Corridor
- Terminal
- Pump Station (Pump Addition, Station Modifications, and/or Scraper Facilities)
- New Pump Station (Proposed)
- Pump Station (Reactivated)
- Existing Pump Station
- Highway
- Railway
- Air Quality RSA
- Acoustic Environment RSA
- City / Town / District Municipality
- Indian Reserve / Métis Settlement
- National Park
- Provincial Park
- Protected Area / Natural Area / Provincial Recreation Area / Wilderness Provincial Park / Conservancy Area
- Provincial Boundary
- International Boundary

Projection: NAD83 UTM Zone 11N. Routing: Baseline TMPL & Facilities: provided by KMC, 2012; Proposed Pipeline Corridor V6: provided by UPI, Aug. 23, 2013; Transportation: IHS Inc., 2013, BC Forests, Lands and Natural Resource Operations, 2012 & Natural Resources Canada, 2012; Geopolitical Boundaries: Natural Resources Canada, 2003, AltaLIS, 2013, IHS Inc., 2011, BC FLNRO, 2007 & ESRI, 2005; First Nation Lands: Government of Canada, 2013, AltaLIS, 2010 & IHS Inc., 2011; Hydrology: Natural Resources Canada, 2007 & BC Crown Registry and Geographic Base Branch, 2008; Parks and Protected Areas: Natural Resources Canada, 2012, AltaLIS, 2012 & BC FLNRO, 2008; ATS Grid: AltaLIS, 2009; Edmonton TUC: Alberta Infrstructure, 2011; Canadian Hillshade: TERA Environmental Consultants, 2008; US Hillshade: Copyright:© 2013 Esri.

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5.4.1 General Overview of Air Quality

The Project setting for air quality is characterized based on a review of historical measurements of ambient concentrations along the pipeline corridor. Meteorological conditions along the pipeline corridor were also reviewed as meteorological conditions determine how airborne contaminants are transported and dispersed in the atmosphere.

Historical ambient monitoring data were collected from the Clean Air Strategic Alliance (CASA), the BC MOE, Metro Vancouver and Environment Canada's National Air Pollution Surveillance (NAPS) Program. The proposed pipeline corridor was divided into 11 areas for the purpose of characterizing ambient concentrations along the corridor and a number of stations were selected to represent each area. A summary of the air quality stations selected and the parameters monitored are shown in Table 5.4-1. Parameters monitored include PM, CO, nitrogen dioxide (NO_2), SO_2, H_2S, total reduced sulphur (TRS), ozone and BTEX.

TABLE 5.4-1

LIST OF AIR QUALITY STATIONS ALONG THE PROPOSED PIPELINE CORRIDOR

Pipeline Segment	Station ID	Station Name	Data Source	Latitude/Longitude (Decimal Degrees)	Elevation (m)	Parameters Monitored	Period of Data
Edmonton to Hinton	*Edmonton Area* (*surrounding Edmonton Terminal*)						
	1a	Edmonton East	CASA (ID 1029)	53.548, -113.368	679	$PM_{2.5}$, CO, NO_2, SO_2, H_2S, ozone	2002 to 2011
	1b	Edmonton East	NAPS (ID 90121)	53.548, -113.368	670	BTEX	2002 to 2011
	2a	Edmonton Central	CASA (ID 1028)	53.544, -113.499	663	$PM_{2.5}$, CO, NO_2, ozone	2002 to 2011
	2b	Edmonton Central	NAPS (ID 90130)	53.545, -113.499	663	BTEX	2002 to 2011
	3	Edmonton McIntyre	CASA (ID 1224)	53.486, -113.465	681	$PM_{2.5}$	2006 to 2011
	4	Edmonton South	CASA (ID 1036)	53.5, -113.526	681	PM_{10}, $PM_{2.5}$, CO, NO_2, SO_2, ozone	September 2005 to 2011 (SO_2 from March 2007)
	5	Edmonton Northwest	CASA (ID 1031)	53.594, -113.54	679	PM_{10}, $PM_{2.5}$, CO, NO_2, ozone	2002 to 2005
	6	Fort Saskatchewan	CASA (ID N/A)	53.699, -113.223	629	$PM_{2.5}$, CO, NO_2, SO_2, H_2S, ozone	2002 to 2011
	7	Sherwood Park	CASA (ID 1035)	53.532, -113.321	710	SO_2, H_2S	2002 to February 2004
	8	Elk Island National Park	NAPS (ID 91101)	53.682, -112.868	714	BTEX	2005
	Gainford Area (*surrounding Gainford Pump Station*)						
	9	Meadows	CASA (ID 1058)	53.53, -114.637	735	NO_2, SO_2	July 2004 to 2011
	10	Power	CASA (ID 1059)	53.633, -114.42	776	$PM_{2.5}$, NO_2, SO_2	July 2004 to 2011
	11	Wagner	CASA (ID 1060)	53.395, -114.409	728	NO_2, SO_2	July 2004 to January 2009
	12	Wagner 2	CASA (ID 1241)	53.494, -114.45	684	NO_2, SO_2	2009 to 2011
	13	Tomahawk	CASA (ID 1053)	53.372, -114.769	790	PM_{10}, $PM_{2.5}$, NO_2, SO_2, ozone	2002 to 2011 (PM_{10} until June 2009)
	Edson Area (*surrounding Edson Pump Station*)						
	14	Edson	CASA (ID 1062)	53.594, -116.393	894	$PM_{2.5}$, SO_2	$PM_{2.5}$ from November 2004 to 2011 SO_2 from November 2008 to 2011
	15	Carrot Creek	CASA (ID 1054)	53.621, -115.869	859	NO_2, SO_2, ozone	2002 to 2011

TABLE 5.4-1 Cont'd

Pipeline Segment	Station ID	Station Name	Data Source	Latitude/Longitude (Decimal Degrees)	Elevation (m)	Parameters Monitored	Period of Data
Edmonton to Hinton (cont'd)	*Hinton Area (surrounding Hinton Pump Station)*						
	16	Hinton	CASA (ID 1056)	53.427, -117.544	984	PM_{10}, $PM_{2.5}$, TRS	PM_{10} from 2004 to 2009 $PM_{2.5}$ from February 2010 to 2011 TRS from 2004 to 2011
	17	Steeper	CASA (ID 1055)	53.133, -117.091	1431	PM_{10}, $PM_{2.5}$, NO_2, SO_2, ozone	PM_{10} from 2002 to August 2003 and August 2009 to July 2010 $PM_{2.5}$ from August 2010 to 2011 NO_2, SO_2 and ozone from 2002 to August 2003 and March 2009 to 2011
	18a	Hightower Ridge	CASA (ID 1051)	53.647, -118.178	1525	PM_{10}, $PM_{2.5}$, NO_2, SO_2, ozone	2002 to September 2004 and December 2007 to 2011 (PM_{10} from 2002 to September 2004)
	18b	Hightower Ridge	NAPS (ID 91201)	53.647, -118.178	1516	BTEX	June 2003 to June 2004
Hargreaves to Darfield	N/A	No stations available					
Black Pines to Hope	*Kamloops Area (surrounding Kamloops Terminal)*						
	19	Kamloops Brocklehurst	BC MOE	50.698, -120.397	347	PM_{10}, $PM_{2.5}$, CO, NO_2, SO_2, ozone	2002 to May 2011 (PM_{10} until June 2009)
	20	Kamloops Fire Station #2	BC MOE	50.703, -120.394	348	$PM_{2.5}$, NO_2, SO_2, TRS, ozone	June to December 2011
	Merritt Area (surrounding Kingsvale Pump Station)						
	N/A	No stations available					
	Hope Area						
	21a	Hope Airport	MV (ID T29)	49.37, -121.499	131	PM_{10}, $PM_{2.5}$, CO, NO_2, ozone	2002 to 2011 ($PM_{2.5}$ from February 2004)
	21b	Hope Airport	NAPS (ID 101401)	49.37, -121.499	131	BTEX	February 2002 to March 2007
Hope to Burnaby	*Chilliwack Area*						
	22a	Chilliwack Airport	MV (ID T12)	49.156, -121.941	10	PM_{10}, $PM_{2.5}$, CO, NO_2, SO_2, ozone	2002 to 2011
	22b	Chilliwack Airport(1)	NAPS (ID 101101)	49.156, -121.941	16	BTEX	March 2002 to 2011
	Abbotsford Area (surrounding Sumas Terminal and Sumas Pump Station)						
	23	Abbotsford Airport	MV (ID T34)	49.024, -122.343	65	$PM_{2.5}$, NO_2, SO_2, ozone	$PM_{2.5}$ and SO_2 from 2002 to April 2010(2) NO_2 from December 2003 to 2011 Ozone from August 2006 to 2011
	24	Abbotsford Airport	NAPS (ID 101004)	49.033, -122.353	59	BTEX	March 2007 to April 2010

TABLE 5.4-1 Cont'd

Pipeline Segment	Station ID	Station Name	Data Source	Latitude/Longitude (Decimal Degrees)	Elevation (m)	Parameters Monitored	Period of Data
Hope to Burnaby (cont'd)	25	Abbotsford Central	MV (ID T45)	49.043, -122.310	80	PM_{10}, CO, NO_2, SO_2, ozone	2002 to 2011
Burnaby to Westridge	*Burnaby Area* (*surrounding Burnaby and Westridge Marine Terminals*)						
	26a	Burmount	MV (ID T22)	49.267, -122.936	101	TRS	2002 to 2011
	26b	Burmount	NAPS (ID 100133)	49.267, -122.936	101	BTEX	2002 to 2011
	27	North Burnaby Capitol Hill	MV (ID T23)	49.288, -122.986	200	SO_2, TRS	2002 to 2011
	28	Burnaby North Eton	MV (ID T24)	49.288, -123.008	70	PM_{10}, SO_2, TRS	2002 to 2011 (PM_{10} from June 2010)
	29	Burnaby Kensington Park	MV (ID T04)	49.279, -122.971	133	PM_{10}, $PM_{2.5}$, CO, NO_2, SO_2, TRS, ozone	2002 to 2011 ($PM_{2.5}$ from June 2003)
	30	Port Moody	MV (ID T09)	49.281, -122.849	15	PM_{10}, $PM_{2.5}$, CO, NO_2, SO_2, ozone	2002 to 2011(3) ($PM_{2.5}$ from July 2003)
	31	Coquitlam	MV (ID T32)	49.288, -122.791	61	CO, NO_2, ozone	2002 to 2011
	32	North Vancouver Mahon Park	MV (ID T26)	49.324, -123.084	80	PM_{10}, CO, NO_2, SO_2, ozone	2002 to 2011
	33	Second Narrows	MV (ID T06)	49.302, -123.020	15	$PM_{2.5}$, CO, NO_2, SO_2, ozone	2002 to 2011 ($PM_{2.5}$ from April 2006)
	34	Burnaby South	MV (ID T18)	49.215, -122.986	122	PM_{10}, $PM_{2.5}$, CO, NO_2, SO_2, ozone	2002 to 2011(4)

Sources: BC MOE 2013d, CASA 2013, Environment Canada 2013k, Metro Vancouver 2012b

Notes:

1. The NAPS website identifies this station to be Chilliwack Works Yard but it is located at the Chilliwack Airport.
2. $PM_{2.5}$ data is missing from January to April 2007; data completeness is 77%.
3. PM_{10} data is missing in 2009; data completeness is 85%. $PM_{2.5}$ data is missing from September to December 2008; data completeness is 77%.
4. SO_2 data is missing from May to November 2002; data completeness is 92%.

5.4.1.1 Edmonton to Hinton Segment

Meteorological Conditions

Most of Alberta has a semi-arid continental climate, characterized by warm summers and cold winters. Arctic air masses in the winter and continental air masses in the summer result in large temperature variability throughout the year. Located in the “rain-shadow” of the Rocky Mountains, the proposed pipeline corridor between Edmonton and Hinton tends to receive little precipitation. Meteorological conditions for this segment are discussed in Section 5.1.3.1.

Monthly visibility data, based on 30 year climate normals at the Edmonton International Airport, are shown in Table 5.4-2. November has the most hours with the lowest visibility while July has the most hours with the highest visibility. Deep temperature inversions in the winter months along with calm conditions can create a layer of cold, stagnant air near the ground. This, along with increased fuel consumption and vehicle idling during cold spells, can lead to conditions that will lead to low visibility. Quite often in Edmonton, these conditions usually occur when a warm front approaches, trapping emissions close to the surface. Edson Airport climate normal visibility readings are summarized in Table 5.4-3. Similar to Edmonton, visibility at Edson is greater in the summer than in the winter. Reduced visibility in the winter is likely due to deep temperature inversions along with increased NO_2 concentrations, which is a large contributor to light absorption in the atmosphere.

TABLE 5.4-2

MONTHLY VISIBILITY OBSERVATIONS FROM EDMONTON INTERNATIONAL AIRPORT CLIMATE NORMALS, 1971 TO 2000

Visibility	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Hours with < 1 km	8.2	7.9	9.1	4.8	2.4	1.1	1	4	1.9	3.2	15.7	8	67.2
Hours with 1-9 km	91.7	85	76.9	33.8	22	17	19.1	24.9	20	26.3	80.8	87.2	584.5
Hours with > 9 km	644.2	585.4	658.1	681.4	719.6	702	723.8	715.2	698.1	714.4	623.5	648.9	8,114.5

Source: Environment Canada 2013l

TABLE 5.4-3

MONTHLY VISIBILITY OBSERVATIONS FROM EDSON AIRPORT CLIMATE NORMALS, 1971 TO 2000

Visibility	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Hours with < 1 km	5.6	5.4	7.8	4.8	5	4.6	6.4	8.4	12.9	12.2	12.7	6.3	91.9
Hours with 1-9 km	72.2	60.5	62.5	32.2	18.1	16.6	15.4	25.9	39.8	36.2	67.3	69.3	515.9
Hours with > 9 km	666.1	611.9	673.7	683	720.9	698.9	722.3	709.8	667.3	695.7	640.1	668.5	8,157.9

Source: Environment Canada 2013l

5.4.1.2 Hargreaves to Darfield Segment

Meteorological Conditions

The proposed pipeline corridor between Hargreaves and Darfield is located in the Rocky Mountains which tend to experience longer and sometimes colder winters. Moisture-laden air masses from the coast of BC travel upslope and are forced to cool, generating heavy precipitation over the mountains. Meteorological conditions for this segment are discussed in Section 5.1.3.2.

There are no visibility observation data available for the Hargreaves to Darfield Segment.

5.4.1.3 Black Pines to Hope Segment

Meteorological Conditions

Located east of the Coast Mountains, the Black Pines to Hope Segment has a drier and more continental climate with warm dry summers and cool winters. The southern interior region commonly experiences BC's hottest summers. Meteorological conditions for this segment are discussed in Section 5.1.3.3.

Kamloops experiences the most hours with low visibility in January and the most hours with high visibility in July, as shown in Table 5.4-4. Reduced visibility in the winter is possibly due to higher NO_2 concentrations observed during this time.

TABLE 5.4-4

MONTHLY VISIBILITY OBSERVATIONS FROM KAMLOOPS AIRPORT CLIMATE NORMALS, 1971 TO 2000

Visibility	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Hours with < 1 km	14.6	5.7	1.9	0.3	0	0	0	0	0.2	2.2	3.7	5.5	34.1
Hours with 1-9 km	85	45.9	10.1	1.2	0.9	1.1	0.4	0.7	2.2	21.4	31.7	67.8	268.4
Hours with > 9 km	644.4	626.6	732.0	718.5	743.1	718.9	743.6	743.3	717.7	720.4	684.6	670.7	8,463.7

Source: Environment Canada 2013l

5.4.1.4 Hope to Burnaby and Burnaby to Westridge Segments

Meteorological Conditions

The climate along the Hope to Burnaby and Burnaby to Westridge segments in the Lower Fraser Valley is known as an oceanic, or west coast, climate, characterized by mild temperatures with little seasonal variability. Rainfall dominates the winter in this region due to cyclonic low-pressure systems from the North Pacific. Meteorological conditions for this segment are discussed in Section 5.1.3.4.

The City of Abbotsford experiences the most hours with low visibility in October and the most hours with high visibility in July, as shown in Table 5.4-5. Reduced visibility in October may be a result of elevated VOC concentrations in October. Greater visibility in the summer corresponds to months with the least precipitation that can cause light scattering.

TABLE 5.4-5

MONTHLY VISIBILITY OBSERVATIONS FROM ABBOTSFORD AIRPORT CLIMATE NORMALS, 1971 TO 2000

Visibility	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Hours with < 1 km	22.2	13.4	4.7	1.3	0.4	1.3	1.6	6.1	14.2	29.2	10.1	21.5	126.1
Hours with 1-9 km	109.2	79.7	54.4	35.6	33.7	36	29.7	49.5	77.1	113.7	94.3	110.7	823.4
Hours with > 9 km	612.7	585.1	684.9	683.2	709.9	682.7	712.7	688.4	628.7	601.1	615.7	611.9	7,816.8

Source: Environment Canada 2013l

Monthly visibility readings based on climate normals from the Vancouver International Airport are shown in Table 5.4-6. The most hours with low visibility are observed in January, whereas, the most hours with high visibility are observed in July. This corresponds with the precipitation regime in the area. There may also be some correlation with elevated NO_2 and VOC concentrations in the winter.

TABLE 5.4-6

MONTHLY VISIBILITY OBSERVATIONS FROM VANCOUVER INTERNATIONAL AIRPORT CLIMATE NORMALS, 1971 TO 2000

Visibility	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Hours with < 1 km	30.8	11.5	2.8	0.3	0.1	0.2	0.2	0.4	4.7	27	14.1	25	117.1
Hours with 1-9 km	134.4	81	46.4	26.7	18	19.1	13.2	23.4	50.7	111.4	94.5	122.7	741.6
Hours with > 9 km	578.8	584.6	694.8	693	725.9	700.7	730.6	720.2	664.6	605.7	611.5	596.3	7,906.5

Source: Environment Canada 2013l

5.4.2 Criteria Air Contaminants and Volatile Organic Compounds

CACs are a group of commonly found contaminants typically formed from combustion for which there are ambient air quality criteria, including PM, CO, NO_2 and SO_2. Observed CAC concentrations for 2011, or the most recent year if 2011 was not available, are summarized in Figures 5.4-5 to 5.4-9. No exceedances of the air quality objectives for CO, NO_2 or SO_2 were observed in 2011. Some exceedances of PM_{10} and $PM_{2.5}$ were observed infrequently. Overall, existing air quality conditions along the proposed pipeline corridor, with respect to CAC concentrations, was very good with few exceedances of the relevant ambient air quality objectives. Each area is discussed separately in more detail in the following subsections.

VOCs are a group of organic compounds with sufficiently high vapour pressures under ambient conditions to evaporate from the liquid form of the compound and enter the surrounding air, and participate in atmospheric photochemical reactions. Of particular interest are BTEXs, typical VOCs found in petroleum derivatives, also collectively known as BTEX. Existing BTEX concentrations along the proposed pipeline corridor were analyzed based on a review of historical ambient monitoring data from Environment Canada's NAPS network. BTEX is primarily measured at more urban or populated areas where ambient air quality is a greater concern. Areas for which BTEX data are available are discussed in the following subsections. For all other areas, the main sources of BTEX emissions is the use of gasoline in vehicles and agricultural equipment, occasional biomass burning from land clearing or other activities, and occasional forest fires in the summer. The magnitude of BTEX concentrations in these areas are expected to be relatively low compared to BTEX concentrations in the more urban and/or industrialized areas for which there are BTEX monitoring results.

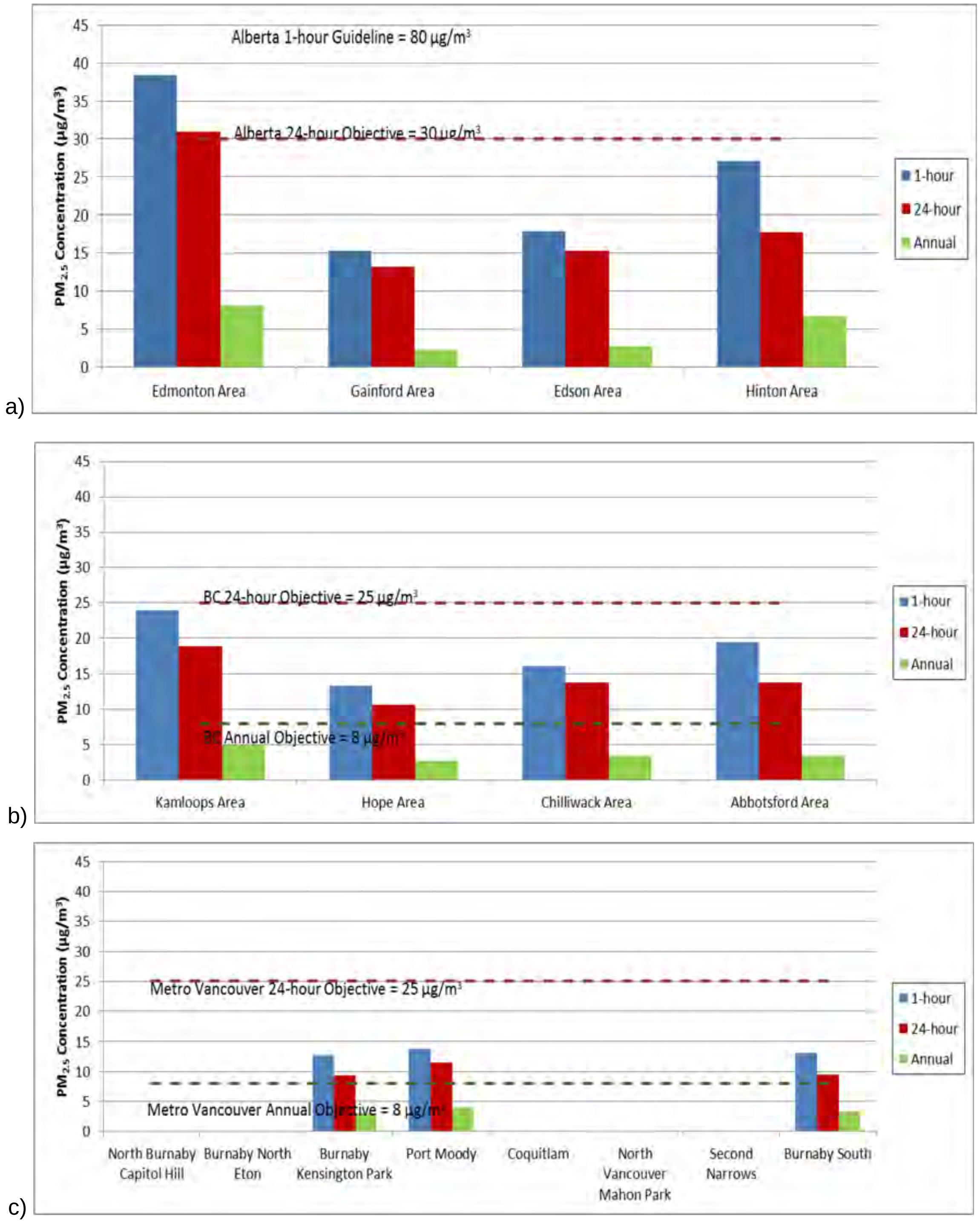
Figure 5.4-5 Observed PM_{10} concentrations in 2011 for (a) Alberta, (b) BC, Outside Metro Vancouver and (c) Metro Vancouver (in µg/m[3])

a)
b)
c)

Notes: There was no PM_{10} data from the Gainford and Hinton areas in 2011. Data from 2008 and 2009 respectively are presented.

There are no PM_{10} objectives for Alberta and, therefore, the BC objective is shown to place observed concentrations in context. There is no annual PM_{10} objective in BC.

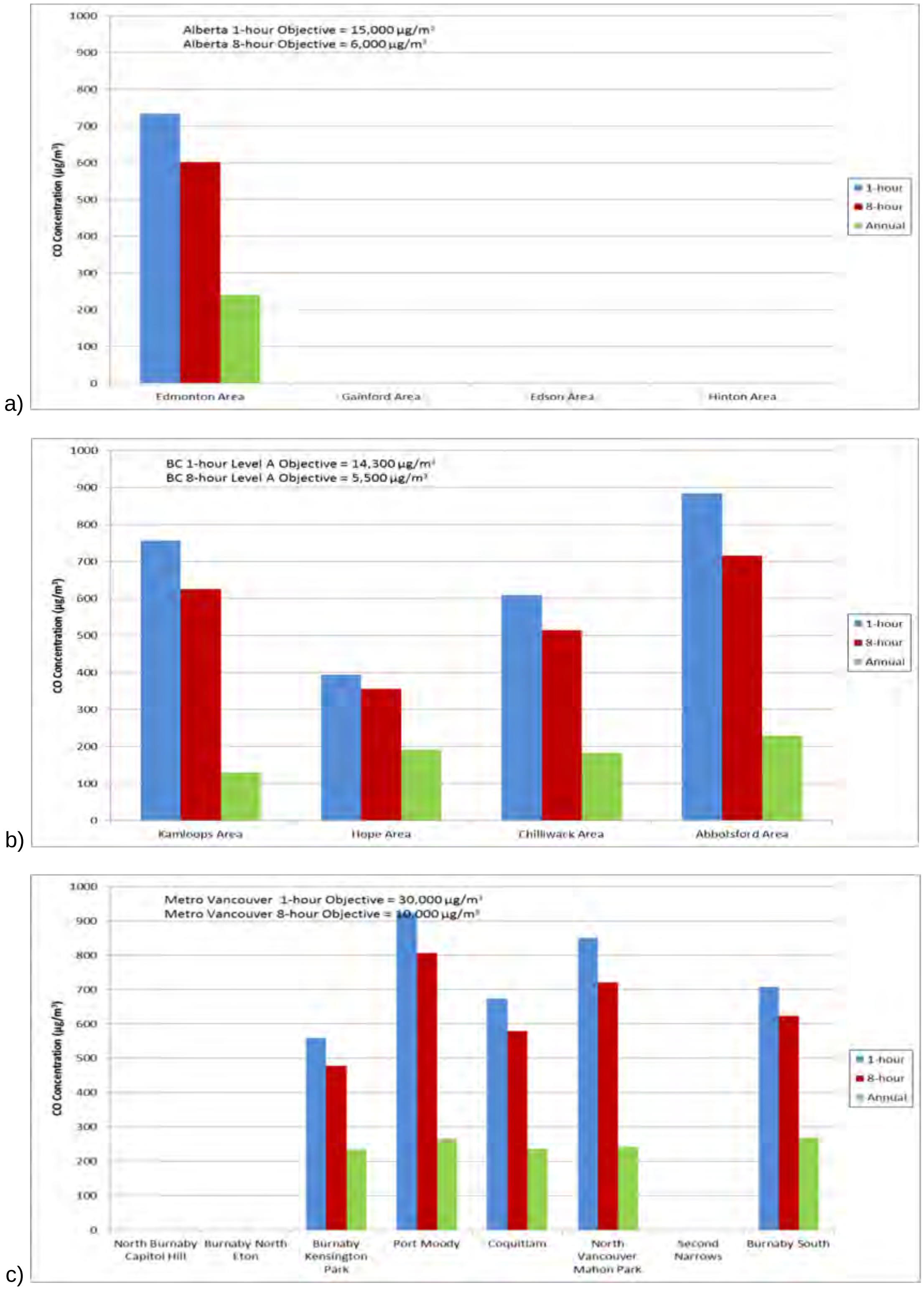
Figure 5.4-6 Observed $PM_{2.5}$ concentrations in 2011 for (a) Alberta, (b) BC, Outside Metro Vancouver and (c) Metro Vancouver (in µg/m^3)



Notes: There is no $PM_{2.5}$ data from the Abbotsford area in 2011. Data from 2009 are presented.

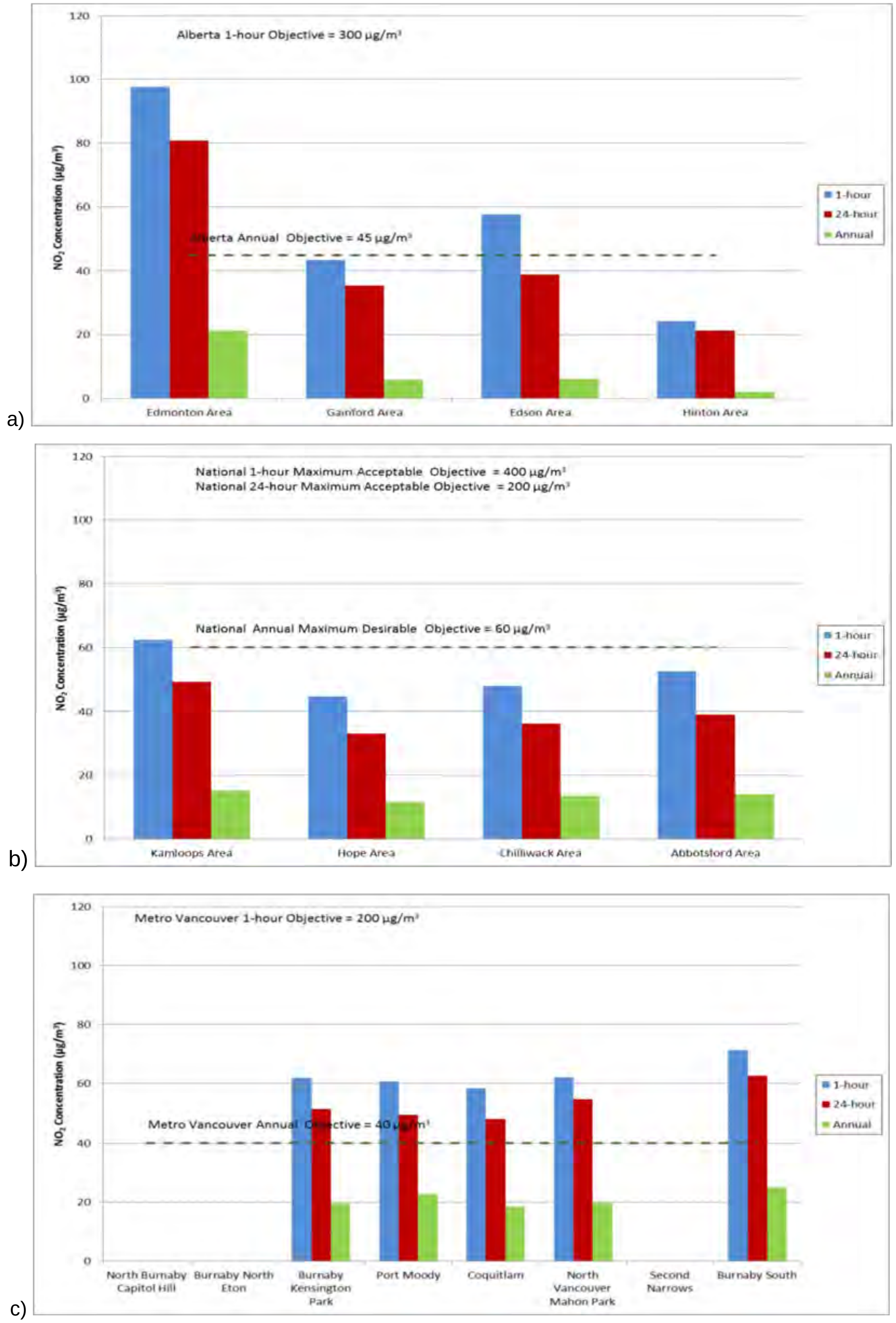
There is no 1 hour $PM_{2.5}$ objective in BC or Metro Vancouver.

Figure 5.4-7 Observed CO concentrations in 2011 for (a) Alberta, (b) BC, Outside Metro Vancouver and (c) Metro Vancouver (in µg/m^3)



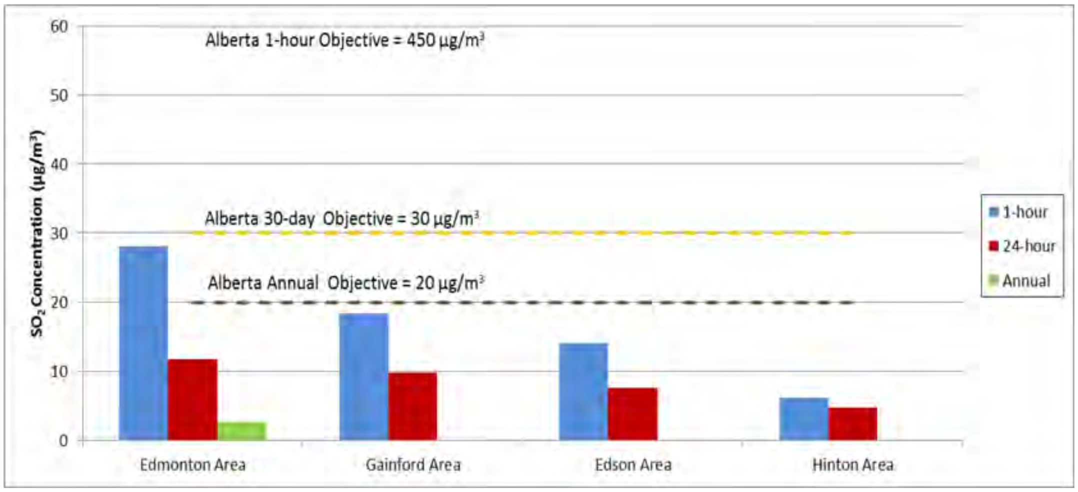
Notes: There is incomplete CO data from the Kamloops area in 2011. Data from 2010 are presented.
There is no annual CO objective in Alberta, BC or Metro Vancouver.

Figure 5.4-8 Observed NO_2 concentrations in 2011 for (a) Alberta, (b) BC, Outside Metro Vancouver and (c) Metro Vancouver (in µg/m^3)

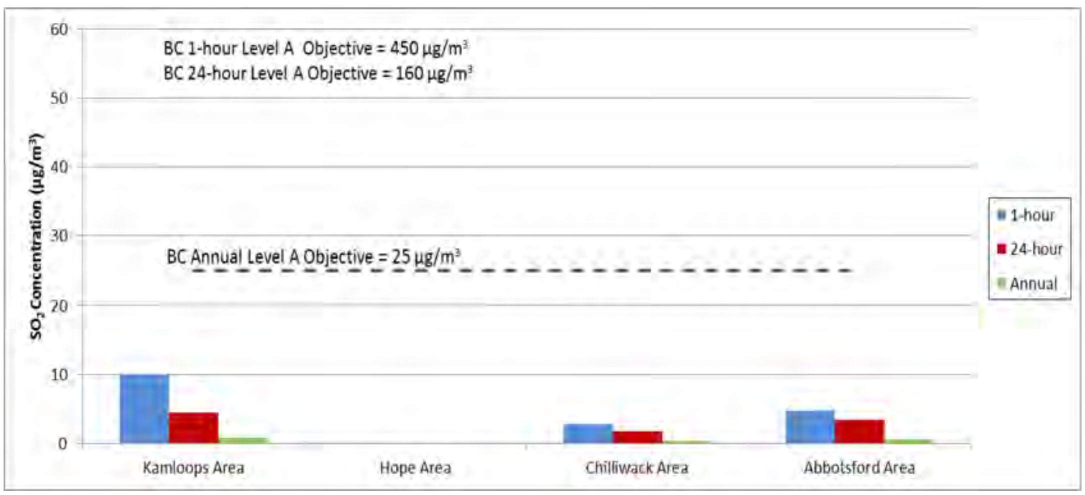


Notes: There are no provincial NO_2 objectives in BC; national objectives are applicable.
There is no 24 hour NO_2 objective in Alberta or Metro Vancouver.

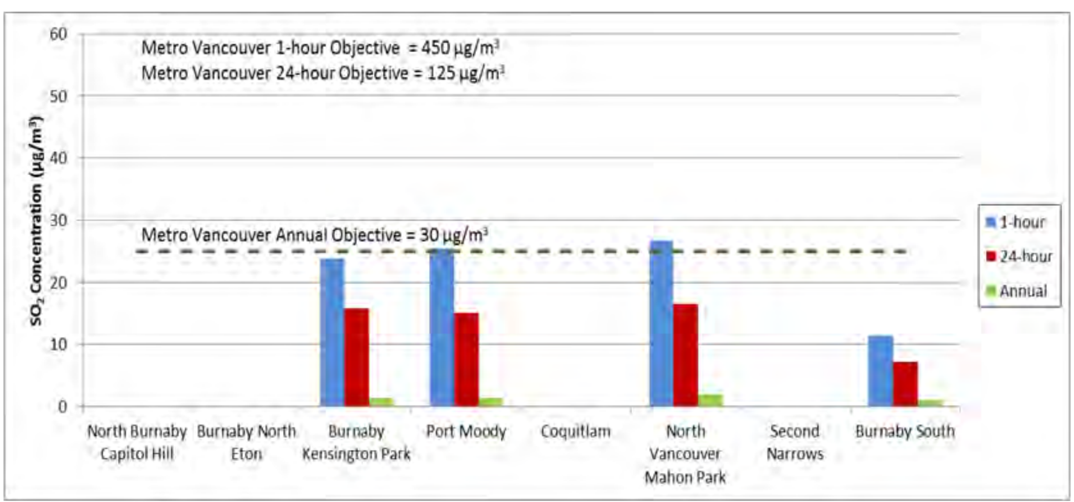
Figure 5.4-9 Observed SO_2 concentrations in 2011 for (a) Alberta, (b) BC, Outside Metro Vancouver and (c) Metro Vancouver (in µg/m^3)



a)



b)



c)

Notes: There is no 24 hour SO_2 objective in Alberta; there is a 30 day objective instead.
There is no equivalent 30 day SO_2 objective in BC or Metro Vancouver.

5.4.2.1 Edmonton to Hinton Segment

There are four main areas in which ambient monitoring data are available along the Edmonton to Hinton Segment: in and around the City of Edmonton; Hamlet of Gainford; Town of Edson; and Town of Hinton. With the exception of PM_{10}, the highest CAC concentrations along the Edmonton to Hinton Segment were observed in the Edmonton area. This is primarily attributable to urban emissions in the area such as residential heating and traffic. The highest PM_{10} concentrations along the Edmonton to Hinton Segment and along the proposed pipeline corridor were observed at the Hinton monitoring station and are likely attributable to nearby industrial sources such as the West Fraser Mills pulp and paper plant. These high concentrations are likely localized to the Town of Hinton and are expected to be lower in the surrounding area.

With the exception of the Hinton area, existing air quality along the Edmonton to Hinton Segment with respect to PM concentrations are generally good, with rare exceedances of the Alberta ambient air quality objectives for $PM_{2.5}$, occurring up to 1% of the time in the Edmonton area. Occasional high levels of PM may be attributable to increased traffic along nearby roads and/or activities at nearby industrial and construction sites. Long range transport of PM related to smoke from large forest fires have also been attributed to elevated PM levels over Edmonton during the summer. With respect to CO, NO_2 and SO_2 concentrations, existing air quality conditions are very good along the entire segment. There were no exceedances of the Alberta ambient air quality objectives for CO, NO_2 and SO_2.

BTEX measurements in the Edmonton area are available from the Edmonton East and Edmonton Central NAPS stations. For most years, concentrations at Edmonton East tended to be higher than those at Edmonton Central. Maximum concentrations for the Edmonton East station ranged from 15.6-116.1 $\mu g/m^3$ over the 10 year period from 2002 to 2011. High BTEX levels at the Edmonton East station are expected to be attributable to nearby industrial sources, most notably, the Suncor Energy and Imperial Oil refineries.

In the Hinton area, BTEX measurements are available from the Hightower Ridge NAPS station, which measured BTEX concentrations from June 2003 to June 2004. Observed BTEX concentrations ranged from 0.2 $\mu g/m^3$ to 2.6 $\mu g/m^3$ over the 1 year period. Due to the high elevation of the Hightower Ridge station and the absence of nearby emission sources, BTEX observations at this station may be somewhat lower than ambient BTEX concentrations near the proposed pipeline corridor and related pump stations.

5.4.2.2 Hargreaves to Darfield Segment

Based on the nearby emission sources, it is expected that existing air quality conditions along the Hargreaves to Darfield Segment are generally very good. There may be higher PM levels in the vicinity of a sawmill located approximately 50 km northwest of the Blackpool Pump Station, but these are expected to decrease rapidly with distance. PM concentrations near the communities of McLure and Blue River may be higher during the winter due to emissions from wood-burning appliances. Beyond that, there may be occasional episodes of high PM concentrations from forest fires in the region. Ambient concentrations of CO, NO_2 and SO_2 are expected to be low, concentrated within several hundred metres of Highway 5 as a result of emissions from vehicle traffic.

5.4.2.3 Black Pines to Hope Segment

Existing air quality conditions along the Black Pines to Hope Segment is considered for two main areas: in and around the City of Kamloops; and the City of Merritt.

Temperature inversions in the Thompson Valley can cause contaminants to accumulate in the Kamloops area, potentially resulting in poorer air quality than areas that do not have similar surrounding topography. This is evidenced by the PM concentrations in the Kamloops area, which are the highest amongst all BC areas along the proposed pipeline corridor. Nonetheless, existing air quality conditions in Kamloops are fair. Exceedances of the 24 hour BC provincial objective for PM_{10} were observed less than 1% of the time in 2008 and no exceedances of the 24 hour BC provincial objective for $PM_{2.5}$ were observed in 2011. Concentrations of CO, NO_2 and SO_2 remained below their respective air quality objectives in 2011.

There are no continuous monitoring stations near the City of Merritt. Existing air quality in the Merritt area is discussed qualitative based on a BC MOE air quality report describing a provincial monitoring study from 1990 to 2003. Observed PM concentrations in Merritt were relatively similar to those observed in Kamloops, with concentrations below the relevant objectives. BC MOE (2006) references high PM concentrations due to a beehive burner which has since been decommissioned. Higher PM levels in the Merritt area may be attributable to open burning, wood-burning appliances and vehicle traffic. Compared to Kamloops and other communities in the southern interior of BC, Merritt observed higher concentrations of CO and NO_2, and lower concentrations of SO_2. The higher concentrations of CO and NO_2 have been attributed to incomplete combustion emissions from motor vehicles.

There are no representative BTEX ambient monitoring data for the Black Pines to Hope Segment. BTEX concentrations along this segment are expected to be low.

5.4.2.4 Hope to Burnaby Segment

There are three main areas in which ambient monitoring data are available along the Hope to Burnaby Segment: in and around the District of Hope; the City of Chilliwack; and the City of Abbotsford. The highest CAC concentrations along the Hope to Burnaby Segment tend to be observed near the Abbotsford area, possibly due to a larger concentration of industrial sources in the area. Industrial sources in the Abbotsford area include gravel pits, chemical processing facilities and wood processing facilities. Overall, existing air quality conditions in the Hope, Chilliwack and Abbotsford areas with respect to CAC concentrations are good, with the 99th percentile of observed PM and NO_2 concentrations at approximately half the ambient air quality objectives or less, and the 99th percentile of observed CO and SO_2 concentrations less than 10% of the objectives.

BTEX concentrations along the Hope to Burnaby Segment are highest in the Chilliwack area. The highest BTEX concentration observed in the Chilliwack area during the 10 year period from 2002 to 2011 was 17.7 $\mu g/m^3$, compared to a maximum of 3.2 $\mu g/m^3$ in the Hope area and 13.7 $\mu g/m^3$ in the Abbotsford area (when excluding one outlier concentration in August 2006 at Hope and in July 2007 at Abbotsford). The higher BTEX concentrations observed in the Chilliwack area may be due to the influence of industrial sources such as wood and plastic product manufacturing facilities.

5.4.2.5 Burnaby to Westridge Segment

CAC monitoring data from eight Metro Vancouver stations in the Burnaby area were used to characterize existing air quality along the Burnaby to Westridge Segment: North Burnaby Capitol Hill; Burnaby North Eton; Burnaby Kensington Park; Port Moody; Coquitlam; North Vancouver Mahon Park; Second Narrows; and Burnaby South. The Burnaby Mountain Station was not considered since it is located at a higher elevation (360 m asl) compared to the rest of the area and data from this station may not be representative of the proposed pipeline corridor.

Ambient concentrations of PM and NO_2 were similar in magnitude amongst all stations in the Burnaby area. SO_2 concentrations in the Burnaby area were highest at the Burnaby North Eton Station, likely due to the influence of the nearby Chevron tank farm. CO concentrations were highest at the Port Moody and North Vancouver Mahon Park stations. The Port Moody Station may be influenced by the Burrard Generating Plant and the North Vancouver Mahon Park Station, located on higher terrain just north of the Vancouver Ship Yards and a private marina, may be influenced by marine emissions at the harbour. There were no exceedances of the Metro Vancouver air quality objectives in the Burnaby area in 2011.

One NAPS station measures BTEX concentrations in the Burnaby area. BTEX concentrations at the Burmount NAPS station over the last decade reached a maximum of 226.7 $\mu g/m^3$ and 115.2 $\mu g/m^3$ in June and July 2007, respectively. No explanation for these high readings could be found. BTEX data at Burmount reached up to 35.5 $\mu g/m^3$ when these high readings are not included.

5.4.3 Secondary Smog-Related Products

Smog refers to a mixture of gases and particles that often appear as haze in the air and is linked to a number of adverse effects on health and the environment. The two primary pollutants in smog are ground-level ozone and secondary PM, formed from atmospheric chemical reactions between precursors such as NO_x and VOCs.

Observed ozone concentrations for 2011 are summarized in Figure 5.4-10. For the most part, ozone concentrations along the proposed pipeline corridor have remained below relevant objectives. Ozone concentrations along the proposed pipeline corridor tend to be highest towards the east, in Alberta, and lowest towards the west, in the Burnaby area. High ozone concentrations in Alberta are attributable to large quantities of precursor NO_x and VOC emissions from petroleum refining and upgrading, and other heavy industries plus urban emissions in the Edmonton area, mining and oil and gas activity to the west of Edmonton towards Hinton and/or the topography of the region (*i.e.*, higher elevation). Within the Lower Fraser Valley, the eastern portion is prone to higher ozone concentrations due to the constricted nature of the valley and the tendency for precursor NO_x and VOC emissions to be transported eastward from Metro Vancouver and urban areas.

5.4.3.1 Edmonton to Hinton Segment

Short-term peak ozone concentrations along the Edmonton to Hinton Segment were similar amongst all four areas. However, average ozone concentrations were highest in the Hinton area and lowest in the Edmonton area. The Steeper Station, which was used to represent the Hinton area, may experience higher ozone concentrations due to its higher elevation and the potential for it to pick up natural background ozone from aloft. Lower ozone concentrations in the Edmonton area may be due to the presence of nitric oxide from vehicle traffic emissions in the urban area of Edmonton, which causes destruction of ozone.

5.4.3.2 Hargreaves to Darfield Segment

There is no representative ozone monitoring data available for the Hargreaves to Darfield Segment.

5.4.3.3 Black Pines to Hope Segment

Ozone concentrations measured in the Kamloops area in 2011 exceeded the 1 hour national maximum desirable objective 0.7% of the time and the 24 hour national maximum desirable objective 74% of the time. Based on the BC MOE air quality report (BC MOE 2006), ozone concentrations in the Merritt area based on the provincial monitoring study from 1990 to 2003 were similar to those observed in Kamloops.

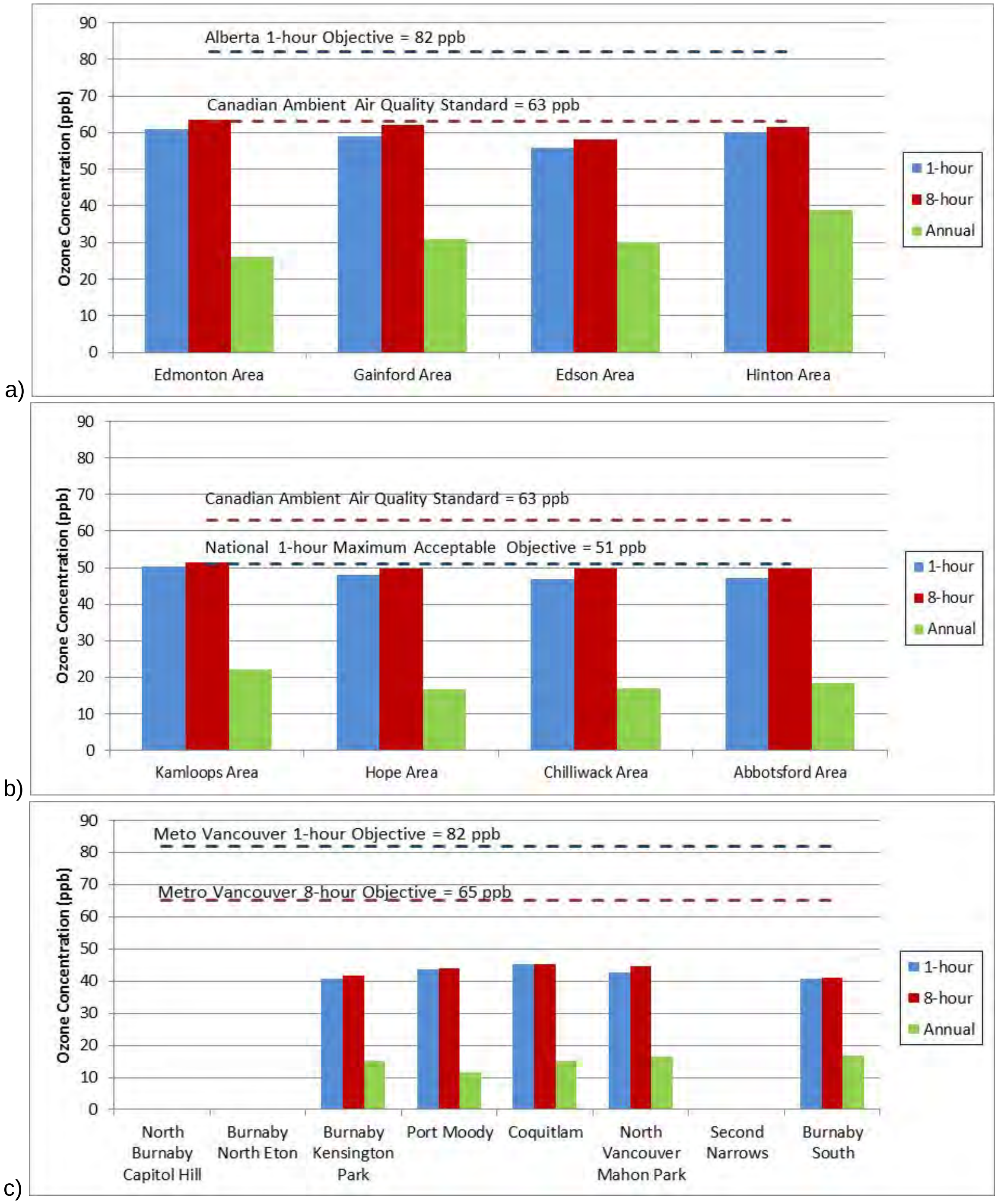
5.4.3.4 Hope to Burnaby Segment

Observed ozone concentrations in the Hope, Chilliwack and Abbotsford areas were similar to those for the Kamloops area discussed in Section 5.4.3.3.

5.4.3.5 Burnaby to Westridge Segment

The Burnaby Kensington Park, Port Moody, Coquitlam, North Vancouver Mahon Park, Second Narrows and Burnaby South stations monitor ozone. Ozone concentrations at all stations in the area are similar. Over the 10 year period from 2002 to 2011, there were occasional exceedances of the 1 hour and 8 hour Metro Vancouver objectives at the Port Moody and Coquitlam stations. There were also occasional exceedances of the 8 hour objective at the Burnaby Kensington Park and North Vancouver Mahon Park stations. No exceedances of the 1 hour or 8 hour Metro Vancouver objectives for ozone were observed at any of the stations in 2011.

Figure 5.4-10 Observed Ozone Concentrations in 2011 for (a) Alberta, (b) BC, Outside Metro Vancouver and (c) Metro Vancouver (in parts per billion [ppb])



Notes: The Canadian Ambient Air Quality Standard is based on the 4th highest annual 8 hour daily maximum value, averaged over 3 consecutive years, and will be effective in 2015, replacing the national ozone objectives.

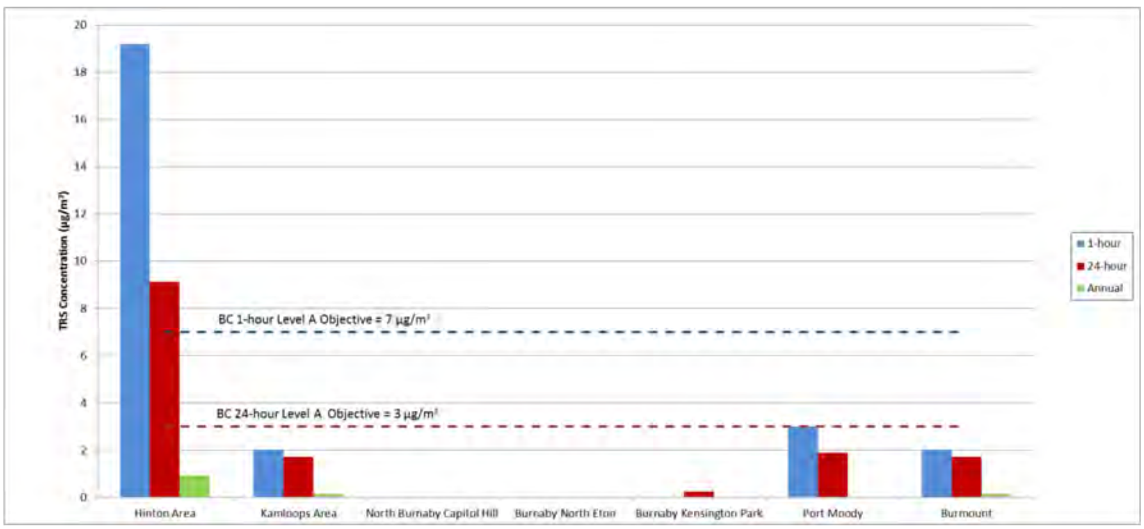
There is no annual ozone objective in Alberta, BC or Metro Vancouver.

5.4.4 Odorous Emissions

Reduced sulphur compounds are a complex family of substances defined by the presence of sulphur in a reduced state and are generally characterized by strong odours at relatively low concentrations. A common reduced sulphur compound is H_2S, a foul smelling gas resembling rotten eggs that is a by-product of anaerobic decomposition. H_2S can be further oxidized to form mercaptans which have strong odours resembling that of rotten garlic and are used as odorants to assist with the detection of natural gas. Individual reduced sulphur compounds are sometimes aggregated into what is known as TRS, expressed in terms of H_2S. These types of odours are often found in boiled eggs, raw sewage, swamps, brackish water, paper pulping mills, sour gas (*i.e.*, natural gas containing H_2S) and some condensates used to thin bitumen for shipping. Fugitive emissions from handling, shipping and storage of dilbit will be evaluated for their odour potential.

Only one CASA station in Edmonton measures H_2S concentrations. This is presented in Section 5.4.4.1. There is no monitoring data for mercaptans. Typically, monitoring data report TRS, which include H_2S and mercaptans and of which H_2S is the most prevalent. Observed TRS concentrations in 2011 are shown in Figure 5.4-11. TRS concentrations are highest in the Hinton area and those in the remaining areas were below the BC ambient objectives.

Figure 5.4-11 Observed TRS Concentrations in 2011 Along the Proposed Pipeline Corridor (in µg/m^3)



Note: There are no TRS objectives in Alberta or Metro Vancouver. BC objectives are shown to place observed concentrations in context. There is no annual TRS objective in BC.

5.4.4.1 Edmonton to Hinton Segment

The Edmonton East CASA station is the only station along the proposed pipeline corridor that records H_2S concentrations. In 2011, the maximum 1 hour and 24 hour concentrations remained below their respective Alberta ambient air quality objectives. The 99th percentile 1 hour concentration was approximately 30% of the objective.

Observed TRS concentrations along the proposed pipeline corridor were highest in the Hinton area. Since there are no Alberta or federal ambient air quality objectives for TRS, observed concentrations were compared to the BC objectives to place them in context. In 2011, 1 hour average TRS concentrations in the Hinton area were greater than 7 µg/m^3 (the 1 hour BC Level A objective) 5.9% of the time. For the 24 hour averaging period, concentrations were greater than 3 µg/m^3 (24 hour BC level A objective) 20% of the time. The high concentrations observed are likely attributable to the West Fraser Mills pulp and paper plant that reported 187 tonnes of TRS emissions to Environment Canada's National Pollutant Release Inventory (NPRI) in 2010 (Environment Canada 2013m).

5.4.4.2 Hargreaves to Darfield Segment

There is no representative TRS monitoring data available for the Hargreaves to Darfield Segment.

5.4.4.3 Black Pines to Hope Segment

TRS concentrations in the Kamloops area are available from June to December 2011. Overall, TRS concentrations were below detection limit most of the time. Exceedances of the 1 hour provincial objective were rare, having occurred less than 1% of the time from June to December 2011. TRS concentrations are not available for the Merritt area but are expected to be similar to Kamloops.

5.4.4.4 Hope to Burnaby Segment

There is no representative TRS monitoring data available for the Hope to Burnaby Segment.

5.4.4.5 Burnaby to Westridge Segment

The following Metro Vancouver monitoring stations in the Burnaby area monitor TRS: North Burnaby Capitol Hill; Burnaby North Eton; Burnaby Kensington Park; Port Moody; and Burmount. The Burmount Station is owned by KMC, but operated by Metro Vancouver and measures TRS near the Burnaby Terminal. TRS concentrations were highest at the Port Moody Station, followed by the Burmount and Burnaby North Eton stations. TRS concentrations at the Burnaby Kensington Park and North Burnaby Capitol Hill stations were low. No exceedances of the provincial or federal TRS objectives were observed at any of the stations in the 2002 to 2011 period.

5.5 Greenhouse Gas Emissions

This subsection discusses the existing conditions of the GHG emissions along the proposed pipeline corridor. The indicators selected for this element discussed below include common GHGs that are relevant to the Project (CO_2, CH_4, N_2O and SF_6) and the effect of the Project on climate change. The rationale for the selection of indicators is provided in Section 7.2.5. The potential Project-related effects and mitigation pertaining to the meteorological environment arising from construction and operation of the proposed pipeline are discussed in Section 7.2.5. Refer to the Air Quality and Greenhouse Gas Technical Report of Volume 5C for additional details on the existing conditions of the GHG emissions.

GHG emissions and the effects of the Project on climate change are global. With respect to the first indicator, common GHG, it is noted that global annual GHG emissions are aggregated from national inventories; moreover, in Canada this inventory is aggregated from provincial and territorial emission totals. Therefore, the estimated GHG emissions from the Project are set in the context of provincial, national and global emissions. In 2011, Canada had total GHG emissions of 702 Mt of carbon dioxide equivalent (CO_2e) as reported in the National Inventory Report 1990-2011 (Environment Canada 2013m). Alberta's contribution to national GHG emissions in 2011 was 72.7 Mt CO_2e, which is 10.4% of total Canadian emissions. Latest global GHG emission information available is for 2010 through the World Resources Institute (2013) CAIT tool. Including the effects of land use change and forestry, 2010 total global GHG emissions were approximately 47,183 Mt CO_2e.

An unknown percentage of the GHG emissions from fuel combustion in vehicles and aircraft for service, maintenance and aerial patrols are associated with the pipeline corridor. To ensure that all emissions are accounted for, aircraft emissions are attributed to the pipeline segments. This assumes that all jet fuel consumption was for the purpose of aerial patrols and that the aerial patrols primarily serve the pipeline segments. Only total GHG emissions from jet fuel combustion are known from previous years. The average GHG emissions over the last 3 years were pro-rated based on each pipeline segment's length. Since the pipeline is buried and sealed, no fugitive GHG emissions are expected to occur. In case of an accidental spill, small amounts of GHGs (*e.g.*, CH_4 and formation CO_2) associated with the product would be released, but would be classified as de-minimus (*i.e.*, intermittent, short-term or transient in nature) compared with GHG emissions from facility operations.

The main sources of direct GHG emissions as a result of pipeline operations are aerial patrols for maintenance purposes. Since pipelines are buried underground, no fugitive emissions are expected to happen under normal operations. Also, no indirect emissions are associated with the operation of the existing pipeline segments. Aerial patrols cause GHG emissions through the combustion of jet fuel. Associated GHG emissions were calculated for each pipeline segment averaged over years 2010 to 2012, and the results are summarized in Table 5.5-1.

TABLE 5.5-1

ANNUAL GHG EMISSIONS ASSOCIATED WITH THE EXISTING PIPELINE SEGMENTS (IN TONNES CO_2e)

Pipeline Segment	Length (km)	GHG Emissions
Edmonton to Hinton	318	97.6
Hargreaves to Darfield	268	84.7
Black Pines to Hope	227	69.6
Hope to Burnaby	135	41.4
Burnaby to Westridge	3.6	1.1
Total GHG Emissions		294.4

After global dispersion, the GHG emissions from any single industrial activity contribute very little to global emissions. Therefore, the current framework for environmental impact assessments is unlikely to trigger collective actions to reduce GHG emissions. Federal and provincial legislation has been put in place to address this issue. All facilities emitting more than 50,000 tonnes of GHGs are required to submit a report under Environment Canada's *Greenhouse Gas Emissions Reporting Program* (Environment Canada 2013m) pursuant to Section 46 of the *Canadian Environmental Protection Act*. Facilities in Alberta emitting more than 50,000 tonnes of GHGs are also required to submit reports under AESRD's *Specified Gas Reporting Regulation*. BC's *Reporting Regulation under the Greenhouse Gas Reduction (Cap and Trade) Act* sets out the requirements for reporting GHG emissions from BC facilities emitting 10,000 tonnes or more of GHGs. Facilities emitting 25,000 tonnes or more are required to have emissions reports verified by a third party. Based on the GHG emissions reported in Table 5.5-1, reporting would not be required from pipeline operations alone.

5.5.1 Climate Change

The second indicator is effects of the Project on climate change, defined as changes in long-term weather patterns caused by natural phenomena and human activities that alter the chemical composition of the atmosphere through the build-up of GHGs, which trap heat and reflect it back to the Earth's surface (Environment Canada 2013m). Annual temperatures in Canada have been at or above normal since 1993, with a warming trend of 1.5°C over the last 64 years (Environment Canada 2013m). It was demonstrated by Matthews *et al*. (2009) that global temperature increases are directly related to cumulative emissions of GHG. In its report, the National Research Council (NRC) (2010) estimated, based on the most current modeling results, approximately linear warming per cumulative emissions ranging from roughly 0.27°C to 0.68°C per 1,000,000 Mt CO_2e, or roughly 20 years of 2010 annual global GHG emissions. The NRC noted that other changes in the climate system and physical environment (*e.g.*, precipitation changes and decreases in crop yields) are likewise proportional to cumulative GHG emissions. On the basis of these expected changes per cumulative GHG emissions, the effect of the Project on climate change can be quantified (see Section 7.2.5).

5.6 Acoustic Environment

This subsection discusses the existing conditions of the acoustic environment. The indicators selected for this element discussed below include sound and vibration levels. The rationale for the selection of indicators is provided in Section 7.2.6. The potential Project-related effects and mitigation pertaining to the acoustic environment arising from construction and operation of the proposed pipeline are discussed in Section 7.2.6. Refer to the Terrestrial Noise and Vibration Technical Report of Volume 5C for additional details on the existing conditions of ambient sound and vibration levels.

This setting discusses the ambient sound level (ASL) within the Acoustic Environmental LSA, which is the ZOI potentially affected by sound generated during construction and operations, consisting of a 1.5 km band on both sides of the proposed pipeline corridor (*i.e.*, for a total width of 3.15 km). Vibration levels are discussed within the Acoustic Environment RSA, which is the area potentially affected by construction vibration, consisting of a 5 km band on both sides of the proposed pipeline corridor (*i.e.*, for a total width of 10.15 km). The spatial boundaries of the Acoustic Environment RSA are shown on Figures 5.4-1 to 5.4-4.

The ambient sound and vibration levels in the acoustic environment are a combination of both natural and/or man-made sources. Since each segment covers a vast area along the proposed pipeline corridor, the ambient levels at each potential receptor vary due to proximity to noise sources. A potential receptor has been defined in Section 7.2.6 as a residence or dwelling. Existing man-made sources can include, but are not limited to, transportation corridors, activities related to both energy and non-energy facilities, air craft flyovers and recreational trails.

5.6.1 All Pipeline Segments

Ambient conditions to be used in assessments are defined under the Alberta Energy Regulator (AER) *Directive 038: Noise Control Directive* (ERCB 2007) and BC Oil and Gas Commission (OGC) *Noise Control Best Practices Guideline* (BC OGC 2009) for each respective province. The normal operation of any buried pipeline does not create sound or vibration levels that are detectable or contributes to the ambient acoustical environment at surrounding receptors. The aspect of pipeline operation that may generate audible sound is when the pipeline is exposed at facilities and intermittent maintenance. Minor maintenance and inspections may be routinely completed, but have not been analyzed due to the infrequent nature of the activities. ASL along all segments of the proposed pipeline corridor (with the exception of major urban areas as noted in the subsections below) were assumed to follow the Category 1, least density for a populated area, for the ASL or base sound level (BSL), as per either AER *Directive 038: Noise Control Directive* (ERCB 2007) or BC OGC *Noise Control Best Practices Guideline* (BC OGC 2009).

Details for each pipeline segment regarding receptors, dwelling density and roadway proximity are provided in the Terrestrial Noise and Vibration Technical Report of Volume 5C.

5.6.2 Edmonton to Hinton Segment

The ambient acoustic environment along the Edmonton to Hinton Segment of the proposed pipeline corridor is influenced in several areas by large facility operations and urbanized areas. The largest portion of this segment that is influenced by urbanization is the Edmonton area, which has large scale industrial operations, heavily travelled roadways, an airport and dense residential development. The existing sound levels are expected to be consistent with other dense urban developments with heavily travelled roads. The urban ASL based on AER *Directive 038: Noise Control Directive* (ERCB 2007) would range between 41-51 decibels (dBA) at night and 51-61 dBA during the day.

West of the Edmonton area, the proposed pipeline corridor loosely parallels Highways 16 and 16A. The ambient environment in close proximity to the highway will be elevated due to the presence of vehicle traffic. In general, if a heavily travelled roadway is within the Acoustic Environment LSA, then an elevated acoustic ambient environment may exist. AER *Directive 038: Noise Control Directive* (ERCB 2007) indicates that traffic affects ASLs at up to 500 m from the roadway, which is a consideration for assessing receptors within the Acoustic Environment LSA. The ASL at residences, based on AER *Directive 038: Noise Control Directive* (ERCB 2007), would range between 35-48 decibels (dBA) at night and 45-58 dBA during the day, depending on density of residential development and proximity to heavily travelled roads.

Several communities, including the City of Spruce Grove, the Hamlet of Entwistle and the towns of Stony Plain, Edson and Hinton, are located within the Acoustic Environment LSA. Due to the size of these communities, background sound levels are expected to reflect the degree of development based on density of residences and proximity to Highway 16/16A. The ASL at residences would range between 38-48 dBA at night and 48-58 dBA during the day, depending on density of residential development and proximity to heavily travelled roads.

The remainder of this pipeline segment is located in undeveloped, rural lands where natural sounds dominate the existing background. Some human activity may occur, but would not appreciably affect sound levels. For these areas, existing sound levels follow the rural ASL of 35 dBA at night and 45 dBA during the day as found in the AER *Directive 038: Noise Control Directive* (ERCB 2007).

Bylaws addressing noise or nuisance exist for communities where this segment of the proposed pipeline corridor is located within the respective community boundary. Bylaws exist for the cities of Edmonton and Spruce Grove, and the towns of Edson and Hinton. These noise bylaws state the hours of the day where it is acceptable to undertake activities (*e.g.*, construction) within the community and the City of Edmonton bylaw provides quantitative sound level limits. Generally, for most communities, activities are permitted from 7 AM to 10 PM, though timing is variable on weekends and holidays. No activities or sources of existing blast vibration were identified within the Acoustic Environment RSA for this segment.

5.6.3 Hargreaves to Darfield Segment

The main influences on the ambient acoustic environment along the Hargreaves to Darfield Segment of the proposed pipeline corridor are small communities, activities associated with forestry, small community airports and scattered commercial operations. This segment closely parallels Highway 5, with a deviation occurring between Blackpool Pump Station and the Village of Little Fort. The ambient environment in close proximity to Highway 5 will be elevated due to the presence of vehicle traffic. In general, if a heavily travelled roadway is within the Acoustic Environment LSA, then an elevated ambient acoustic environment may exist. The BC OGC *Noise Control Best Practices Guideline* (BC OGC 2009) indicates that traffic affects ASLs up to 500 m from the roadway, which is a consideration for assessing receptors within the Acoustic Environment LSA. The ASL at residences along the highways would range between 35-43 dBA at night and 45-53 dBA during the day.

Several communities, including the Village of Valemount, the communities of Blue River, Avola, Vavenby, the District of Clearwater and the Hamlet of Blackpool, are located within the Acoustic Environment LSA. Due to the size of these communities, background sound levels are expected to reflect the degree of development based on density of residences and proximity to Highway 5, as well as arterial roadways. The ASL at residences would range between 38-43 dBA at night and 48-53 dBA during the day.

The remainder of this segment is located in undeveloped, rural lands where natural sounds dominate the existing acoustic environment. Some human activity may occur, but would not appreciably affect sound levels. For these areas, existing sound levels follow the rural ASL of 35 dBA at night and 45 dBA during the day as found in the BC OGC *Noise Control Best Practices Guideline* (BC OGC 2009).

This segment of the proposed pipeline corridor is located within the respective community boundary of the District of Clearwater. The District of Clearwater Bylaw No. 14 addresses nuisance noise and states the hours of the day where it is acceptable to undertake activities (*e.g.*, construction) within the community. Activities are permitted from 6 AM to 9 PM, though timing is variable on weekends and holidays. No activities or sources of existing blast vibration were identified within the Acoustic Environment RSA for this segment.

5.6.4 Black Pines to Hope Segment

The level of urbanization as well as forestry activities, airport flight routes and major industrial operations are the main influences of the ambient acoustic environment along the Black Pines to Hope segment of the proposed pipeline corridor. This segment follows several key transportation routes. The proposed pipeline corridor closely follows Westsyde Road to the north end of Kamloops (Westsyde), then follows trails to Kamloops and finally meanders and parallels Highways 5 and 5A to the District of Hope. The ambient environment in close proximity to the highway will be elevated due to the presence of vehicle traffic. In general, if a heavily travelled roadway is within the Acoustic Environment LSA, then an elevated acoustic ambient environment may exist. The BC OGC *Noise Control Best Practices Guideline* (BC OGC 2009) indicates that traffic affects ASLs at up to 500 m from the roadway, which is a consideration for assessing receptors within the Acoustic Environment LSA. The ASL at residences along the highways would range between 35-43 dBA at night and 45-53 dBA during the day.

Several communities, including the Hamlet of Black Pines, the cities of Kamloops and Merritt, and the District of Hope, are located within the Acoustic Environment LSA. Due to the size of these communities, existing sound levels are expected to reflect the degree of development based on density of residences and proximity to major highways and roadways. The ASL at residences would range between 38-43 dBA at night and 48-53 dBA during the day.

The remainder of this pipeline segment is located in undeveloped, rural lands where natural sounds dominate existing background. Some human activity may occur, but would not appreciably affect sound levels. For these areas, existing sound levels follow the rural ASL of 35 dBA at night and 45 dBA during the day as found in the BC OGC *Noise Control Best Practices Guideline* (BC OGC 2009).

Bylaws addressing noise or nuisance exist for communities where this segment of the proposed pipeline corridor is located within the respective community boundary. Bylaws exist for the cities of Kamloops and Merritt, and the District of Hope. The noise bylaws address nuisance noise and state the hours of the day where it is acceptable to undertake activities (*e.g.*, construction) within the community. Generally, for most communities, activities are permitted from 7 AM to 10 PM, though timing is variable on weekends and holidays. No current activities or sources of existing blast vibration were identified within the Acoustic Environment RSA for this segment. The Ajax-Afton Mine near the City of Kamloops did include blasting activity, but stopped operations in 1997.

5.6.5 Hope to Burnaby Segment

The level of urbanization along the Hope to Burnaby segment changes from rural to areas with sparse housing to fully developed areas such as the cities of Surrey and Burnaby. The major sources contributing to the ambient acoustic environment are small industrial and commercial activities, aggregate operations and agricultural activities. The proposed pipeline corridor varies in distance from highways and communities.

The ambient environment for portions in close proximity to the highway will be elevated due to the presence of vehicle traffic. In general, if a heavily travelled roadway is located within the Acoustic Environment LSA, then an elevated acoustic ambient environment may exist. The BC OGC *Noise Control Best Practices Guideline* (BC OGC 2009) indicates that traffic affects ASLs up to 500 m from the roadway, which is a consideration for assessing receptors within the Acoustic Environment LSA. The urban ASLs based on the BC OGC *Noise Control Best Practices Guideline* (BC OGC 2009) for the cities of Surrey and Burnaby would range between 41-51 dBA at night and 51-61 dBA during the day.

Several communities, including the District of Hope, the cities of Chilliwack and Abbotsford, the Village of Clayburn, the Township of Langley and the cities of Surrey and Burnaby, are located within the Acoustic Environment LSA. Due to the size of these communities, background sound levels are expected to reflect the degree of development based on density of residences and proximity to major highways and roadways. The ASL at residences would range between 38-43 dBA at night and 48-53 dBA during the day.

Bylaws addressing noise or nuisance exist for communities where this segment of the proposed pipeline corridor is located within the respective community boundary. Bylaws exist for the cities of Chilliwack, Abbotsford, Surrey and Burnaby, and the Township of Langley. The noise bylaws address nuisance noise and state the hours of the day where it is acceptable to undertake activities (*e.g.*, construction) within the community. The cities of Chilliwack and Burnaby, and the District of Langley bylaws also provide some quantitative noise limits for residential areas. Generally, for most communities, activities are permitted from 7 AM to 10 PM, though timing is variable on weekends and holidays. No activities or sources of existing blast vibration were identified within the Acoustic Environment RSA for this segment.

5.6.6 Burnaby to Westridge Segment

There is a high level of urbanization along the Burnaby to Westridge Segment, as it is on the outskirts of the City of Burnaby. The major sources contributing to the ambient acoustic environment are due to human activities which include a large-scale industrial operation, activities along the waterway and vehicle roadways. The existing sound levels are expected to be consistent with other urban developments with heavily travelled roads. The urban ASL based on the BC OGC *Noise Control Best Practices Guideline* (BC OGC 2009) would range between 41-51 dBA at night and 51-61 dBA during the day.

The only applicable noise bylaw for this segment of the proposed pipeline corridor is the District of Burnaby's Bylaw No. 7332 (Corporation of the District of Burnaby 1979). This bylaw has a qualitative clause that no sound may disturb the peace and quiet in the area, stating that no sound, be it continuous or non-continuous, exceed the sound levels stated in the bylaw, in addition to providing qualitative and quantitative sound level limits for construction. Generally, construction activities are permitted from 7 AM to 10 PM on weekends and from 9 AM to 10 PM on weekends and holidays.

No activities or sources of existing blast vibration were identified within the Acoustic Environment RSA for this segment.

5.7 Fish and Fish Habitat

This subsection presents a summary of the findings related to fish and fish habitat in watercourses, non-classified drainages (NCDs) and fish-bearing wetlands crossed by the proposed pipeline corridor. The indicators selected for this element include riparian habitat, instream habitat, and fish mortality and injury. These three indicators apply in both Alberta and BC. A total of 11 indicator species (6 in Alberta and 5 in BC) were also selected. The rationale for the selection of indicators is provided in Section 7.2.7. Habitat potential for spawning, rearing, wintering and migration was rated at watercourse crossings identified along the proposed pipeline corridor and is documented in the Fish-Bearing Atlases (see Appendix C of the Fisheries [Alberta] Technical Report and Appendix B of the Fisheries [British Columbia] Technical Report of Volume 5C). The potential Project-related effects and mitigation pertaining to fish and fish habitat are discussed in Section 7.2.7.

This setting discusses the fish and fish habitat in the Fish and Fish Habitat LSA and the Aquatics RSA. The Fish and Fish Habitat LSA consists of the area extending 100 m above the centre of the proposed pipeline corridor to a minimum of 300 m downstream from the centre of the proposed pipeline corridor at defined watercourses and includes the area of riparian vegetation to a width of 30 m back from each bank edge the width of the construction right-of-way. The Aquatics RSA includes all watersheds directly affected by the Project. The spatial boundaries of the Aquatics RSA are shown on Figures 5.3-1 and 5.3-2.

All Aboriginal communities potentially affected by the Project were invited to participate in the fisheries field surveys conducted for the Project to allow for the collection of TEK. During the 2012 and 2013 fisheries field surveys, traditional methods of resource procurement were discussed, as well as modern methods currently employed. Seasonality of resource harvesting was also shared by the Aboriginal participants. At each investigating site, discussions were held with participants about the seasonality of fish and aquatic habitat and any changes to fisheries and aquatic resources over time. Potential mitigation measures to reduce any Project-related effects on a resource were also discussed during the fisheries field surveys. ATK includes, but is not limited to, the collection of TEK during field survey participation for the Project and TLU study information from potentially affected Aboriginal communities. Prior to TEK field data collection, preliminary background ATK data was compiled through sources such as open houses, community gatherings, public record of past projects and published reports.

5.7.1 Indicator Species

Indicator species were selected for each province as described in Section 7.2.7 based on initial feedback from regulatory authorities, Aboriginal communities, stakeholders and the professional judgment of the assessment team.

It was determined that each province traversed by the proposed pipeline corridor (*i.e.*, Alberta and BC) should have a unique set of fish species indicators due to several factors, including regional differences in fish community compositions, species abundance and the recreational, commercial or traditional use of fish. Indicator species in Alberta and BC included sportfish species of recreational, commercial and/or Aboriginal value that could potentially be encountered in watercourses crossed by the proposed pipeline corridor.

5.7.1.1 Alberta Indicator Species

Six indicator species (Arctic grayling, Athabasca rainbow trout, bull trout, burbot, northern pike and walleye) were selected for Alberta based on their distribution throughout the Aquatics RSA (see Fisheries [Alberta] Technical Report of Volume 5C), including 23 watercourses, NCDs or wetlands crossed by the proposed pipeline corridor in the Edmonton to Hinton Segment (Table 5.7-6). The selection of indicator species in Alberta also considered interactions with stakeholders and species with management (*e.g.*, conservation) concerns. Of the six indicator species, five (*i.e.*, Arctic Grayling, Athabasca rainbow trout, burbot, northern pike and walleye) are neither *Species at Risk Act* [*SARA*]-listed or COSEWIC listed.

Fish play a large role in the subsistence lifestyle of many Aboriginal individuals and communities along the proposed pipeline corridor. According to Aboriginal communities, traditional fishing activities occur in waterbodies and watercourses crossed by the proposed pipeline corridor, and the species caught change seasonally. Species caught in the region include mountain trout (trout species), whitefish (mountain whitefish), jackfish (northern pike), rainbow trout, perch and pickerel (walleye) (Montana First Nation 2011, Neufeld 2012).

The use of lake sturgeon as an indicator species was suggested at the Edmonton ESA Workshop. Lake sturgeon is Endangered under the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) (2013a) and is considered Threatened under the Alberta *Wildlife Act* and *Wildlife Regulation*. Historical data and the results of the field program indicate that lake sturgeon is only found in one watercourse (*i.e.*, North Saskatchewan River) crossed by the proposed pipeline corridor (see Sections 4.4.1 and 5.0 of the Fisheries [Alberta] Technical Report of Volume 5C). Since lake sturgeon have a limited distribution in watercourses crossed by the proposed pipeline corridor, it was determined that this species would not be useful as an indicator since potential effects to lake sturgeon and their habitat would not be representative of potential effects to all fish and fish habitat in Alberta (see Section 7.2.7 for additional information about selection of indicator species).

Arctic grayling, Athabasca rainbow trout, bull trout, burbot, northern pike and walleye are found in watercourses crossed by the proposed pipeline corridor and elsewhere within the Aquatics RSA, according to historical data, literature review and/or field surveys. Table 5.7-1 shows the current distribution of the Alberta indicator species in the watersheds crossed by the Edmonton to Hinton Segment.

A brief description of the Alberta indicator species and their habitat requirements is presented in Sections 5.7.7 to 5.7.12. Additional information (*e.g.*, water quality requirements for each species) can be found in Section 4.3 of the Fisheries (Alberta) Technical Report of Volume 5C.

TABLE 5.7-1

CURRENT DISTRIBUTION OF ALBERTA INDICATOR SPECIES IN THE EDMONTON TO HINTON SEGMENT

Watershed	Alberta Indicator Species					
	Arctic Grayling	Athabasca Rainbow Trout	Bull Trout	Burbot	Northern Pike	Walleye
Lower North Saskatchewan River				✔	✔	✔
Middle North Saskatchewan River				✔	✔	✔
Sturgeon River				✔	✔	✔
Upper North Saskatchewan River				✔	✔	✔
Pembina River	✔		✔	✔	✔	✔
Lower McLeod River	✔	✔	✔	✔	✔	✔
Upper McLeod River	✔	✔	✔	✔	✔	
Athabasca River	✔	✔	✔	✔	✔	

Note: ✔ Denotes known presence of species within the watershed, based on historical data, literature review and/or field surveys.

5.7.1.2 British Columbia Indicator Species

Five indicator species (bull trout/Dolly Varden, Chinook salmon, coho salmon, cutthroat trout and rainbow trout/steelhead) were selected for BC based on their historical distribution throughout the Aquatics RSA, including 172 watercourses, NCDs and wetlands crossed by the proposed pipeline corridor (Tables 5.7-9, 5.7-13 and 5.7-17). The selection of indicator species in BC also considered interactions with stakeholders and species with management (*e.g.*, conservation) concerns. Of the five indicator species, two (*i.e.*, Chinook salmon and rainbow trout/steelhead) are neither *SARA* or COSEWIC listed.

There are four federally-listed (*i.e.*, *SARA*-listed) species (white sturgeon, green sturgeon, Nooksack dace and Salish sucker) in the Aquatics RSA that have not been used as indicator species because they are not well-represented (*i.e.*, distributed) in watercourses crossed by the proposed pipeline corridor and, therefore, potential effects to these species and their habitat are not representative of potential effects to fish and fish habitat as a whole.

The use of Nooksack dace as an indicator was considered after a suggestion by the FVRD. Nooksack dace is Endangered under COSEWIC (2013a) and *SARA* (Environment Canada 2013o) and has a very limited distribution in BC. Historical data and the results of the field program (see Section 4.4.4 of the Fisheries [British Columbia] Technical Report of Volume 5C) indicate that Nooksack dace are only found in two watercourse(s) (*i.e.*, Salmon River and Stoney Creek) crossed by the proposed pipeline corridor. Since Nooksack dace has a limited distribution in watercourses crossed by the proposed pipeline corridor, it was determined that this species would not be useful as an indicator since potential effects to Nooksack dace and their habitat would not be representative of potential effects to all fish and fish habitat in BC (see Section 7.2.7 for additional information about selection of indicator species).

Table 5.7-2 shows the current distribution of the BC indicator species in the watersheds crossed by the proposed pipeline corridor segments in BC.

A brief description of the indicator species and their habitat requirements is presented in Sections 5.7.13 to 5.7.17. Additional information (*e.g.*, water quality requirements for each species) can be found in the Fisheries (British Columbia) Technical Report of Volume 5C.

TABLE 5.7-2

CURRENT DISTRIBUTION OF BC INDICATOR SPECIES BY PROPOSED PIPELINE SEGMENT

<table>
<tr><th rowspan="2">Pipeline Segment</th><th rowspan="2">Watershed</th><th colspan="5">BC Indicator Species</th></tr>
<tr><th>Bull Trout/Dolly Varden</th><th>Chinook Salmon</th><th>Coho Salmon</th><th>Cutthroat Trout</th><th>Rainbow Trout/ Steelhead</th></tr>
<tr><td rowspan="5">Hargreaves to Darfield</td><td>Upper Fraser River</td><td>✔</td><td>✔</td><td></td><td></td><td>✔</td></tr>
<tr><td>Canoe Reach</td><td>✔</td><td></td><td></td><td></td><td>✔</td></tr>
<tr><td>Upper North Thompson River</td><td>✔</td><td></td><td>✔</td><td></td><td>✔</td></tr>
<tr><td>Clearwater River</td><td>✔</td><td>✔</td><td>✔</td><td></td><td>✔</td></tr>
<tr><td rowspan="2">Lower North Thompson River</td><td>✔</td><td rowspan="2">✔</td><td rowspan="2">✔</td><td rowspan="2"></td><td rowspan="2">✔</td></tr>
<tr><td rowspan="5">Black Pines to Hope</td><td></td></tr>
<tr><td>Thompson River</td><td>✔</td><td>✔</td><td>✔</td><td></td><td>✔</td></tr>
<tr><td>South Thompson River</td><td></td><td>✔</td><td>✔</td><td></td><td>✔</td></tr>
<tr><td>Lower Nicola River</td><td>✔</td><td>✔</td><td>✔</td><td></td><td>✔</td></tr>
<tr><td rowspan="2">Fraser Canyon</td><td>✔</td><td rowspan="2">✔</td><td rowspan="2">✔</td><td rowspan="2">✔</td><td rowspan="2">✔</td></tr>
<tr><td rowspan="4">Hope to Burnaby</td><td></td></tr>
<tr><td>Harrison River</td><td></td><td>✔</td><td>✔</td><td>✔</td><td>✔</td></tr>
<tr><td>Chilliwack River</td><td>✔</td><td>✔</td><td>✔</td><td>✔</td><td>✔</td></tr>
<tr><td rowspan="2">Lower Fraser River</td><td>✔</td><td rowspan="2">✔</td><td rowspan="2">✔</td><td rowspan="2">✔</td><td rowspan="2">✔</td></tr>
<tr><td rowspan="2">Burnaby to Westridge</td><td></td></tr>
<tr><td>Squamish River</td><td></td><td></td><td>✔</td><td>✔</td><td>✔</td></tr>
</table>

Note: ✔ Denotes known presence of species within the watershed, based on historical data, literature review, and/or field surveys.

5.7.2 General Information – Edmonton to Hinton Segment

The proposed pipeline corridor along the Edmonton to Hinton Segment from RK 0.0 to RK 339.4 is located in both the North Saskatchewan and Athabasca river basins. There are 202 proposed waterbody crossings in this segment, of which 88 are crossings of watercourses (*i.e.*, having defined beds and banks). Of the 88 proposed watercourse crossings, 25 are located in the North Saskatchewan River Basin and 63 are located in the Athabasca River Basin.

The North Saskatchewan River originates from the Columbia Icefields in Banff National Park in western Alberta and flows for approximately 1,400 km to its confluence with the South Saskatchewan River in central Saskatchewan. The North Saskatchewan River generally flows northeast across Alberta, passing through the City of Edmonton before it crosses the provincial border into Saskatchewan.

The Athabasca River generally flows northeast from its mountain headwaters in Jasper National Park, in west central Alberta. It flows across the province and drains into Lake Athabasca, north of the City of Fort McMurray in northeast Alberta.

Many of the watercourses along the proposed Edmonton to Hinton Segment move slowly and TEK participants attribute this to beavers building dams that partially block the flow of water. Beaver dams have also influenced fish and their habitat, since these dams lower the water levels downstream.

The following subsections describe the watersheds, areas of special interest, hydrometric data, fish-bearing watercourses, riparian habitat and field results along the Edmonton to Hinton Segment.

5.7.2.1 Watersheds

Within the Alberta portion of the Project (*i.e.*, the Edmonton to Hinton Segment), the proposed pipeline corridor traverses eight watersheds. Watersheds were identified from the Environment Canada four-character sub-basins data (Prairie Farm Rehabilitation Administration - Agriculture and Agri-Food Canada 2008) and were assigned names based on the major watercourse within each watershed. The Lower, Middle and Upper North Saskatchewan River watersheds and the Sturgeon River Watershed comprise the area from the City of Edmonton to the Hamlet of Evansburg and drain into the North Saskatchewan River. The Pembina River, Upper and Lower McLeod River and the Athabasca River watersheds comprise the area from the Hamlet of Evansburg to the border of Jasper National Park and drain into the Athabasca River. The proposed pipeline corridor crosses several named watercourses within these watersheds, including the North Saskatchewan, Pembina, McLeod and Lobstick rivers. Table 5.7-3 provides the drainage areas and RK range(s) for each of the watersheds crossed by the Edmonton to Hinton Segment. Additional information about the watercourses crossed by the proposed pipeline corridor within each watershed is provided in the Fisheries (Alberta) Technical Report of Volume 5C.

TABLE 5.7-3

WATERSHEDS CROSSED BY THE PROPOSED PIPELINE CORRIDOR IN THE EDMONTON TO HINTON SEGMENT

Watershed	Approximate Drainage Area	RK Range(s)
Lower North Saskatchewan River	4,400 km²	RK 0 to RK 23.1
Middle North Saskatchewan River	3,100 km²	RK 23.1 to RK 51.5
Sturgeon River	3,300 km²	RK 51.5 to RK 75.2 RK 78.7 to RK 84.0 RK 117.5 to RK 131.0
Upper North Saskatchewan River	4,750 km²	RK 75.2 to RK 78.7 RK 84.0 to RK 117.5
Pembina River	6,250 km²	RK 131.0 to RK 191.5
Lower McLeod River	4,750 km²	RK 191.5 to RK 241.8
Upper McLeod River	4,900 km²	RK 241.8 to RK 278.0
Athabasca River	2,400 km²	RK 278.01 to RK 339.4

5.7.2.2 Areas of Special Interest

<u>Wabamun Lake Provincial Park</u>

Wabamun Lake Provincial Park is located approximately 60 km west of the City of Edmonton in the Upper North Saskatchewan River Watershed. Although the park is not crossed by the proposed pipeline corridor, the downstream LSA of two proposed crossings (two unnamed tributaries to Wabamun Lake [AB-36 and AB-39]) extends into the park. Wabamun Lake Provincial Park has the widest range of land and water users of any lake in Alberta including industrial, residential, recreational and agricultural uses

(Marshall Macklin Monaghan Western Limited 1985). A policy objective in the Lake Wabamun Management Plan (Marshall Macklin Monaghan Western Limited 1985) is to improve, develop and control the sport and commercial fishery at Lake Wabamun, since the importance of it as a valuable fisheries resource was recognized at the policy level. The erosion of bed and banks of Wabamun Lake was a topic of concern raised by participants at the Wabamun Lake Community Workshop. In Alberta, provincial parks are managed and designated under the *Provincial Parks Act.*

Environmentally Significant Areas

There are five Environmentally Significant Areas that have been identified as being traversed by the proposed pipeline corridor along this segment (Table 5.7-4). Environmentally Significant Areas are defined as those areas that are critical to the long-term maintenance of biological diversity, landscape features and natural processes at multiple spatial scales (Fiera Biological Consulting Ltd. 2009). Environmentally Significant Areas are categorised and defined based on seven different criteria: areas that contain elements of conservation concern; areas that contain rare or unique landforms; areas that contain habitat for local species; areas that contain important wildlife habitat; riparian areas; large natural areas; and sites of recognized significance. However, ATPR states that Environmentally Significant Areas do not represent government policy and do not necessarily require legal protection. They are intended to be an information tool to help inform land use planning and policy at local, regional and provincial scales.

TABLE 5.7-4

CHARACTERISTICS OF ENVIRONMENTALLY SIGNIFICANT AREAS TRAVERSED BY THE PROPOSED PIPELINE CORRIDOR IN THE EDMONTON TO HINTON SEGMENT

Environmentally Significant Area No.	Significance Rating	Natural Region; Natural Subregion	River Basins	Area (km²)	Criterion 1: Contains Elements of Conservation Concern	Criterion 2: Contains Rare or Unique Landforms	Criterion 3: Contains Habitat for Local Species	Criterion 4: Contains Important Wildlife Habitat	Criterion 5: Contains Riparian Areas			Criterion 6: Contains Large Natural Areas	Criterion 7: Contains Sites of Recognized Significance	Fish Species of Conservation Concern	Municipalities
									Headwater Streams	Intact Riparian Areas	Areas Along the Six Major Rivers				
70	Provincial	Foothills; Lower Foothills	Athabasca River	15.8	√				√	√				N/A	Yellowhead County
99	Provincial	Foothills, Boreal and Rocky Mountain; Lower Foothills, Central Mixedwood and Montane	Athabasca River	712.7	√	√			√	√	√	√		Pygmy whitefish	Woodlands, Yellowhead and Lac Ste. Anne counties, Municipal District of Greenview No. 16, County of Barrhead No.11
441	Provincial	Boreal; Dry Mixedwood and Central Mixedwood	North Saskatchewan and Athabasca Rivers	96.1	√			√						N/A	Parkland and Lac Ste. Anne counties
442	Provincial	Boreal; Dry Mixedwood	North Saskatchewan River	115.4	√			√						N/A	Parkland County
690	National	Boreal, Foothills and Parkland; Dry Mixedwood, Lower Foothills, Central Parkland, Central Mixedwood and Upper Foothills	North Saskatchewan River	1,397.3	√		√	√	√	√	√	√	√	Lake sturgeon, river shiner and silver redhorse	Clearwater, Parkland, Brazeau, Smoky Lake, Leduc, Lamont, Sturgeon, Strathcona and Yellowhead counties, and County of St. Paul No. 19, Two Hills No. 21, Vermilion River No. 24 and Thorchild No. 7

Source: Fiera Biological Consulting 2009

Canadian Heritage Rivers System

The headwaters of the North Saskatchewan River (*i.e.*, in Banff National Park) were designated to the Canadian Heritage Rivers System in 1989 (Canadian Heritage Rivers System 2011b). The 48.7 km long segment of the North Saskatchewan River designated as a Canadian Heritage River is outside of the Aquatics RSA and is not crossed by the proposed pipeline corridor. The proposed crossing of the North Saskatchewan River is several hundred kilometres downstream of the designated section.

A 168 km long segment of the Athabasca River that lies entirely within Jasper National Park was designated to the Canadian Heritage Rivers System in 1989 (Canadian Heritage Rivers System 2011c). The portion of the Athabasca River designated as a Canadian Heritage River is within the Aquatics RSA. There are no proposed crossings of the Athabasca River; however, there are tributaries to the Athabasca River crossed by the proposed pipeline corridor.

5.7.2.3 Hydrometric Data

The Water Survey of Canada maintains year-round hydrometric stations on several of the watercourses crossed by the proposed pipeline corridor along the Edmonton to Hinton Segment. A summary of discharge rates can be found in Table 5.7-5. Additional information about each station and the monthly mean flows can be found in Section 5.3 of this volume and in Appendix B of the Fisheries (Alberta) Technical Report of Volume 5C.

Seasonal flow patterns are similar between hydrometric stations identified in Table 5.7-5, indicating that the annual high flow events coincide with snowmelt. Flows are lowest during the winter months from October through March and discharge begins to increase during the spring, in April. Peak flows vary depending on the size and location of the waterbody. Lower elevation streams reach peak flows in early spring due to early spring snowmelt on the plains. Peak flows in the foothills correlate with spring snowmelt and are typically highest in mid-spring. Flow for mountain-fed streams correlates with delayed snowmelt in the mountains and is highest in early summer. Water flows in the North Saskatchewan River are regulated by two large hydroelectric dams. The Bighorn Dam is located on the North Saskatchewan River at Abraham Lake in the foothills of the Rocky Mountains. The Brazeau Dam is located on the Brazeau Reservoir near the Brazeau River's confluence with the North Saskatchewan River. These dams increase winter flows and decrease summer flows (Partners for the Saskatchewan River Basin 2009). The North Saskatchewan River reaches peak flow in July, while the smaller rivers and creeks reach peak flow from April to June. Flows begin to decline in July and continue to decline until October, just prior to freeze-up.

TABLE 5.7-5

SUMMARY OF STREAMFLOWS FROM HYDROLOGICAL STATIONS NEAR THE PROPOSED PIPELINE CORRIDOR IN THE EDMONTON TO HINTON SEGMENT

Watercourse Name	Station Name, Station Number	Years Station Data Available	Approximate Location of Station Relative to the Nearest RK	Month and Mean Monthly Discharge (m^3/s) During Lowest Flow Period	Month and Mean Monthly Discharge (m^3/s) During Highest Flow Period
North Saskatchewan River	North Saskatchewan River at Edmonton 05DF001	1911 to 2010	20 km downstream of RK 33.5	February 68.7 m^3/s	July 483.0 m^3/s
Pembina River	Pembina River near Entwistle 07BB002	1914 to 1923 1954 to 2010	2 km downstream of RK 135.0	February 2.31 m^3/s	May 48.9 m^3/s
McLeod River	McLeod River near Rosevear 07AG007	1984 to 2011	24 km downstream of RK 223.9	February 6.29 m^3/s	June 96.4 m^3/s

Sources: Environment Canada 2013b-d

5.7.2.4 Fish-Bearing Crossings

Based on historical data or where field studies were conducted for the Project (see Fisheries [Alberta] Technical Report of Volume 5C), 56 of the 185 proposed crossings assessed were identified as fish-bearing (refer to the Fisheries [Alberta] Technical Report of Volume 5C) along the Edmonton to Hinton Segment. The 56 fish-bearing water crossings include 49 watercourses, 3 NCDs and 4 fish-bearing wetlands. An additional 17 sites, not assessed during the fisheries field program, have been defaulted to fish-bearing status. Table 5.7-6 provides a list of fish-bearing water crossings, their location along the proposed pipeline corridor, watershed, sensitivity rating, restricted activity periods (RAPs), recommended least risk biological windows, and the presence of indicator species. Additional information about these crossings, including known fish species presence, recommended crossing methods, water quality parameters, watercourse characteristics, and fish habitat ratings is provided in the Fisheries (Alberta) Technical Report of Volume 5C, particularly the Watercourse Crossing Summary Table (Appendix A) and the Fish-Bearing Atlas (Appendix C). Fish-bearing wetlands and drainages lack defined beds and banks and, therefore, do not fall under the Code of Practice in Alberta and have no classification or instream RAP. However, if sportfish are present, species-specific RAPs may be applicable, at the direction of the Qualified Aquatic Environment Specialist (QAES). Aboriginal participants reported that fly-fishing is the most common form of fishing along the Pembina River, but more traditional methods, such as net fishing are also used. Northern pike, suckers (sucker species), Arctic grayling and rainbow trout can be found in this river. Additional information is provided in the Fisheries (Alberta) Technical Report of Volume 5C.

The fish-bearing water crossings include one crossing of each of the North Saskatchewan, Pembina, Lobstick and McLeod rivers, 26 crossings of named creeks (including two crossings of Bench Creek), 3 NCDs and 7 wetlands (Table 5.7-6).

Fish and fish habitat sensitivity ratings were established for each proposed crossing using the professional judgment of a QAES and are based on the fish species present at the time of the field assessment or previously documented within a given system, flow regime (*i.e.*, seasonal or perennial) or the habitat type available for each life history stage (*e.g.*, spawning) of the key fish species present. This closely follows criteria defined by Fisheries and Oceans Canada (DFO) (Canadian Association of Petroleum Producers [CAPP] *et al.* 2005). A sensitivity rating allows the use of a risk assessment approach to determine the overall risk to fishes and their habitat at a given watercourse crossing. Ratings for Sensitivity of Fish and Fish Habitat allow regulators and the proponent to determine the level of risk associated with pipeline construction activities and methods/designs for pipeline and vehicle crossings for each proposed watercourse crossing. The associated effects can be evaluated by DFO to define the Categories of Risk (*i.e.*, Significant, Negative Effects, High Risk, Medium Risk and Low Risk) once an appropriate construction method and construction timing have been selected for a particular watercourse. Where fish habitat has been ranked as sensitive, the level of risk to fish and fish habitat has been determined to be high. Additional information about the evaluation criteria and corresponding sensitivity rankings is provided in the Fisheries (Alberta) Technical Report of Volume 5C.

TABLE 5.7-6

FISH-BEARING WATER CROSSINGS ALONG THE PROPOSED PIPELINE CORRIDOR OF THE EDMONTON TO HINTON SEGMENT

Site No.	RK	Name	Watershed[1]	Fish and Fish Habitat Sensitivity Rating[2]	Indicator Species Previously Documented[3] (Captured/Observed)	RAP (Least Risk Biological Window Proposed)
WATERCOURSES						
AB-2	5.1	Goldbar Creek	Lower North Saskatchewan River	Low	None (none)	April 16 to June 30 (Open)
AB-7	12.7	Mill Creek*	Lower North Saskatchewan River	High	None (to be determined)	April 16 to June 30 (To be determined)
AB-12	24.2	Blackmud Creek	Middle North Saskatchewan River	High	None (none)	April 16 to June 30 (July 1 to April 15)

TABLE 5.7-6 Cont'd

Site No.	RK	Name	Watershed[1]	Fish and Fish Habitat Sensitivity Rating[2]	Indicator Species Previously Documented[3] (Captured/Observed)	RAP (Least Risk Biological Window Proposed)
AB-13	28.1	Whitemud Creek	Middle North Saskatchewan River	High	Burbot, northern pike (none)	April 16 to June 30 (July 1 to April 15)
AB-14	33.5	North Saskatchewan River	Middle North Saskatchewan River	High	Bull trout, burbot, northern pike, walleye, (northern pike, walleye)	September 16 to July 31 (August 1 to September 15)
AB15	36.9	Unnamed tributary to North Saskatchewan River*	Middle North Saskatchewan River	High	None (to be determined)	April 16 to June 30 (To be determined)
AB-18	59.4	Dog Creek	Sturgeon River	Low	None (none)	April 16 to June 30 (Open)
AB-19	62.9	Atim Creek	Sturgeon River	Low	None (none)	April 16 to June 30 (Open)
AB-20	64.2	Unnamed tributary to Atim Creek	Sturgeon River	Low	None (none)	April 16 to June 30 (Open)
AB-21	65.5	Unnamed tributary to Atim Creek	Sturgeon River	Low	None (none)	April 16 to June 30 (Open)
AB-23	69.9	Unnamed tributary to Atim Creek*	Sturgeon River	High	None (to be determined)	April 16 to June 30 (To be determined)
AB-25	82.6	Killini Creek	Sturgeon River	Low	Northern pike (none)	April 16 to June 30 (Open)
AB-33	90.1	Unnamed tributary to Killini Creek*	Upper North Saskatchewan River	High	None (to be determined)	April 16 to June 30 (To be determined)
AB-34	91.1	Unnamed tributary to Killini Creek	Upper North Saskatchewan River	Low	None (none)	April 16 to June 30 (Open)
AB-35	92.6	Unnamed tributary to Killini Creek*	Upper North Saskatchewan River	High	None (to be determined)	April 16 to June 30 (To be determined)
AB-36	94.7	Unnamed tributary to Wabamun Lake*	Upper North Saskatchewan River	High	None (to be determined)	April 16 to June 30 (To be determined)
AB-44	108.5	Unnamed tributary to Wabamun Lake	Upper North Saskatchewan River	Low	None (none)	April 16 to June 30 (Open)
AB-60	126.8	Unnamed tributary to Isle Lake	Sturgeon River	Low	None (none)	April 16 to June 30 (Open)
AB-66	135.0	Pembina River	Pembina River	High	Arctic grayling, bull trout, burbot, northern pike, walleye (walleye)	September 1 to June 30 (July 1 to August 31)
AB-78	142.5	Zeb-igler Creek	Pembina River	Low	None (none)	April 16 to June 30 (Open)
AB-82	146.0	Unnamed tributary to Lobstick River*	Pembina River	High	None (to be determined)	September 1 to June 30 (To be determined)
AB-83	146.3	Unnamed tributary to Lobstick River*	Pembina River	High	None (to be determined)	September 1 to June 30 (To be determined)
AB-91	152.0	Unnamed tributary to Chip Lake*	Pembina River	High	None (To be determined)	April 16 to June 30 (To be determined)
AB-92	156.5	Unnamed tributary to Chip Lake	Pembina River	Low	None (none)	April 16 to June 30 (Open)
AB-93	157.1	Unnamed tributary to Chip Lake	Pembina River	Low	None (none)	April 16 to June 30 (Open)
AB-98	159.7	Unnamed tributary to Chip Lake	Pembina River	Low	None (none)	April 16 to June 30 (Open)
AB-101	164.2	Unnamed tributary to Chip Lake*	Pembina River	High	None (To be determined)	April 16 to June 30 (To be determined)
AB-102	164.3	Unnamed tributary to Chip Lake*	Pembina River	High	None (To be determined)	April 16 to June 30 (To be determined)

TABLE 5.7-6 Cont'd

Site No.	RK	Name	Watershed[1]	Fish and Fish Habitat Sensitivity Rating[2]	Indicator Species Previously Documented[3] (Captured/Observed)	RAP (Least Risk Biological Window Proposed)
AB-106	168.2	Unnamed tributary to Chip Lake	Pembina River	Low	None (none)	April 16 to June 30 (Open)
AB-111	173.7	Little Brule Creek	Pembina River	High	Arctic grayling, northern pike (Arctic grayling)	September 1 to June 30 (July 1 to August 31)
AB-114	178.9	Unnamed tributary to Brule Creek	Pembina River	Low	None (none)	September 1 to June 30 (Open)
AB-116	181.0	Brule Creek	Pembina River	High	None (none)	September 1 to June 30 (July 1 to August 31)
AB-117	185.4	Lobstick River	Pembina River	High	Burbot, northern pike (northern pike)	September 1 to June 30 (July 1 to August 31)
AB-118	189.0	Unnamed tributary to Lobstick	Pembina River	Low	None (none)	September 1 to June 30 (Open)
AB-119	193.1	Carrot Creek	Lower McLeod River	High	Arctic grayling, northern pike (northern pike)	September 1 to July 15 (July 16 to August 31)
AB-123	198.8	Unnamed tributary to January Creek	Lower McLeod River	Low	None (none)	September 1 to July 15 (Open)
AB-124	199.8	Unnamed tributary to January Creek	Lower McLeod River	High	None (none)	September 1 to July 15 (July 16 to August 31)
AB-125	202.6	Unnamed tributary to January Creek	Lower McLeod River	High	None (none)	September 1 to July 15 (July 16 to August 31)
AB-126	202.8	Unnamed tributary to January Creek	Lower McLeod River	High	None (none)	September 1 to July 15 (July 16 to August 31)
AB-128	207.1	January Creek	Lower McLeod River	Low	Northern pike (none)	September 1 to July 15 (July 16 to August 31)
AB-129	220.6	Wolf Creek	Lower McLeod River	High	Arctic grayling, Athabasca rainbow trout, burbot, northern pike, walleye (Arctic grayling, northern pike, burbot)	September 1 to July 15 (July 16 to August 31)
AB-131	223.9	McLeod River	Lower McLeod River	High	Arctic grayling, Athabasca rainbow trout, bull trout, burbot, northern pike, walleye (Arctic grayling, burbot, northern pike, walleye)	September 1 to June 30 (July 1 to August 31)
AB-132	227.5	Bench Creek	Lower McLeod River	High	Northern pike (none)	September 1 to July 15 (July 16 to August 31)
AB-136	236.6	Bench Creek	Lower McLeod River	High	Northern pike (none)	September 1 to July 15 (July 16 to August 31)

TABLE 5.7-6 Cont'd

Site No.	RK	Name	Watershed[1]	Fish and Fish Habitat Sensitivity Rating[2]	Indicator Species Previously Documented[3] (Captured/Observed)	RAP (Least Risk Biological Window Proposed)
AB-137	245.2	Little Sundance Creek	Upper McLeod River	High	Arctic grayling, Athabasca rainbow trout, burbot (Athabasca rainbow trout)	September 1 to July 15 (July 16 to August 31)
AB-138	248.0	Sundance Creek	Upper McLeod River	High	Arctic grayling, Athabasca rainbow trout, burbot (Athabasca rainbow trout, burbot)	September 1 to July 15 (July 16 to August 31)
AB-140	257.7	Unnamed tributary to McLeod River	Upper McLeod River	Low	None (none)	September 1 to July 15 (Open)
AB-141	260.1	Unnamed tributary to McLeod River *	Upper McLeod River	High	None (to be determined)	September 1 to July 15 (To be determined)
AB-143	269.6	Unnamed tributary to McLeod River	Upper McLeod River	Low	None (none)	September 1 to July 15 (July 16 to August 31)
AB-144	270.1	Unnamed tributary to McLeod River	Upper McLeod River	High	None (none)	September 1 to July 15 (July 16 to August 31)
AB-153	291.9	Rooster Creek	Athabasca River	High	Athabasca rainbow trout (none)	September 1 to July 15 (July 16 to August 31)
AB-155	295.2	Ponoka Creek	Athabasca River	High	Athabasca rainbow trout (none)	September 1 to July 15 (July 16 to August 31)
AB-157	298.6	Roundcroft Creek	Athabasca River	High	Athabasca rainbow trout, bull trout (none)	September 1 to July 15 (July 16 to August 31)
AB-162	302.4	Sandstone Creek*	Athabasca River	High	Athabasca rainbow trout (to be determined)	September 1 to July 15 (To be determined)
AB-163	304.7	Unnamed tributary to Hunt Creek	Athabasca River	High	None (none)	September 1 to July 15 (July 16 to August 31)
AB-164	307.8	Hunt Creek	Athabasca River	High	None (none)	September 1 to July 15 (July 16 to August 31)
AB-167	309.0	Trail Creek	Athabasca River	High	Northern pike (none)	September 1 to July 15 (July 16 to August 31)
AB-168	310.8	Unnamed tributary to Athabasca River	Athabasca River	High	None (Athabasca rainbow trout)	September 1 to July 15 (July 16 to August 31)
AB-176	315.6	Unnamed tributary to Cache Percotte Creek*	Athabasca River	High	None (to be determined)	September 1 to July 15 (To be determined)
AB-177	316.4	Cache Percotte Creek	Athabasca River	High	Athabasca rainbow trout (none)	September 1 to July 15 (July 16 to August 31)

TABLE 5.7-6 Cont'd

Site No.	RK	Name	Watershed[1]	Fish and Fish Habitat Sensitivity Rating[2]	Indicator Species Previously Documented[3] (Captured/Observed)	RAP (Least Risk Biological Window Proposed)
AB-180	319.8	Hardisty Creek	Athabasca River	High	Bull trout, burbot, northern pike (none)	September 1 to July 15 (July 16 to August 31)
AB-188	327.6	Maskuta Creek	Athabasca River	High	Bull trout, burbot, northern pike (none)	September 1 to July 15 (July 16 to August 31)
AB-202	338.6	Unnamed tributary to Maskuta Creek	Athabasca River	Low	None (none)	September 1 to July 15 (Open)
NCDs and WETLANDS						
AB-16	40.5	Unnamed Wetland	Middle North Saskatchewan River	Low	None (none)	None (Open)
AB-17	41.7	Unnamed NCD	Middle North Saskatchewan River	Low	None (none)	None (Open)
AB-28	85.0	Unnamed Wetland	Upper North Saskatchewan River	Low	None (none)	None (Open)
AB-31	88.9	Unnamed Wetland*	Upper North Saskatchewan River	High	None (to be determined)	To be determined (To be determined)
AB-37	95.2	Unnamed Wetland*	Upper North Saskatchewan River	High	None (to be determined)	To be determined (To be determined)
AB-38	95.3	Unnamed Wetland*	Upper North Saskatchewan River	High	None (to be determined)	To be determined (To be determined)
AB-79	142.9	Unnamed Wetland	Pembina River	Low	None (none)	None (Open)
AB-103	165.6	Unnamed NCD	Pembina River	Low	None (none)	None (Open)
AB-113	177.5	Unnamed NCD	Pembina River	Low	None (none)	None (Open)
AB-146	280.4	Unnamed Wetland	Athabasca River	Low	None (none)	None (Open)

Notes:
1 Project watershed as described in detail in Section 5.7.3.1.
2 Methodology for determination of watercourse sensitivity is described in detail in the Fisheries (Alberta) Technical Report of Volume 5C.
3 Athabasca rainbow trout may be pure, possible, suspected or confirmed (Table 4.21 of the Fisheries [Alberta] Technical Report of Volume 5C).
* Indicates that an aquatic assessment was not conducted at the site during the fisheries field program. These sites have been defaulted to fish-bearing status with a fish and fish habitat sensitivity rating of high until field work has been conducted (see Section 9.0 for information on supplemental studies).

5.7.2.5 Riparian Habitat

Riparian habitat composition at watercourses crossed by the proposed pipeline corridor within the Edmonton to Hinton Segment varies from east to west. Within the Edmonton Transportation/Utility Corridor (TUC) (RK 0.0 to RK 33.5), riparian habitat is largely comprised of mixed coniferous and deciduous trees, although grasses and shrubs are also present at some proposed crossing sites. Crown closure ranges from 1-40% at watercourses. From the Edmonton TUC to approximately RK 220.0 (*i.e.*, near the proposed crossing of Wolf Creek), riparian habitat composition shifts from being dominated by coniferous and deciduous trees to predominantly grasses and shrubs. Grazing is a common land use practice in this portion of the proposed pipeline corridor, resulting in diminished riparian health and diversity. Crown closure in this portion of the proposed pipeline corridor generally ranges between 0-20%. As the proposed pipeline corridor extends into the Green Area (RK 247.9) to the western boundary of the Edmonton to Hinton Segment, riparian habitat shifts back to (in general) mature stands of deciduous and coniferous trees, with grasses and shrubs included in some instances. Crown closure ranges between

0-70% in this portion. The total area of riparian habitat within the Aquatics RSA in the Edmonton to Hinton Segment is approximately 193,182.1 ha.

5.7.2.6 Field Results

A total of 202 potential water crossings were identified in the proposed pipeline corridor along the Edmonton to Hinton Segment. During the fisheries field program, habitat use and potential were assessed at 185 locations. Limited access permission and limiting existing information at the remaining 17 locations prevented field assessments (see Section 9.3). Of the 185 crossings assessed during the fisheries field program, 39 were visited in 2 seasons. There were 3 crossings visited during the 2012 fall spawning survey, 16 were visited during the 2013 wintering habitat potential assessment, 138 were assessed during the spring 2013 fisheries program and 4 crossings were visited during the fall 2013 spawning assessment. Of the 185 potential watercourse crossings assessed during the fisheries field program of where suitable historic information exists, 56 were determined to be fish-bearing and 129 were determined to be nonfish-bearing. The 17 potential crossings not assessed during the fisheries field program are presumed to be fish-bearing and to have a fish and fish habitat sensitivity rating of high based on previously documented fish information or by default.

During the field surveys, traditional methods of resource procurement were discussed, as well as modern methods currently employed. Seasonality of resource harvesting was also important information shared by the Aboriginal participants. Geographical locations were identified, as were areas that are not used and the reasons why these are not used. Participants assisted in the identification of potential fish species within each watercourse crossed. At each investigation site, discussions were held with participants about the seasonality of fish, aquatic habitat, water quality and quantity, suitability for navigation and any changes to fisheries and water resources over time. Potential mitigation measures to reduce any Project-related effects on a resource were also discussed during the fisheries field surveys. Open discussions occurred regularly between participants and TEK facilitators regarding the resources present and available to Aboriginal communities. These discussions were important to help build relationships among the field crews. Aboriginal participants spoke about aspects of the environment that were important to them and the importance of the resource from a western science perspective was also discussed. The TEK collected during the fisheries field surveys has: added results that western science may not have gathered or considered; confirmed results that had been collected through the field surveys; and identified and confirmed issues of concern to be addressed. The TEK collected is also used to assist in the review of potential Project-related effects on fish and fish habitat.

<u>Fish and Fish Habitat Assessment</u>

Fish and fish habitat assessments (Fisheries [Alberta] Technical Report of Volume 5C) were conducted in order to document existing fish and fish habitat conditions at each proposed water crossing with fish and fish habitat. Information will be provided to DFO to assist with any case-specific reviews of water crossings they may need to conduct.

During the fisheries field program, 157 of the 185 crossings were determined to be sites of Low sensitivity for species of management concern (*i.e.*, sportfish and/or provincially or federally-listed fish species). This total includes all 129 crossings of nonfish-bearing habitat and 28 crossings of fish-bearing habitat. Sites with fish habitat of High sensitivity for species of management concern were confirmed at 28 of 56 proposed crossings of known fish-bearing habitat. These High sensitivity sites resulted where fish capture or observation included species of management concern and/or where the habitat potential for species of management concern of two or more fish life stages (*i.e.*, of rearing, spawning and wintering) were rated as Moderate-High or High. Refer to Section 5.2 of the Fisheries (Alberta) Technical Report of Volume 5C for further details.

Indicator Species

Information on indicator species captured or observed during the fisheries field program are discussed in Sections 5.7.7 to 5.7.12.

Species of Management Concern

Five of the 12 additional species of management concern (*i.e.*, in addition to indicator species) that occur frequently within the Edmonton to Hinton Segment were captured at watercourse crossings within the proposed pipeline corridor. These species include: brook trout; rainbow trout (introduced populations); mountain whitefish; mooneye; and spoonhead sculpin. Species of management concern that were not captured or observed at any of the proposed crossings within the studied watercourse crossings include brown trout; lake sturgeon; cutthroat trout; yellow perch; sauger; goldeye; and northern redbelly dace.

Brook trout were captured or observed at eight watercourses. One watercourse is within the Lower McLeod River Watershed, one watercourse is located within the Upper McLeod River Watershed and six watercourses are located within the Athabasca River Watershed. Rainbow trout (introduced populations) were captured or observed at four watercourses; one watercourse lies within the Lower McLeod River Watershed and the other three watercourses are located within the Athabasca River Watershed. Mountain whitefish were captured or observed at five watercourses. One watercourse is located within the Middle North Saskatchewan River Watershed, one watercourse is within the Pembina River Watershed, two watercourses lie within the Lower McLeod River Watershed and one watercourse is within the Upper McLeod River Watershed. Mooneye were captured or observed at one watercourse in the Middle North Saskatchewan River Watershed. Spoonhead sculpin were captured from one watercourse in the Pembina River Watershed and one watercourse in the Athabasca River Watershed.

Refer to Section 5.2.8 of the Fisheries (Alberta) Technical Report of Volume 5C for additional information on watercourses at which species of management concern were captured or observed.

Spawning Assessments

Spawning assessments were performed in September 2012 in the Pembina River (RK 135.0), Wolf Creek (RK 220.6) and McLeod River (RK 223.9) and in September 2013 at Maskuta, Hardisty, Sundance and Little Sundance creeks.

A total of 102 fish were observed in the Pembina River. Most were sucker species, although, mountain whitefish, walleye and trout species were also observed. No spawning activity was observed; however, fish were observed using the deep pool habitat, supporting the high habitat sensitivity rating assigned to the Pembina River. According to TEK participants, fish are abundant in watercourses in the fall and participants reported that the fish caught in the fall taste better than those caught at other times of the year.

Comparatively fewer fish were observed during the snorkel survey of Wolf Creek (RK 220.6) (n=68) which included mountain whitefish, Arctic grayling, brook trout, northern pike, trout species (unidentified) and sucker species (unidentified). One redd was identified and presumed to be that of a nearby brook trout. Spawning activity and diversity of species observed during the fall 2012 survey support the high habitat sensitivity rating assigned to Wolf Creek.

Results from the 2012 fall spawning survey supported the assertion that fish habitat near the proposed crossing of the McLeod River is of high sensitivity for species of management concern since 4,225 fish were observed. This total was comprised of Arctic grayling, mountain whitefish, northern pike, walleye, burbot, rainbow trout (introduced populations) and sucker species. Many of the mountain whitefish were estimated to be of adult size and presumed to be staging or in the process of spawning.

A total of 11 fish were observed at Maskuta Creek during the 2013 spawning survey. Of this, eight fish were confirmed to the species-level (*i.e.*, five rainbow trout and three brook trout). Two additional trout (unconfirmed species) and one sculpin (unconfirmed species) were also observed.

The 2013 spawning survey at Hardisty Creek observed 130 fish, including rainbow trout (n=53), brook trout (n=29). An additional 48 trout (unidentified) were also observed. No confirmed observations of mountain whitefish or bull trout resulted.

The survey at Sundance Creek observed 162 fish, including mountain (n=153), rainbow trout (n=2), burbot (n=2) and 5 sucker species. The rainbow trout occurring in Sundance Creek are “possible” pure strain Athabasca rainbow trout (Sterling pers. comm.).

No fish or redds were observed during the spawning assessment at Little Sundance Creek due to numerous woody debris piles and abundant instream vegetation, which limited the effectiveness of the snorkel survey. Although no fish were observed during the fall 2013 spawning assessment, limited visibility and abundant cover elements indicate that the absence of spawning activity should not be assumed.

2013 Potential Wintering Habitat Survey

A total of 16 proposed crossings were visited during the 2013 potential wintering habitat survey. Of these, seven were confirmed as having habitat of high sensitivity for species of management concern or rated higher (*i.e.*, as compared to ratings assigned during assessments conducted in the open water season). Winter habitat ratings for five watercourse crossings diminished due to limited water depth, flow and water quality parameters (Section 5.2.5 of the Fisheries [Alberta] Technical Report of Volume 5C).

5.7.3 General Information - Hargreaves to Darfield Segment

The proposed pipeline corridor along the Hargreaves to Darfield Segment from RK 489.6 to RK 769.0 traverses the Fraser River Basin for most of its length, with only a 20 km section (RK 527.9 to RK 547.7) in the Columbia River Basin. The Fraser and Columbia River basins have drainage areas of 232,300 km^2 and 102,800 km^2, respectively (Fisheries [British Columbia] Technical Report of Volume 5C). There are 349 proposed water crossings along the Hargreaves to Darfield Segment, of which 189 are crossings of watercourses (*i.e.*, having defined beds and banks), including the Fraser, Canoe, North Thompson and Clearwater rivers.

The Fraser River, the longest river in BC, originates in Mount Robson Provincial Park in BC, flowing northwest to Prince George before bending south to the Lower Mainland where it enters the Pacific Ocean after 1,370 km. The Fraser River Basin provides spawning and rearing habitat for six species of Pacific salmon (including steelhead trout) and is the largest salmon producing river in BC (DFO 2012). There are seven proposed watercourse crossings in the Fraser River Basin within this segment, including one proposed crossing of the Fraser River at RK 499.7.

The Columbia River originates in the Rocky Mountain Trench. It flows northwest through the Columbia Valley to Kinbasket Lake, after which it flows south, eventually crossing the border into the US before draining into the Pacific Ocean. The total length of the Columbia River is approximately 1,930 km, of which 668 km is in Canada (US Geological Survey 2013). The Columbia River is not crossed by the proposed corridor along this pipeline segment, although there are seven crossings of watercourses that drain into the Columbia River Basin, including one proposed crossing of the Canoe River upstream of Kinbasket Lake at RK 531.3.

The Canoe River originates in the Caribou Mountains and flows east for approximately 40 km to its confluence with Kinbasket Lake. This arm of Kinbasket Lake is referred to as Canoe Reach and was previously the lower reaches of the Canoe River. Canoe Reach was created when lower portions of the Canoe River were flooded during installation of the Mica Dam in 1973.

The headwaters to the North Thompson River originate in the Caribou Mountains at the foot of the Thompson Glacier, east of Wells Gray Provincial Park. The North Thompson River flows approximately 325 km, first east towards Highway 5 then south, to its confluence with the South Thompson River at Kamloops, marking the beginning of the Thompson River which shortly drains into Kamloops Lake. There are three proposed crossings of the North Thompson River (at RK 581.2, RK 619.9 and RK 651.6) along the Hargreaves to Darfield Segment. Other river crossings include three proposed crossings of the Albreda River (RK 552.1, RK 561.2 and RK 563.6) and one each of the Thunder (RK 600.2), Blue (RK 613.8), Mad (RK 683.4), Raft (RK 717.7) and Clearwater (RK 725.5) rivers, all of which are tributaries to the North Thompson River.

The Clearwater River is a direct tributary to the North Thompson River, flowing mainly south for 201 km from its headwaters to the confluence with the North Thompson River. The Clearwater River flows through Wells Gray and North Thompson River provincial parks for much of its length. There is one proposed crossing of the Clearwater River in the Hargreaves to Darfield Segment at RK 725.5.

Fishing remains an important traditional and commercial activity for Aboriginal communities residing in BC. The Barriere, Fraser, Raft, Blue, Albreda and North Thomson rivers, and Lemieux, Dunn, Moonbeam, and Finn creeks are currently fished by TEK participants.

The following subsections describe the watersheds, areas of special interest, hydrometric data, fish-bearing watercourses, riparian habitat and field results along the Hargreaves to Darfield Segment.

5.7.3.1 Watersheds

The proposed pipeline corridor traverses five watersheds in this segment, identified by the BC Freshwater Atlas Watershed Groups data file (BC MFLNRO 2008a). The Upper Fraser, Upper and Lower North Thompson and Clearwater river watersheds drain into the Fraser River Basin. The Canoe Reach Watershed is the only watershed crossed within the Columbia River Basin.

Table 5.7-7 provides the drainage areas and RK range(s) for each of the watersheds crossed by the proposed pipeline corridor in the Hargreaves to Darfield Segment. Additional information about the watercourses crossed by the proposed pipeline corridor within each watershed is provided in the Fisheries (British Columbia) Technical Report of Volume 5C.

TABLE 5.7-7

WATERSHEDS CROSSED BY THE PROPOSED PIPELINE CORRIDOR IN THE HARGREAVES TO DARFIELD SEGMENT

Watershed	Approximate Drainage Area	RK Range(s)
Upper Fraser River	6,759 km²	RK 489.6 to RK 527.9
Canoe Reach	3,168 km²	RK 527.9 to RK 547.7
Upper North Thompson River	5,388 km²	RK 547.7 to RK 722.9 RK 723.0 to RK 723.1 RK 724.0 to RK 724.5
Clearwater River	3,113 km²	RK 722.9 to RK 723.0 RK 723.1 to RK 724.0 RK 724.5 to RK 725.2 RK 725.2 to RK 725.3 RK 725.3 to RK 725.9
Lower North Thompson River	4,911 km²	RK 725.2 to RK 725.2 RK 725.3 to RK 725.3 RK 725.9 to RK 769.0

5.7.3.2 Areas of Special Interest

Finn Creek Provincial Park is traversed by the proposed pipeline corridor from RK 638.7 to RK 639.3 and there are two proposed crossings of watercourses in the park (BC-201 and BC-202). Participants of the Blue River Community Workshop commented that Finn Creek Provincial Park contains good quality salmon habitat. The proposed pipeline corridor also crosses one watercourse (BC-312) in the North Thompson River Provincial Park, which is traversed from RK 725.5 to RK 725.9.

The entire length of the Fraser River, from its origins in Mount Robson Provincial Park to its outflow into the Pacific Ocean at Vancouver, is designated as a Canadian Heritage River by the Canadian Heritage Rivers System as well as a BC Heritage River by the BC MOE (BC MOE 2011b, Canadian Heritage Rivers System 2011a). No other designated or nominated Canadian or BC Heritage Rivers are crossed by the proposed pipeline corridor in this segment (BC MOE 2011c, Canadian Heritage Rivers System 2011a).

There are no national parks, Fisheries Sensitive Watersheds or other areas of special interest traversed by this proposed pipeline segment (BC MOE 2013e).

5.7.3.3 Hydrometric Data

The Water Survey of Canada maintains several hydrometric stations on watercourses crossed by the proposed pipeline corridor in this segment (Table 5.7-8). In general, the annual high flow event occurs in spring/early summer (*i.e.*, May to July) and mean monthly flows are lowest in the winter (*i.e.*, February and March). Additional information about each station and the monthly mean flows can be found in Section 5.3.

TABLE 5.7-8

SUMMARY OF STREAMFLOWS FROM HYDROLOGICAL STATIONS NEAR THE PROPOSED PIPELINE CORRIDOR IN THE HARGREAVES TO DARFIELD SEGMENT

Watercourse Name	Station Name, Station Number	Years Station Data Available	Approximate Location of Station Relative to the Nearest RK	Month and Mean Monthly Discharge (m^3/s) During Lowest Flow Period	Month and Mean Monthly Discharge (m^3/s) During Highest Flow Period
Fraser River	Fraser River at Red Pass 08KA007	1955 to 2010	27 km upstream of RK 499.7	March 5.32 m^3/s	June 152 m^3/s
Clearwater River	Clearwater River Near Clearwater Station 08LA001	1914 to 1919 1921 to 1928 1950 to 2010	2 km upstream of RK 725.5	February 45.3 m^3/s	June 714 m^3/s
North Thompson River	North Thompson River at Birch Island 08LB047	1960 to 2010	65 km downstream of RK 651.7	February 28.1 m^3/s	June 444 m^3/s

Sources: Environment Canada 2013e-g

5.7.3.4 Fish-Bearing Crossings

Based on historical data and field studies conducted for the Project (see Fisheries [British Columbia] Technical Report of Volume 5C), 84 of the proposed water crossings were identified as fish-bearing. Table 5.7-9 provides a list of fish-bearing water crossings, their location along the proposed pipeline corridor, watershed, sensitivity rating, instream work windows, least risk biological windows and the presence of indicator species. Additional information about these crossings, including known fish species presence, recommended crossing methods, water quality parameters, watercourse characteristics, and fish habitat ratings is provided in the Fisheries (British Columbia) Technical Report of Volume 5C, particularly the Watercourse Crossing Summary Table (Appendix A) and the Fish-Bearing Atlas (Appendix B).

The fish-bearing watercourse crossings include at least one proposed crossing of each of the Fraser, Canoe, Albreda, North Thompson, Mad, Raft, Clearwater, Thunder and Blue rivers (Table 5.7-9). Participants of the Blue River and Kamloops Community Workshops agreed that important fish habitat is found in at least two of the named rivers (*i.e.*, Blue River, Thompson River).

TEK participants identified several types of salmon during field surveys along the proposed Hargreaves to Darfield Segment including: Chinook; dog (*i.e.*, chum); coho; and sockeye.

Sensitivity ratings were established using the professional judgment of a Qualified Environmental Professional (QEP) and are based on the fish species present at the time of the field assessment or previously documented within a given system, flow regime (*i.e.*, seasonal or perennial) or the habitat type available for each life history stage (*e.g.*, spawning) of the key fish species present. This closely follows criteria defined by DFO (CAPP *et al.* 2005). A sensitivity rating allows the use of a risk assessment approach to determine the overall risk to fishes and their habitat at a given watercourse crossing. Additional details about the fish and fish habitat sensitivity ratings are provided in Section 5.7.2.4 and the Fisheries (British Columbia) Technical Report of Volume 5C.

TABLE 5.7-9

FISH-BEARING WATER CROSSINGS ALONG THE PROPOSED PIPELINE CORRIDOR OF THE HARGREAVES TO DARFIELD SEGMENT

Site No.	RK	Name	Watershed[1]	Sensitivity Rating[2]	Historical Indicator Species Present (Captured/Observed)[3]	Instream Work Window [BC MOE and DFO] (Least Risk Biological Window)[4]
WATERCOURSES						
BC-3	490.5	Baer Creek	Upper Fraser River	High	Bull trout/Dolly Varden, rainbow trout/steelhead (none)	July 15 to August 15 (to be determined)
BC-5	491.6	Marathon Creek	Upper Fraser River	High	Rainbow trout/steelhead (none)	July 15 to April 15 (to be determined)
BC-8	495.8	Terry Fox Creek	Upper Fraser River	High	Bull trout/Dolly Varden, rainbow trout/steelhead (none)	July 15 to August 15 (to be determined)
BC-10	499.7	Fraser River	Upper Fraser River	High	Bull trout/Dolly Varden, Chinook salmon, rainbow trout/steelhead (rainbow trout/steelhead)	July 15 to August 15 [Contact DFO] (July 15 to August 15) [Contact DFO]
BC-27	515.5	Teepee Creek	Upper Fraser River	High	Bull trout/Dolly Varden (bull trout/Dolly Varden)	June 15 to August 15 (June 15 to August 15)
BC-28	517.8	Crooked Creek	Upper Fraser River	High	Bull trout/Dolly Varden, rainbow trout/steelhead (bull trout/Dolly Varden, rainbow trout/steelhead)	July 15 to August 15 (July 15 to August 15)
BC-32	522.5	Swift Creek	Upper Fraser River	High	Bull trout/Dolly Varden, Chinook salmon, rainbow trout/steelhead (bull trout/Dolly Varden, Chinook salmon)	July 15 to August 15 [Contact DFO] (July 15 to August 15) [Contact DFO]
BC-36	531.3	Canoe River	Canoe Reach	High	Bull trout/Dolly Varden, rainbow trout/steelhead (bull trout/Dolly Varden)	July 15 to August 15 (July 15 to August 15)
BC-38	534.5	Camp Creek	Canoe Reach	High	Bull trout/Dolly Varden, rainbow trout/steelhead (bull trout/Dolly Varden, rainbow trout/steelhead)	July 15 to August 15 (July 15 to August 15)
BC-43	540.6	Unnamed Channel	Canoe Reach	High	None (rainbow trout/steelhead)	July 15 to April 15 (July 15 to April 15)
BC-51	544.8	Unnamed Channel	Canoe Reach	High	Rainbow trout/steelhead (rainbow trout/steelhead)	July 15 to April 15 (July 15 to April 15)
BC-52	545.9	Camp Creek	Canoe Reach	High	Bull trout/Dolly Varden, rainbow trout/steelhead (bull trout/Dolly Varden, rainbow trout/steelhead)	July 15 to August 15 (July 15 to August 15)
BC-55	546.9	Unnamed Channel	Canoe Reach	High	None (bull trout/Dolly Varden, rainbow trout/steelhead)	July 15 to August 15 (Open)
BC-56	547.6	Camp Creek	Canoe Reach	High	Bull trout/Dolly Varden, rainbow trout/steelhead (bull trout/Dolly Varden, rainbow trout/steelhead)	July 15 to August 15 (July 15 to August 15)
BC-65	552.1	Albreda River	Upper North Thompson River	High	Bull trout/Dolly Varden, coho salmon, rainbow trout/steelhead (bull trout/Dolly Varden, coho salmon)	July 22 to August 15 (July 22 to August 15)
BC-70	555.1	Unnamed Channel	Upper North Thompson River	Low	None (coho salmon)	July 15 to August 15 (Open)
BC-71	555.5	Unnamed Channel	Upper North Thompson River	High	Coho salmon (coho salmon)	July 15 to August 15 (Open)
BC-74	556.8	Unnamed Channel	Upper North Thompson River	Low	None (coho salmon, rainbow trout/steelhead)	July 22 to August 15 (Open)
BC-76	559.0	Clemina Creek	Upper North Thompson River	High	Bull trout/Dolly Varden (bull trout/Dolly Varden)	June 1 to August 15 (June 1 to August 15)
BC-78	559.4	Dora Creek	Upper North Thompson River	High	Bull trout/Dolly Varden, coho salmon (bull trout/Dolly Varden)	July 15 to August 15 (July 15 to August 15)
BC-80	560.3	Unnamed Channel	Upper North Thompson River	High	Bull trout/Dolly Varden, coho salmon (bull trout/Dolly Varden, coho salmon)	July 15 to August 15 (Open)
BC-82	561.2	Albreda River	Upper North Thompson River	High	Bull trout/Dolly Varden, coho salmon, rainbow trout/steelhead (bull trout/Dolly Varden, coho salmon)	July 22 to August 15 (July 22 to August 15)

TABLE 5.7-9 Cont'd

Site No.	RK	Name	Watershed[1]	Sensitivity Rating[2]	Historical Indicator Species Present (Captured/Observed)[3]	Instream Work Window [BC MOE and DFO] (Least Risk Biological Window)[4]
BC-84	563.5	Unnamed Channel	Upper North Thompson River	High	Bull trout/Dolly Varden, coho salmon (bull trout/Dolly Varden, coho salmon)	July 15 to August 15 (Open)
BC-85	563.6	Albreda River	Upper North Thompson River	High	Bull trout/Dolly Varden, coho salmon, rainbow trout/steelhead (bull trout/Dolly Varden, coho salmon)	July 22 to August 15 (July 22 to August 15)
BC-90	565.9	Unnamed Channel	Upper North Thompson River	High	None (coho salmon)	July 15 to August 15 (July 15 to August 15)
BC-91	566.5	Unnamed Channel	Upper North Thompson River	Low	Chinook salmon, coho salmon (Chinook salmon, coho salmon)	July 15 to August 15 (Open)
BC-93	567.6	Dominion Creek	Upper North Thompson River	High	Bull trout/Dolly Varden, coho salmon (bull trout/Dolly Varden)	June 1 to August 15 (June 1 to August 15)
BC-94	571.9	Moonbeam Creek	Upper North Thompson River	High	Bull trout/Dolly Varden(bull trout/Dolly Varden)	June 1 to August 15 (June 1 to August 15)
BC-104	576.3	Unnamed Channel	Upper North Thompson River	Low	Bull trout/Dolly Varden (bull trout/Dolly Varden)	June 1 to August 15 (June 1 to August 15)
BC-107	577.7	Switch Creek	Upper North Thompson River	Low	None (bull trout/Dolly Varden, Chinook salmon)	July 15 to August 15 (July 15 to August 15)
BC-110	580.4	Serpentine Creek	Upper North Thompson River	High	Bull trout/Dolly Varden, Chinook salmon (bull trout/Dolly Varden)	August 7 to August 15 (August 7 to August 15)
BC-111	581.2	North Thompson River	Upper North Thompson River	High	Bull trout/Dolly Varden, Chinook salmon, coho salmon, rainbow trout/steelhead (none)	July 22 to August 15 (July 22 to August 15)
BC-112	582.0	Chappell Creek	Upper North Thompson River	High	Bull trout/Dolly Varden (bull trout/Dolly Varden)	June 1 to August 15 (June 1 to August 15)
BC-151	592.9	Miledge Creek	Upper North Thompson River	High	Bull trout/Dolly Varden, coho salmon (bull trout/Dolly Varden)	August 7 to August 15 (August 7 to August 15)
BC-168	600.2	Thunder River	Upper North Thompson River	High	Bull trout/Dolly Varden, coho salmon (bull trout/Dolly Varden)	June 1 to August 15 (June 1 to August 15)
BC-175	607.6	Unnamed Channel	Upper North Thompson River	High	None (bull trout/Dolly Varden, rainbow trout/steelhead)	June 15 to August 15 (June 15 - August 15)
BC-176	609.4	Cook Creek	Upper North Thompson River	High	Bull trout/Dolly Varden, Chinook salmon, coho salmon, rainbow trout/steelhead (coho salmon)	August 7 to August 15 (August 7 to August 15)
BC-177	611.6	Cedar Creek	Upper North Thompson River	High	Bull trout/Dolly Varden, coho salmon, rainbow trout/steelhead (bull trout/Dolly Varden, Chinook salmon, coho salmon)	June 1 to August 15 (June 1 to August 15)
BC-178	613.8	Blue River	Upper North Thompson River	High	Bull trout/Dolly Varden, Chinook salmon, coho salmon, rainbow trout/steelhead (Chinook salmon, coho salmon)	August 7 to August 15 (August 7 to August 15)
BC-181	619.8	Unnamed Channel	Upper North Thompson River	High	None (coho salmon)	July 15 to August 15 (July 15 to August 15)
BC-182	619.9	North Thompson River	Upper North Thompson River	High	Bull trout/Dolly Varden, Chinook salmon, coho salmon, rainbow trout/steelhead (none)	July 22 to August 15 (July 22 to August 15)
BC-186	623.7	Unnamed Channel	Upper North Thompson River	High	None (coho salmon)	July 15 to August 15 (Open)
BC-187	623.9	Unnamed Channel	Upper North Thompson River	Low	None (coho salmon)	July 15 to August 15 (Open)
BC-189	626.6	Froth Creek	Upper North Thompson River	High	Bull trout/Dolly Varden, rainbow trout/steelhead (Bull trout/Dolly Varden, Chinook salmon, coho salmon)	August 7 to August 15 (August 7 to August 15)
BC-201	638.8	Finn Creek	Upper North Thompson River	High	Bull trout/Dolly Varden, Chinook salmon, coho salmon, rainbow trout/steelhead (bull trout/Dolly Varden, rainbow trout/steelhead)	July 22 to August 15 (July 22 to August 15)
BC-210	642.3	Unnamed Channel	Upper North Thompson River	Low	None (rainbow trout/steelhead)	July 22 to October 31 (July 22 to October 31)
BC-217	645.3	Unnamed Channel	Upper North Thompson River	High	None (coho salmon)	July 15 to August 15 (July 15 to August 15)

TABLE 5.7-9 Cont'd

Site No.	RK	Name	Watershed[1]	Sensitivity Rating[2]	Historical Indicator Species Present (Captured/Observed)[3]	Instream Work Window [BC MOE and DFO] (Least Risk Biological Window)[4]
BC-217a	645.5	Unnamed Channel	Upper North Thompson River	Low	None (coho salmon)	July 15 to August 15 (Open)
BC-224	648.0	Sundt Creek	Upper North Thompson River	High	Coho salmon (rainbow trout/steelhead)	August 7 to August 15 (August 7 to August 15)
BC-227	648.9	Tumtum Creek	Upper North Thompson River	High	Chinook salmon, coho salmon, rainbow trout/steelhead (coho salmon)	July 22 to August 15 (July 22 to August 15)
BC-230	649.7	Unnamed Channel	Upper North Thompson River	Low	None (coho salmon)	July 15 to August 15 (Open)
BC-236	651.6	North Thompson River	Upper North Thompson River	High	Bull trout/Dolly Varden, Chinook salmon, coho salmon, rainbow trout/steelhead (none)	July 22 to August 15 (July 22 to August 15)
BC-238	652.7	Unnamed Channel	Upper North Thompson River	High	None (bull trout/Dolly Varden, rainbow trout/steelhead)	July 22 to August 15 (July 22 to August 15)
BC-239	653.3	Unnamed Channel*	Upper North Thompson River	High	None (unidentified salmonid)	July 15 to August 15/ (July 15 to August 15)
BC-240	653.9	Unnamed Channel	Upper North Thompson River	High	None (bull trout/Dolly Varden, coho salmon)	June 1 to August 15 (July 15 to August 15)
BC-242	656.1	Avola Creek	Upper North Thompson River	High	Coho salmon, rainbow trout/steelhead (bull trout/Dolly Varden, coho salmon, rainbow trout/steelhead)	July 22 to August 15 (July 22 to August 15)
BC-244	659.1	Unnamed Channel	Upper North Thompson River	High	None (bull trout/Dolly Varden, coho salmon)	July 15 to August 15 (July 15 to August 15)
BC-248	663.1	Unnamed Channel	Upper North Thompson River	High	None (rainbow trout/steelhead)	July 22 to October 31 (July 22 to October 31)
BC-249	664.3	Sager Creek	Upper North Thompson River	Low	Coho salmon (coho salmon)	August 7 to August 15 (Open)
BC-259	675.1	Hornet Creek	Upper North Thompson River	High	None (rainbow trout/steelhead)	July 22 to October 31 (July 22 to October 31)
BC-260	676.0	Cornet Creek	Upper North Thompson River	High	None (rainbow trout/steelhead)	July 22 to October 31 (July 22 to October 31)
BC-275	683.4	Mad River	Upper North Thompson River	High	Chinook salmon, coho salmon, rainbow trout/steelhead (coho salmon, rainbow trout/steelhead)	August 7 to September 30 (August 7 to September 30)
BC-277	686.4	Cove Creek	Upper North Thompson River	High	None (rainbow trout/steelhead)	July 22 to October 31 (July 22 to October 31)
BC-296	701.9	Peavine Creek	Upper North Thompson River	High	None (rainbow trout/steelhead)	July 22 to October 31 (July 22 to October 31)
BC-309	717.7	Raft River	Upper North Thompson River	High	Bull trout/Dolly Varden, Chinook salmon, coho salmon, rainbow trout/steelhead (coho salmon, rainbow trout/steelhead)	July 22 to August 15 (July 22 to August 15)
BC-310	719.8	School Creek	Upper North Thompson River	Low	None (coho salmon)	July 15 to August 15 (July 15 to August 15)
BC-312	725.5	Clearwater River	Clearwater River	High	Bull trout/Dolly Varden, Chinook salmon, coho salmon, rainbow trout/steelhead (none)	August 7 to August 15 (August 7 to August 15)
BC-315	735.0	Mann Creek	Lower North Thompson River	High	Bull trout/Dolly Varden, Chinook salmon, coho salmon, rainbow trout/steelhead (coho salmon, rainbow trout/steelhead)	July 22 to August 20 (July 22 to August 20)
BC-330	749.3	Lemieux Creek	Lower North Thompson River	High	Chinook salmon, coho salmon, rainbow trout/steelhead (bull trout/Dolly Varden, Chinook salmon, coho salmon)	July 22 to August 15 (July 22 to August 15)
BC-331	751.0	Nehalliston Creek	Lower North Thompson River	High	Rainbow trout/steelhead (coho salmon, rainbow trout/steelhead)	July 22 to August 15 (July 22 to August 15)
BC-332	752.3	Eakin Creek	Lower North Thompson River	High	Coho salmon, rainbow trout/steelhead (coho salmon, rainbow trout/steelhead)	July 22 to August 15 (July 22 to August 15)
BC-336	757.9	Montigny Creek	Lower North Thompson River	High	Rainbow trout/steelhead (rainbow trout/steelhead)	July 22 to October 31 (July 22 to October 31)

TABLE 5.7-9 Cont'd

Site No.	RK	Name	Watershed[1]	Sensitivity Rating[2]	Historical Indicator Species Present (Captured/Observed)[3]	Instream Work Window [BC MOE and DFO] (Least Risk Biological Window)[4]
BC-338	761.1	Thuya Creek	Lower North Thompson River	High	Rainbow trout/steelhead (rainbow trout/steelhead)	July 22 to October 31 (July 22 to October 31)
BC-343	768.2	Darlington Creek	Lower North Thompson River	High	Coho salmon (coho salmon, rainbow trout/steelhead)	July 22 to August 15 (July 22 to August 15)
BC-344	768.5	Lindquist Creek	Lower North Thompson River	High	Coho salmon, rainbow trout/steelhead (coho salmon, rainbow trout/steelhead)	July 22 to August 15 (July 22 to August 15)
NCDs and WETLANDS						
BC-67	554.0	Unnamed Drainage (Wetland)	Upper North Thompson River	Low	Bull trout/Dolly Varden, coho salmon (bull trout/Dolly Varden, coho salmon)	July 15 to August 15 (Open)
BC-73	556.5	Unnamed Drainage	Upper North Thompson River	High	Coho salmon, rainbow trout/steelhead (coho salmon, rainbow trout/steelhead)	July 22 to August 15 (Open)
BC-180	616.9	Goose Creek	Upper North Thompson River	High	Bull trout/Dolly Varden, coho salmon, rainbow trout/steelhead (coho salmon)	July 22 to August 15 (Open)
BC-185	622.9	Unnamed Drainage (Wetland)	Upper North Thompson River	Low	None (coho salmon)	July 15 to August 15 (Open)
BC-213	642.6	Unnamed Drainage (Wetland)	Upper North Thompson River	Low	None (coho salmon)	July 15 to August 15 (Open)
BC-214	642.8	Unnamed Drainage (Wetland)	Upper North Thompson River	High	None (coho salmon)	July 15 to August 15 (Open)
BC-215	643.8	Unnamed Drainage (Wetland)	Upper North Thompson River	Low	None (coho salmon)	July 15 to August 15 (Open)
BC-222	647.1	Unnamed Drainage (Wetland)	Upper North Thompson River	Low	None (coho salmon)	July 15 to August 15 (Open)
BC-317	737.0	Unnamed Drainage (Wetland)	Lower North Thompson River	High	Chinook salmon, coho salmon (Chinook salmon, coho salmon)	July 15 to August 15 (Open)

Notes:
1 Project watershed as described in detail in Section 5.7.4.1.
2 Methodology for determination of watercourse sensitivity is described in detail in the Fisheries (British Columbia) Technical Report of Volume 5C.
3 Blended species indicator (*i.e.*, bull trout/Dolly Varden, rainbow trout/steelhead) presence indicates that at least one species was found at the watercourse.
4 Watercourses requiring ongoing studies are identified in Appendix F of the Fisheries (British Columbia) Technical Report of Volume 5C.
* Indicates unidentified species because it was only observed, therefore; species level could not be positively identified.

5.7.3.5 Riparian Habitat

Riparian habitat composition at watercourses crossed by the proposed pipeline corridor within the Hargreaves to Darfield Segment (RK 489.6 to RK 769.0) varies. Within the Hargreaves to Darfield segment the main biogeoclimatic zone crossed is the Interior Cedar-Hemlock (ICH) Zone. Riparian habitat within this zone is mainly comprised of mixed coniferous trees: ponderosa pine; Douglas-fir; western larch; lodgepole pine; and western white pine. Devil's club and large ferns are also common within the riparian zone.

5.7.3.6 Field Results

Fish and fish habitat assessments (Fisheries [British Columbia] Technical Report of Volume 5C) were conducted in order to document existing fish and fish habitat conditions at proposed watercourse crossings with fish and fish habitat. A total of 333 potential watercourse crossings were assessed within the Hargreaves to Darfield Segment. Three sites (*i.e.*, Baer, Marathon and Terry Fox creeks [BC-3, BC-5 and BC-8, respectively]) have been assigned a stream classification based on adequate historical information. Overall, 84 watercourse crossings are considered to be fish-bearing and 252 are considered to be nonfish-bearing based on sites assessed in the field and historical information. Sixteen potential watercourse crossings require ongoing studies to confirm stream classification (see Appendix F of the Fisheries [British Columbia] Technical Report of Volume 5C). Table 5.7-10 summarizes the stream classifications for all fish-bearing and nonfish-bearing drainages crossed by the proposed pipeline corridor along the Hargreaves to Darfield Segment.

TABLE 5.7-10

STREAM CLASSIFICATIONS OF POTENTIAL CROSSINGS INVESTIGATED ALONG THE HARGREAVES TO DARFIELD SEGMENT

Classification[1]	Total Number
Fish-bearing	
S1A	4
S1B	9
S2	33
S3	21
S4	9
NCD-W/Wetlands	8
Nonfish-bearing	
S5	14
S6	99
NCDs	62
NVCs	62
NCD-W/Wetlands	15

Note: 1 Classification refers to BC Stream Classification System (BC Ministry of Forests [BC MOF] 1995).

Of the 84 proposed fish-bearing crossings in the Hargreaves to Darfield Segment, 68 were rated as High sensitivity while the 16 fish-bearing crossings were rated as Low sensitivity (Table 5.7-10 of this volume and Section 5.2 of the Fisheries [British Columbia] Technical Report of Volume 5C).

Indicator Species

Information on indicator species captured or observed during the fisheries field program is discussed in Sections 5.7.13 to 5.7.17.

Species of Management Concern

No *SARA*-listed species were captured or observed along the Hargreaves to Darfield Segment during the 2012/2013 fisheries field program. Bull trout, which are Blue-listed provincially (BC Conservation Data Centre [CDC] 2013a) were captured during the 2012/2013 fisheries fish program and these results are discussed in Section 5.7.13. Coho salmon, which is listed as Endangered under COSEWIC (2013a), was also captured and is discussed in Section 5.7.15. Additional information about species of management concern captured or observed during the 2012/2013 fisheries field program is provided in the Fisheries [British Columbia] Technical Report of Volume 5C.

5.7.4 General Information - Black Pines to Hope Segment

The Black Pines to Hope Segment, from RK 811.9 to RK 1043.7, lies entirely within the Fraser River Basin. There are 318 proposed crossings in this segment, of which 111 are crossings of watercourses (*i.e.*, having defined beds and banks), including the Thompson, Nicola, Coquihalla and Coldwater rivers. There are no proposed crossings of the South Thompson River.

The Thompson River drains from Kamloops Lake near the Town of Savona and flows southwest for approximately 120 km to its confluence with the Fraser River. The Thompson River is the largest tributary to the Fraser River and supports five species of Pacific salmon (DFO 2011). TEK participants identified the North Thompson River as a major salmon migration route. The salmon run in this river from August through September or October. There is one proposed crossing of the Thompson River at RK 846.8 in the Black Pines to Hope Segment.

The Nicola River is a major tributary to the Thompson River, which drains west from the Thompson Plateau and feeds both Douglas and Nicola lakes. From the outlet to Nicola Lake, the Nicola River meanders northwest for approximately 85 km to its confluence with the Thompson River near the Town of Spences Bridge. Both trout and salmon are present in the Nicola River according to TEK participants. There is one proposed crossing of the Nicola River at RK 928.0 in the Black Pines to Hope Segment.

The Coldwater River originates in the Cascade Mountains near the Coquihalla Summit Recreation Area. The Coldwater River flows for approximately 95 km, mostly paralleling Highway 5, before draining into the Nicola River near the City of Merritt. There are four proposed crossings of the Coldwater River (at RK 957.9, RK 970.3, RK 980.0 and RK 990.0) along the Black Pines to Hope Segment.

The Coquihalla River originates in the Coquihalla Lakes within the Coquihalla Summit Recreation Area. The Coquihalla River flows through the Cascade Mountains, following Highway 5 and Old Coquihalla Road for approximately 56 km to its confluence with the Fraser River at the District of Hope. The Coquihalla is a major tributary to the lower Fraser River and is known to support all six species of Pacific salmon. TEK participants noted that fish are healthier in the smaller fresh water watercourse in the region since the water quality in the Coquihalla is poor. There are five proposed crossings of the Coquihalla River (at RK 1021.8, RK 1026.5, RK 1028.6, RK 1032.6 and RK 1043.2) along the Black Pines to Hope Segment.

The following subsections describe the watersheds, areas of special interest, hydrometric data, fish-bearing watercourses, riparian habitat and field results along the Black Pines to Hope Segment.

5.7.4.1 Watersheds

The Black Pines to Hope Segment lies entirely within the Fraser River Basin and traverses several watersheds. The proposed pipeline corridor crosses the Lower North Thompson, Thompson, South Thompson and Lower Nicola river watersheds as well as the Fraser Canyon Watershed (BC MFLNRO 2008a).

Table 5.7-11 provides the drainage areas and RK range(s) for each of the watersheds crossed by the proposed pipeline corridor in the Black Pines to Hope Segment. Additional information about the watercourses crossed by the proposed pipeline corridor within each watershed is provided in the Fisheries (British Columbia) Technical Report of Volume 5C.

TABLE 5.7-11

WATERSHEDS CROSSED BY THE PROPOSED PIPELINE CORRIDOR IN THE BLACK PINES TO HOPE SEGMENT

Watershed	Total Drainage Area	RK Range(s)
Lower North Thompson River	4,911 km²	RK 811.9 to RK 840.9
Thompson River	3,617 km²	RK 840.9 to RK 853.2 RK 856.5 to RK 857.8
South Thompson River	3,666 km²	RK 853.2 to RK 856.5 RK 857.8 to RK 875.6
Lower Nicola River	3,675 km²	RK 875.6 to RK 991.4
Fraser Canyon	5,158 km²	RK 991.4 to RK 1057.6

5.7.4.2 Areas of Special Interest

The proposed pipeline corridor crosses Lac du Bois Grasslands Protected Area from RK 829 to RK 836.8 and from RK 842.4 to RK 843.9 and crosses 17 watercourses within the Protected Area. The Coquihalla Summit Recreational Area is also crossed by the proposed pipeline corridor, from RK 992.4 to RK 1005.1. There are 12 proposed watercourse crossings in the Coquihalla Summit Recreational Area. There are no national parks, Environmentally Significant Areas, Canadian or BC Heritage Rivers, fisheries sensitive watersheds or any other areas of special interest related to fish and fish habitat along the proposed pipeline corridor for the Black Pines to Hope Segment.

5.7.4.3 Hydrometric Data

The Water Survey of Canada maintains hydrometric stations on several watercourses crossed by the proposed pipeline corridor in this segment (Table 5.7-12). The stations on the Coquihalla and Thompson rivers (near Hope and Kamloops, respectively) are located within 1 km of a proposed crossing location. In the Coquihalla River, lowest mean monthly flows occur in August (12 m^3/s) and the highest monthly mean flow is June (78.5 m^3/s). In the Thompson River, low mean monthly flow occurs in winter (*i.e.*, March) and the mean monthly high flow is in the spring/early summer (*i.e.*, June). Additional information about each station and the monthly mean flows can be found in Section 5.3.

TABLE 5.7-12

SUMMARY OF STREAMFLOWS FROM HYDROLOGICAL STATIONS NEAR THE PROPOSED PIPELINE CORRIDOR IN THE BLACK PINES TO HOPE SEGMENT

Watercourse Name	Station Name, Station Number	Years Station Data Available	Approximate Location of Station Relative to the Nearest RK	Month and Mean Monthly Discharge (m^3/s) During Lowest Flow Period	Month and Mean Monthly Discharge (m^3/s) During Highest Flow Period
Thompson River	Thompson River at Kamloops 8LF023	1911 to 2011	Within 1 km of RK 846.8	March 3.411 m^3/s	June 7.114 m^3/s
Coquihalla River	Coquihalla River near Hope 08MF003	1911 to 1983	Within 1 km of RK 1043.2	August 12.0 m^3/s	June 78.5 m^3/s

Sources: Environment Canada 2013h,i

5.7.4.4 Fish-Bearing Crossings

Along the Black Pines to Hope Segment, the desktop review identified that fish are still harvested by many Aboriginal communities. Kokanee, steelhead, rainbow trout, cutthroat trout, suckerfish, whitefish, burbot, sturgeon and salmon are among the fish caught in this region. Migrating salmon are caught in the Thompson River and the Nicola River (AMEC Earth and Environmental 2010). Bull trout and Dolly Varden char are fished at the Coldwater River and at the Fraser River (Katzie Development Corporation 2011).

Based on historical data and field studies conducted for the Project (see Fisheries [British Columbia] Technical Report of Volume 5C), 39 of the proposed crossings were identified as fish-bearing. Table 5.7-13 provides a list of fish-bearing water crossings, their location along the proposed pipeline corridor, watershed, sensitivity rating, instream work windows, least risk biological windows and the presence of indicator species. Additional information about these crossings, including known fish species presence, recommended crossing methods, water quality parameters, watercourse characteristics, and fish habitat ratings is provided in the Fisheries (British Columbia) Technical Report of Volume 5C, particularly the Watercourse Crossing Summary Table (Appendix A) and the Fish-Bearing Atlas (Appendix B).

The fish-bearing watercourse crossings include at least one proposed crossing of each of the Thompson, Nicola, Coldwater and Coquihalla rivers.

Sensitivity ratings were established using the professional judgment of a QEP and are based on the fish species present at the time of the field assessment or previously documented within a given system, flow regime (*i.e.*, seasonal or perennial) or the habitat type available for each life history stage (*e.g.*, spawning) of the key fish species present. This closely follows criteria defined by DFO (CAPP *et al.* 2005). A sensitivity rating allows the use of a risk assessment approach to determine the overall risk to fishes and their habitat at a given watercourse crossing. Additional details about the fish and fish habitat sensitivity ratings are provided in Section 5.7.2.4 and the Fisheries (British Columbia) Technical Report of Volume 5C.

TABLE 5.7-13

FISH-BEARING WATER CROSSINGS ALONG THE PROPOSED PIPELINE CORRIDOR OF THE BLACK PINES TO HOPE SEGMENT

Site No.	RK	Name	Watershed[1]	Fish and Fish Habitat Sensitivity Rating[2]	Indicator Species Previously Documented (Captured/Observed)[3]	Instream Work Window [BC MOE and DFO] (Least Risk Biological Window)[4]
WATERCOURSES						
BC-371	820.2	Jamieson Creek	Lower North Thompson River	High	Bull trout/Dolly Varden, coho salmon, rainbow trout/steelhead (coho salmon)	July 22 to August 15 (July 22 to August 15)
BC-374	824.6	Unnamed Channel	Lower North Thompson River	Low	None (rainbow trout/steelhead)	July 22 to October 31 (July 22 to October 31)
BC-376	825.5	Lanes Creek	Lower North Thompson River	High	Rainbow trout/steelhead (rainbow trout/steelhead)	July 22 to September 30 (July 22 to September 30)
BC-381	828.3	Dairy Creek	Lower North Thompson River	High	Rainbow trout/steelhead (rainbow trout/steelhead)	July 22 to September 30 (July 22 to September 30)
BC-413	846.8	Thompson River	Thompson River	High	Bull trout/Dolly Varden, Chinook salmon, coho salmon, rainbow trout/steelhead (none)	July 22 to August 15 (July 22 to August 15)
BC-459	892.8	Moore Creek	Lower Nicola River	High	Rainbow trout/steelhead (rainbow trout/steelhead)	July 22 to August 1 (July 22 to August 31)
BC-482	915.9	Clapperton Creek	Lower Nicola River	High	Chinook salmon, coho salmon, rainbow trout/steelhead (rainbow trout/steelhead)	July 22 to August 1 (July 22 to October 31)
BC-486	918.3	Shuta Creek	Lower Nicola River	High	None (rainbow trout/steelhead)	To be determined (to be determined)
BC-504	928.0	Nicola River	Lower Nicola River	High	Bull trout/Dolly Varden, Chinook salmon, coho salmon, rainbow trout/steelhead (none)	July 22 to August 1 (July 22 to August 1)
BC-531	941.5	Kwinshatin Creek	Lower Nicola River	High	None (rainbow trout/steelhead)	July 22 to October 31 (July 22 to October 31)
BC-532	914.5	Unnamed Channel	Lower Nicola River	Low	None (none)	July 22 to October 31 (July 22 to October 31)
BC-533	914.7	Unnamed Channel*	Lower Nicola River	High	None (none)	July 22 to October 31) (July 22 to October 31)
BC-534	943.0	Skuagam Creek*	Lower Nicola River	Low	None (none)	July 22 to October 31 (Open) To be determined (to be determined))
BC-538	949.3	Salem Creek	Lower Nicola River	Low	None (rainbow trout/steelhead)	July 22 to October 31 (Open)
BC-548	957.9	Coldwater River	Lower Nicola River	High	Bull trout/Dolly Varden, Chinook salmon, coho salmon, rainbow trout/steelhead (Chinook salmon, coho salmon)	August 7 to August 10 (August 7 to August 10)
BC-549	958.1	Gillis Creek	Lower Nicola River	High	Rainbow trout/steelhead (coho salmon, rainbow trout/steelhead)	July 22 to August 15 (July 22 to August 15)
BC-559	970.3	Coldwater River	Lower Nicola River	High	Bull trout/Dolly Varden, Chinook salmon, coho salmon, rainbow trout/steelhead (Chinook salmon, coho salmon, rainbow trout/steelhead)	July 22 to August 1 (July 22 to August 1)

TABLE 5.7-13 Cont'd

Site No.	RK	Name	Watershed[1]	Fish and Fish Habitat Sensitivity Rating[2]	Indicator Species Previously Documented (Captured/Observed)[3]	Instream Work Window [BC MOE and DFO] (Least Risk Biological Window)[4]
BC-562	972.0	Unnamed Channel	Lower Nicola River	Low	None (coho salmon)	July 15 to August 15 (July 15 to August 15)
BC-564	973.6	Unnamed Channel	Lower Nicola River	High	None (rainbow trout/steelhead)	July 22 to October 31 (July 22 to October 31)
BC-570	980.0	Coldwater River	Lower Nicola River	High	Bull trout/Dolly Varden, Chinook salmon, coho salmon, rainbow trout/steelhead (Chinook salmon, coho salmon)	July 22 to August 1 (July 22 to August 1)
BC-571	980.8	Juliet Creek	Lower Nicola River	High	Bull trout/Dolly Varden, Chinook salmon, coho salmon, rainbow trout/steelhead (Chinook salmon, coho salmon)	July 22 to August 15 (July 22 to August 15)
BC-579	987.1	Mine Creek	Lower Nicola River	High	Rainbow trout/steelhead (bull trout/Dolly Varden, Chinook salmon, coho salmon, rainbow trout/steelhead)	July 22 to August 15 (July 22 to August 15)
BC-582	990.0	Coldwater River	Lower Nicola River	High	Bull trout/Dolly Varden, Chinook salmon, coho salmon, rainbow trout/steelhead (Chinook salmon, coho salmon)	July 22 to August 1 (July 22 to August 1)
BC-588	997.3	Fallslake Creek	Lower Nicola River	High	Rainbow trout/steelhead (none)	August 1 to October 31 (August 1 to October 31)
BC-624	1019.0	Unnamed Channel	Fraser Canyon	Low	None (rainbow trout/steelhead)	August 1 to October 31 (Open)
BC-625	1019.1	Unnamed Channel	Fraser Canyon	High	None (rainbow trout/steelhead)	August 1 to October 31 (August 1 to October 31)
BC-629	1020.3	Ladner Creek	Fraser Canyon	High	Bull trout/Dolly Varden, rainbow trout/steelhead (rainbow trout/steelhead)	August 1 to August 31 (August 1 to August 31)
BC-630	1021.1	Unnamed Channel	Fraser Canyon	Low	None (rainbow trout/steelhead)	August 1 to October 31 (August 1 to October 31)
BC-631	1021.8	Coquihalla River	Fraser Canyon	High	Bull trout/Dolly Varden, Chinook salmon, coho salmon, cutthroat trout, rainbow trout/steelhead, (bull trout/Dolly Varden, rainbow trout/steelhead)	August 1 to August 31 (August 1 to August 31)
BC-632	1022.9	Dewdney Creek	Fraser Canyon	High	Bull trout/Dolly Varden, rainbow trout/steelhead, (rainbow trout/steelhead)	August 1 to August 31 (August 1 to August 31)
BC-634	1024.5	Karen Creek	Fraser Canyon	High	Bull trout/Dolly Varden, rainbow trout/steelhead (rainbow trout/steelhead)	August 1 to August 31 (August 1 to August 31)
BC-635	1025.4	Unnamed Channel	Fraser Canyon	High	None (rainbow trout/steelhead)	August 1 to October 31 (August 1 to October 31)
BC-636	1026.5	Coquihalla River	Fraser Canyon	High	Bull trout/Dolly Varden, Chinook salmon, coho salmon, cutthroat trout, rainbow trout/steelhead (bull trout/Dolly Varden, rainbow trout/steelhead)	August 1 to August 31 (August 1 to August 31)

TABLE 5.7-13 Cont'd

Site No.	RK	Name	Watershed[1]	Fish and Fish Habitat Sensitivity Rating[2]	Indicator Species Previously Documented (Captured/Observed)[3]	Instream Work Window [BC MOE and DFO] (Least Risk Biological Window)[4]
BC-639	1028.6	Coquihalla River	Fraser Canyon	High	Bull trout/Dolly Varden, Chinook salmon, coho salmon, cutthroat trout, rainbow trout/steelhead (bull trout/Dolly Varden, rainbow trout/steelhead)	August 1 to August 31 (August 1 to August 31)
BC-645	1032.6	Coquihalla River	Fraser Canyon	High	Bull trout/Dolly Varden, Chinook salmon, coho salmon, cutthroat trout, rainbow trout/steelhead (bull trout/Dolly Varden, rainbow trout/steelhead)	August 1 to August 31 (August 1 to August 31)
BC-646	1033.2	Railway Creek	Fraser Canyon	High	None (rainbow trout/steelhead)	August 1 to September 15 (August 1 to September 15)
BC-654	1043.2	Coquihalla River	Fraser Canyon	High	Bull trout/Dolly Varden, Chinook salmon, coho salmon, cutthroat trout, rainbow trout/steelhead (bull trout/Dolly Varden, rainbow trout/steelhead)	August 1 to August 31 (August 1 to August 31)
NCDs and WETLANDS						
BC-414	847.4	Unnamed Drainage (Wetland)	Thompson River	Low	None (none)	None (Open)
BC-433	865.2	Anderson Creek	South Thompson River	High	Rainbow trout/steelhead (rainbow trout/steelhead)	July 22 to August 15 (July 22 to October 31)

Notes:
1 Project watershed as described in detail in Section 5.7.5.1.
2 Methodology for determination of watercourse sensitivity is described in detail in the Fisheries (British Columbia) Technical Report of Volume 5C.
3 Blended indicator (*i.e.*, bull trout/Dolly Varden, rainbow trout/steelhead) presence indicates that at least one species is found in the watercourse.
4 Watercourses requiring ongoing studies are identified in Appendix F of the Fisheries (British Columbia) Technical Report of Volume 5C.
* Located in a community watershed and received a S1 to S4 (fish-bearing) stream classification status as per BC OGC's *Environmental Protection and Management Regulation* (see Section 4.1.2 of the Fisheries (British Columbia) Technical Report of Volume 5C).

5.7.4.5 Riparian Habitat

Riparian habitat composition at watercourses crossed by the proposed pipeline corridor within the Black Pines to Hope Segment (RK 811.8 to RK 1043.7) varies. Within the Black Pines to Hope Segment and both power lines, the main biogeoclimatic zone is IDF. Riparian habitat within this zone is mainly comprised of dense, closed-canopy spruce (coniferous) forest.

5.7.4.6 Field Results

Fish and fish habitat assessments (Fisheries [British Columbia] Technical Report of Volume 5C) were conducted in order to document existing fish and fish habitat conditions at proposed watercourse crossings with fish and fish habitat. Information will be provided to DFO to assist with any case-specific reviews of water crossings they may need to conduct.

A total of 303 potential watercourse crossings were assessed within the Black Pines to Hope Segment. One watercourse (*i.e.*, Shuta Creek) has been assigned a stream classification based on adequate historical information. Overall, 39 watercourse crossings are considered to be fish-bearing and 265 are considered to be nonfish-bearing based on sites assessed in the field and historical information. Of these, 15 watercourse crossings require ongoing studies to confirm stream classification (see Appendix F of the

Fisheries [British Columbia] Technical Report of Volume 5C). Overall, 39 watercourse crossings are considered to be fish-bearing and 265 are considered to be nonfish-bearing based on sites assessed in the field and historical information. A summary of stream classifications for all fish-bearing and nonfish-bearing drainages crossed by the proposed pipeline corridor along the Black Pines to Hope Segment is presented in Table 5.7-14.

TABLE 5.7-14

STREAM CLASSIFICATIONS OF THE POTENTIAL CROSSINGS INVESTIGATED ALONG THE BLACK PINES TO HOPE SEGMENT

Classification[1]	Total Number
Fish-bearing	
S1A	1
S1B	11
S2	10
S3	13
S4	2
NCD-W/Wetlands	2
Nonfish-bearing	
S5	16
S6	58
NCDs	73
NVCs	112
NCD-W/Wetlands	6

Note: 1 Classification refers to BC Stream Classification System (BC MOF 1995).

Of the 39 proposed fish-bearing crossings in the Black Pines to Hope Segment, 30 were rated as High sensitivity while the remaining 9 fish-bearing crossings were rated as Low sensitivity (Table 5.7-14 of this volume and Section 5.3 of the Fisheries [British Columbia] Technical Report of Volume 5C).

Indicator Species

Information on indicator species captured or observed during the fisheries field program is discussed in Sections 5.7.13 to 5.7.17.

Species of Management Concern

No *SARA*-listed species were captured or observed in the Black Pines to Hope Segment during the 2012/2013 fisheries field program. Capture or observation of provincially listed or COSEWIC-listed species included bull trout (Blue-listed [BC CDC 2013a]), chiselmouth (Blue-listed [BC CDC 2013a]) and interior Fraser coho (Endangered under COSEWIC [2013a]). Chiselmouth were captured in the Nicola River LSA; capture data for bull trout and coho are discussed in Sections 5.7.13 and 5.7.15. Additional information about species of management concern captured or observed during the 2012/2013 fisheries field program is provided in the Fisheries [British Columbia] Technical Report of Volume 5C.

5.7.5 General Information - Hope to Burnaby Segment

The Hope to Burnaby Segment, from RK 1043.7 to RK 1179.8, is located entirely within the Fraser River Basin. There are 131 proposed crossings along this segment, of which 84 are crossings of watercourses (*i.e.*, having defined beds and banks), including the Chilliwack/Vedder and Fraser rivers.

The Chilliwack River originates in North Cascades National Park in Washington State and flows north into Chilliwack Lake and then west for approximately 61 km to its confluence with the Fraser River. Below Vedder Crossing, the Chilliwack River becomes the Vedder River. The Chilliwack/Vedder River converges with the Sumas River approximately 3.5 km upstream of the confluence with the lower Fraser River. There are three proposed crossings of the Chilliwack/Vedder River (RK 1102.1, RK 1102.3, RK 1102.4) and one proposed crossing of the Sumas River (RK 1114.6) in the Hope to Burnaby Segment.

The Fraser River is the largest watercourse crossed by the proposed pipeline corridor along this segment. The lower Fraser River drains into the Strait of Georgia approximately 30 km downstream of the proposed crossing location. This portion of the lower Fraser River is important, as salmon undergo physiological changes in this region to acclimatise between a saline and freshwater environment. Additional information about the Fraser River can be found in Section 5.7.2. The Fraser River is crossed once, at RK 1168.9, in the Hope to Burnaby Segment.

The following subsections describe the watersheds, areas of special interest, hydrometric data, fish-bearing watercourses, riparian habitat and field results along the Hope to Burnaby Segment.

5.7.5.1 Watersheds

The Hope to Burnaby Segment lies entirely within the Fraser River Basin and traverses several watersheds. The proposed pipeline corridor crosses the Harrison River, Chilliwack River and Lower Fraser River watersheds (BC MFLNRO 2008a).

Table 5.7-15 provides the drainage areas and RK range(s) for each of the watersheds crossed in the Hope to Burnaby Segment. Additional information about the watercourses crossed by the proposed pipeline corridor within each watershed is provided in the Fisheries (British Columbia) Technical Report of Volume 5C.

TABLE 5.7-15

WATERSHEDS CROSSED BY THE PROPOSED PIPELINE CORRIDOR IN THE HOPE TO BURNABY SEGMENT

Watershed	Approximate Drainage Area	RK Range(s)
Harrison River	3,007 km²	RK 1057.2 to RK 1081.1
Chilliwack River	1,209 km²	RK 1081.1 to RK 1117.4
Lower Fraser River	4,679 km²	RK 1117.4 to RK 1179.8

5.7.5.2 Areas of Special Interest

The proposed pipeline corridor traverses F.H Barber Provincial Park from RK 1062.8 to RK 1062.8 and there are no crossings of watercourses in the park. There are two proposed watercourse crossings in Surry Bend Regional Park, which is traversed by the proposed pipeline corridor from RK 1160.5 to RK 1163.7. Cheam Lake Wetlands Regional Park is also crossed by the proposed pipeline corridor, from RK 1079.9 to RK 1080.0 and RK 1080.1 to RK 1080.4. There are no national parks, Environmentally Significant Areas, Canadian Heritage Rivers, fisheries sensitive watersheds or any other areas of special interest related to fish and fish habitat along the proposed pipeline corridor in the Hope to Burnaby Segment.

5.7.5.3 Hydrometric Data

The Water Survey of Canada maintains a hydrometric station on the lower Fraser River at Mission, BC approximately 47 km upstream of the proposed crossing location (Table 5.7-16). The flow data indicates low mean monthly flows occur in the winter (*i.e.*, February) and highest mean monthly flows occur in the spring/early summer (*i.e.*, June).

TABLE 5.7-16

SUMMARIES OF STREAMFLOWS FROM HYDROLOGICAL STATIONS NEAR THE PROPOSED PIPELINE CORRIDOR IN THE HOPE TO BURNABY SEGMENT

Watercourse Name	Station Name, Station Number	Years Station Data Available	Approximate Location of Station Relative to the Proposed Pipeline Corridor	Month and Mean Monthly Discharge (m^3/s) During Lowest Flow Period	Month and Mean Monthly Discharge (m^3/s) During Highest Flow Period
Fraser River	Lower Fraser River at Mission 08MH024	1911 to 2011	47 km upstream of RK 1168.9	February 1,400 m^3/s	June 8,180 m^3/s

Source: Environment Canada 2013j

5.7.5.4 Fish-Bearing Crossings

Along the Hope to Burnaby Segment, the desktop review identified that fish are still harvested by many Aboriginal communities. In particular, salmon fishing is of great importance to the Aboriginal communities in the region. TEK participants reported that fish are generally harvested from the spring to the fall and each family typically harvests from 50 to 200 salmon annually. The timing and location of the salmon runs historically dictated seasonal movements and locations of habitation sites for many communities.

Based on historical data and field studies conducted for the Project (see Fisheries [British Columbia] Technical Report of Volume 5C), 59 of the proposed crossings were identified as fish-bearing Table 5.7-17 provides a list of fish-bearing water crossings, their location along the proposed pipeline corridor, watershed, sensitivity rating, instream work windows, least risk biological windows and the presence of indicator species. Additional information about these crossings, including known fish species presence, recommended crossing methods, water quality parameters, watercourse characteristics and fish habitat ratings is provided in the Fisheries (British Columbia) Technical Report of Volume 5C, particularly the Watercourse Crossing Summary Table (Appendix A) and the Fish-Bearing Atlas (Appendix B).

The fish-bearing watercourse crossings include one crossing of each of the Fraser, Sumas and Chilliwack rivers (Table 5.7-17).

Sensitivity ratings were established using the professional judgment of a QEP and are based on the fish species present at the time of the field assessment or previously documented within a given system, flow regime (*i.e.*, seasonal or perennial) or the habitat type available for each life history stage (*e.g.*, spawning) of the key fish species present. This closely follows criteria defined by DFO (CAPP *et al.* 2005). A sensitivity rating allows the use of a risk assessment approach to determine the overall risk to fishes and their habitat at a given watercourse crossing. Additional details about the fish and fish habitat sensitivity ratings are provided in Section 5.7.2.4 and the Fisheries (British Columbia) Technical Report of Volume 5C.

TABLE 5.7-17

FISH-BEARING WATER CROSSINGS ALONG THE PROPOSED PIPELINE CORRIDOR OF THE HOPE TO BURNABY SEGMENT

Site No.	RK	Name	Watershed[1]	Sensitivity Rating[2]	Indicator Species Previously Documented (Captured/Observed)[3]	Instream Work Window [BC MOE and DFO] (Least Risk Biological Window)[4]
WATERCOURSES						
BC-657	1047.2	Silverhope Creek	Fraser Canyon	High	Bull trout/Dolly Varden, coho salmon, cutthroat trout, rainbow trout/steelhead (rainbow trout/steelhead)	August 1 to August 31 (August 1 to August 31)
BC-658	1051.5	Chawuthen Creek*	Fraser Canyon	High	Cutthroat trout (unidentified salmonid)	August 1 to October 31 (August 1 to October 31)

TABLE 5.7-17 Cont'd

Site No.	RK	Name	Watershed[1]	Sensitivity Rating[2]	Indicator Species Previously Documented (Captured/Observed)[3]	Instream Work Window [BC MOE and DFO] (Least Risk Biological Window)[4]
BC-662	1055.5	Hunter Creek	Fraser Canyon	High	Coho salmon, cutthroat trout, rainbow trout/steelhead (Chinook salmon, coho salmon, rainbow trout/steelhead)	August 1 to September 15 (August 1 to September 15)
BC-666	1060.9	Lorenzetta Creek	Harrison River	High	Coho salmon, cutthroat trout, rainbow trout/steelhead (Chinook salmon, coho salmon, rainbow trout/steelhead)	August 1 to September 15 (August 1 to September 15)
BC-668	1061.5	Wahleach Creek	Harrison River	High	Coho salmon, cutthroat trout, rainbow trout/steelhead (Chinook salmon, rainbow trout/steelhead)	August 1 to August 15 (August 1 to August 15)
BC-681	1069.2	Unnamed Channel	Harrison River	High	None (cutthroat trout)	August 1 to October 31 (August 1 to October 31)
BC-685	1071.4	Unnamed Channel	Harrison River	High	None (coho salmon, rainbow trout/steelhead)	August 1 to September 15 (August 1 to September 15)
BC-688	1072.3	Unnamed Channel	Harrison River	High	None (Chinook salmon, cutthroat trout)	August 1 to September 15 (August 1 to September 15)
BC-690	1072.8	Unnamed Channel	Harrison River	High	None (Chinook salmon, rainbow trout/steelhead)	August 1 to September 15 (August 1 to September 15)
BC-695	1074.2	Unnamed Channel	Harrison River	High	None (cutthroat trout)	August 1 to October 31 (August 1 to October 31)
BC-697	1074.8	Unnamed Channel	Harrison River	Low	None (bull trout/Dolly Varden, cutthroat trout, rainbow trout/steelhead)	August 1 to August 31 (August 1 to August 31)
BC-700	1076.0	Unnamed Channel	Harrison River	High	None (coho salmon, rainbow trout/steelhead)	August 1 to September 15 (August 1 to September 15)
BC-705	1078.2	Anderson Creek	Harrison River	High	Bull trout/Dolly Varden, Chinook salmon, coho salmon, cutthroat trout, rainbow trout/steelhead (cutthroat trout)	August 1 to August 15 (August 1 to August 15)
BC-706	1079.8	Bridal Creek	Harrison River	High	Coho salmon, cutthroat trout, rainbow trout/steelhead (coho salmon, cutthroat trout)	August 1 to September 15 (August 1 to September 15)
BC-707	1080.0	Tributary to Bridal Creek	Chilliwack River	High	None (cutthroat trout)	August 1 to September 15 (August 1 to September 15)
BC-708	1083.4	Nevin Creek	Chilliwack River	High	Coho salmon, cutthroat trout (coho salmon, cutthroat trout)	To be determined (to be determined)
BC-709	1083.9	Dunville Creek	Chilliwack River	High	Coho salmon, cutthroat trout, rainbow trout/steelhead (coho salmon)	August 1 to September 15 (August 1 to September 15)
BC-710	1083.9	Unnamed Channel	Chilliwack River	High	None (none)	None (Open)
BC-712	1086.6	Unnamed Channel	Chilliwack River	High	None (coho salmon)	July 15 to September 15 (July 15 to September 15)

TABLE 5.7-17 Cont'd

Site No.	RK	Name	Watershed[1]	Sensitivity Rating[2]	Indicator Species Previously Documented (Captured/Observed)[3]	Instream Work Window [BC MOE and DFO] (Least Risk Biological Window)[4]
BC-713	1087.6	Elk Creek	Chilliwack River	High	Coho salmon, cutthroat trout, rainbow trout/steelhead (Chinook salmon, coho salmon, cutthroat trout)	August 1 to September 15 (August 1 to September 15)
BC-713	1087.6	Elk Creek	Chilliwack River	High	Coho salmon, cutthroat trout, rainbow trout/steelhead (Chinook salmon, coho salmon, cutthroat trout)	August 1 to September 15 (August 1 to September 15)
BC-714	1092.7	Semmihault Creek	Chilliwack River	High	Coho salmon, cutthroat trout (none)	To be determined (to be determined)
BC-715	1094.0	Chilliwack Creek	Chilliwack River	High	Coho salmon, cutthroat trout, rainbow trout/steelhead (coho salmon)	August 1 to September 15 (August 1 to September 15)
BC-716	1102.1	Chilliwack/Vedder River Side Channel	Chilliwack River	High	Coho salmon (Chinook salmon, coho salmon)	July 15 to September 15 (July 15 to September 15)
BC-717	1102.3	Chilliwack/Vedder River	Chilliwack River	High	Bull trout/Dolly Varden, Chinook salmon, coho salmon, cutthroat trout, rainbow trout/steelhead (rainbow trout/steelhead)	August 1 to August 15 (August 1 to August 15)
BC-718	1102.4	Chilliwack/Vedder River	Chilliwack River	High	None (coho salmon, rainbow trout/steelhead)	August 1 to September 15 (August 1 to September 15)
BC-719	1102.7	Unnamed Channel	Chilliwack River	High	None (coho salmon)	July 15 to September 15 (Open)
BC-720	1103.2	Street Creek	Chilliwack River	High	Coho salmon, cutthroat trout, rainbow trout/steelhead (coho salmon, rainbow trout/steelhead)	August 1 to September 15 (August 1 to September 15)
BC-721	1105.0	Unnamed Channel	Chilliwack River	High	None (coho salmon)	July 15 to September 15 (July 15 to September 15)
BC-722	1106.0	Stewart Slough	Chilliwack River	High	Coho salmon, cutthroat trout, rainbow trout/steelhead (coho salmon)	August 1 to September 15 (August 1 to September 15)
BC-723	1110.1	Unnamed Channel	Chilliwack River	Low	None (none)	None (Open)
BC-724	1110.1	Unnamed Channel	Chilliwack River	Low	None (none)	None (Open)
BC-725	1110.7	Sumas Lake Canal	Chilliwack River	High	Coho salmon (none)	July 15 to September 15 (July 15 to September 15)
BC-726	1114.6	Sumas River	Chilliwack River	High	Bull trout/Dolly Varden, Chinook salmon, coho salmon, cutthroat trout, rainbow trout/steelhead (none)	August 1 to August 15 (August 1 to August 15)
BC-730	1120.2	Tributary to Clayburn Creek	Lower Fraser River	High	None (coho salmon, cutthroat trout)	August 15 to September 15 (August 1 to September 15)
BC-731	1122.4	Clayburn Creek	Lower Fraser River	High	Bull trout/Dolly Varden, Chinook salmon, coho salmon, cutthroat trout, rainbow trout/steelhead (coho salmon, rainbow trout/steelhead)	August 1 to August 15 (August 1 to August 15)
BC-732	1123.4	Clayburn Creek	Lower Fraser River	High	Bull trout/Dolly Varden, Chinook salmon, coho salmon, cutthroat trout, rainbow trout/steelhead (coho salmon, rainbow trout/steelhead)	August 1 to August 15 (August 1 to August 15)

TABLE 5.7-17 Cont'd

Site No.	RK	Name	Watershed[1]	Sensitivity Rating[2]	Indicator Species Previously Documented (Captured/Observed)[3]	Instream Work Window [BC MOE and DFO] (Least Risk Biological Window)[4]
BC-733	1125.2	Tributary to Gifford Slough	Lower Fraser River	Low	Coho salmon, cutthroat trout (none)	August 1 to September 15 (Open)
BC-734	1127.8	McLennan Creek	Lower Fraser River	High	Bull trout/Dolly Varden, Chinook salmon, coho salmon, cutthroat trout, rainbow trout/steelhead (coho salmon)	August 1 to August 15 (August 1 to August 15)
BC-736	1129.9	Unnamed Channel	Lower Fraser River	High	None (cutthroat trout)	August 1 to October 31 (August 1 to October 31)
BC-747	1138.0	Nathan Creek	Lower Fraser River	High	Chinook salmon, coho salmon, cutthroat trout, rainbow trout/steelhead (coho salmon)	August 1 to September 15 (August 1 to September 15)
BC-749	1143.0	West Creek	Lower Fraser River	High	Chinook salmon, coho salmon, cutthroat trout, rainbow trout/steelhead (coho salmon, rainbow trout/steelhead)	August 1 to September 15 (August 1 to September 15)
BC-751	1145.6	Davidson Creek	Lower Fraser River	High	Coho salmon, cutthroat trout, rainbow trout/steelhead (coho salmon, cutthroat trout)	August 1 to September 15 (August 1 to September 15)
BC-753	1147.4	Salmon River	Lower Fraser River	High	Bull trout/Dolly Varden, Chinook salmon, coho salmon, cutthroat trout, rainbow trout/steelhead(coho salmon)	August 1 to August 31 (August 1 to August 31)
BC-766	1152.4	Tributary to Yorkson Creek	Lower Fraser River	High	Coho salmon, cutthroat trout (none)	To be determined (to be determined)
BC-767	1154.0	Tributary to Yorkson Creek	Lower Fraser River	High	Coho salmon (coho salmon, cutthroat trout)	To be determined (to be determined)
BC-768	1154.3	Yorkson Creek	Lower Fraser River	High	Coho salmon, cutthroat trout, rainbow trout/steelhead (coho salmon)	To be determined (to be determined)
BC-771	1159.6	Unnamed Channel	Lower Fraser River	High	None (cutthroat trout)	August 1 to October 31 (August 1 to October 31)
BC-773	1161.7	Tributary to Fraser River	Lower Fraser River	High	Coho salmon, cutthroat trout (none)	To be determined (to be determined)
BC-774	1163.8	Centre Creek	Lower Fraser River	High	Chinook salmon, coho salmon, cutthroat trout (none)	August 1 to September 15 (August 1 to September 15)
BC-775	1163.9	Centre Creek	Lower Fraser River	High	Chinook salmon, coho salmon, cutthroat trout (none)	August 1 to September 15 (August 1 to September 15)
BC-776	1164.6	Tributary to Fraser River	Lower Fraser River	High	None (cutthroat trout, rainbow trout)	August 1 to October 31 (August 1 to October 31)
BC 777	1165.2	Tributary to Fraser River	Lower Fraser River	High	None (cutthroat trout)	August 1 to October 31 (August 1 to October 31)
BC-778	1166.9	Bon Accord Creek	Lower Fraser River	High	Coho salmon, cutthroat trout, rainbow trout/steelhead (cutthroat trout, rainbow trout/steelhead)	August 1 to September 15 (August 1 to September 15)
BC-779	1166.9	Bon Accord Creek	Lower Fraser River	High	Coho salmon, cutthroat trout, rainbow trout/steelhead (cutthroat trout, rainbow trout/steelhead)	August 1 to September 15 (August 1 to September 15)

TABLE 5.7-17 Cont'd

Site No.	RK	Name	Watershed[1]	Sensitivity Rating[2]	Indicator Species Previously Documented (Captured/Observed)[3]	Instream Work Window [BC MOE and DFO] (Least Risk Biological Window)[4]
BC-780	1168.9	Fraser River	Lower Fraser River	High	Bull trout/Dolly Varden, Chinook salmon, coho salmon, cutthroat trout, rainbow trout/steelhead (none)	August 1 to August 15 (August 1 to August 15)
BC-781	1172.1	Como Creek	Lower Fraser River	High	Chinook salmon, coho salmon, cutthroat trout, rainbow trout/steelhead (rainbow trout/steelhead)	August 1 to September 15 (August 1 to September 15)
BC-782	1172.2	Nelson Creek/ Suusex Creek	Lower Fraser River	High	Coho salmon, cutthroat trout, rainbow trout/steelhead (none)	August 1 to September 15 (August 1 to September 15)
BC-785	1176.5	Stoney Creek	Lower Fraser River	High	Coho salmon, cutthroat trout, rainbow trout/steelhead (none)	August 1 to September 15 (August 1 to September 15)
NCDs and Wetlands						
BC-754	1147.7	Unnamed Drainage (Wetland)	Lower Fraser River	Low	None (none)	None (Open)

Notes:
1 Project watershed as described in detail in Section 5.7.1.1.
2 Methodology for determination of watercourse sensitivity is described in detail in the Fisheries (British Columbia) Technical Report of Volume 5C.
3 Blended indicator species (*i.e.*, bull trout/Dolly Varden, rainbow trout/steelhead) indicates that at least one species is found in the watercourse.
4 Watercourses requiring ongoing studies are identified in Appendix F of the Fisheries (British Columbia) Technical Report of Volume 5C.
* Indicates unidentified species because it was only observed, therefore; species level could not be positively identified.

5.7.5.5 Riparian Habitat

Riparian habitat composition at watercourses crossed by the proposed pipeline corridor within the Hope to Burnaby Segment (RK 1043.7 to RK 1179.8) varies. Within the Hope to Burnaby Segment the main biogeoclimatic zone is CWH. Riparian habitat within this zone is mainly comprised of mixed deciduous and coniferous trees; western hemlock, western red cedar, ambilis fir, yellow cedar, Douglas-fir, grand fir, western white pine and bigleaf maple.

5.7.5.6 Field Results

Fish and fish habitat assessments (Fisheries [British Columbia] Technical Report of Volume 5C) were conducted in order to document existing fish and fish habitat conditions at proposed watercourse crossings with fish and fish habitat. Information will be provided to DFO to assist with any case-specific reviews of water crossings they may need to conduct. A total of 105 potential watercourse crossings were assessed within the Hope to Burnaby Segment. Four sites (*i.e.*, two unnamed tributaries to Yorkson Creek [BC-766 and BC-767], Yorkson Creek and an unnamed tributary to the Fraser River [BC-773]) have been assigned a stream classification based on adequate historical information. Overall, 59 watercourse crossings are considered to be fish-bearing and 50 are considered to be nonfish-bearing based on sites assessed in the field and historical information. Of these, 26 proposed watercourse crossings require ongoing studies to confirm stream classification (see Appendix F of the Fisheries [British Columbia] Technical Report of Volume 5C). A summary of stream classifications for all fish-bearing and nonfish-bearing drainages crossed by the proposed pipeline corridor along the Hope to Burnaby Segment is presented in Table 5.7-18.

TABLE 5.7-18

STREAM CLASSIFICATIONS OF POTENTIAL CROSSINGS INVESTIGATED ALONG THE HOPE TO BURNABY SEGMENT

Classification	Total Number
Fish-bearing	
S1A	1
S1B	8
S2	19
S3	27
S4	3
Wetland/Fish Sensitive Zone	1
Nonfish-bearing	
S5	10
S6	16
NCDs	11
NVCs	11
NCD-W/Wetlands	2

Note: 1 Classification refers to BC Stream Classification System (BC MOF 1995).

Of the 59 fish-bearing crossings in the Hope to Burnaby Segment, 54 were rated as high sensitivity while 5 were rated as low sensitivity (Table 5.7.18 of this volume and Section 5.6 of the Fisheries [British Columbia] Technical Report of Volume 5C).

Indicator Species

Information on indicator species captured or observed during the fisheries field program is discussed in Sections 5.7.13 to 5.7.17.

Species of Management Concern

No *SARA*-listed species were captured or observed along the Hope to Burnaby Segment during the 2012/2013 fisheries field program; however, ongoing studies are required at Semmihault and Stoney creeks, and there is the potential for capture of Salish sucker or Nooksack dace (both species are Endangered under *SARA* and Red-listed provincially). Salish sucker has previously recorded in Semmihault Creek, Salmon River and Chilliwack Creek. Nooksack dace has been previously recorded in Salmon River and Stoney Creek. Historical records for provincially-listed species present in watercourses crossed by the proposed pipeline corridor included bull trout (Blue-listed) (BC CDC 2013a) (see Appendix A of the Fisheries [British Columbia] Technical Report of Volume 5C for specific crossings at which bull trout has been historically reported). Bull trout were captured during the 2012/2013 fisheries field program, and these results are discussed in Section 5.7.13. Additional information about fish species of management concern captured or observed during the 2012/2013 fisheries field program is provided in the Fisheries [British Columbia] Technical Report of Volume 5C.

5.7.6 General Information - Burnaby to Westridge Segment

The Burnaby to Westridge Segment, from RK 0 to RK 3.6, is located entirely within the Fraser River Basin and traverses the Lower Fraser River and Squamish River watersheds. There are no proposed crossings of any named creeks or rivers in the Burnaby to Westridge Segment, however, there is one proposed watercourse crossing at RK 1182.5.

In particular, salmon fishing is of great importance to the Aboriginal communities in the region. The timing and location of the salmon runs historically dictated seasonal movements and locations of habitation sites for many communities.

The following subsections describe the watersheds, areas of special interest, hydrometric data, fish-bearing watercourses, riparian habitat and field results along the Burnaby to Westridge Segment.

5.7.6.1 Watersheds

The Burnaby to Westridge Segment traverses the Lower Fraser River Watershed and the Squamish River Watershed. Table 5.7-19 provides the drainage area and RK range for the watersheds crossed in the Burnaby to Westridge Segment. Additional information about the watercourses crossed by the proposed pipeline corridor within the watershed is presented in the Fisheries (British Columbia) Technical Report of Volume 5C.

TABLE 5.7-19

WATERSHEDS CROSSED BY THE PROPOSED PIPELINE CORRIDOR IN THE BURNABY TO WESTRIDGE SEGMENT

Watershed	Approximate Drainage Area	RK Range
Lower Fraser River Watershed	4,679 km^2	RK 0 to RK 1.6
Squamish River	105.4 km^2	RK 1.6 to RK 3.6

5.7.6.2 Areas of Special Interest

There are no provincial or national parks, Environmentally Significant Areas, Canadian or BC Heritage Rivers or any other areas of special interest related to fish and fish habitat along the proposed pipeline corridor in the Burnaby to Westridge Segment.

5.7.6.3 Hydrometric Data

There are no hydrometric stations on any watercourses crossed by the proposed pipeline corridor in the Burnaby to Westridge Segment.

5.7.6.4 Fish-Bearing Crossings

Along the Burnaby to Westridge Segment, the desktop review identified that fish are still harvested by many Aboriginal communities. Kwikwetlem First Nation members historically moved to the Lower Fraser River area in the summer to fish for salmon and sturgeon. A fishing camp on the south shore of the Fraser River near the Pattullo Bridge (approximately 4 km west of KP 1136) was used by a number of Aboriginal communities. Villages and fishing camps were also located along the north Fraser River shoreline from the Pitt River to New Westminster approximately 3 km north of RK 1164 to 5 km south of RK 1178 (Kwickwetlem First Nation 2007). In addition to salmon, the Kwikwetlem fish for eulachon, trout, catfish, and carp in the Fraser River (crossed at RK 118.8) and the Pitt River (approximately 3 km north of RK 1164) (Kwickwetlem First Nation 2007). Additional information on ATK fishing sites can be found in the Fisheries (British Columbia) Technical Report of Volume 5C. While salmon such as Chinook, coho and kokanee constitute the main fishery for the region, steelhead, rainbow trout, cutthroat trout, and burbot are also fished (AMEC Earth and Environmental 2010).

Based on historical data and field studies conducted for the Project (see Fisheries [British Columbia] Technical Report of Volume 5C), the proposed crossing was identified as non-fish-bearing. Additional information about this nonfish-bearing watercourse is provided in the Fisheries [British Columbia] Technical Report of Volume 5C.

5.7.6.5 Riparian Habitat

Within the Burnaby to Westridge Segment the main biogeoclimatic zone is Coastal Western Hemlock (CWH). Riparian habitat within this zone is mainly comprised of: mixed deciduous and coniferous trees; western hemlock; western red cedar; ambilis fir; yellow cedar; Douglas-fir; grand fir; western white pine; and bigleaf maple.

5.7.6.6 Field Results

The watercourse in the Burnaby to Westridge Segment was assessed during the 2012/2013 fisheries field program and was assigned a stream classification of S6. Refer to the Fisheries (British Columbia) Technical Report of Volume 5C for additional information.

5.7.7 Arctic Grayling

Populations of Arctic grayling (*Thymallus arcticus*) occupy three major watersheds in Alberta: the Hay; Peace; and Athabasca river watersheds. With respect to temperature, water levels, gradients and winter conditions, Arctic grayling live in environmentally variable conditions compared to other fish species that require stable environments. Arctic grayling spawn in the spring once water temperatures reach 5°C to 10°C. Unlike many other salmonids, Arctic grayling are broadcast spawners and do not construct redds. They are confined to the cold and coolwater streams, rivers and lakes, usually occupying boreal and foothill rivers and streams and occasionally small lakes.

Population declines, particularly in the southern portions of their range in Alberta, are often attributed to pollution, habitat degradation, fragmentation, increasing water temperatures and overharvest by anglers (Alberta Sustainable Resource Development [ASRD] and Alberta Conservation Association [ACA] 2005, Berry 1998). Arctic grayling are highly mobile and use different reaches of the stream. Habitat fragmentation disrupting Arctic grayling movement is one of the biggest contributors affecting populations (MacPherson and Furukawa 2010).

Provincially, Arctic grayling are listed as Sensitive by the General Status of Alberta Wild Species 2010 (ASRD 2011). Arctic grayling are neither *SARA* or COSEWIC listed. Alberta has implemented a management and recovery plan for Arctic grayling (Berry 1998) and Alberta's Endangered Species Conservation Committee (ESCC) has identified Arctic grayling as a Species of Special Concern (AESRD 2012b). Arctic grayling have not been considered for a status designation by the COSEWIC, but are considered to be an immediate priority candidate for status evaluation (COSEWIC 2013b).

Arctic grayling was selected as an indicator species in Alberta because of its provincial listing and the distribution of Arctic grayling in four watersheds along the Edmonton to Hinton Segment, namely the Pembina River, Lower McLeod River, Upper McLeod River and Athabasca River watersheds (Table 5.7-1). Based on the existing data and the results of the aquatic assessment, Arctic grayling may be found in seven watercourses crossed by the proposed pipeline corridor in the Edmonton to Hinton Segment (Table 5.7-6).

Refer to the Fisheries (Alberta) Technical Report of Volume 5C for additional information on the life history phases and biology of the Arctic grayling as well as the watercourses at which this indicator species was captured or observed.

5.7.8 Athabasca Rainbow Trout

Athabasca rainbow trout (*Oncorhynchus mykiss*) are an indigenous stock of rainbow trout in Alberta restricted to an area less than 2,000 km^2 within the Upper Athabasca River watershed, its tributaries and headwater streams including the McLeod, Berland, Wildhay and Freeman rivers (ASRD and ACA 2009). Although Athabasca rainbow trout are not considered to be a distinct subspecies, COSEWIC guidelines recognize Athabasca rainbow trout populations as a designatable unit below the species level (ASRD and ACA 2009). Athabasca rainbow trout have a general status of At Risk in Alberta (ASRD 2011). Athabasca rainbow trout are neither *SARA* or COSEWIC listed. Rainbow trout thrive in cool waters where they prefer temperatures under 20°C, but can withstand temperatures up to 24°C (Nelson and Paetz 1992). Athabasca rainbow trout are known to spawn later in the spring, grow more slowly and mature at a smaller size than that of Alberta's introduced rainbow trout populations and are thought to be better adapted to colder, less productive headwater streams (ASRD and ACA 2009).

Athabasca rainbow trout was selected because of its provincial listing and its distribution across three watersheds along the Edmonton to Hinton Segment, namely Lower McLeod River, Upper McLeod River and Athabasca River watersheds (Table 5.7-1). Based on the historical data and the results of the fisheries field program, Athabasca rainbow trout may be found in 10 watercourses crossed by the proposed pipeline corridor in the Edmonton to Hinton Segment (Table 5.7-6).

Refer to the Fisheries (Alberta) Technical Report of Volume 5C for additional information on the life history phases and biology of the Athabasca rainbow trout as well as the watercourses at which this indicator species was captured or observed.

5.7.9 Bull Trout

Bull trout (*Salvelinus confluentus*) have been designated a Species of Special Concern by the Alberta ESCC (AESRD 2012b) and are listed under COSEWIC as Threatened and Special Concern, depending on population (see Table 4.3 of the Fisheries [Alberta] Technical Report of Volume 5C) (COSEWIC 2013a). Bull trout are not listed under Schedule 1 of *SARA*. A management and recovery plan for the species has been implemented (ASRD 2012). Bull trout are frequently referenced as having the most sensitive habitat requirements among trout and char species in western North America (Brewin *et al.* 2001, Mackay *et al.* 1997). They are a late summer to early fall spawning species that requires clean gravels and groundwater inflow for spawning. They are often a top predator in the ecosystems where they occur. Their susceptibility to angler overharvest, slow maturity and sensitive habitat requirements, as well as competition from introduced non-native species and habitat fragmentation, are frequently cited as factors contributing to the species decline through most of their range in North America (*e.g.*, Berry 1994, P. Brewin and M. Brewin 1997, Pollard and Down 2001, Post and Johnston 2002).

Bull trout was selected as an indicator species in Alberta because of its provincial and COSEWIC listings and because of its presence in four watersheds along the Edmonton to Hinton Segment, namely Pembina River, Lower McLeod River, Upper McLeod River and Athabasca River watersheds (Table 5.7-1). Bull trout were not captured or observed at any proposed crossings along the proposed pipeline corridor during the fisheries field program in Alberta (see Table 5.7-6), however, they have been previously documented in six watercourses crossed by the proposed pipeline corridor.

Refer to the Fisheries (Alberta) Technical Report of Volume 5C for additional information on the life history phases and biology of bull trout.

5.7.10 Burbot

Burbot (*Lota lota*) are a sportfish that occur in cold lakes, rivers and small streams. Burbot prey and scavenge on fish, insect larvae and fish eggs. Burbot are a broadcast spawner, spawning in the late winter and early spring over a variety of substrates including sand and silt (Nelson and Paetz 1992). Nelson and Paetz (1992) also indicate that although their popularity as a sportfish is increasing, a large portion of the angler harvest often results from incidental catches of burbot by anglers targeting other highly desired species. Burbot are not *SARA*, COSEWIC or provincially listed as a species of concern.

Burbot was selected as an indicator species because it is a sportfish species (Government of Alberta 2013b), a winter spawner and by suggestion in the Edmonton ESA Workshop as well as its distribution in all eight watersheds along the Edmonton to Hinton Segment. Burbot may be found at 10 watercourses crossed by the proposed pipeline corridor based on historical data, and burbot were observed at Sundance Creek during the fisheries field program (Table 5.7-6).

Refer to the Fisheries (Alberta) Technical Report of Volume 5C for additional information on the life history phases and biology of burbot as well as the watercourse at which this indicator species was captured or observed.

5.7.11 Northern Pike

Northern pike (*Esox lucius*) are a coolwater sportfish species that prefer relatively shallow, weedy and clear water. They occur primarily in lakes and marshes, but are also commonly found in streams and rivers with slow to moderate currents. They are known as a voracious predator that feeds on insects as well as fish, amphibians and small mammals and birds (Nelson and Paetz 1992). Northern pike spawn in the early spring, often before all of the ice cover has melted (Berry 1999). Typical spawning areas include shallow marsh areas or flooded vegetation that forms shallow bays. The presence of vegetation is important for spawning success since their eggs stick to vegetation. Young hatchlings often remain sticking to vegetation with their yolk sacs for about two weeks and it is thought this may help them stay off the bottom where silt accumulation and lower dissolved oxygen concentrations often occur.

Although Alberta considers northern pike Secure (ASRD 2011), the species has experienced severe population declines across most of their range and the province has implemented management and recovery plans (Berry 1999). Northern pike are neither Schedule 1 of *SARA* or COSEWIC listed. Angler overharvest and habitat degradation are commonly cited in these management plans as key factors that have led to the decline of this species.

Northern pike was selected as an Alberta indicator species because it is a sportfish species (Government of Alberta 2013b) with a management and recovery strategy in place (Berry 1999) and because it is distributed in all eight watersheds crossed by the proposed pipeline corridor. Based on existing data and the results of the fisheries field program, northern pike may be found at 15 watercourses in the Edmonton to Hinton Segment (Table 5.7-6). Northern pike were captured or observed at five proposed watercourse crossings during the fisheries field program.

Refer to the Fisheries (Alberta) Technical Report of Volume 5C for additional information on the life history phases and biology of northern pike as well as the watercourses at which this indicator species were captured or observed.

5.7.12 Walleye

Walleye (*Sander vitreus*) in Alberta are found primarily in lakes and large rivers. Spawning occurs when water temperatures reach 5°C, usually in early spring and before northern pike and suckers spawn. Walleye can live up to 14 years old, reaching a maximum length of 100 cm.

Although Alberta considers walleye as Secure (ASRD 2011), the species has experienced severe population declines across most of their range and the province has implemented management and recovery plans (Berry 1995). Angler overharvest and habitat degradation are commonly cited in the management plan as key factors that have led to the decline of this species. Walleye are not *SARA*, COSEWIC or provincially listed as a species of concern.

Walleye was selected as an indicator species in Alberta because it is a sportfish species (Government of Alberta 2013b) with a management and recovery plan in place (Berry 1995) and because it is distributed in six watersheds (the Lower North Saskatchewan River, Middle North Saskatchewan River, Sturgeon River, Upper North Saskatchewan River, Pembina River and Lower McLeod River watersheds [Table 5.7-1]) in the Edmonton to Hinton Segment. Based on results of the fisheries field program and existing data, walleye may be found in 4 watercourses crossed by the proposed pipeline corridor (Table 5.7-6). Walleye were captured or observed at four proposed watercourse crossings during the fisheries field program.

Refer to the Fisheries (Alberta) Technical Report of Volume 5C for additional information on the life history phases and biology of walleye as well as the watercourses at which this indicator species were captured or observed.

5.7.13 Bull Trout/Dolly Varden

Bull trout and Dolly Varden coexist and hybridise in Coast Mountain drainages. Where the two species overlap, they are often difficult to tell apart, although their morphology is different (McPhail 2007). Dolly Varden are a true coastal and anadromous species, which regularly enters the ocean. Its distribution does not typically extend far inland (*i.e.*, past the District of Hope, BC). Dolly Varden are generally smaller than bull trout, inhabiting small streams. Bull trout are typically larger and distributed in cool waters throughout the interior, but are absent from many coastal rivers, with the exception of the Fraser River (McPhail 2007).

Bull trout are Blue-listed as a Species of Special Concern in BC (BC CDC 2013a) and the south coast population is considered a Species of Special Concern under COSEWIC. Bull trout are not listed under Schedule 1 of *SARA*. Bull trout are particularly vulnerable to angling pressure and poaching (McPhail 2007). Hybridization and competitive interactions with introduced brook trout can also cause declines in bull trout populations (McPhail 2007). The typically low densities of bull trout, low reproductive capacity, susceptibility to angling pressure and sensitivity to changes in water quality support the provincial Blue-listing of bull trout.

Bull trout/Dolly Varden was selected as an indicator species in BC because of the provincial and COSEWIC listings of bull trout and because bull trout/Dolly Varden are found in 10 Project watersheds crossed by the proposed pipeline corridor in BC (Table 5.7-2). Based on existing data and the results of the fisheries field program, bull trout/Dolly Varden may be found in 72 watercourses crossed by the proposed pipeline corridor in BC (Tables 5.7-9, 5.7-13 and 5.7-17). Bull trout/Dolly Varden were captured or observed at 39 proposed watercourse crossings during the fisheries field program.

Refer to the Fisheries (British Columbia) Technical Report of Volume 5C for additional information on the life history phases and biology of bull trout/Dolly Varden as well as the watercourses at which this indicator species was captured or observed.

5.7.14 Chinook Salmon

Chinook salmon are the largest anadromous salmon species that spawn and rear in Fraser River mainstems and tributaries. The Fraser River is also the largest Canadian producer of Chinook salmon (DFO 1999). DFO (1999) has divided Fraser River Chinook salmon into four major geographical stock complexes and three timing groups (spring-run, summer-run and late-run) (refer to Section 4.3.2 of the Fisheries [British Columbia] Technical Report of Volume 5C). Chinook salmon can be found throughout the Aquatics RSA in BC.

Chinook salmon were selected based on their presence in 10 Project watersheds crossed by the proposed pipeline corridor in BC (Table 5.7-2). Chinook salmon are neither *SARA* or COSEWIC listed. Based on existing data and results of the fisheries field program, Chinook salmon may be found in 54 watercourses crossed by the proposed pipeline corridor in BC (Tables 5.7-9, 5.7-13 and 5.7-17). Chinook salmon were captured or observed at 21 proposed watercourse crossings during the fisheries field program.

Refer to the Fisheries (British Columbia) Technical Report of Volume 5C for additional information on the life history phases and biology of Chinook salmon as well as the watercourses at which this indicator species was captured or observed.

5.7.15 Coho Salmon

Coho salmon are a Yellow-listed anadromous species in BC. The Interior Fraser population was designated as Endangered under COSEWIC in 2002 due to overexploitation and changes in marine and freshwater habitats (COSEWIC 2002). Coho salmon are not listed under Schedule 1 of *SARA*. Coho salmon spawn and rear in many coastal streams of BC; their distribution is especially extensive through the Lower Mainland portion of the Aquatics RSA which includes many tributaries to the lower Fraser River (DFO 2013). The upper and middle Fraser River Basin, particularly the Thompson River and its tributaries, are also extremely important for coho salmon reproduction in BC. Coho salmon do not migrate as far up the Fraser River system as Chinook salmon or sockeye salmon, but reach the headwaters of the North and South Thompson rivers. Interior Fraser River coho salmon have been divided into five subpopulation groups based on genetics (refer to Section 4.3.3 of the Fisheries [British Columbia] Technical Report of Volume 5C).

Coho salmon was selected as an indicator species in BC because of its COSEWIC listing and because it is found in 11 Project watersheds crossed by the proposed pipeline corridor in BC (Table 5.7-2). Based on existing data and the results of the fisheries field program, coho salmon may be found at 113 watercourses crossed by the proposed pipeline corridor (Tables 5.7-9, 5.7-13 and 5.7-17) Coho salmon were captured or observed at 74 proposed watercourse crossings during the fisheries field program.

Refer to the Fisheries (British Columbia) Technical Report of Volume 5C for additional information on the life history phases and biology of coho salmon as well as the watercourses at which this indicator species was captured or observed.

5.7.16 Cutthroat Trout

Cutthroat trout are distributed widely throughout BC and coexist commonly with rainbow trout (McPhail 2007). Cutthroat trout is a polytypic species and two native subspecies, the coastal cutthroat and the westslope cutthroat, are common to BC (McPhail 2007). The main external difference between coastal and westslope cutthroat trout is the pattern of black spots on the body, however, these two subspecies also differ in their morphology, genetics, chromosome number, biology and geographic distributions (McPhail 2007).

Westslope cutthroat trout are the northern most and only interior subspecies of cutthroat trout (Hagen and Baxter 2009). They are located along the Eastern Slopes and west of the Continental Divide but have also been introduced into tributaries to the South Thompson River, the Fraser River basin, streams in southeastern BC and some lakes in the lower Peace River system (COSEWIC 2006, McPhail 2007). Westslope cutthroat in BC are listed as a Species of Special Concern due to stresses to the population associated with hybridization, increased competition with introduced species, habitat loss and degradation and increased exploitation (COSEWIC 2013b). Westslope cutthroat trout are Blue-listed provincially, indicating that they are At Risk (BC CDC 2013a). This subspecies is also listed under Schedule 1 of *SARA*. Westslope cutthroat trout have limited distribution within the South Thompson and Fraser river drainage systems (*e.g.*, tributaries to the Eagle River and Mabel Lake) (McPhail 2007). Westslope cutthroat are most common to the Kootenay and Pend d'Oreille river systems (Columbia River Basin) in the southeastern portion of the province, although a few introductions of westslope cutthroat have been made into other areas of the Fraser River system (McPhail 2007).

Coastal cutthroat trout are a Blue-listed species in BC. There are three general life history forms of coastal cutthroat within the Aquatics RSA: a non-migratory freshwater-resident form; a migratory (often adfluvial) freshwater-resident form; and a sea-run form (anadromous) (McPhail 2007). Sexual maturity for coastal cutthroat is typically reached by 3 to 6 years of age.

Cutthroat trout was selected as an indicator species in BC because of its provincial listing and because it is distributed in five project watersheds crossed by the pipeline segments in BC, namely the Fraser Canyon, Harrison River, Chilliwack River, Lower Fraser River and Squamish River watersheds (Table 5.7-2). Based on the results of the aquatic assessment and existing data, cutthroat trout may be found in 52 watercourses crossed by the proposed pipeline corridor (Tables 5.7-13 and 5.7-17). Cutthroat trout were captured or observed at 18 proposed watercourse crossings during the fisheries field program.

Refer to the Fisheries (British Columbia) Technical Report of Volume 5C for additional information on the life history phases and biology of cutthroat trout as well as the watercourses at which this indicator species was captured or observed.

5.7.17 Rainbow Trout/Steelhead

Rainbow trout are a cool water salmonoid species that is widespread throughout BC and may occur both as freshwater resident (rainbow trout) and anadromous (steelhead) populations within the Fish and Fish Habitat LSA (McPhail 2007). Rainbow trout live entirely in freshwater with possible short periods of time spent in estuarine or near-shore marine waters (Alaska Department of Fish and Game 2013). It is suggested that there are two subspecies of resident rainbow trout in BC, which includes coastal and interior forms (McPhail 2007). Rainbow trout are known to hybridise commonly with cutthroat trout (McPhail 2007).

Juvenile rainbow trout and steelhead occupy the same habitat, display similar foraging characteristics and are not distinguishable within the first few years of their life (Alaska Department of Fish and Game 2013). Juvenile steelhead will spend two to three summers in freshwater before migrating to the ocean where they grow to maturity and return to their natal streams after 1 to 4 years at sea. There are two major groups of steelhead recognized within the Fish and Fish Habitat LSA: a southern coastal group; and a southern interior group.

Rainbow trout/steelhead was selected as an indicator species in BC because it is found in all 13 Project watersheds crossed by the pipeline segments in BC (Table 5.7-2). Rainbow trout/steelhead are neither *SARA* or COSEWIC listed. Based on existing data and the results of the aquatic assessment, rainbow trout/steelhead may be found in 112 watercourses crossed by the proposed pipeline corridor (Tables 5.7-9, 5.7-13 and 5.7-17). Rainbow trout/steelhead were captured or observed at 73 proposed watercourse crossings during the fisheries field program.

Refer to the Fisheries (British Columbia) Technical Report of Volume 5C for additional information on the life history phases and biology of rainbow trout/steelhead as well as the watercourses at which this indicator species was captured or observed.

5.8 Wetland Loss or Alteration

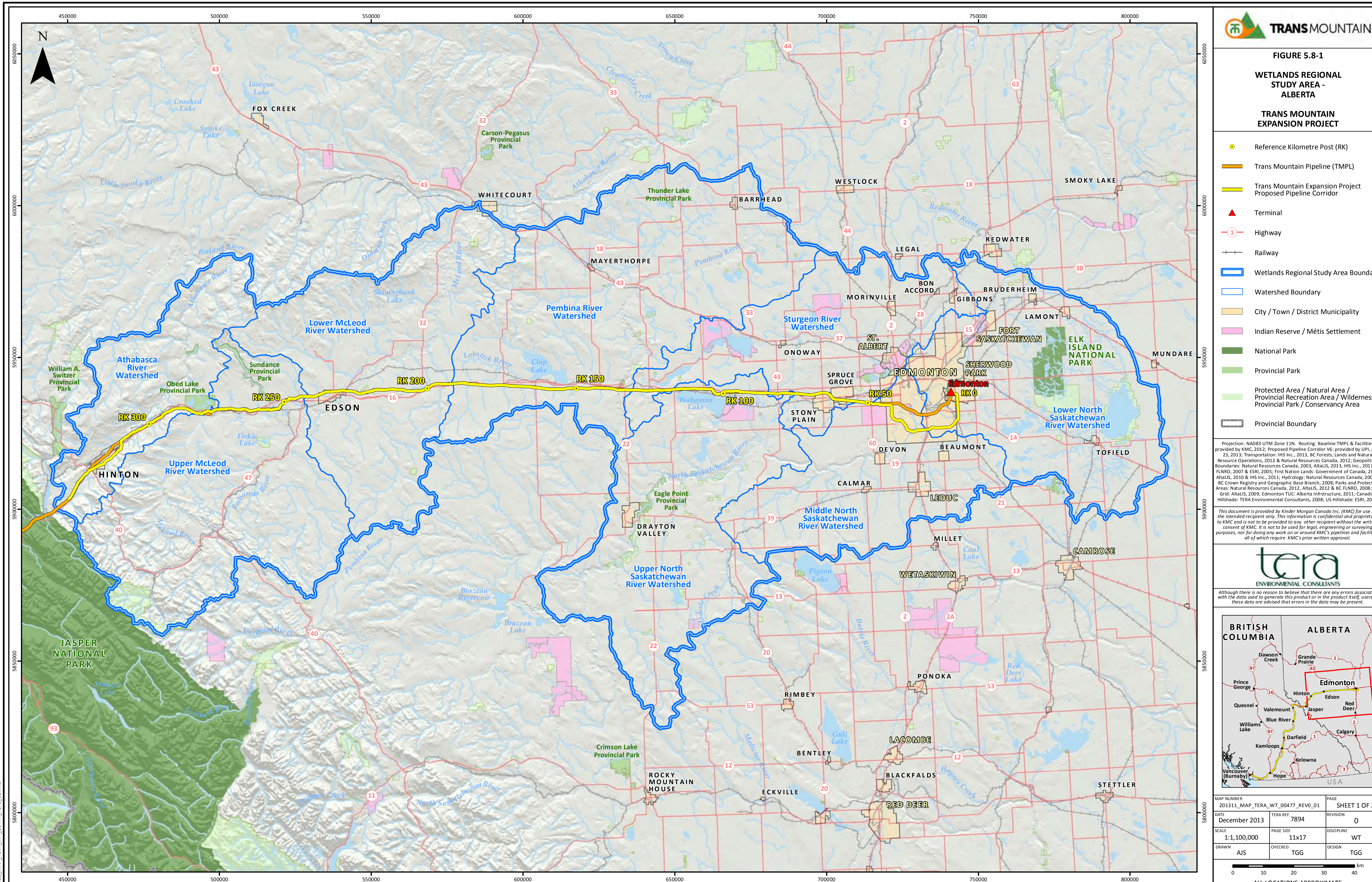
This subsection presents a summary of the findings related to wetlands in the Wetland LSA and Wetland RSA. The indicator selected for this element discussed below is wetland function. The rationale for the selection of this indicator is provided in Section 7.2.8. The potential Project-related effects and mitigation pertaining to wetlands are discussed in Section 7.2.8. Refer to the Wetland Evaluation Technical Report of Volume 5C for additional details on the existing conditions of wetlands.

This setting discusses wetland loss or alteration within the Wetland LSA and Wetland RSA. The Wetland LSA is considered the ZOI likely to be affected by direct disturbance during construction and operations, consisting of a 300 m wide band generally from the proposed pipeline corridor (*i.e.*, 150 m on both sides of the proposed pipeline corridor centre) with site-specific tailoring to extend around larger wetland complexes that are encountered by the proposed pipeline corridor. The Wetland RSA includes all watersheds affected by the Project. The spatial boundaries of the Wetland RSA are shown on Figures 5.8-1 and 5.8-2.

Wetlands are defined as follows:

> "*…land that is saturated with water long enough to promote wetland or aquatic processes as indicated by poorly-drained soils, hydrophytic vegetation and various kinds of biological activity which are adapted to a wet environment*" (National Wetland Working Group [NWWG] 1997).

This wetland definition encompasses a wide range of ecosystems, from semi-terrestrial fens, bogs and swamps to semi-aquatic marshes and shallow open water complexes. Wetlands include a broad range of ecosystem types, from those permanently flooded by shallow water and dominated by aquatic organisms to forested sites with merely moist soils.



TRANS MOUNTAIN

FIGURE 5.8-1

WETLANDS REGIONAL STUDY AREA - ALBERTA

TRANS MOUNTAIN EXPANSION PROJECT

Projection: NAD83 UTM Zone 11N. Routing: Baseline TMPL & Facilities: provided by KMC, 2012; Proposed Pipeline Corridor V6: provided by UPI, Aug. 23, 2013; Transportation: IHS Inc., 2013, BC Forests, Lands and Natural Resource Operations, 2012 & Natural Resources Canada, 2012; Geopolitical Boundaries: Natural Resources Canada, 2003, AltaLIS, 2013, IHS Inc., 2011, BC FLNRO, 2007 & ESRI, 2005; First Nation Lands: Government of Canada, 2013, AltaLIS, 2010 & IHS Inc., 2011; Hydrology: Natural Resources Canada, 2007 & BC Crown Registry and Geographic Base Branch, 2008; Parks and Protected Areas: Natural Resources Canada, 2012, AltaLIS, 2012 & BC FLNRO, 2008; ATS Grid: AltaLIS, 2009; Edmonton TUC: Alberta Infrstructure, 2011; Canadian Hillshade: TERA Environmental Consultants, 2008; US Hillshade: ESRI, 2009.

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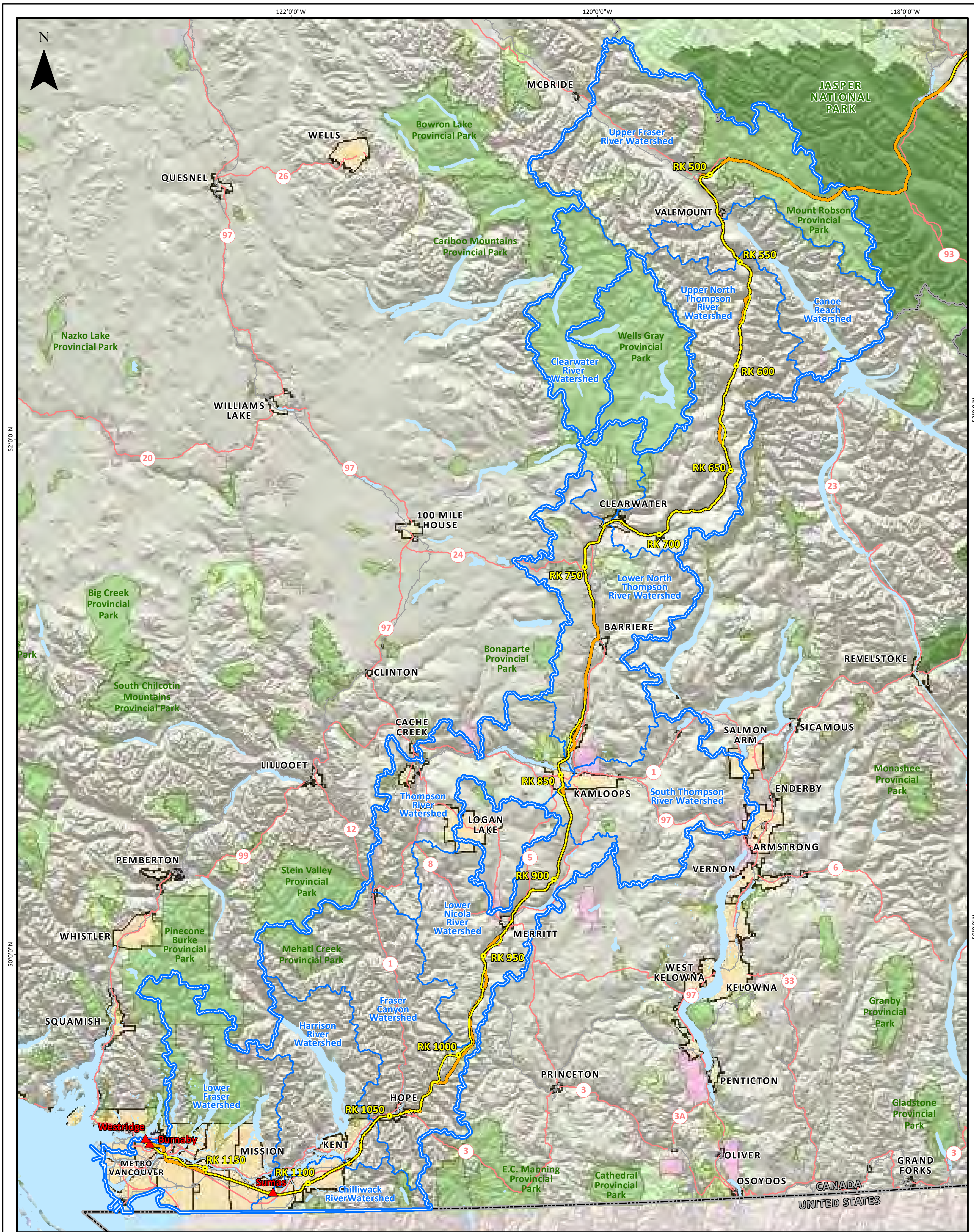
MAP NUMBER		PAGE
201311_MAP_TERA_WT_00477_REV0_01		SHEET 1 OF 2
DATE: December 2013	TERA REF.: 7894	REVISION: 0
SCALE: 1:1,100,000	PAGE SIZE: 11x17	DISCIPLINE: WT
DRAWN: AJS	CHECKED: TGG	DESIGN: TGG

0 10 20 30 40 km

ALL LOCATIONS APPROXIMATE

201311_MAP_TERA_WT_00477_Rev0_01.mxd



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Legend		
Reference Kilometre Post (RK)	Railway	National Park
Trans Mountain Pipeline (TMPL)	Wetlands Regional Study Area Boundary	Provincial Park
Trans Mountain Expansion Project Proposed Pipeline Corridor	Watershed Boundary	Protected Area / Natural Area / Provincial Recreation Area / Wilderness Provincial Park / Conservancy Area
Terminal	City / Town / District Municipality	Provincial Boundary
Highway	Indian Reserve / Métis Settlement	International Boundary

Projection: NAD 1983 UTM 10N. Routing:Baseline TMPL & Facilities: provided by KMC, 2012; Proposed Pipeline Corridor V6: provided by UPI, Aug. 23, 2013; Facilities: Provided by KMC, 2012; Transportation: IHS Inc., 2013, BC Forests, Lands and Natural Resource Operations, 2012 & Natural Resources Canada, 2012; Geopolitical Boundaries: Natural Resources Canada, 2003, AltaLIS, 2013, IHS Inc., 2011, BC FLNRO, 2007 & ESRI, 2005; First Nation Lands: Government of Canada, 2013, AltaLIS, 2010 & IHS Inc., 2011; Hydrology: Natural Resources Canada, 2007 & BC Crown Registry and Geographic Base Branch, 2008; Parks and Protected Areas: Natural Resources Canada, 2012, AltaLIS, 2012 & BC FLNRO, 2008; ATS Grid: AltaLIS, 2009; Edmonton TUC: Alberta Infrstructure, 2011; Canadian Hillshade: TERA Environmental Consultants, 2008; US Hillshade: ESRI, 2009; World Shaded Relief: Copyright:© 2013 Esri

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TRANS MOUNTAIN

FIGURE 5.8-2

WETLANDS REGIONAL STUDY AREA - BRITISH COLUMBIA

TRANS MOUNTAIN EXPANSION PROJECT

MAP NUMBER		PAGE
201311_MAP_TERA_WT_00477_REV0_02		SHEET 2 OF 2
DATE: December 2013	TERA REF.: 7894	REVISION: 0
SCALE: 1:1,600,000	PAGE SIZE: 11x17	DISCIPLINE: WT
DRAWN: AJS	CHECKED: TGG	DESIGN: TGG

0 15 30 45 60 Km

ALL LOCATIONS APPROXIMATE

Wetlands surveyed were classified to both class and form hierarchical levels according to the Canadian Wetland Classification System (NWWG 1997) and the Mackenzie and Moran (2004) Wetland Classification System in BC. Table 3.6-1 of the Wetland Evaluation Technical Report (Volume 5C) lists wetland characteristics of the dominant wetland classes of the Canadian Wetland Classification System that commonly occur in the wetland regions encountered by the proposed pipeline corridor. The dominant wetland classes include bogs, fens, swamps, marshes and shallow open water wetlands.

Wetland data collection for the Project utilized both helicopter reconnaissance and ground-based wetland surveys where ground access was available. The helicopter reconnaissance, used to gather high-level delineation and classification information for wetlands, and the ground-based surveys were completed by wetland ecologists in 2012. The field program focused on the proposed pipeline corridor.

An additional helicopter reconnaissance was conducted in April and May 2013 along segments of the proposed pipeline corridor that were finalized subsequent to the 2012 field program completion.

Following the spring 2013 overflights, all wetlands identified during the helicopter reconnaissance were ground-truthed where land access was available. The intent is that all wetlands within the proposed pipeline corridor will be surveyed on the ground prior to Project construction. The multiple helicopter reconnaissances conducted at various times throughout the year (*i.e.*, spring and fall) give a better understanding of the seasonal fluctuations of the local hydrologic regime.

Wetland function can be described as the ability of wetlands to perform numerous hydrological, biogeochemical and habitat-related functions within an ecosystem. These functions include: flood control; ground water recharge; water quality functions, such as water purification as well as sediment and nutrient retention; carbon sequestration; substrate protection; and maintaining biodiversity. Wetland function can change throughout the year and from year to year (*e.g.*, from times of drought to excessive precipitation). Given changing conditions, wetland function is used as a general description of the ability of a wetland to perform a variety of functions. A literature review summary for wetland function is provided below (*e.g.*, Hoorens *et al.* 2010, Houlahan *et al.* 2006, Hunt *et al.* 1999, Kellner and Halldin 2002, McLatchey and Reddy 1998, Mitsch and Gosselink 2007, Price *et al.* 2005, van der Kamp and Hayashi 1998, Vitt 2000). Description of wetland function conditions identified can be found in Section 7.0 of this volume and in the Wetland Evaluation Technical Report of Volume 5C. The methods used to evaluate wetland function, which were developed through consultation with Environment Canada can be found in the Wetland Evaluation Technical Report of Volume 5C.

Wetland function was evaluated at each wetland visited during the ground-based field work. The function of wetlands crossed by the proposed pipeline corridor are reported on the premise that disturbed wetlands would be revisited in the years following construction to document the progress of function returning to the wetland system after pipeline construction. Wetland function documented during the existing (*i.e.*, pre-construction) condition ground-based wetland surveys will be compared to wetland function observed along the reclaimed (*i.e.*, post-construction) construction right-of-way. The results of this comparison will be used to measure the effectiveness and efficiency of mitigation and reclamation measures, to ensure that wetlands are on the trajectory to returning to pre-construction functional condition and provide support to the determination of loss or “no net loss” of wetland function. Data collection methods are based on the Wisconsin Rapid Assessment Methodology (Wisconsin Department of Natural Resources 2001), Manual for the Wetland Ecosystem Services Protocol for the US (Adamus 2011), Riparian Health Assessment for Lakes, Sloughs and Wetlands (Ambrose *et al.* 2009), Riparian Health Assessment for Streams and Small Rivers (Fitch *et al.* 2001), Ontario Wetland Evaluation System (Ontario Ministry of Natural Resources 1993) and are part of an Environment Canada recommended approach (Hanson *et al.* 2008). These methods were presented to Environment Canada through consultation and no issue was presented at that time.

Wetlands provide a nutrient-rich habitat for a variety of plants and animals that are important to Aboriginal communities for subsistence harvesting and sustaining traditional practices. Large mammals found in and around these areas, such as caribou and moose, as well as small furbearers make these ecosystems important for Aboriginal trapping and hunting activities. Medicinal and other culturally important plants, such as the diamond willow, are also frequently found in wetland regions.

In 2012 and 2013, TEK was gathered and recorded during the wetlands field surveys. During the field surveys, traditional methods of resource procurement were discussed, as well as modern methods currently employed. Seasonality of resource harvesting, species of traditional importance, classification of wetland areas and descriptions of traditional resources contained within the different wetland areas was also important information shared by the Aboriginal participants. Geographical locations were identified, as were areas that are not used and the reasons why. Potential mitigation measures to reduce any Project-related effects on a resource were also discussed during the wetland field surveys.

5.8.1 Edmonton to Hinton Segment

The proposed pipeline corridor along the Edmonton to Hinton Segment is located within: two ecozones (*i.e.*, Prairies and Boreal Plains) and three ecoregions of Canada (*i.e.*, Aspen Parkland, Boreal Transition and Western Alberta Upland) (Agriculture and Agri-Food Canada 2013, Ecological Stratification Working Group 1995); two Wetland Regions of Canada (*i.e.*, Continental and Transitional Mid-Boreal) (Government of Canada 1986); and five natural subregions of Alberta, including the Central Parkland, Dry Mixedwood, Central Mixedwood, Lower Foothills and Montane Natural Subregions (Natural Regions Committee 2006b).

Alberta represents approximately 7% of Canada's land mass. Wetlands in Alberta cover approximately 20% of the province, over 90% of which are peatlands in the boreal region, while the remaining 5% to 10% are mineral wetlands (*i.e.*, marshes, swamps and shallow open water wetlands) in the parkland and prairie region (NWWG 1986, Tarnocai 1984, Vitt *et al.* 1996).

In Alberta, the proposed pipeline corridor does not encounter the 200 m setback of any provincially identified piping plover waterbodies (AESRD 2010-2012). The proposed pipeline corridor does encounter the 1,000 m setback of provincially identified colonial nesting bird waterbodies and the 800 m setback of many provincially identified trumpeter swan waterbodies (AESRD 2010-2012).

The proposed pipeline corridor along the Edmonton to Hinton Segment does not cross any Migratory Bird Sanctuaries (Environment Canada 2013n), Western Hemisphere Shorebird Reserves (Western Hemisphere Shorebird Reserve Network [WHSRN] 2013), Important Bird Areas (IBAs) (Bird Studies Canada and Nature Canada 2012) or Ramsar wetlands (Bureau of the Convention on Wetlands 2013).

Ducks Unlimited Canada (DUC) has identified three levels of priority for wetland conservation in Canada. The Edmonton to Hinton Segment travels through the DUC Level 1 Priority Landscapes, Prairie Pothole and Western Boreal Forest (DUC 2013). No DUC sites are crossed by the proposed pipeline corridor (McFarlane pers. comm.).

Provincial parks, recreational areas, protected areas and regional parks were identified within the Wetland LSA for all of the proposed pipeline segments. In Alberta, two protected areas, Nojack Provincial Recreation Area (RK 175) and Yates Natural Area (RK 222), were identified in proximity to the proposed pipeline corridor along the Edmonton to Hinton Segment. The proposed pipeline corridor is located approximately 70 m south of Nojack Provincial Recreation Area and 20 m south of the Yates Natural Area but does not cross through these areas. During the Edmonton ESA Workshop, the Wagner Natural Area was raised as a concern. This natural area is located 3.4 km to the north of the proposed pipeline corridor, however, areas that feed this natural area are crossed by the Project.

Along the Edmonton to Hinton Segment, the most common land use consists of cultivation, pasture, residential developments and linear disturbances (*e.g.*, highways, pipeline rights-of-way) which has contributed to disturbance to wetlands. For additional information on the current level of disturbance to wetlands along the Edmonton to Hinton Segment, see Appendix B in the Wetland Evaluation Technical Report of Volume 5C.

Aboriginal Traditional Knowledge

Available ATK related to wetlands along the Edmonton to Hinton Segment is limited. However, the desktop review identified concerns regarding the disruption of wetlands and "muskeg" (a colloquial term for peatlands) due to pipeline construction activities since these disruptions could result in lower animal populations and affect medicinal plants (Northern Gateway Pipelines Limited Partnership Inc. [NGPLP] 2010).

Consultation

Table 5.8-1 provides the outcomes from ESA Workshops and meetings held with federal, provincial and municipal representatives and community workshops relating to presence and characteristics of wetland areas along the Edmonton to Hinton Segment. For more information on other topics raised during these workshops and meetings, see Section 3.0 of this volume and Section 2.0 of the Wetland Evaluation Technical Report of Volume 5C.

TABLE 5.8-1

SUMMARY OF ESA WORKSHOP AND MEETING OUTCOMES

Workshop Location	Date	Outcome[1]
Edmonton, Alberta	March 4, 2013	During this workshop, it was identified that Wagner Bog and the Wagner Natural Area exist near the proposed pipeline corridor and concerns were expressed that the pipeline may potentially cut across areas feeding that region and may impact the water supply.
Spruce Grove, Alberta	October 1, 2012	Staff at the City of Spruce Grove identified some areas of environmental concerns, including wetlands/peatlands (around RK 61.5 to RK 61.9 and south of RK 59.4 to RK 59.7 along the existing TMPL right-of-way).
Yellowhead County, Alberta	October 17, 2012	Staff at Yellowhead County commented that there is a peatland area surrounding Chip Lake.
Edson, Alberta	April 23, 2013	Participants identified a bog area west of the Town of Edson that has been difficult to revegetate which many other companies have avoided.
Hinton, Alberta	April 24, 2013	Participants identified some wet areas along the proposed pipeline corridor as well as noted that there seems to be a layer of mineral soil within boggy areas about 0.6 m down indicating high water tables.

Note: 1 Terminology captured at community workshops may be colloquial in nature and may not reflect wetland classification based on the Canadian Wetland Classification System (NWWG 1997).

Results of Field Data Collection

Helicopter reconnaissances along this segment were conducted from August 16 to 17, 2012 and on May 10, 2013. Ground-based field work at wetlands along this segment with available land access permission was conducted from August 13 to 23, 2012 and from May to July 2013.

A desktop review of overflight photographs and satellite imagery was conducted to try and identify and delineate all potential wetland areas along the proposed pipeline corridor. The desktop review identified 339 wetlands (51.6 km), comprising approximately 5.2% of the proposed pipeline corridor. Wetlands crossed by the proposed pipeline corridor include 154 basin marshes, 31 riparian marshes, 59 flat swamps, 26 riparian swamps, 2 discharge swamps, 1 slope swamps, 18 basin water, 3 riparian water, 11 basin fens, 23 horizontal fens, 7 riparian fens, 2 channel fens, 1 feather fen and 1 basin bog.

The 2012 and 2013 wetland field surveys were conducted on lands where access was granted and confirmed that 261 wetlands are crossed by the proposed pipeline corridor. Wetlands crossed by the proposed pipeline corridor visited during the 2012 and 2013 ground-based wetland field surveys include 115 basin marshes, 24 riparian marshes, 46 flat swamps, 21 riparian swamps, 2 discharge swamps, 1 slope swamps, 9 basin water, 3 riparian water, 10 basin fens, 22 horizontal fens, 7 riparian fens and 1 feather fen. Typical wetland community types documented include seasonal emergent and deep marsh community types, open water community types, shrubby community types, mixedwood treed community types, broad-leaf treed community types, needle-leaf treed community types, treed community types and graminoid community types. These numbers will be updated following the completion of the 2014 supplemental field program.

Wetland functional assessments were conducted at all wetlands ground-truthed in 2012 and 2013. The results of this assessment identified that the Edmonton to Hinton Segment encounters 78 wetlands were High Functional Condition, 142 wetlands were High-Moderate Functional Condition and 41 wetlands were of Low-Moderate Functional Condition within the proposed pipeline corridor.

It was also determined that approximately 13 rare plants or rare ecological communities are associated with wetlands found along the Edmonton to Hinton Segment. Additional information on the rare ecological communities found associated with wetlands is provided in the Vegetation Technical Report of Volume 5C.

Table 5.8-2 provides a summary of the classes, approximate length of disturbance and percent of proposed pipeline corridor crossed by wetlands along the proposed pipeline corridor along the Edmonton to Hinton Segment. Additional information on wetlands along this segment, including conservation status, is provided in Section 5.1 of the Wetland Evaluation Technical Report of Volume 5C. As the Environmental Alignment Sheets were finalized prior to field work being conducted in October 2013, the numbers provided in Table 5.8-2 may differ from those provided on the Environmental Alignment Sheets of Volume 6E.

TABLE 5.8-2

SUMMARY OF WETLANDS CROSSED ALONG THE EDMONTON TO HINTON SEGMENT

Wetland Class	All Wetlands Crossed by Proposed Pipeline Corridor	Number of Ground-Truthed Wetlands Crossed by Proposed Pipeline Corridor[1]	Approximate Length of Wetland Crossed by Proposed Pipeline Corridor (m)	Percent of Proposed Pipeline Corridor Crossed
Basin Marsh	154	115	13,727	1.4
Riparian Marsh	31	24	5,486	0.6
Flat Swamp	59	46	10,433	1.1
Riparian Swamp	26	21	5,045	0.5
Discharge Swamp	2	2	465	0.05
Slope Swamp	1	1	82	0.01
Basin Water	18	9	2,139	0.2
Riparian Water	3	3	619	0.1
Basin Fen	11	10	1,983	0.2
Horizontal Fen	23	22	9,690	1.0
Riparian Fen	7	7	1,676	0.2
Channel Fen	2	--[2]	131	0.01
Feather Fen	1	1	125	0.01
Basin Bog	1	--[2]	114	0.01
Total	339	261	51,714	4

Notes: 1 Ground-truthing and functional assessments were conducted at wetlands where land access permission was available in 2012 and 2013.

2 A double dash indicates that those particular wetland classes were not ground-truthed in 2012 or 2013.

Traditional Ecological Knowledge

During the field studies along the proposed Edmonton to Hinton Segment, TEK participants reported that wetlands are complex ecosystems used by many animals. Moose, deer, elk, beaver, muskrat, ducks, geese and other birds access wetlands for food, water and protection from predators. Wetlands are abundant in willows, muskeg moss, hard woods, berries and roots, and medicinal plants that thrive in wet soils.

Participants noted that wetlands are often used as migratory routes for moose, elk, coyotes and wolves and bears are also drawn to these nutrient-rich areas. Moose will calve in wetlands where nearby tall grasses and tree cover offer protection from predators and make ideal calving beds. Muskeg moss (peat moss) is used by Aboriginal peoples for diapers, whereby the moss is harvested and hung to dry before it is used.

5.8.2 Hargreaves to Darfield Segment

The Hargreaves to Darfield Segment is located within: one ecozone (*i.e.*, Montane Cordillera) and three ecoregions of Canada (*i.e.*, Eastern Continental Ranges, Western Continental Ranges and the Mountains and Highlands) (Agriculture and Agri-Food Canada 2013, Ecological Stratification Working Group 1995); two Wetland Regions of Canada (*i.e.*, Continental Mid-Boreal and South Interior Mountain) (Government of Canada 1986); and three BGC zones of BC (*i.e.*, ICH, SBS and IDF) (BC MFLNRO 2012, Meidinger and Pojar 1991).

BC represents approximately 10% of Canada's land mass. Wetlands in BC cover approximately 3% of the province, approximately 33% of which are peatlands, while approximately 66% are mineral wetlands (*i.e.*, marshes, swamps and shallow open water wetlands) (NWWG 1986, Tarnocai 1984).

The Hargreaves to Darfield Segment does not cross any Migratory Bird Sanctuaries (Environment Canada 2013n), Western Hemisphere Shorebird Reserves (WHSRN 2013), IBAs (Bird Studies Canada and Nature Canada 2012), Ramsar wetlands (Bureau of the Convention on Wetlands 2013) or any of the DUC Priority Landscapes (DUC 2013). No DUC sites are crossed by the proposed pipeline corridor (Harrison pers. comm.).

There were six protected areas identified within the Wetland LSA along the Hargreaves to Darfield Segment. The proposed pipeline corridor crosses two of these, Finn Creek Provincial Park and North Thompson River Provincial Park. The other four protected areas are located within the Wetland LSA at the following distances from the proposed pipeline corridor: Blue River Black Spruce Provincial Park (30 m east); Jackman Flats Provincial Park (40 m west); Eskin Creek Canyon Provincial Park (70 m west); and Chu Chua Cottonwood Provincial Park (30 m east).

Along the Hargreaves to Darfield Segment, the most common land uses consist of cultivation, pasture, residential developments, forestry and linear disturbances (*e.g.*, highways, pipeline rights-of-way) which has contributed to disturbance to wetlands. For additional information on the current level of disturbance to wetlands along the Hargreaves to Darfield Segment, see Appendix B in the Wetland Evaluation Technical Report of Volume 5C.

Aboriginal Traditional Knowledge

Available ATK related to wetlands along the Hargreaves to Darfield Segment is limited. However, the desktop review identified concerns regarding peatland areas where Labrador tea may be harvested (Lifeways of Canada Ltd. 2012, NGPLP 2010).

Consultation

Table 5.8-3 provides the outcomes community workshops relating to presence and characteristics of wetland areas along the Hargreaves to Darfield Segment. For more information on other topics raised during these workshops and meetings, see Section 3.0 of this volume and Section 2.0 of the Wetland Evaluation Technical Report of Volume 5C.

TABLE 5.8-3

SUMMARY OF COMMUNITY WORKSHOP OUTCOMES IN THE HARGREAVES TO DARFIELD SEGMENT

Workshop Location	Date	Outcome[1]
Valemount, BC	May 28, 2013	The Valemount Community Workshop identified that generally the area to the southwest of Valemount is quite wet and marshy, seasonally and permanently. They also commented on the presence of Cranberry Marsh located south of the Village of Valemount.
Blue River, BC	May 29, 2013	The Blue River Community Workshop identified the presence of a black spruce bog located south of the community which provides unique habitat. This area was felt by the participants to perhaps be a protected area, although it is not marked as a park. Participants also commented that there are many swampy areas in the general area around the Community of Blue River.
Clearwater, BC	June 5, 2013	During the Clearwater Community Workshop, participants made note that there is an abundance of wetlands around Blackpool.

Note: 1 Terminology captured at community workshops may be colloquial in nature and may not reflect wetland classification based on the Canadian Wetland Classification System (NWWG 1997).

Results of Field Data Collection

Helicopter reconnaissances along this segment were conducted from August 19 to 20, 2012 and on May 8, 2013. Ground-based field work at wetlands along this segment with available land access permission was conducted from September 27 to October 3, 2012 and from April to July 2013.

A desktop review of overflight photographs and satellite imagery was conducted to try and identify and delineate all potential wetland areas along the proposed pipeline corridor. The desktop review identified 155 wetlands (totalling approximately 27.5 km in length), comprising approximately 2.8% of the proposed pipeline corridor. Wetlands crossed by the proposed pipeline corridor include 31 basin marshes, 17 riparian marshes, 2 lacustrine marshes, 1 slope marsh, 30 flat swamps, 41 riparian swamps, 3 slope swamps, 10 basin water, 10 riparian water, 1 basin fen, 3 horizontal fens and 1 riparian fens.

The 2012 and 2013 wetland field surveys were conducted on lands where access was granted and confirmed that 106 wetlands are crossed by the proposed pipeline corridor. Wetlands crossed by the proposed pipeline corridor visited during the 2012 and 2013 ground-based wetland field surveys include 21 basin marshes, 13 riparian marshes, 1 slope marsh, 21 flat swamps, 36 riparian swamps, 3 slope swamps, 2 basin water, 6 riparian water, 1 basin fen and 2 horizontal fens. Typical wetland community types documented include seasonal emergent and deep marsh community types, open water community types, shrubby community types, mixedwood treed community types, broad-leaf treed community types, needle-leaf treed community types and graminoid community types. These numbers will be updated following the completion of the 2014 supplemental field program.

Wetland functional assessments were conducted at all wetlands ground-truthed in 2012 and 2013. The results of this assessment identified 24 wetlands that were High Functional Condition, 72 wetlands were High-Moderate Functional Condition and 10 wetlands were of Low-Moderate Functional Condition.

It was also determined that approximately 20 wetlands were associated with 4 rare plant observations and 6 rare ecological communities found along the Hargreaves to Darfield Segment. Of these rare plants and rare ecological communities, 2 are Red-listed, 6 are Blue-listed and 1 currently is not listed.

Table 5.8-4 provides a summary of the classes, length of disturbance and percent of proposed pipeline corridor crossed by wetlands along the proposed pipeline corridor in the Hargreaves to Darfield Segment. Additional information on wetlands along this segment, including conservation status, is provided in Section 5.1 of the Wetland Evaluation Technical Report of Volume 5C.

TABLE 5.8-4

SUMMARY OF WETLANDS CROSSED ALONG THE HARGREAVES TO DARFIELD SEGMENT

Wetland Class	All Wetlands Crossed by Proposed Pipeline Corridor	Number of Ground-Truthed Wetlands Crossed by Proposed Pipeline Corridor[1]	Approximate Length of Wetland Crossed by Proposed Pipeline Corridor (m)	Percent of Proposed Pipeline Corridor Crossed
Basin Marsh	31	21	3,750	0.4
Riparian Marsh	17	13	2,954	0.3
Lacustrine Marsh	2	--[2]	244	0.02
Slope Marsh	1	1	45	0.005
Flat Swamp	30	21	6,980	0.7
Riparian Swamp	41	36	8,702	0.9
Slope Swamp	3	3	524	0.1
Basin Water	10	2	931	0.1
Riparian Water	10	6	1,501	0.2
Basin Fen	1	1	9	0.001
Horizontal Fen	3	2	437	0.04
Riparian Fen	6	--[2]	1,266	0.1
Total	155	106	27,343	2.8

Notes: 1 Ground-truthing and functional assessments were conducted at wetlands where land access permission was available in 2012 and 2013.

2 A double dash indicates that those particular wetland classes were not ground-truthed in 2012 or 2013.

Traditional Ecological Knowledge

During the field studies along the proposed Hargreaves to Darfield Segment, TEK participants identified wildlife typically observed in wetland habitats including moose, beavers, fish, toads, frogs, snakes, red-winged blackbirds, chicks, minnows, migratory birds, eagles, bats, deer, bears, muskrat, caribou, hare, ducks, elk and deer. Participants explained that the diversity of the vegetation supported by wetland habitats attracts a wide range of wildlife species. Wetland vegetation identified during the field studies includes fireweed, dogbane, cottonwood, water lilies, bulrushes, thistle species, cattail, birch, bunchberry, Saskatoon berry, wild rhubarb, no-leaves plant, cedar, soapberry, mint and poplar.

5.8.3 Black Pines to Hope Segment

The Black Pines to Hope Segment is located within: one ecozone (*i.e.*, Montane Cordillera) and two ecoregions of Canada (*i.e.*, Thompson-Okanagan Plateau and Okanagan Range) (Agriculture and Agri-Food Canada 2013, Ecological Stratification Working Group 1995); three Wetland Regions of Canada (*i.e.*, Intermountain Prairie, South Coastal Mountain and Pacific Temperate) (Government of Canada 1986); and eight BGC zones of BC (*i.e.*, PP, BG, IDF, MS, CWH, ESSF and MH) (BC MFLNRO 2012, Meidinger and Pojar 1991).

BC represents approximately 10% of Canada's land mass. Wetlands in BC cover approximately 3% of the province; approximately 33% of which are peatlands, while approximately 66% are mineral wetlands (*i.e.*, marshes, swamps and shallow open water wetlands) (NWWG 1986, Tarnocai 1984).

The Black Pines to Hope Segment does not cross any Migratory Bird Sanctuaries (Environment Canada 2013n), Western Hemisphere Shorebird Reserves (WHSRN 2013) or Ramsar wetlands (Bureau of the Convention on Wetlands 2013).

One IBA is located within the Wetland LSA along the Black Pines to Hope Segment, namely the Douglas Lake Plateau (RK 850.6 to RK 863.7) (Bird Studies Canada and Nature Canada 2012). The Douglas Lake Plateau IBA is located south of the City of Kamloops. The proposed pipeline corridor crosses a small portion of this IBA at its northern extent where it crosses Highway 5. This IBA consists of rolling BG grasslands, small marshy lakes, Douglas-fir/PP forests and aspen parkland. This area is home to a small population of American badger (Red-listed), great basin spadefoot toad (Blue-listed) and rubber boa (Yellow-listed). The Douglas Lake Plateau is an important migration breeding area for the sandhill crane (a Blue-listed, vulnerable species in BC). The number of sandhill cranes that use this area for breeding and migration staging areas represent over 1.5% of the North American population. The area is also a major migration corridor for loons, grebes, waterfowl, raptors, shorebirds, gulls and passerines. Perhaps 5-10% of the population of the flammulated owl, a nationally vulnerable species, breed within the IBA. The Lewis' woodpecker is also known to breed within the Douglas Lake Plateau IBA, though exact numbers of this nationally vulnerable species are not known. There are 10 burrowing owls (Red-listed) that have been released within this IBA at several locations. Swainson's hawk (Red-listed), ferruginous hawk and prairie falcon (Red-listed) are also known to breed within the IBA. Birds that are not common within BC that are known to breed within the Douglas Lake Plateau are bobolink (Blue-listed), Brewer's sparrow (Yellow-listed), common nighthawk (Yellow-listed), American avocet (Blue-listed), black tern (Yellow-listed) and yellow-headed blackbird (Yellow-listed) (Bird Studies Canada and Nature Canada 2012).

The Black Pines to Hope Segment encounters the DUC Level 3 Priority Landscapes. This priority level is classified as Eastern Boreal Forest since it consists of characteristics similar to those found in the eastern reaches of this forest zone (DUC 2013). No DUC conservation sites are crossed by the proposed pipeline corridor (Harrison pers. comm.).

The Black Pines to Hope Segment encounters four protected areas within the Wetland LSA. The proposed pipeline corridor crosses two of these, Lac du Bois Grasslands Protected Area and Coquihalla Summit Recreational Area. The other two protected areas are located within the Wetland LSA at the following distances from the proposed pipeline corridor: Coldwater River Provincial Park (10 m east); and Coquihalla River Provincial Park (50 m west).

Aboriginal Traditional Knowledge

Along the Black Pines to Hope Segment, the desktop review identified that several Aboriginal communities harvest wapato, a nutritious tuber that is found scattered throughout marshy areas. The harvest is collected by using canoes or by wading into the shallows and treading on the plants until the roots float to the surface (Golder Associates 2008).

Consultation

Table 5.8-5 provides the outcomes of community workshops relating to presence and characteristics of wetland areas along the Black Pines to Hope Segment. For more information on other topics raised during these workshops and meetings, see Section 3.0 of this volume and Section 2.0 of the Wetland Evaluation Technical Report of Volume 5C.

TABLE 5.8-5

SUMMARY OF COMMUNITY WORKSHOP OUTCOMES IN THE BLACK PINES TO HOPE SEGMENT

Workshop Location	Date	Outcome
Merritt, BC	June 12, 2013	The Merritt Community Workshop brought forth information on the wetland habitat found along the Nicola River at the proposed crossing location.

Results of Field Data Collection

Helicopter reconnaissances along this segment were conducted from September 22 to 23, 2012 and on May 8, 2013. Ground-based field work at wetlands along this segment with available land access was conducted from April 28 to May 7, 2013.

A desktop review of overflight photographs and satellite imagery was conducted to identify and delineate all potential wetland areas along the proposed pipeline corridor. The desktop review identified 88 wetlands (totalling approximately 10.3 km in length), comprising approximately 1.0% of the proposed pipeline corridor. Wetlands crossed by the proposed pipeline corridor include 45 basin marshes, 7 riparian marshes, 2 lacustrine marshes, 6 slope marsh, 10 flat swamps, 4 riparian swamps, 2 slope swamps, 7 basin water, 3 riparian water, 1 basin fen and 1 slope fen.

The 2012 and 2013 wetland field surveys were conducted on lands where access was granted and confirmed that four wetlands are crossed by the proposed pipeline corridor. Wetlands crossed by the proposed pipeline corridor visited during the 2012 and 2013 ground-based wetland field surveys include three basin marshes and one flat swamp. Typical wetland community types documented include seasonal emergent, alkali and deep marsh community types, open water community types, shrubby community types, broad-leaf treed community types, needle-leaf treed community types and graminoid community types. These numbers will be updated following the completion of the 2014 supplemental field program.

Wetland functional assessments were conducted at all wetlands ground-truthed in 2012 and 2013. The results of this assessment identified two wetlands were High-Moderate Functional Condition and two wetlands were of Low-Moderate Functional Condition.

It was also determined that one wetland was associated with one rare ecological community found along the Black Pines to Hope Segment. This rare ecological community is Blue-listed.

Table 5.8-6 provides a summary of the classes, length of disturbance and percent of proposed pipeline corridor crossed by wetlands along the proposed pipeline corridor in the Black Pines to Hope Segment. Additional information on wetlands along this segment, including conservation status, is provided in Section 5.1 of the Wetland Evaluation Technical Report of Volume 5C.

TABLE 5.8-6

SUMMARY OF WETLANDS CROSSED ALONG THE BLACK PINES TO HOPE SEGMENT

Wetland Class	All Wetlands Crossed by Proposed Pipeline Corridor	Number of Ground-truthed Wetlands Crossed by Proposed Pipeline Corridor[1]	Approximate Length of Wetland Crossed by Proposed Pipeline Corridor (m)	Percent of Proposed Pipeline Corridor Crossed
Basin Marsh	45	3	3,913	0.4
Riparian Marsh	7	--[2]	1,028	0.1
Lacustrine Marsh	2	--[2]	476	0.05
Slope Marsh	6	--[2]	599	0.06
Flat Swamp	10	1	1,350	0.14
Riparian Swamp	4	--[2]	941	0.1
Slope Swamp	2	--[2]	412	0.04
Basin Water	7	--[2]	781	0.08
Riparian Water	3	--[2]	411	0.04
Basin Fen	1	--[2]	195	0.02
Slope Fen	1	--[2]	187	0.02
Total	88	4	10,292	1.0

Notes: 1 Ground-truthing and functional assessments were conducted at wetlands where land access permission was available in 2012 and 2013.

2 A double dash indicates that those particular wetland classes were not ground-truthed in 2012 or 2013.

Traditional Ecological Knowledge

TEK information was not gathered during the wetland field surveys associated with the Black Pines to Hope Segment due the limited amount of field work that was conducted in this area as a result of lack of access to the Hope to Burnaby Segment.

The Hope to Burnaby Segment is located within: one ecozone (*i.e.*, Pacific Maritime) and three ecoregions of Canada (*i.e.*, Pacific Ranges, Cascade Ranges and Lower Mainland) (Agriculture and Agri-Food Canada 2013, Ecological Stratification Working Group 1995); one wetland region of Canada (*i.e.*, Pacific Temperate) (Government of Canada 1986); and one BGC zone of BC (*i.e.*, CWH) (BC MFLNRO 2012, Meidinger and Pojar 1991).

The Hope to Burnaby Segment does not cross any Migratory Bird Sanctuaries (Environment Canada 2013n), Western Hemisphere Shorebird Reserves (WHSRN 2013), IBAs (Bird Studies Canada and Nature Canada 2012) or Ramsar wetlands (Bureau of the Convention on Wetlands 2013).

The Hope to Burnaby Segment encounters the DUC Level 2 Priority Landscapes. The Level 2 Priority Landscapes consist of the BC Coastal Areas and Estuaries and the BC Interior (DUC 2013). One DUC conservation site was identified as being indirectly crossed by the proposed pipeline corridor, Cheam Lake Wetlands (Harrison pers. comm.). The proposed pipeline corridor does not cross the wetland, but does cross the southern portion of the regional park in which the conservation site is located.

The Hope to Burnaby Segment encounters the southwestern portion of the Cheam Lake Wetlands Regional Park in two locations (RK 1079.9 to RK 1080.0 and RK 1080.1 to RK 1080.4) and Surrey Bend Regional Park (RK 1160.5 to RK 1163.7).

Aboriginal Traditional Knowledge

The desktop review did not identify available ATK related to wetlands along the Hope to Burnaby Segment.

Consultation

Table 5.8-7 provides the outcomes of community workshops relating to presence and characteristics of wetland areas along the Hope to Burnaby Segment. The ESA workshops and meetings held with federal, provincial and municipal representatives did not reveal any site-specific wetland information. For more information on other topics raised during these workshops and meetings, see Section 3.0 of this volume and Section 2.0 of the Wetland Evaluation Technical Report of Volume 5C.

TABLE 5.8-7

SUMMARY OF COMMUNITY WORKSHOP OUTCOMES IN THE HOPE TO BURNABY SEGMENT

Workshop Location	Date	Outcome[1]
Hope, BC	June 11, 2013	During the Hope Community Workshop, participants commented that the Thacker Marsh is a valued wetland area near Kakawa Lake.
Chilliwack, BC	June 17, 2013	The participants at the Chilliwack Community Workshop identified the importance of the Cheam wetland.
Coquitlam, BC	June 25, 2013	The Coquitlam Community Workshop brought attention to the peaty soils and potential for subsidence and instability in the area after the Fraser River towards the Blue Mountain area.

Note: 1 Terminology captured at community workshops may be colloquial in nature and may not reflect wetland classification based on the Canadian Wetland Classification System (NWWG 1997).

Results of Field Data Collection

Helicopter reconnaissances along this segment were conducted from September 22 to 23, 2012 and on May 8, 2013. Ground-based field work at wetlands along this segment with available land access was conducted from April 28 to May 7 and June 10 to 12, 2013.

A desktop review of overflight photographs and satellite imagery was conducted to try and identify and delineate all potential wetland areas along the proposed pipeline corridor. The desktop review identified 55 wetlands (totalling approximately 4.8 km in length), comprising approximately 0.9% of the proposed pipeline corridor. Wetlands crossed by proposed pipeline corridor include 17 basin marshes, 12 riparian marshes, 2 hummock marshes, 5 flat swamps, 6 riparian swamps, 10 basin water and 3 riparian water.

The 2012 and 2013 wetland field surveys were conducted on lands where access was granted and confirmed that 6 wetlands are crossed by the proposed pipeline corridor. Wetlands crossed by the proposed pipeline corridor visited during the 2012 and 2013 ground-based wetland field surveys include one basin marsh, one riparian marsh, two hummock marshes, one basin water and one riparian water. Typical wetland community types documented include seasonal emergent, and deep marsh community types, open water community types, shrubby community types, and mixedwood treed community types. These numbers will be updated following the completion of the 2014 supplemental field program.

Wetland functional assessments were conducted at all wetlands ground-truthed in 2012 and 2013. The results of this assessment identified five wetlands were Low-Moderate Functional Condition and one wetlands were of Low Functional Condition.

It was also determined that two wetlands were associated with two rare ecological community found along the Hope to Burnaby Segment. These rare ecological communities are Blue-listed.

Table 5.8-8 provides a summary of the classes, length of disturbance and percent of proposed pipeline corridor crossed by wetlands along the proposed pipeline corridor in the Hope to Burnaby Segment. Additional information on wetlands along this segment is provided in Section 5.1 of the Wetland Evaluation Technical Report of Volume 5C.

TABLE 5.8-8

SUMMARY OF WETLANDS CROSSED ALONG THE HOPE TO BURNABY SEGMENT

Wetland Class	All Wetlands Crossed by Proposed Pipeline Corridor	Number of Ground-Truthed Wetlands Crossed by Proposed Pipeline Corridor[1]	Approximate Length of Wetland Crossed by Proposed Pipeline Corridor (m)	Percent of Proposed Pipeline Corridor Crossed
Basin Marsh	17	1	1,166	0.1
Riparian Marsh	12	1	1,087	0.1
Hummock Marsh	2	2	185	0.02
Flat Swamp	5	--[2]	529	0.1

TABLE 5.8-8 Cont'd

Wetland Class	All Wetlands Crossed by Proposed Pipeline Corridor	Number of Ground-Truthed Wetlands Crossed by Proposed Pipeline Corridor[1]	Approximate Length of Wetland Crossed by Proposed Pipeline Corridor (m)	Percent of Proposed Pipeline Corridor Crossed
Riparian Swamp	6	--[2]	752	0.1
Basin Water	10	1	653	0.1
Riparian Water	3	1	453	0.05
Total	55	6	4,824	0.5

Notes: 1 Ground-truthing and functional assessments were conducted at wetlands where land access permission was available in 2012 and 2013.

2 A double dash indicates that those particular wetland classes were not ground-truthed in 2012 or 2013.

Traditional Ecological Knowledge

TEK information was not gathered during the wetland field surveys associated with the Hope to Burnaby Segment due the limited amount of field work that was conducted in this area as a result of lack of access.

5.8.4 Burnaby to Westridge Segment

The Burnaby to Westridge Segment is located within one ecozone (*i.e.*, Pacific Maritime) and one ecoregion of Canada (*i.e.*, Lower Mainland) (Agriculture and Agri-Food Canada 2013, Ecological Stratification Working Group 1995); one wetland region of Canada (*i.e.*, Pacific Temperate) (Government of Canada 1986); and one BGC zone of BC (*i.e.*, CWH) (BC MFLNRO 2012, Meidinger and Pojar 1991).

The Burnaby to Westridge Segment does not cross any Migratory Bird Sanctuaries (Environment Canada 2013n), Western Hemisphere Shorebird Reserves (WHSRN 2013) or Ramsar wetlands (Bureau of the Convention on Wetlands 2013).

One IBA, the English Bay and Burrard Inlet IBA (RK 3.2 to RK 3.6), is crossed by the Burnaby to Westridge Segment (Bird Studies Canada and Nature Canada 2012). This sheltered fjord of the Strait of Georgia incorporates a variety of habitats. This IBA was designated for three species of global importance including the western grebe, Barrow's goldeneye and surf scoter, and one species of national importance, the great blue heron. Historically, large numbers of western grebe wintered here, however, due to population decline these numbers have decreased so that often no more than approximately 1% of the global population have been observed. Counts of Barrow's goldeneye have also declined from approximately 4% of the global population utilizing the area in 1990 to about 1.5% in 2000. This IBA also supports on a regular basis at least 1% of the global surf scoter population. A known great blue heron nesting colony is also present within this IBA in the Stanley Park area. The great blue heron population located here has increased since 2001 resulting in approximately 1% of the Canadian population breeding in this area. The English Bay and Burrad Inlet IBA also supports other valuable bird species such a purple martin, pelagic and double-crested cormorants, osprey and bald eagles.

Within BC, the Burnaby to Westridge Segment encounters the DUC Level 2 Priority Landscapes. The Level 2 Priority Landscapes consist of the BC Coastal Areas and Estuaries and the BC Interior (DUC 2013). No DUC conservation sites are crossed by the proposed pipeline corridor (Harrison pers. comm.).

The Burnaby to Westridge Segment does not encounter any protected areas within the Wetland LSA.

Aboriginal Traditional Knowledge

The desktop review did not identify available ATK related to wetlands along the Burnaby to Westridge Segment.

Consultation

The ESA workshops, meetings held with federal, provincial and municipal representatives and community workshops did not provide any information on the presence and characteristics of wetland areas along the Burnaby to Westridge Segment. For more information on other topics raised during these workshops and meetings, see Section 3.0 of this volume and Section 2.0 of the Wetland Evaluation Technical Report Results of Volume 5C.

Field Data Collection

Helicopter reconnaissances along this segment were conducted from September 22 to 23, 2012 and on May 8, 2013. Ground-based field work was not conducted along the Burnaby to Westridge Segment due to lack of land access.

A desktop review of overflight photographs and satellite imagery was conducted to try and identify and delineate all potential wetland areas along the proposed pipeline corridor. The desktop review identified 1 wetland (totalling approximately 79.1 m in length), comprising approximately 0.01% of the proposed pipeline corridor. The wetland crossed by the proposed pipeline corridor is a basin marsh. This number will be updated following the completion of the 2014 supplemental field program.

This area was not ground-truthed in 2012 or 2013 due to the lack of land access. Potential wetland community types documented through the desktop review include seasonal emergent marsh community type.

As this area was not ground-truthed in 2012 or 2013, it is uncertain whether any wetlands associated with rare ecological communities are present.

Table 5.8-9 provides a summary of the classes, length of disturbance and percent of proposed pipeline corridor crossed by wetlands along the proposed pipeline corridor in the Burnaby to Westridge Segment. Additional information on wetlands along this segment, including conservation status, is provided in Section 5.1 of the Wetland Evaluation Technical Report of Volume 5C.

TABLE 5.8-9

SUMMARY OF WETLANDS CROSSED ALONG THE BURNABY TO WESTRIDGE SEGMENT

Wetland Class	All Wetlands Crossed by Proposed Pipeline Corridor	Number of Ground-Truthed Wetlands Crossed by Proposed Pipeline Corridor[1]	Approximate Length of Wetland Crossed by Proposed Pipeline Corridor (m)	Percent of Proposed Pipeline Corridor Crossed
Basin Marsh	1	--[2]	79	0.01
Total	1	--[2]	79	0.01

Notes: 1 Ground-truthing and functional assessments were conducted at wetlands where land access permission was available in 2012 and 2013.

2 A double dash indicates that those particular wetland classes were not ground-truthed in 2012 or 2013.

5.9 Vegetation

This subsection discusses the existing conditions of vegetation in the Vegetation RSA. The indicators selected for this element include vegetation communities of concern, plant species of concern (*i.e.*, vascular plants [those containing a vascular system for transporting fluids] and non-vascular plants [those without a vascular system, including bryophytes {mosses and liverworts}]), lichen species of concern and presence of infestations of provincially-listed weed species and other invasive non-native species identified as a concern. The rationale for the selection of indicators is provided in Section 7.2.9. The potential Project-related effects to vegetation arising from construction and operation of the proposed pipeline and mitigation pertaining to vegetation are discussed in Section 7.2.9. Refer to the Vegetation Technical Report of Volume 5C for additional details on the existing condition of vegetation resources.

This setting discusses the vegetative environment within the Vegetation RSA, which is the area where the direct and indirect influence of other land uses and activities could interact with Project-specific effects and may cause cumulative effects on vegetation. The Vegetation RSA consists of a 2 km wide band generally from the centre of the proposed pipeline corridor centre and facilities (*e.g.*, 1,000 m on both sides of the centre of the proposed pipeline corridor). The spatial boundaries of the Vegetation RSA are shown on Figures 5.9-1 to 5.9-4.

The vegetation surveys were comprised of rare vascular plant surveys, Terrestrial Ecosystem Mapping (TEM) field verification, a weed survey, a targeted survey for rare non-vascular plants and lichens as well as non-vascular collection. Where vegetation communities of concern were observed, the communities were mapped and photographed and their locations were recorded. All listed weeds and non-listed, non-native species were recorded at all locations where they were observed during the survey. Refer to the Vegetation Technical Report of Volume 5C for additional details on field survey methodology.

In order to determine pre-construction vegetation diversity, relative abundance and distribution of vegetation communities of ecological, economic or human importance, vegetation communities in the Vegetation RSA needed to be described using relevant and up-to-date ecological classification and mapping. Ecosite phase and site series variants were mapped for segments in Alberta and BC, respectively. There are no provincial guidelines for mapping ecological units in Alberta. Therefore, the provincial guidelines for mapping ecological units in BC were adopted for the portion of the proposed pipeline corridor in Alberta. In BC, the most relevant and up to date ecological classification system is outlined in the Field Manual for Describing Terrestrial Ecosystems Second Edition (BC Ministry of Forests and Range and BC MOE 2010) and various regional land management handbooks. See the Vegetation Technical Report of Volume 5C for more details on the field guides used in each natural subregion for the Project. Mapping methodology for the Project was developed according to the Standards for TEM in BC (Resources Inventory Committee 1998) and was applied to both the BC and Alberta portions of the Project.

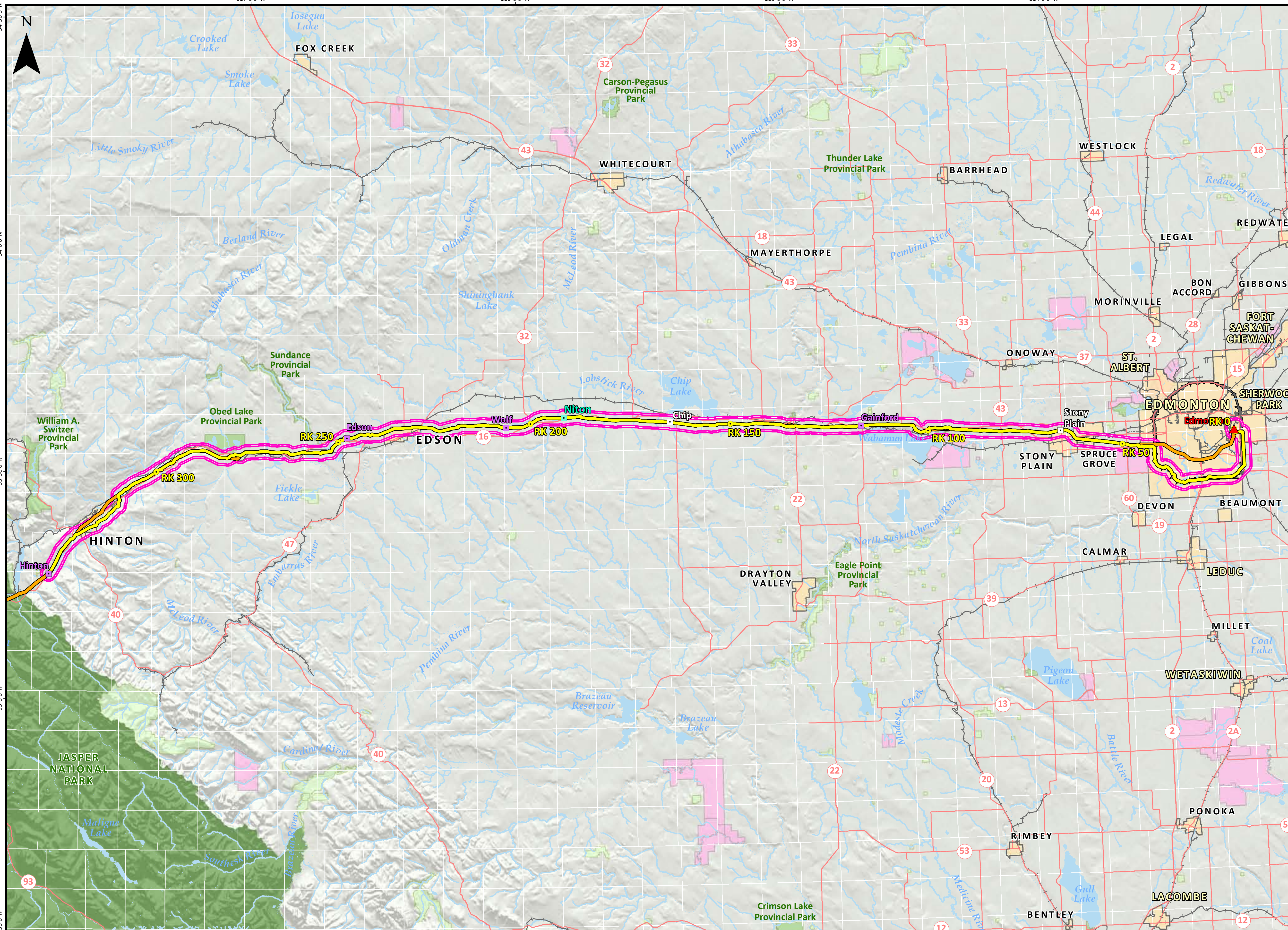
In 2012 and 2013, TEK was gathered and recorded during the vegetation field surveys. During the field surveys, traditional methods of resource procurement were discussed, as well as modern methods currently employed. Seasonality of resource harvesting, species of traditional importance, identification of traditionally harvested plants, description of uses and preparation techniques as well as plant rarity and abundance was also important information shared by the Aboriginal participants. Geographical locations were identified, as were areas that are not used and the reasons why. Potential mitigation measures to reduce any Project-related effects on a resource were also discussed during the vegetation field surveys.

TRANS MOUNTAIN

FIGURE 5.9-1

VEGETATION STUDY AREA BOUNDARIES - EDMONTON TO HINTON

TRANS MOUNTAIN EXPANSION PROJECT



●	Village / Hamlet
	Kilometre Post (KP)
	Reference Kilometre Post (RK)
	Trans Mountain Pipeline (TMPL)
	Trans Mountain Expansion Project Proposed Pipeline Corridor
▲	Terminal
	Pump Station (Pump Addition, Station Modifications and/or Scraper Facilities)
	New Pump Station (Proposed)
	Pump Station (Reactivated)
	Existing Pump Station
	Highway
	Railway
	Vegetation RSA Boundary
	City / Town / District Municipality
	Indian Reserve / Métis Settlement
	Transportation and Utility Corridor (TUC)
	National Park
	Provincial Park
	Protected Area / Natural Area / Provincial Recreation Area / Wilderness Provincial Park / Conservancy Area
	Provincial Boundary

Projection: NAD83 UTM Zone 11N. Routing: Baseline TMPL & Facilities: provided by KMC, 2012; Proposed Pipeline Corridor V6: provided by UPI, Aug. 23, 2013; Transportation: IHS Inc., 2013, BC Forests, Lands and Natural Resource Operations, 2012 & Natural Resources Canada, 2012; Geopolitical Boundaries: Natural Resources Canada, 2003, AltaLIS, 2013, IHS Inc., 2011, BC FLNRO, 2007 & ESRI, 2005; First Nation Lands: Government of Canada, 2013, AltaLIS, 2010 & IHS Inc., 2011; Hydrology: Natural Resources Canada, 2007 & BC Crown Registry and Geographic Base Branch, 2008; Parks and Protected Areas: Natural Resources Canada, 2012, AltaLIS, 2012 & BC FLNRO, 2008; ATS Grid: AltaLIS, 2009; Edmonton TUC: Alberta Infrstructure, 2011; Canadian Hillshade: TERA Environmental Consultants, 2008; US Hillshade: ESRI, 2009.

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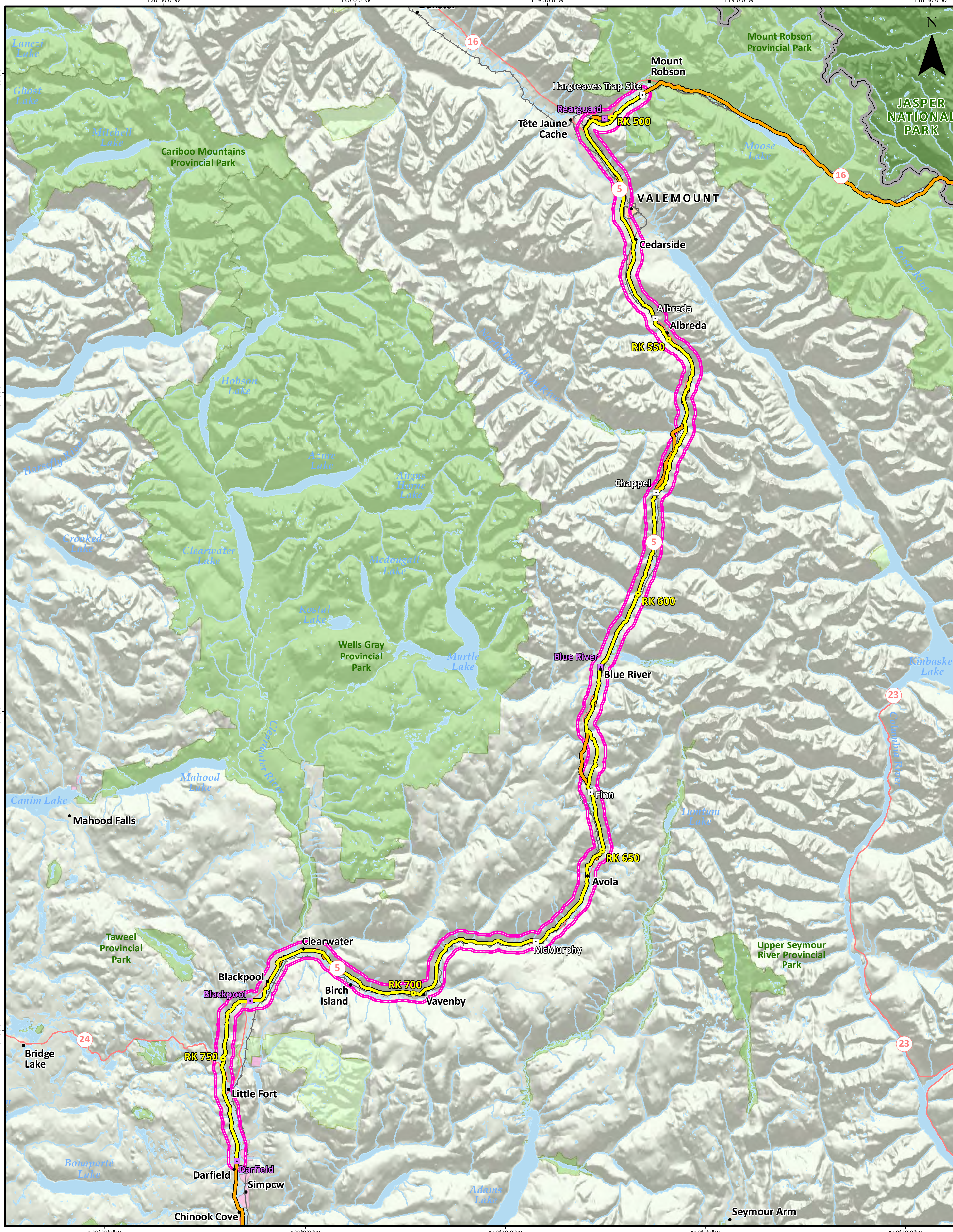

- Village / Hamlet
- Kilometre Post (KP)
- Reference Kilometre Post (RK)
- Existing Trans Mountain Pipeline
- Trans Mountain Expansion Project Proposed Pipeline Corridor
- Terminal
- Pump Station (Pump Addition, Station Modifications and/or Scraper Facilities)
- New Pump Station (Proposed)
- Pump Station (Reactivated)
- Existing Pump Station
- Highway
- Railway
- Vegetation RSA Boundary
- City / Town / District Municipality
- Indian Reserve / Métis Settlement
- National Park
- Provincial Park
- Protected Area / Natural Area / Provincial Recreation Area / Wilderness Provincial Park / Conservancy Area
- Provincial Boundary

Projection: NAD 1983 UTM 11N. Routing: Baseline TMPL & Facilities: provided by KMC, 2012; Proposed Pipeline Corridor V6: provided by UPI, Aug. 23, 2013; Transportation: IHS Inc., 2013, BC Forests, Lands and Natural Resource Operations, 2012 & Natural Resources Canada, 2012; Geopolitical Boundaries: Natural Resources Canada, 2003, AltaLIS, 2013, IHS Inc., 2011, BC FLNRO, 2007 & ESRI, 2005; First Nation Lands: Government of Canada, 2013, AltaLIS, 2010 & IHS Inc., 2011; Hydrology: Natural Resources Canada, 2007 & BC Crown Registry and Geographic Base Branch, 2008; Parks and Protected Areas: Natural Resources Canada, 2012, AltaLIS, 2012 & BC FLNRO, 2008; ATS Grid: AltaLIS, 2009; Edmonton TUC: Alberta Infrstructure, 2011; Canadian Hillshade: TERA Environmental Consultants, 2008; US Hillshade: ESRI, 2009.

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TRANS MOUNTAIN

FIGURE 5.9-2

VEGETATION STUDY AREA BOUNDARIES - HARGREAVES TO DARFIELD

TRANS MOUNTAIN EXPANSION PROJECT

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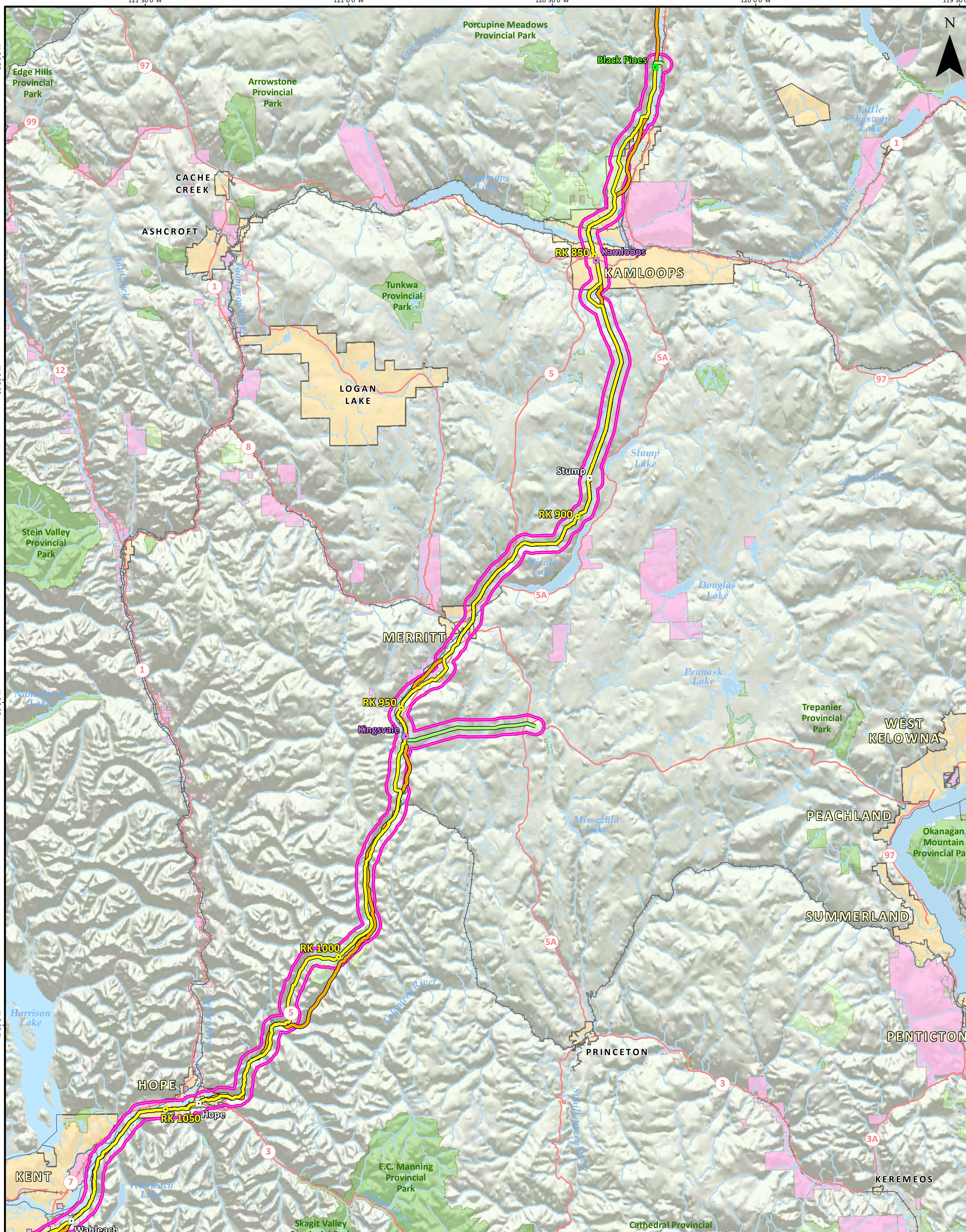
ALL LOCATIONS APPROXIMATE



Legend

- Village / Hamlet
- Kilometre Post (KP)
- Reference Kilometre Post (RK)
- Trans Mountain Pipeline (TMPL)
- Trans Mountain Expansion Project Proposed Pipeline Corridor
- Proposed Power Line
- Terminal
- Pump Station (Pump Addition, Station Modifications and/or Scraper Facilities)
- New Pump Station (Proposed)
- Pump Station (Reactivated)
- Existing Pump Station
- Highway
- Railway
- Vegetation RSA Boundary
- City / Town / District Municipality
- Indian Reserve / Métis Settlement
- National Park
- Provincial Park
- Protected Area / Natural Area / Provincial Recreation Area / Wilderness Provincial Park / Conservancy Area
- Provincial Boundary

Projection: NAD 1983 UTM 10N. Routing: Baseline TMPL & Facilities: provided by KMC, 2012; Proposed Pipeline Corridor V6: provided by UPI, Aug. 23, 2013; Transportation: IHS Inc., 2013, BC Forests, Lands and Natural Resource Operations, 2012 & Natural Resources Canada, 2012; Geopolitical Boundaries: Natural Resources Canada, 2003, AltaLIS, 2013, IHS Inc., 2011, BC FLNRO, 2007 & ESRI, 2005; First Nation Lands: Government of Canada, 2013, AltaLIS, 2010 & IHS Inc., 2011; Hydrology: Natural Resources Canada, 2007 & BC Crown Registry and Geographic Base Branch, 2008; Parks and Protected Areas: Natural Resources Canada, 2012, AltaLIS, 2012 & BC FLNRO, 2008; ATS Grid: AltaLIS, 2009; Edmonton TUC: Alberta Infrstructure, 2011; Canadian Hillshade: TERA Environmental Consultants, 2008; US Hillshade: ESRI, 2009.

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TRANS MOUNTAIN

FIGURE 5.9-3

VEGETATION STUDY AREA BOUNDARIES - BLACK PINES TO HOPE

TRANS MOUNTAIN EXPANSION PROJECT

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DRAWN: AJS	CHECKED: TGG	DESIGN: TGG

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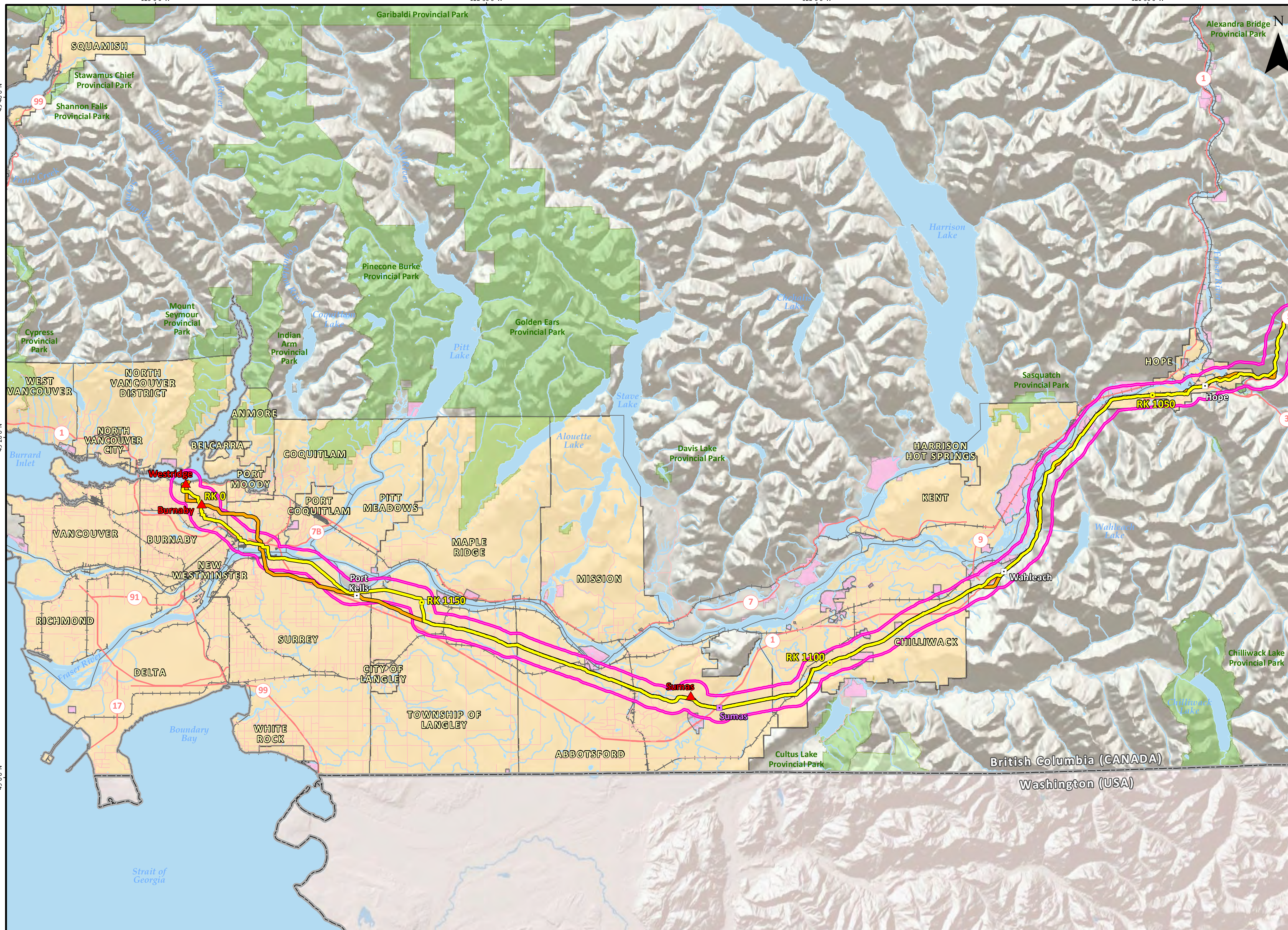
ALL LOCATIONS APPROXIMATE

TRANS MOUNTAIN

FIGURE 5.9-4

VEGETATION STUDY AREA BOUNDARIES - HOPE TO WESTRIDGE

TRANS MOUNTAIN EXPANSION PROJECT



- Kilometre Post (KP)
- Reference Kilometre Post (RK)
- Trans Mountain Pipeline (TMPL)
- Trans Mountain Expansion Project Proposed Pipeline Corridor
- Terminal
- Pump Station (Pump Addition, Station Modifications, and/or Scraper Facilities)
- New Pump Station (Proposed)
- Pump Station (Reactivated)
- Existing Pump Station
- Highway
- Railway
- Vegetation RSA Boundary
- City / Town / District Municipality
- Indian Reserve / Métis Settlement
- National Park
- Provincial Park
- Protected Area / Natural Area / Provincial Recreation Area / Wilderness Provincial Park / Conservancy Area
- Provincial Boundary
- International Boundary

Projection: NAD83 UTM Zone 10N. Routing: Baseline TMPL & Facilities: provided by KMC, 2012; Proposed Pipeline Corridor V6: provided by UPI, Aug. 23, 2013; Transportation: IHS Inc., 2013, BC Forests, Lands and Natural Resource Operations, 2012 & Natural Resources Canada, 2012; Geopolitical Boundaries: Natural Resources Canada, 2003, AltaLIS, 2013, IHS Inc., 2011, BC FLNRO, 2007 & ESRI, 2005; First Nation Lands: Government of Canada, 2013, AltaLIS, 2010 & IHS Inc., 2011; Hydrology: Natural Resources Canada, 2007 & BC Crown Registry and Geographic Base Branch, 2008; Parks and Protected Areas: Natural Resources Canada, 2012, AltaLIS, 2012 & BC FLNRO, 2008; ATS Grid: AltaLIS, 2009; Edmonton TUC: Alberta Infrstructure, 2011; Canadian Hillshade: TERA Environmental Consultants, 2008; US Hillshade: Copyright:© 2013 Esri.

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5.9.1 Overview

5.9.1.1 Edmonton to Hinton Segment

The Edmonton to Hinton Segment is located in five natural subregions within four natural regions in Alberta. This pipeline segment encounters the Central Parkland Natural Subregion within the Parkland Natural Region, the Dry Mixedwood and Central Mixedwood Natural Subregions within the Boreal Forest Natural Region, the Lower Foothills Natural Subregion within the Foothills Natural Region and the Montane Natural Subregion within the Rocky Mountain Natural Region (Natural Regions Committee 2006a).

The Central Parkland Natural Subregion occupies over 50,000 km² of land and most of these lands are under cultivation. Undulating till plains and hummocky uplands dominate the landscape. Plains rough fescue dominates the vegetation communities in the southern and eastern areas of the subregion with small trembling aspen-dominated communities occurring in more moist habitats. The northern and western parts of the subregion are composed of trembling aspen forest with grasslands restricted to the driest areas (Natural Regions Committee 2006a).

The Dry Mixedwood Natural Subregion is the most southern and the warmest of the Boreal Forest Subregions in Alberta. Trembling aspen forests with understories dominated by prickly rose, low-bush cranberry, beaked hazelnut and Canada buffaloberry are typical of the uplands. Treed, shrubby or sedge-dominated fens are common in wet areas. Jack pine typically dominates dry, well-drained areas (Natural Regions Committee 2006a).

The Central Mixedwood Natural Subregion is the largest natural subregion in Alberta and is characterized by upland forests and wetlands on level to gently undulating plains. Upland forests are a mosaic of trembling aspen, mixedwood and white spruce. Jack pine stands occur on coarser materials. Wetlands are often extensive and are dominated by black spruce fens and bogs (Natural Regions Committee 2006a).

Natural landscapes in the Lower Foothills Natural Subregion are characterized by rolling, till-covered plateaus forested by mesic, closed canopy mixed stands of trembling aspen, lodgepole pine, white spruce and balsam poplar (Natural Regions Committee 2006a).

Vegetation communities in the Montane Natural Subregion are mainly comprised of closed forest communities dominated by lodgepole pine, Douglas-fir, trembling aspen and white spruce. Deciduous forests occur on fluvial fans, terraces and flood plains. Open grasslands occur on dry and exposed sites, and are dominated by various grasses including June grass, northern wheatgrass, western wheatgrass, Kentucky bluegrass and slender wheatgrass (Natural Regions Committee 2006a).

The Edmonton to Hinton Segment is located within five provincial Environmentally Significant Areas (70, 99, 441, 442 and 690) (Fiera Biological Consulting Ltd. 2009). ATPR defines Environmentally Significant Areas as being important to the long-term maintenance of biological diversity, soil, water or other natural processes, at multiple spatial scales and/or areas that contain rare or unique elements or that include elements that may require special management consideration due to their conservation needs. However, ATPR states that Environmentally Significant Areas do not represent government policy and do not necessarily require legal protection. They are intended to be an information tool to help inform land use planning and policy at local, regional and provincial scales. Further details regarding these Environmentally Significant Areas are provided in the Vegetation Technical Report of Volume 5C.

There were six protected areas identified within the Vegetation RSA along the Edmonton to Hinton Segment: Strathcona Science Provincial Park; Wabamun Lake Provincial Park; Nojack Provincial Recreation Area; Yates Natural Area; Hornbeck Creek Provincial Recreation Area; and Obed Lake Provincial Park (ATPR 2012, NRCan 2013b). A summary of vegetation communities traversed by this segment is detailed in the TEM Report in Appendix C of the Vegetation Technical Report of Volume 5C.

Land use along the Edmonton to Hinton Segment is a mix of native land use (49% of the length of the segment) and agricultural and anthropogenic (*e.g.*, recreational, cleared or disturbed) (44% of the length of the segment). The dominant native vegetation land use traversed by the route is treed (46%) with some treed pasture (3%). The dominant agricultural land uses are hay (20%), cultivation (12%) and tame pasture (10%). Approximately 7% of this segment was not surveyed for land use, some of which was due to access issues. The Project parallels existing disturbance for approximately 92% of the length in this segment. Land use and length of new cut for this segment are further discussed in Section 5.0 of Volume 5B.

Vegetation surveys in this segment were conducted from May 17 to 28 (TEM), June 7 to 13 and 18 to 29 (early-season), July 16 to 22 and August 3 to 14, 2013 (late-season).

5.9.1.2 Hargreaves to Darfield Segment

The Hargreaves to Darfield Segment is located within three BGC zones. The first zone, the ICH Zone, has the highest diversity of tree species of any zone in BC. Western redcedar and western hemlock dominate mature climax forests, while lodgepole pine, trembling aspen and paper birch are common in all areas. Wetlands are infrequent due to the mountainous terrain throughout most of the zone. Where they do occur, wetlands are usually small transitional bogs, fens and skunk cabbage swamps. Riparian and lakeshore marshes tend to be more common (Meidinger and Pojar 1991). The proposed pipeline corridor crosses five subzones in the ICH BGC Zone: Moist Mild (mm); Wells Gray Wet Cool (wk1); Mica Very Wet Cool (vk1); Thompson Moist Warm (mw3); and North Thompson Dry Warm (dw3).

The SBS BGC Zone dominates the central interior of BC. The climate in this zone is one of extremes; the winter is severe and snowy, and the summers are relatively warm and moist. However, the winters are slightly shorter and the growing season is slightly longer than those of other boreal zones. The zone is characterized by upland coniferous forests of subalpine fir and hybrid white spruce. Major streams and rivers are bordered by alluvial forests that are dominated by black cottonwood with an occasional spruce. Wetlands are common and include sedge marshes, shrub and tree dominated fens, treed swamps and bogs (Meidinger and Pojar 1991). The proposed pipeline corridor crosses one subzone in the SBS BGC Zone, the McLennan Dry Hot (dh1).

The landscape of the IDF BGC Zone consists largely of open to closed, mature forests of Douglas-fir. Pure Douglas-fir climax stands are common. Mixed stands of Douglas-fir and lodgepole pine are often present in areas frequently affected by fire. Extensive grassland communities also occur in parts of the zone due to a combination of edaphic and topographic conditions and fire history. Non-forested wetlands are common in this zone and include marshes, sedge and shrub fens, shrub-carrs and saline meadows. Willow swamps often occur along small streams and drainages (Meidinger and Pojar 1991). The proposed pipeline corridor crosses seven subzones in the IDF BGC Zone: the Thompson Moist Warm (mw2); the Thompson Moist Warm – Steep South phase (mw2b); the Thompson Very Dry Hot (xh2); the Thompson Very Dry Hot – Grassland phase (xh2a); the Okanagan Very Dry Hot (xh1); the Thompson Dry Cool (dk1); and the Cascade Dry Cool (dk2).

There were 12 protected areas identified within the Vegetation RSA along the Hargreaves to Darfield Segment. The proposed pipeline corridor crosses two of these: Finn Creek Provincial Park from RK 638.7 to RK 639.3; and North Thompson River Provincial Park from RK 725.5 to RK 725.9 (BC MFLNRO 2008b,c, NRCan 2013b). The other 10 protected areas located within the Vegetation RSA, but not crossed by the corridor, include Mount Robson Provincial Park, Rearguard Falls Provincial Park, Jackman Flats Provincial Park, Pyramid Creek Falls Provincial Park, Blue River Black Spruce Provincial Park, Blue River Pine Provincial Park, Wire Cache Provincial Park, Eakin Creek Canyon Provincial Park, North Thompson Islands Provincial Park and Chu Chua Cottonwood Provincial Park (BC MFLNRO 2008b,c, NRCan 2013b). Within the Vegetation RSA, this segment encounters 169 legal Old Growth Management Areas (OGMAs) and 40 non-legal OGMAs (BC MFLNRO 2009a,b). Of these OGMAs, 32 legal and 7 non-legal OGMAs are crossed by the proposed pipeline corridor. A summary of vegetation communities traversed by this segment of the Project is detailed in the TEM Report in Appendix C of the Vegetation Technical Report of Volume 5C.

The Hargreaves to Darfield Segment is dominated by native vegetation and the predominant native vegetation type is treed (85% of the length of the segment) with some treed pasture (1%). The dominant agricultural land uses are tame pasture (7%) and hay (4%), with some anthropogenic land use (*e.g.*, recreational, disturbed). Less than 1% of this segment was not surveyed for land use due to access issues. The Project parallels existing disturbance for approximately 88% of the length in this segment. Land use and length of new cut for this segment are further discussed in Section 5.0 of Volume 5B.

Vegetation surveys were conducted from May 6 to 13 (TEM), June 17 to 30 (early-season) and August 1 to 14, 2013 (late-season).

5.9.1.3 Black Pines to Hope Segment

The Black Pines to Hope Segment crosses seven different BGC zones. One zone, the IDF BGC Zone, is described above in Section 5.9.1.2 and the other six zones are described below.

The PP BGC Zone is the driest and has the warmest summer temperatures of all the forested zones in BC. The forests in this zone are dominated by very open PP stands with an understory consisting largely of bluebunch wheatgrass. Grasslands are commonly scattered throughout the zone. Fires have played an important role in the ecology of the zone. Alkaline ponds can occur in depressional areas (Meidinger and Pojar 1991). The proposed pipeline corridor crosses one Subzone in the PP BGC Zone, the Thompson Very Dry Hot (xh2).

The BG BGC Zone is an arid zone largely characterized by grasslands dominated by BGs, such as bluebunch wheatgrass, and shrubs, such as big sagebrush, are also present. The vegetation reflects minor changes in topography, aspect and drainage. Patterns of native plant communities are poorly understood because of heavy livestock grazing throughout the zone, which has lead to an increased abundance of unpalatable or weedy vascular species. Small patches of trembling aspen can occur on wetter areas at higher elevations. Wetlands are common throughout the zone and include shrub dominated habitats, marshes with shallow open water and saline meadows (Meidinger and Pojar 1991). The proposed pipeline corridor crosses two subzones in the BG BGC Zone, the Nicola Very Dry Warm (xw1) and the Thompson Very Dry Hot (xh2).

The MS BGC Zone is characterized by climax stands of hybrid white spruce and subalpine fir. Extensive, young and maturing seral stands of lodgepole pine are common in areas following wildfires. Trembling aspen occurs throughout the zone. Wetland areas are uncommon due to mountainous topography, but where they do occur they are usually shrub fens (Meidinger and Pojar 1991). The proposed pipeline corridor crosses two Subzones in the MS BGC Zone, the South Thompson Dry Mild (dm2) and the Cascade Moist Warm (mw1).

The CWH is, on average, the wettest BGC zone in BC. Western hemlock is the most common tree species in forested areas. Western redcedar occurs throughout the zone and Douglas-fir is abundant in drier areas of the zone. Shore pine is common on very dry or very boggy areas throughout the zone. Sitka spruce occurs over a wide variety of habitats north of Vancouver Island but is restricted to flood plains and exposed beaches in the south (Meidinger and Pojar 1991). The proposed pipeline corridor crosses four subzones in the CWH BGC Zone: the Southern Moist Submaritime (ms1); the Southern Dry Submaritime (ds1); the Dry Maritime (dm); and the Eastern Very Dry Maritime (xm1).

The ESSF BGC Zone is the uppermost (highest elevation) zone in southern interior BC and is characterized by mountainous terrain. The climate is generally cool with a short growing season and a long winter. As a result, most of the precipitation (50-70%) is in the form of snow. Engelmann spruce and subalpine fir are the dominant climax tree species. Engelmann spruce typically dominates the canopy of mature stands with subalpine fir being more common in the understory. In drier areas or areas affected by fire, lodgepole pine may be dominant (Meidinger and Pojar 1991). The proposed pipeline corridor crosses one subzone in the ESSF BGC Zone, the Moist Warm (mw).

The MH BGC Zone occurs at relatively high elevations (400-1,000 m) and is characterized by short, cool summers and long, cool, wet winters, with heavy snow cover for several months (Meidinger and Pojar 1991). The most common tree species in the zone are MH, amabilis fir and yellow-cedar, although they do not grow in continuous stands and are largely confined to lower elevations. Other characteristics of the MH BGC Zone are the high occurrence of shrubs such as blueberries and copperbush, the relatively low occurrence of herbs and the dominance of bryophytes (Meidinger and Pojar 1991). The proposed pipeline corridor crosses one subzone in the MH BGC Zone, the Leeward Moist Maritime (mm2).

The Black Pines to Hope Segment encounters seven protected areas within the Vegetation RSA. The proposed pipeline corridor crosses two of these, the Lac du Bois Grasslands Protected Area from RK 829.0 to RK 836.8 and RK 842.4 to RK 843.9, as well as the Coquihalla Summit Recreation Area from

RK 992.5 to RK 1005.1 (BC MFLNRO 2008b,c, NRCan 2013b). The other five protected areas located within the Vegetation RSA are North Thompson Oxbows Jensen Island Provincial Park, McQueen Creek Ecological Reserve, Coldwater River Provincial Park, Coquihalla River Provincial Park and Coquihalla Canyon Provincial Park (BC MFLNRO 2008b,c, NRCan 2013b). Within the Vegetation RSA, this segment encounters 33 legal OGMAs and 67 non-legal OGMAs (BC MFLNRO 2009a,b). There are 9 legal OGMAs and 19 non-legal OGMAs crossed by the proposed pipeline corridor. A summary of vegetation communities traversed by this segment is detailed in the TEM Report in Appendix C of the Vegetation Technical Report of Volume 5C.

The Black Pines to Hope Segment is dominated by native vegetation (70% of the length of the segment) and the predominant native vegetation type is treed (54%) with some native grassland (9%) and some treed pasture (7%). The dominant agricultural land uses are tame pasture (10%) and hay (2%), with anthropogenic land use (*e.g.*, disturbed) making up 4%. Approximately 13% of this segment was not surveyed for land use due to access issues. The Project parallels existing disturbance for approximately 86% of the length in this segment. Land use and length of new cut for this segment are further discussed in Section 5.0 of Volume 5B.

Vegetation surveys in this segment were conducted from June 3 to 9 (TEM), May 23 to June 3 (early-season), July 15 to 25 and August 26 to 29, 2013 (late-season).

5.9.1.4 Hope to Burnaby Segment

The Hope to Burnaby Segment crosses only one BGC zone, the CWH BGC Zone in BC, which was described above in Section 5.9.1.3.

The Hope to Burnaby Segment encounters four protected areas within the Vegetation RSA. The proposed pipeline corridor crosses three of these, F.H. Barber Provincial Park from RK 1062.8 to RK 1062.8, Cheam Lake Wetlands Regional Park from RK 1079.9 to RK 1080.0 and from RK 1080.1 to RK 1080.4 as well as Surrey Bend Regional Park from RK 1160.5 to RK 1163.7 (BC MFLNRO 2008b,c, NRCan 2013b). The other protected area within the Vegetation RSA is Bridal Veil Falls Provincial Park. Within the Vegetation RSA, this segment encounters seven legal OGMAs and does not encounter any non-legal OGMAs (BC MFLNRO 2009a,b). One legal OGMA is crossed by the proposed pipeline corridor. The proposed pipeline corridor does not cross any non-legal OGMAs. A summary of vegetation communities traversed by this segment of the Project is detailed in the TEM Report in Appendix C of the Vegetation Technical Report of Volume 5C.

Land use along the Hope to Burnaby Segment is predominantly native land use (52% of the length of the segment) with anthropogenic land use making up 36% of the length of the proposed pipeline corridor. Native land use is composed of treed areas (51%) and some treed pasture (1%). The dominant agricultural land uses are cultivation (11%), tame pasture (4%) and hay (4%), with anthropogenic land use (*e.g.*, recreational, disturbed land [*e.g.*, residential, roads, greenhouses, farm yards, blueberry cultivation]) making up 15% of the length of the segment. Approximately 12% of this segment was not surveyed for land use, primarily due to access issues. The Project parallels existing disturbance for approximately 99% of the length in this segment. Land use and length of new cut for this segment are further discussed in Section 5.0 of Volume 5B.

Vegetation surveys in this segment were conducted from April 11 to 19 (TEM), May 7 to 10 and May 22 to 23 (early-season), and July 13 to 15 and August 19 to 23, 2013 (late-season).

5.9.1.5 Burnaby to Westridge Segment

The Burnaby to Westridge Segment crosses only one BGC zone, the CWH BGC Zone in BC, which is described above in Section 5.9.1.3.

The Burnaby to Westridge Segment does not encounter any protected areas within the Vegetation RSA (BC MFLNRO 2008b,c, NRCan 2013b). This segment does not encounter any legal or non-legal OGMAs (BC MFLNRO 2009a,b). A summary of vegetation communities traversed by this segment of the Project is detailed in the TEM Report in Appendix C of the Vegetation Technical Report of Volume 5C.

Land use and length of new cut for this segment are further discussed in Section 5.0 of Volume 5B. Due to lack of land access in 2013, vegetation surveys were not conducted on the Burnaby to Westridge Segment of the proposed pipeline corridor. Vegetation surveys on this segment are expected to be conducted in 2014.

5.9.2 Vegetation Communities of Concern

The vegetation communities of concern indicator addresses rare ecological communities as identified by the Alberta Conservation Information Management System (ACIMS), the BC Identified Wildlife Management Strategy (IWMS) and the BC CDC, as well as the vegetation communities identified as the most impacted by the Project (as determined through TEM). In addition, this indicator addresses vegetation communities identified as of concern during consultation, specifically grassland communities within the BG BGC Zone. This indicator addresses the NEB *Filing Manual* requirement to consider avoidance of sensitive or rare communities. Potential rare ecological community locations along the proposed pipeline corridor are identified on Figure 2 in the Vegetation Technical Report of Volume 5C and shown on the Environmental Alignment Sheets of Volume 6E.

5.9.2.1 Edmonton to Hinton Segment

Vegetation surveys were conducted along those locations of the Edmonton to Hinton Segment that were representative of the different vegetation types in the area, as well as those with a high potential to support vegetation communities of concern. The survey methodology used and complete results of the 2013 vegetation surveys are provided in the Vegetation Technical Report of Volume 5C. A list of rare communities that have the potential to occur within the Vegetation RSA of this proposed pipeline segment is included in Appendix B of the Vegetation Technical Report of Volume 5C.

A search of the ACIMS database identified no previously recorded occurrences of rare ecological communities within the Vegetation RSA in this segment (ACIMS 2013). See the Vegetation Technical Report of Volume 5C for more details. Five potentially rare ACIMS-listed ecological communities were observed during the 2013 vegetation surveys (see Table 5.9-1).

TABLE 5.9-1

VEGETATION COMMUNITIES OF CONCERN OBSERVED ALONG THE EDMONTON TO HINTON SEGMENT

Common Name	Scientific Name	Provincial Rank[1]	Observed Number of Occurrences
beaked sedge marsh[2]	*Carex rostrata* marsh (needs confirmation)	S3?	1
beaked willow - red osier dogwood community	*Salix bebbiana - Cornus stolonifera* community	S3?	1
white birch – stiff club-moss community	*Betula papyrifera – Lycopodium annotinum* community	S2?	3

Notes: 1 Provincial (S) ratings range from S1 (five or fewer occurrences or very few remaining hectares) to S5 (demonstrably secure, though it may be quite rare in parts of its range, especially at the periphery). Ranks may be combined (*e.g.*, S1S2). This indicates a larger margin of error than ranks assigned a "?" qualifier. Ratings that are not of concern (4-5) are not included.

S1 = Critically Imperilled: because of extreme rarity or because of some factor(s) making it especially vulnerable to extirpation. Typically five or fewer occurrences or very few remaining individuals (< 1,000).

S2 = Imperilled: because of rarity or because of some factor(s) making it very vulnerable to extirpation. Typically 6-20 occurrences or few remaining individuals (1,000-3,000).

S3 = Vulnerable: because rare and uncommon, or found in a restricted range (even if abundant at some locations), or because of other factors making it vulnerable to extirpation. Typically 21-100 occurrences or between 3,000 and 10,000 individuals.

S#? = Inexact numeric rank: denotes inexact numeric rank.

? = Element is not yet ranked (*i.e.*, S?), or has an inexact numerical rank (*e.g.*, S3?).

2 Potentially observed community. The non-vascular species collected require confirmation before community can be confirmed.

Communities most affected were selected as those ecosites in Alberta with more than 2.75% of the total ecosite located on the Footprint, based on the distribution of values between 0.5% and 6.4%. The total area of the ecosites within the Vegetation RSA may not be large; most of the ecosites occupy less than 100 ha of the Vegetation RSA, while the Vegetation RSA in Alberta occupies approximately 50,000 ha.

However, these ecosites are disproportionately located along the Footprint (more than 2.75% of their total area within the Vegetation RSA is located along the Footprint), meaning that these ecosites will be more affected by the Project than other ecosites within the Vegetation RSA.

The most affected communities in Alberta are ecosites varying from nutrient poor to medium with acidic soil conditions, dominated by lodgepole pine, black spruce, common Labrador tea, bog cranberry and common blueberry (Labrador tea-mesic), to alkaline nutrient rich fens characterized by Tamarack, dwarf birch or willow and sedges. The ecosite most affected by the Project is a marsh ecosite found along shorelines of water bodies and riparian zones. The most affected communities in Alberta are discussed in detail in Section 7.2.9.6.

5.9.2.2 Hargreaves to Darfield Segment

Vegetation surveys were conducted along those locations of the Hargreaves to Darfield Segment that were representative of the different vegetation types in the area, as well as those with a high potential to support vegetation communities of concern. The survey methodology used and the complete results of the summer 2013 vegetation surveys are provided in the Vegetation Technical Report of Volume 5C. A list of rare communities that have the potential to occur within the Vegetation RSA of this proposed pipeline segment is included in Appendix B of the Vegetation Technical Report of Volume 5C.

A search of the BC CDC identified one rare ecological community within the Vegetation RSA in this segment (BC CDC 2013b). The previously observed rare ecological community is a lodgepole pine - velvet-leaved blueberry – *Cladonia* lichens community (ranked S2S3, Blue). See the Vegetation Technical Report of Volume 5C for more details. There were 25 potentially rare, Blue-listed BC CDC-listed ecological communities either observed during the 2013 vegetation surveys or identified using TEM (see Table 5.9-2).

TABLE 5.9-2

**VEGETATION COMMUNITIES OF CONCERN
OBSERVED ALONG THE HARGREAVES TO DARFIELD SEGMENT**

Common Name	Scientific Name	Provincial Rank[1]	Provincial Listing[2]	Observed Number of Occurrences
Bebb's willow/bluejoint reedgrass community	*Salix bebbiana/Calamagrostis canadensis* community	S3	Blue	4
common cattail marsh	*Typha latifolia* marsh	S3	Blue	7
hard-stemmed bulrush deep marsh	*Schoenoplectus acutus* deep marsh	S3	Blue	1
lodgepole pine - velvet-leaved blueberry – *Cladonia* lichens community	*Pinus contorta - Vaccinium myrtillus – Cladonia* spp. community	S2S3	Blue	7
scrub birch/water sedge community	*Betula nana/Carex aquatilis* community	S3	Blue	1
Sitka willow – Pacific willow/skunk cabbage community	*Salix sitchensis – Salix lasiandra* var. *Lasiandra/Lysichiton americanus* community	S2	Red	1
swamp horsetail – beaked sedge community	*Equisetum fluviatile – Carex utriculata* community	S3	Blue	3
western redcedar – paper birch/oak fern community	*Thuja plicata – Betula/Gymnocarpium dryopteris* community	S3?	Blue	1

Notes: 1 Provincial (S) ratings range from S1 (five or fewer occurrences or very few remaining hectares) to S5 (demonstrably secure, though it may be quite rare in parts of its range, especially at the periphery). Ranks may be combined (*e.g.*, S1S2). This indicates a larger margin of error than ranks assigned a "?" qualifier. Ratings that are not of concern (4-5) are not included.

S2 = Imperilled: because of rarity or because of some factor(s) making it very vulnerable to extirpation. Typically 6-20 occurrences or few remaining individuals (1,000-3,000).

S3 = Vulnerable: because rare and uncommon, or found in a restricted range (even if abundant at some locations), or because of other factors making it vulnerable to extirpation. Typically 21-100 occurrences or between 3,000 and 10,000 individuals.

S#S# = Range Rank: a numeric range rank (*e.g.*, S2S3) is used to indicate the range of uncertainty about the exact status of the element.

S#? = Inexact numeric rank: denotes inexact numeric rank.

? = Element is not yet ranked (*i.e.*, S?), or has an inexact numerical rank (*e.g.*, S3?).

2 Red-listed refers to a species that is Extirpated, Endangered or Threatened in BC. Blue-listed refers to a species of Special Concern (formerly vulnerable) in BC.

Communities most affected were selected as those BGC subzone variants in BC whose total area (ha) on the Footprint, when compared to the BGC subzone variant total area (ha) in the Vegetation RSA, is more than 2.75% of the total community. Communities most affected were selected as those with more than 2.75% of the total community located on the Footprint, based on the distribution of values between 0.05% and 3.75%. These BGC subzone variants are disproportionately located along the Footprint (more than 2.75% of their total area within the Vegetation RSA is located along the Footprint), meaning that these variants will be more affected by the Project than other variants within the Vegetation RSA.

The most affected communities in BC are the McLennan Dry Hot Sub Boreal Spruce (SBSdh1) variant, the Cascade Moist Warm MS (Msmw1) variant and the Moist Warm ESSF (ESSFmw) variant. The McLennan Dry Hot Sub Boreal Spruce community only occurs along the Hargreaves to Darfield Segment. This community is characterized by seral stands of lodgepole pine, hydrid white spruce and Douglas-fir with thimbleberry, birch-leaved spirea, black huckleberry and falsebox common in the understory (Lloyd *et al.* 2005). The most affected communities in BC are discussed in detail in Section 7.2.9.6.

5.9.2.3 Black Pines to Hope Segment

Vegetation surveys were conducted along those locations of the Black Pines to Hope Segment that were representative of the different vegetation types in the area, as well as those with a high potential to support vegetation communities of concern. The survey methodology used and the complete results of the 2013 vegetation surveys are provided in the Vegetation Technical Report of Volume 5C. A list of rare communities that have the potential to occur within the Vegetation RSA of this proposed pipeline segment is included in Appendix B of the Vegetation Technical Report of Volume 5C.

During consultation, grassland communities within the BG BGC Zone in the Kamloops region were also identified as communities of concern. The proposed pipeline corridor intersects the BG BGC Zone at a few locations in the Black Pines to Hope Segment, while avoiding it for most of the pipeline length. The BG BGC Zone is intersected for a total of approximately 35 km. A search of the BC CDC identified no previously observed rare ecological communities within the Vegetation RSA in this segment (BC CDC 2013b). Fifteen potentially rare (Red and Blue-listed) BC CDC-listed ecological communities were either observed during the 2013 vegetation surveys or identified using TEM (see Table 5.9-3). One of these communities, the western redcedar – Sitka spruce/skunk cabbage community, is listed under the BC IWMS.

TABLE 5.9-3

VEGETATION COMMUNITIES OF CONCERN IN THE BLACK PINES TO HOPE SEGMENT

Common Name	Scientific Name	Provincial Rank[1]	Provincial Listing[2]	Observed Number of Occurrences
amabilis fir – western redcedar/devil's club moist submaritime community	*Abies amabilis – Thuja plicata/Oplopanax horridus* moist submaritime community	S3	Blue	2
big sagebrush/bluebunch wheatgrass community	*Artemisia tridentata/Pseudoregneria spicata* community	S2	Red	2
common cattail marsh	*Typha latifolia* marsh	S3	Blue	1
Douglas-fir/common snowberry – Saskatoon community	*Pseudotsuga menziesii/Symphoricarpus albus – Amelanchier alnifolia* community	S2	Red	2
Douglas-fir – ponderosa pine/pinegrass community	*Pseudotsuga menziesii/Pinus ponderosa/Calamagrostis rubescens* community	S3	Blue	2
Douglas-fir – ponderosa pine/snowbrush community	*Pseudotsuga menziesii/Pinus ponderosa/Ceanothus velutinus* community	S3	Blue	1
hybrid white spruce – Douglas-fir – subalpine fir community[3]	*Picea engelmannii x glauca – Pseudotsuga menziesii – Abies lasiocarpa* community	Unknown – unique community	Unknown	1
narrow-leaf willow shrubland	*Salix exigua* shrubland	S2	Red	3
western redcedar – Douglas-fir/vine maple community	*Thuja picata – Pseudotsuga menziesii/Acer circinatum* community	S2S3	Blue	1

TABLE 5.9-3 Cont'd

Notes: 1 Provincial (S) ratings range from S1 (five or fewer occurrences or very few remaining hectares) to S5 (demonstrably secure, though it may be quite rare in parts of its range, especially at the periphery). Ranks may be combined (*e.g.*, S1S2). This indicates a larger margin of error than ranks assigned a "?" qualifier. Ratings that are not of concern (4-5) are not included.

S2 = Imperilled: because of rarity or because of some factor(s) making it very vulnerable to extirpation. Typically 6-20 occurrences or few remaining individuals (1,000-3,000).

S3 = Vulnerable: because rare and uncommon, or found in a restricted range (even if abundant at some locations), or because of other factors making it vulnerable to extirpation. Typically 21-100 occurrences or between 3,000 and 10,000 individuals.

2 Red-listed refers to a species that is Extirpated, Endangered or Threatened in BC. Blue-listed refers to a species of Special Concern in BC.

3 Potentially observed community. The species collected and description require confirmation before the community can be confirmed.

The most affected communities in BC are the McLennan Dry Hot Sub Boreal Spruce (SBSdh1) variant, the Cascade Moist Warm MS (Msmw1) variant and the Moist Warm ESSF (ESSFmw) variant. The Cascade Moist Warm MS variant and the Moist Warm ESSF variant occur only along the Black Pines to Hope Segment. The Cascade variant is characterized by seral stands of lodgepole pine, hydrid white spruce and subalpine fir with thimbleberry, birch-leaved spirea, black huckleberry and falsebox common in the understory. The ESSFmw variant is dominated by Englemann spruce and ambilis with white-flowered rhododendron, sitka valerian and black huckleberry common in the understory (Lloyd *et al*. 1990). The most affected communities in BC are discussed in detail in Section 7.2.9.6.

5.9.2.4 Hope to Burnaby Segment

Vegetation surveys were conducted along those locations of the Hope to Burnaby Segment that were representative of the different vegetation types in the area, as well as those with a high potential to support vegetation communities of concern. The survey methodology used and the complete results of the summer 2012 and summer 2013 vegetation assessments are provided in the Vegetation Technical Report of Volume 5C. A list of rare communities that have the potential to occur within the Vegetation RSA of this proposed pipeline segment is included in Appendix B of the Vegetation Technical Report of Volume 5C.

A search of the BC CDC identified no previously observed rare ecological communities within the Vegetation RSA in this segment (BC CDC 2013b). There were nine potentially rare, Blue-listed BC CDC-listed ecological communities either observed during the 2013 vegetation surveys or identified using TEM (see Table 5.9-4). One of these communities, the western redcedar – Sitka spruce/skunk cabbage community, is listed under the BC IWMS.

TABLE 5.9-4

VEGETATION COMMUNITIES OF CONCERN IN THE HOPE TO BURNABY SEGMENT

Common Name	Scientific Name	Provincial Rank[1]	Provincial Listing[2]	Observed Number of Occurrences
black cottonwood - red alder/salmonberry community	*Populus trichocarpa - Alnus rubra/Rubus spectabilis* community	S3	Blue	2
common cattail marsh	*Typha latifolia* marsh	S3	Blue	2
hard-stemmed bulrush deep marsh	*Schoenoplectus acutus* deep marsh	S3	Blue	1
western redcedar – Douglas-fir/vine maple community	*Thuja picata – Pseudotsuga menziesii/Acer circinatum* community	S2S3	Blue	1
western redcedar - Sitka spruce/skunk cabbage community	*Thuja plicata - Picea sitchensis/Lysichiton americanus* community	S3?	Blue	1
western redcedar/sword fern very dry maritime community	*Thuja plicata – Polystichum munitum* very dry maritime community	S2S3	Blue	2

TABLE 5.9-4 Cont'd

Notes: 1 Provincial (S) ratings range from S1 (five or fewer occurrences or very few remaining hectares) to S5 (demonstrably secure, though it may be quite rare in parts of its range, especially at the periphery). Ranks may be combined (*e.g.*, S1S2). This indicates a larger margin of error than ranks assigned a "?" qualifier. Ratings that are not of concern (4-5) are not included.

S3 = Vulnerable: because rare and uncommon, or found in a restricted range (even if abundant at some locations), or because of other factors making it vulnerable to extirpation. Typically 21-100 occurrences or between 3,000 and 10,000 individuals.

S#? = Inexact numeric rank: denotes inexact numeric rank.

? = Element is not yet ranked (*i.e.*, S?), or has an inexact numerical rank (*e.g.*, S3?).

2 Red-listed refers to a species that is Extirpated, Endangered or Threatened in BC. Blue-listed refers to a species of Special Concern in BC.

The most affected communities in BC are the Cascade, McLennan and Moist Warm ESSF (ESSFmw) variants, none of which occur along the Hope to Burnaby Segment.

5.9.2.5 Burnaby to Westridge Segment

A list of rare communities that have the potential to occur within the Vegetation RSA of the Burnaby to Westridge Segment is included in Appendix B of the Vegetation Technical Report of Volume 5C.

A search of the BC CDC identified no previously observed rare ecological communities within the Vegetation RSA in this segment (BC CDC 2013b).

Due to lack of land access in 2013, vegetation surveys were not conducted on the Burnaby to Westridge Segment. Vegetation surveys on this segment are planned in 2014.

5.9.3 Plant and Lichen Species of Concern

The plant and lichen species of concern indicator addresses rare plant and lichen species as identified by *SARA*, COSEWIC, the Alberta *Wildlife Act* and *Wildlife Regulation*, ACIMS, the BC IWMS and the BC CDC. This indicator addresses the NEB *Filing Manual* requirement to determine effects related to plant species at risk or of special status. Rare plant and rare lichen locations along the proposed pipeline segments are identified on Figure 2 in the Vegetation Technical Report of Volume 5C and shown on the Environmental Alignment Sheets of Volume 6E.

5.9.3.1 Edmonton to Hinton Segment

Vegetation surveys were conducted along those locations of the Edmonton to Hinton Segment that were representative of the different vegetation types in the area, as well as those with a high potential to support rare plants and lichens. The survey methodology used and the complete results of the 2013 vegetation surveys are provided in the Vegetation Technical Report of Volume 5C. A list of rare plants and lichens that have the potential to occur within the Vegetation RSA of this proposed pipeline segment is included in Appendix B of the Vegetation Technical Report of Volume 5C.

A search of the ACIMS database identified 38 occurrences of rare plant and lichen species within the Vegetation RSA in this segment (ACIMS 2013). There are 14 vascular plant species, 13 moss species, 2 liverwort species and 9 lichen species. None of the previously observed species are plants or lichens listed under COSEWIC, *SARA* or the Alberta *Wildlife Act* and *Wildlife Regulation*. See the Vegetation Technical Report of Volume 5C for more detail.

No COSEWIC or *SARA*-listed species were observed during the 2013 vegetation survey of this pipeline segment. In addition, no species designated under the Alberta *Wildlife Act* were observed. A total of 53 ACIMS-listed plant or lichen species were observed during the 2013 vegetation survey of this segment (see Table 5.9-5).

TABLE 5.9-5

PLANT AND LICHEN SPECIES OF CONCERN OBSERVED ALONG THE EDMONTON TO HINTON SEGMENT

Common Name	Scientific Name	Type	Provincial Rank[1]	Observed Number of Occurrences
Anastrophyllum liverwort	*Anastrophyllum helleranum*	liverwort	S2	3
Atrichum moss	*Atrichum selwynii*	moss	S2	1
Blasia liverwort	*Blasia pusilla*	liverwort	S1	1
capitate sedge	*Carex capitata*	vascular plant	S3 (W)	3
Cladonia lichen	*Cladonia humilis*	lichen	S1	1
dragon Cladonia lichen	*Cladonia squamosa*	lichen	S2	1
droplet notchwort	*Lophozia guttulata*	liverwort	S2	1
golden saxifrage	*Chrysosplenium iowense*	vascular plant	S3?	9
goldthread	*Coptis trifolia*	vascular plant	S3	2
linear-leaved pondweed	*Potamogeton strictifolius*	vascular plant	S2	1
meadow bitter cress	*Cardamine pratensis*	vascular plant	S3	1
Pellia species[2]	*Pellia* sp.	liverwort	Unknown	2
Physciella lichen	*Physciella chloantha*	lichen	Not listed	1
prairie wedge grass	*Sphenopholis obtusata*	vascular plant	S2	7
Ricardia liverwort	*Riccardia latifrons*	liverwort	S2	1
rush species[2]	*Juncus* sp.	vascular plant	Unknown	1
Sarmenthypnum moss	*Sarmenthypnum sarmentosum*	moss	S2	1
saxfridge species[2]	*Chrysosplenium* sp.	vascular plant	Unknown	4
scalloped grape fern	*Botrychium crenulatum*	vascular plant	S1	1
Schistidium moss	*Schistidium confertum*	moss	SNR	1
short-tail rush	*Juncus brevicaudatus*	vascular plant	S2	1
slender naiad	*Najas flexilis*	vascular plant	S2	1
snakeskin liverwort	*Conocephalum salebrosum*	liverwort	S2	5
spatulate grape fern	*Botrychium spathulatum*	vascular plant	S2	1
tall blue lettuce	*Lactuca biennis*	vascular plant	S2	1
western oak fern	*Gymnocarpium disjunctum*	vascular plant	S1	1

Notes: 1 Provincial (S) ratings range from S1 (five or fewer occurrences or very few remaining hectares) to S5 (demonstrably secure, though it may be quite rare in parts of its range, especially at the periphery). Ranks may be combined (*e.g.*, S1S2). This indicates a larger margin of error than ranks assigned a "?" qualifier. Ratings that are not of concern (4-5) are not included.

S1 = Critically Imperilled: because of extreme rarity or because of some factor(s) making it especially vulnerable to extirpation. Typically five or fewer occurrences or very few remaining individuals (< 1,000).

S2 = Imperilled: because of rarity or because of some factor(s) making it very vulnerable to extirpation. Typically 6-20 occurrences or few remaining individuals (1,000-3,000).

S3 = Vulnerable: because rare and uncommon, or found in a restricted range (even if abundant at some locations), or because of other factors making it vulnerable to extirpation. Typically 21-100 occurrences or between 3,000 and 10,000 individuals.

SNR = Species not ranked.

S#? = Inexact numeric rank: denotes inexact numeric rank.

? = Element is not yet ranked (*i.e.*, S?), or has an inexact numerical rank (*e.g.*, S3?).

2 Potentially observed species. This species requires confirmation.

5.9.3.2 Hargreaves to Darfield Segment

Vegetation surveys were conducted along those locations of the Hargreaves to Darfield Segment that were representative of the different vegetation types in the area, as well as those with a high potential to support rare plants and lichens. The survey methodology used and the complete results of the summer 2013 vegetation surveys are provided in the Vegetation Technical Report of Volume 5C. A list of rare plants that have the potential to occur within the Vegetation RSA of this proposed pipeline segment is included in Appendix B of the Vegetation Technical Report of Volume 5C.

A search of the BC CDC identified seven occurrences of rare plant and lichen species within the Vegetation RSA in this segment (BC CDC 2013b). Of these previously observed species, five are vascular plant species which include bald sedge (ranked S2S3, Blue), bearded sedge (ranked S2, Blue), Hall's willowherb (ranked S2S3, Blue), meadow willow (ranked S2S3, Blue) and mountain moonwort (ranked S1, Red). Two of the previously observed species, Mexican mosquito fern and Haller's apple moss (near RK 490), are listed as Threatened under COSEWIC and *SARA* (COSEWIC 2013a, Environment Canada 2013o). There were no species designated under the BC IWMS previously observed along this segment. See the Vegetation Technical Report of Volume 5C for more detail.

Candidate critical habitat for whitebark pine, listed as Endangered under COSEWIC and *SARA*, occurs within 1 km of the proposed pipeline corridor along the Hargreaves to Darfield Segment (Environment Canada 2013p). Mapping of draft proposed critical habitat for whitebark pine was provided by Environment Canada (Environment Canada 2013p). Environment Canada provided Project-specific hard-copy maps of critical habitat for species at risk in BC (Environment Canada 2013p). The information on critical habitat is provided in this report with permission from Environment Canada and this information is subject to change since critical habitat mapping is not final until posted in a final recovery strategy on the Species at Risk Public Registry. Environment Canada makes no representation and gives no warranty of any kind with respect to the accuracy, usefulness, novelty, validity, scope, completeness or currency of the Canada Digital Data and expressly disclaims any implied warranty of merchantability or fitness for a particular purpose of the Canada Digital Data.

Candidate Critical Habitat for Species at Risk have been developed by Environment Canada, though a recovery strategy for whitebark pine is not final (Environment Canada 2013o). The critical habitat for whitebark pine is in the "early candidate (pre-review)" stage, meaning that the Recovery Strategy has not yet completed an internal review.

One potential COSEWIC and *SARA*-listed species was observed during the 2013 vegetation survey. Mexican mosquito fern (S2, Red-listed), which is listed as Threatened by COSEWIC and *SARA* (COSEWIC 2013a, Environment Canada 2013o), was observed in a pond approximately 43 m east of the centre of the proposed corridor near RK 749.9. At this location, there were thousands of individual plants along the edges of the pond. This species needs further confirmation. See Section 9.0 for details regarding supplemental studies. No species designated under the BC IWMS were observed. A total of 107 species listed by the BC CDC were observed during the 2013 vegetation survey (see Table 5.9-6).

TABLE 5.9-6

PLANT AND LICHEN SPECIES OF CONCERN IN THE HARGREAVES TO DARFIELD SEGMENT

Common Name	Scientific Name	Type	Provincial Rank[1] (Federal Rank)[2]	Provincial Listing[3]	Observed Number of Occurrences
Alaska moonwort	*Botrychium alaskense*	vascular plant	Not listed Ranked S1S3 by NatureServe	Not listed	1
bald sedge	*Carex tonsa*	vascular plant	S2S3	Blue	27
Canada anemone	*Anemone canadensis*	vascular plant	S2S3	Blue	1
crested wood fern	*Dryopteris cristata*	vascular plant	S2S3	Blue	2
cut notchwort	*Tritomaria exsecta*	liverwort	SNR Ranked S1 by NatureServe	Not listed	1
dainty moonwort	*Botrychium crenulatum*	vascular plant	S2S3	Blue	8
echo moonwort	*Botrychium echo*	vascular plant	S1S2	Red	1
finger ring	*Arctoparmelia incurve*	lichen	S2S3	Blue	1
fox sedge	*Carex vulpinoidea*	vascular plant	S2S3	Blue	1
golden saxifrage species[4]	*Chrysosplenium* sp.	vascular plant	Unknown	Unknown	1
least moonwort	*Botrychium simplex*	vascular plant	S2S3	Blue	1
Mexican mosquito fern[4]	*Azolla mexicana*	vascular plant	S2 (Threatened)	Red	1
Michigan moonwort	*Botrychium michiganense*	vascular plant	S1S3	Red	5
montane Dicranum moss	*Dicranum montanum*	moss	S3	Blue	4
moose moonwort	*Botrychium tunux*	vascular plant	S1S3	Red	1
mountain moonwort	*Botrychium montanum*	vascular plant	S1S2	Red	1
Peltigera lichen	*Peltigera conspersa*	lichen	Not listed	Not listed	3

TABLE 5.9-6 Cont'd

Common Name	Scientific Name	Type	Provincial Rank[1] (Federal Rank)[2]	Provincial Listing[3]	Observed Number of Occurrences
riverbank anemone	*Anemone virginiana* var *cylindroidea*	vascular plant	S3	Blue	1
silvery sedge	*Carex canescens* ssp. *disjuncta*	vascular plant	SU	Not listed	2
spoon-shaped moonwort	*Botrychium spathulatum*	vascular plant	S1	Red	1
stalked moonwort	*Botrychium pedunculosum*	vascular plant	S2	Red	16
tender sedge	*Carex tenera*	vascular plant	S2S3	Blue	3
upswept moonwort	*Botrychium ascendens*	vascular plant	S2	Red	2
western moonwort	*Botrychium hesperium*	vascular plant	S2S3	Blue	19
whip fork moss	*Dicranum flagellare*	moss	S3	Blue	2
white wintergreen	*Pyrola elliptica*	vascular plant	S2S3	Blue	1

Notes:

1 Provincial (S) ratings range from S1 (five or fewer occurrences or very few remaining hectares) to S5 (demonstrably secure, though it may be quite rare in parts of its range, especially at the periphery). Ranks may be combined (*e.g.*, S1S2). This indicates a larger margin of error than ranks assigned a "?" qualifier. Ratings that are not of concern (4-5) are not included.

S1 = Critically Imperilled: because of extreme rarity or because of some factor(s) making it especially vulnerable to extirpation. Typically five or fewer occurrences or very few remaining individuals (< 1,000).

S2 = Imperilled: because of rarity or because of some factor(s) making it very vulnerable to extirpation. Typically 6-20 occurrences or few remaining individuals (1,000-3,000).

S3 = Vulnerable: because rare and uncommon, or found in a restricted range (even if abundant at some locations), or because of other factors making it vulnerable to extirpation. Typically 21-100 occurrences or between 3,000 and 10,000 individuals.

S#S# = Range Rank: a numeric range rank (*e.g.*, S2S3) is used to indicate the range of uncertainty about the exact status of the element.

S#? = Inexact numeric rank: denotes inexact numeric rank.

? = Element is not yet ranked (*i.e.*, S?) or has an inexact numerical rank (*e.g.*, S3?).

SU = Unrankable: currently unrankable due to lack of information or due to substantially conflicting information about status or trends.

SNR = Species not ranked

2 Federal ratings include species listed by COSEWIC (2013b) and listed on Schedule 1 of *SARA* (Environment Canada 2013o). Species listed as “Extirpated”, “Not at Risk” or “Data Deficient” were not included in the table. Federal ratings are current to November 2013.

Threatened = A species likely to become endangered if limiting factors are not reversed.

3 Red-listed refers to a species that is Extirpated, Endangered, or Threatened while Blue-listed refers to a species of Special Concern under the BC *Wildlife Act*.

4 Potentially observed species. This species requires confirmation. See Section 9.0 for details regarding supplemental surveys.

5.9.3.3 Black Pines to Hope Segment

Vegetation surveys were conducted along those locations of the Black Pines to Hope Segment that were representative of the different vegetation types in the area, as well as those with a high potential to support rare plants and lichens. The survey methodology used and the complete results of the 2013 vegetation surveys are provided in the Vegetation Technical Report of Volume 5C. A list of rare plants that have the potential to occur within the Vegetation RSA of this proposed pipeline segment is included in the Vegetation Technical Report of Volume 5C.

A search of the BC CDC database identified eight occurrences of rare plant and lichen species within the Vegetation RSA along this segment (BC CDC 2013b). Of these previously observed species, seven are vascular plant species which include bearded sedge (ranked S2, Red-listed), blue grama (ranked S2, Red-listed), Hall’s willowherb (ranked S2S3, Blue-listed), ovalpurse (ranked S3, Blue-listed), Suksdorf’s lupine (ranked S2, Red-listed), toothcup meadow-foam (ranked S1, Red-listed) and wedgescale orache (ranked S3, Blue-listed). There was one previously observed non-vascular species, which is alkaline wing-nerved moss (ranked S2, Red-listed). One of the previously observed species, toothcup meadow-foam, is listed as Endangered under COSEWIC and *SARA* (COSEWIC 2013a, Environment Canada 2013o). There were no species designated under the BC IWMS previously observed along this segment. See the Vegetation Technical Report of Volume 5C for more detail.

Candidate critical habitat for whitebark pine occurs within 1 km of the proposed pipeline corridor along the Black Pines to Hope Segment (Environment Canada 2013p). There is proposed critical habitat for toothcup meadow-foam overlapping the proposed pipeline corridor in the Black Pines to Hope Segment (Environment Canada 2013p). Candidate Critical Habitat for Species at Risk have been developed by Environment Canada, though recovery strategies for toothcup meadow-foam and whitebark pine are not final (Environment Canada 2013o). The critical habitat for whitebark pine is in the "early candidate (pre-review)" stage, meaning that the Recovery Strategy has not yet completed an internal review. The toothcup meadow-foam critical habitat is in the "candidate (jurisdictional review)" stage, meaning that the Recovery Strategy has completed an internal review and has been partially vetted by the Government of BC and (if relevant) other *Species at Risk Act* participating agencies (*e.g.*, DFO or Parks Canada).

No COSEWIC or *SARA*-listed species were observed during the 2013 vegetation survey of this proposed pipeline segment. In addition, no species designated under the BC IWMS were observed. There were 13 BC CDC-listed plant species observed during the 2013 vegetation surveys (see Table 5.9-7).

TABLE 5.9-7

PLANT AND LICHEN SPECIES OF CONCERN IN THE BLACK PINES TO HOPE SEGMENT

Common Name	Scientific Name	Type	Provincial Rank[1]	Provincial Listing[2]	Observed Number of Occurrences
Alaska moonwort	*Botrychium alaskense*	vascular plant	Not listed Ranked S1S3 by NatureServe	Not listed	1
birdnest vinyl	*Leptogium tenuissimum*	lichen	S2?	Red	1
brown-eyed wolf	*Letharia columbiana*	lichen	S3?	Blue	1
campion species	*Silene* sp.	vascular plant	Unknown	Unknown	1
many-headed sedge	*Carex sychnocephala*	vascular plant	S3	Blue	1
mountain candlewax	*Ahtiana sphaerosporella*	lichen	S2S3	Blue	1
Peltigera lichen	*Peltigera* sp. nov *blue*	lichen	Not listed	Not listed	1
Peltigera lichen	*Peltigera conspersa*	lichen	Not listed	Not listed	1
Racomitrium moss	*Racomitrium affine*	moss	S2S3	Blue	1
slender spike-rush	*Eleocharis nitida*	vascular plant	S1	Red	1
spotted beard	*Usnea glabrescens*	lichen	S3	Blue	1
Syntrichia moss	*Syntrichia caninervis*	moss	S3?	Blue	1
Usnea lichen	*Usnea quasirigida*	lichen	Not listed	Not listed	1

Notes: 1 Provincial (S) ratings range from S1 (five or fewer occurrences or very few remaining hectares) to S5 (demonstrably secure, though it may be quite rare in parts of its range, especially at the periphery). Ranks may be combined (*e.g.*, S1S2). This indicates a larger margin of error than ranks assigned a "?" qualifier. Ratings that are not of concern (4-5) are not included.

S1 = Critically Imperilled: because of extreme rarity or because of some factor(s) making it especially vulnerable to extirpation. Typically five or fewer occurrences or very few remaining individuals (< 1,000).

S3 = Vulnerable: because rare and uncommon, or found in a restricted range (even if abundant at some locations), or because of other factors making it vulnerable to extirpation. Typically 21-100 occurrences or between 3,000 and 10,000 individuals.

2 Under the BC *Wildlife Act*, Red-listed refers to a species that is Extirpated, Endangered, or Threatened in BC. Blue-listed refers to a species of Special Concern in BC.

5.9.3.4 Hope to Burnaby Segment

Vegetation surveys were conducted along those locations of the Hope to Burnaby Segment that were representative of the different vegetation types in the area, as well as those with a high potential to support rare plants and lichens. The survey methodology used and the complete results of the 2013 vegetation surveys are provided in the Vegetation Technical Report of Volume 5C. A list of rare plants that have the potential to occur within the Vegetation RSA of this proposed pipeline segment is included in the Vegetation Technical Report of Volume 5C.

A search of the BC CDC identified 16 occurrences of rare plant and lichen species within the Vegetation RSA in this segment (BC CDC 2013b). One of the previously observed vascular plant species, tall bugbane (S1, Red) is listed as Endangered under COSEWIC, *SARA* and is listed under the BC IWMS (COSEWIC 2013a, Environment Canada 2013o). Another vascular plant species, Vancouver Island beggarticks (S3, Blue), is listed as Special Concern under COSEWIC and *SARA* (COSEWIC 2013a, Environment Canada 2013o). One previously observed lichen species, peacock vinyl lichen (S1S2, Red), is listed as Special Concern under COSEWIC (COSEWIC 2013a). Candidate critical habitat does not yet exist for Vancouver Island beggarticks, Haller's apple moss, tall bugbane, Mexican mosquito fern or peacock vinyl lichen (Government of Canada 2013). See the Vegetation Technical Report of Volume 5C for more detail.

No COSEWIC or *SARA*-listed species were observed during the 2013 vegetation survey of this proposed pipeline segment. In addition, no species designated under the BC IWMS were observed. One BC CDC-listed plant species was observed during the 2013 vegetation surveys: three occurrences of pacific waterleaf (*Hydrophyllum tenuipes*), ranked S2, Red-listed, were observed along this segment.

5.9.3.5 Burnaby to Westridge Segment

A list of rare plants and lichens that have the potential to occur within the Vegetation RSA of the Burnaby to Westridge Segment is included in Appendix B of the Vegetation Technical Report of Volume 5C.

A search of the BC CDC identified no previously observed rare plant or lichen species within the Vegetation RSA in this segment (BC CDC 2013b).

Due to lack of land access in 2013, vegetation surveys were not conducted on the Burnaby to Westridge Segment. Vegetation surveys on this segment are planned in 2014.

5.9.4 Presence of Infestations of Provincial Weed Species and Other Invasive Non-Native Species Identified as a Concern

According to the Alberta *Weed Control Act,* Prohibited Noxious weeds must be destroyed and Noxious weeds must be controlled by the owner or occupant of those lands on which the weeds are present. In BC, Provincial Noxious weeds are those that must be controlled in all regions and Regional Noxious weeds are those that must be controlled in the region(s) for which they are listed. There are many additional, non-listed species that are introduced to Alberta and BC (*i.e.*, non-native), including some agronomic and horticultural species, that can be invasive in certain land uses. Additional invasive non-native species of concern are identified through consultation. This indicator will inform efforts to address the NEB *Filing Manual* requirements to consider weed control measures and seed mixes.

Forest health and forest pests are discussed under the human occupancy and resource use element in Section 5.0 of Volume 5B and in the Managed Forest Areas and Forest Health Technical Report of Volume 5D.

5.9.4.1 Edmonton to Hinton Segment

Stakeholders, including attendees of the Hinton Community Workshop, Edmonton West Community Workshop and Edson Community Workshop as well as representatives of Strathcona County, the City of Edmonton, the City of Spruce Grove, the Town of Stony Plain, the Village of Wabamun, Parkland County and Yellowhead County, were contacted regarding weeds of concern and their associated websites were consulted. Stakeholders expressed concern regarding all species regulated in the Alberta *Weed Control Act* as well as those listed and non-listed species identified in the Vegetation Technical Report of Volume 5C (Anderson, Laubham, Leskiw, Pichette, Zacharias pers. comm., City of Edmonton 2013, Parkland County 2013b, Strathcona County 2013). Listed and non-listed, non-native species that were observed during 2013 vegetation surveys along the Edmonton to Hinton Segment of the Project are also included in the Vegetation Technical Report of Volume 5C. Table 5.9-8 lists the Prohibited Noxious and Noxious species described by stakeholders as being of concern during consultation and indicates which of these were observed during the 2013 vegetation surveys along this segment.

TABLE 5.9-8

PROHIBITED NOXIOUS AND NOXIOUS WEED SPECIES IDENTIFIED DURING STAKEHOLDER CONSULTATION AND VEGETATION SURVEYS FOR THE EDMONTON TO HINTON SEGMENT

Common Name[1]	Scientific Name[1]	Provincial Status	Observed During 2013 Vegetation Surveys
bighead knapweed	*Centaurea macrocephala*	Prohibited Noxious	--
garlic mustard	*Alliaria petiolata*	Prohibited Noxious	--
giant hogweed	*Heracleum mantegazzianum*	Prohibited Noxious	--
himalayan balsam	*Impatiens glandulifera*	Prohibited Noxious	--
meadow hawkweed	*Hieracium caespitosum*	Prohibited Noxious	Yes
orange hawkweed	*Hieracium aurantiacum*	Prohibited Noxious	Yes
purple loosestrife	*Lythrum salicaria*	Prohibited Noxious	--
rough-fruited cinquefoil	*Potentilla recta*	Prohibited Noxious	Yes
Canada thistle (creeping thistle)	*Cirsium arvense*	Noxious	Yes
common burdock	*Arctium minus*	Noxious	--
common mullein	*Verbascum thapsus*	Noxious	--
common tansy	*Tanacetum vulgare*	Noxious	Yes
creeping bellflower	*Campanula rapunculoides*	Noxious	--
dame's rocket	*Hesperis matronalis*	Noxious	--
field scabious	*Knautia arvensis*	Noxious	--
leafy spurge	*Euphorbia esula*	Noxious	Yes
ox-eye daisy	*Chrysanthemum leucanthemum*	Noxious	Yes
perennial sow thistle	*Sonchus arvensis*	Noxious	Yes
scentless chamomile	*Matricaria perforata*	Noxious	Yes
tall buttercup	*Ranunculus acris*	Noxious	Yes
white cockle (bladder campion)	*Silene pratensis*	Noxious	Yes
yellow toadflax (common toadflax)	*Linaria vulgaris*	Noxious	Yes

Note: 1 Species nomenclature is determined according to the list of all elements in Alberta (ACIMS 2013), with more current taxonomic information drawn from NatureServe (2012), when necessary. Where the Alberta *Weed Control Act* nomenclature differs from these sources, the *Weed Control Act* name for the species has been provided in brackets following the ACIMS name.

5.9.4.2 Hargreaves to Darfield Segment

Stakeholders, including attendees of the Clearwater Community Workshop as well as representatives of the Regional District of Fraser-Fort George (RDFFG) Regional District, the TNRD, the Northwest Invasive Plant Council (NWIPC) and the Southern Interior Weed Management Committee (SIWMC) were contacted regarding weeds of concern and their associated websites were consulted. These stakeholders expressed concerns regarding a number of non-native and invasive species. Stakeholders' concerns are discussed in the Vegetation Technical Report of Volume 5C (Fox pers. comm., NWIPC 2013, SIWMC 2013, TNRD 2010). The Provincial Noxious weeds of concern identified by stakeholders during consultation are listed in Table 5.9-9. Table 5.9-9 also indicates which of these Provincial Noxious weeds were observed during the 2013 vegetation surveys within this segment. Non-native and invasive species that were observed during 2013 vegetation surveys along the Hargreaves to Darfield Segment are included in the Vegetation Technical Report of Volume 5C.

TABLE 5.9-9

PROVINCIAL NOXIOUS WEED SPECIES IDENTIFIED DURING STAKEHOLDER CONSULTATION AND VEGETATION SURVEYS FOR THE HARGREAVES TO DARFIELD SEGMENT

Common Name[1]	Scientific Name[1]	Provincial Status	Observed During 2013 Vegetation Surveys
Canada thistle	*Cirsium arvense*	Provincial Noxious	Yes
common hound's-tongue	*Cynoglossum officinale*	Provincial Noxious	Yes
Dalmatian toadflax	*Linaria genistifolia* ssp. *Dalmatica* (*Linaria dalmatica*)	Provincial Noxious	Yes
diffuse knapweed	*Centaurea diffusa*	Provincial Noxious	Yes

TABLE 5.9-9 Cont'd

Common Name[1]	Scientific Name[1]	Provincial Status	Observed During 2013 Vegetation Surveys
scentless mayweed (scentless chamomile)	*Tripleurospermum inodorum* (*Matricaria maritima*)	Provincial Noxious	Yes
spotted knapweed	*Centaurea stoebe* ssp. *micranthos* (*Centaurea maculosa*)	Provincial Noxious	Yes

Note: 1 Species nomenclature and the status of species as native or not is determined according to the BC Species and Ecosystem Explorer (BC MOE 2013f), with more current taxonomic information drawn from NatureServe (2012), when necessary. Where the BC *Weed Control Act* nomenclature differs from these sources, the *Weed Control Act* name for the species has been provided in brackets following the ACIMS or BC CDC name. Where no species nomenclature is available from the BC Species and Ecosystem Explorer (BC MOE 2013f), only the BC *Weed Control Act* name is provided.

5.9.4.3 Black Pines to Hope Segment

Stakeholders, including attendees of the Kamloops ESA Workshop, Kamloops Community Workshop, Merritt Community Workshop and Hope Community Workshop as well as representatives of the TNRD, the FVRD, the SIWMC and the Fraser Valley Invasive Plant Council, were contacted regarding weeds of concern and their associated websites were consulted. These stakeholders expressed concerns regarding a number of native and non-native species. Stakeholders' concerns are discussed in the Vegetation Technical Report of Volume 5C (Fox pers. comm., Fraser Valley Invasive Plants Council 2012, FVRD 2008a, SIWMC 2013, TNRD 2010). The Provincial Noxious weeds of concern identified by stakeholders during consultation are listed in Table 5.9-10. Table 5.9-10 also indicates which of these Provincial Noxious weeds were observed during the 2013 vegetation surveys within this segment. Non-native and invasive species that were observed during 2013 vegetation surveys along the Black Pines to Hope Segment are included in the Vegetation Technical Report of Volume 5C.

TABLE 5.9-10

PROVINCIAL NOXIOUS WEED SPECIES IDENTIFIED DURING STAKEHOLDER CONSULTATION AND VEGETATION SURVEYS FOR THE BLACK PINES TO HOPE SEGMENT

Common Name[1]	Scientific Name[1]	Provincial Status	Observed During 2013 Vegetation Surveys
Canada thistle	*Cirsium arvense*	Provincial Noxious	Yes
common hound's-tongue	*Cynoglossum officinale*	Provincial Noxious	Yes
Dalmatian toadflax	*Linaria genistifolia* ssp. *Dalmatica* (*Linaria dalmatica*)	Provincial Noxious	Yes
diffuse knapweed	*Centaurea diffusa*	Provincial Noxious	Yes
scentless mayweed (scentless chamomile)	*Tripleurospermum inodorum* (*Matricaria maritima*)	Provincial Noxious	Yes
spotted knapweed	*Centaurea stoebe* ssp. *micranthos* (*Centaurea maculosa*)	Provincial Noxious	Yes

Note: 1 Species nomenclature and the status of species as native or not is determined according to the BC Species and Ecosystem Explorer (BC MOE 2013f), with more current taxonomic information drawn from NatureServe (2012), when necessary. Where the BC *Weed Control Act* nomenclature differs from these sources, the *Weed Control Act* name for the species has been provided in brackets following the ACIMS or BC CDC name. Where no species nomenclature is available from the BC Species and Ecosystem Explorer (BC MOE 2013f), only the BC *Weed Control Act* name is provided.

5.9.4.4 Hope to Burnaby Segment

Stakeholders, including attendees of the Hope Community Workshop, Abbotsford Community Workshop, Coquitlam Community Workshop and Langley Community Workshop as well as representatives of the FVRD, the GVRD, the Fraser Valley Invasive Plant Council and the Invasive Species Council of Metro Vancouver, were contacted regarding weeds of concern and their associated websites were consulted. These stakeholders expressed concerns regarding a number of native and non-native species. Stakeholders' concerns are discussed in the Vegetation Technical Report of Volume 5C (Fraser Valley Invasive Plants Council 2012, FVRD 2008a, Metro Vancouver 2011b). The Provincial Noxious weeds of concern identified by stakeholders during consultation are listed in Table 5.9-11. Table 5.9-11 also indicates which of these Provincial Noxious weeds were observed during the 2013 vegetation surveys within this segment. Non-native and invasive species that were observed during 2013 vegetation surveys along the Hope to Burnaby Segment of the Project are also included in the Vegetation Technical Report of Volume 5C.

TABLE 5.9-11

PROVINCIAL NOXIOUS WEED SPECIES IDENTIFIED DURING STAKEHOLDER CONSULTATION AND VEGETATION SURVEYS FOR THE HOPE TO BURNABY SEGMENT

Common Name[1]	Scientific Name[1]	Provincial Status	Observed During 2013 Vegetation Surveys
Canada thistle	*Cirsium arvense*	Provincial Noxious	Yes
Japanese knotweed	*Fallopia japonica*	Provincial Noxious	Yes
spotted knapweed	*Centaurea stoebe ssp. micranthos* (*Centaurea maculosa*)	Provincial Noxious	Yes
tansy ragwort	*Senecio jacobaea*	Provincial Noxious	Yes

Note: 1 Species nomenclature and the status of species as native or not is determined according to the BC Species and Ecosystem Explorer (BC MOE 2013f), with more current taxonomic information drawn from NatureServe (2012), when necessary. Where the BC *Weed Control Act* nomenclature differs from these sources, the *Weed Control Act* name for the species has been provided in brackets following the ACIMS or BC CDC name. Where no species nomenclature is available from the BC Species and Ecosystem Explorer (BC MOE 2013f), only the BC *Weed Control Act* name is provided.

5.9.4.5 Burnaby to Westridge Segment

Stakeholders, including attendees of the Burnaby Community Workshop as well as the GVRD, represented by the Invasive Species Council of Metro Vancouver, were contacted regarding weeds of concern and the associated websites were consulted. These stakeholders expressed concerns regarding a number of native and non-native species. Stakeholders' concerns are discussed in the Vegetation Technical Report of Volume 5C (Invasive Species Council of Metro Vancouver 2013, Metro Vancouver 2011b). The Provincial Noxious weeds of concern identified by stakeholders during consultation are listed in Table 5.9-12.

No vegetation surveys were conducted within the Burnaby to Westridge Segment in 2013. Surveys are expected for this segment in 2014.

TABLE 5.9-12

PROVINCIAL NOXIOUS WEED SPECIES IDENTIFIED DURING STAKEHOLDER CONSULTATION FOR THE BURNABY TO WESTRIDGE SEGMENT

Common Name[1]	Scientific Name[1]	Provincial Status	Observed During 2013 Vegetation Surveys
Bohemian knotweed	*Fallopia x bohemica*	Provincial Noxious	N/A
bur chervil	*Anthriscus caucalis*	Provincial Noxious	N/A
Canada thistle	*Cirsium arvense*	Provincial Noxious	N/A
common reed	*Phragmites australis ssp. australis*	Provincial Noxious	N/A
Crupina	*Crupina vulgaris*	Provincial Noxious	N/A
Dalmatian toadflax	*Linaria genistifolia ssp. dalmatica* (*Linaria dalmatica*)	Provincial Noxious	N/A
diffuse knapweed	*Centaurea diffusa*	Provincial Noxious	N/A
English cordgrass	*Spartina anglica*	Provincial Noxious	N/A
flowering-rush	*Butomus umbellatus*	Provincial Noxious	N/A
garlic mustard	*Alliaria petiolata*	Provincial Noxious	N/A
giant hogweed	*Heracleum mantegazzianum*	Provincial Noxious	N/A
giant knotweed	*Fallopia sachalinensis*	Provincial Noxious	N/A
Gorse	*Ulex europaeus*	Provincial Noxious	N/A
Himalayan knotweed	*Persicaria wallichii* (*Polygonum polystachyum*)	Provincial Noxious	N/A
Japanese knotweed	*Fallopia japonica*	Provincial Noxious	N/A

TABLE 5.9-12 Cont'd

Common Name[1]	Scientific Name[1]	Provincial Status	Observed During 2013 Vegetation Surveys
leafy spurge	*Euphorbia esula*	Provincial Noxious	N/A
milk thistle	*Silybum marianum*	Provincial Noxious	N/A
scentless mayweed (scentless chamomile)	*Tripleurospermum inodorum* (*Matricaria maritima*)	Provincial Noxious	N/A
spotted knapweed	*Centaurea stoebe ssp. micranthos* (*Centaurea maculosa*)	Provincial Noxious	N/A
tansy ragwort	*Senecio jacobaea*	Provincial Noxious	N/A
yellow iris (yellow flag iris)	*Iris pseudacorus*	Provincial Noxious	N/A
yellow starthistle	*Centaurea solstitialis*	Provincial Noxious	N/A

Note: 1 Species nomenclature and the status of species as native or not is determined according to the BC Species and Ecosystem Explorer (BC MOE 2013f), with more current taxonomic information drawn from NatureServe (2012), when necessary. Where the BC *Weed Control Act* nomenclature differs from these sources, the *Weed Control Act* name for the species has been provided in brackets following the ACIMS or BC CDC name. Where no species nomenclature is available from the BC Species and Ecosystem Explorer (BC MOE 2013f), only the BC *Weed Control Act* name is provided.

5.9.5 Traditional Ecological Knowledge

TEK was collected in partnership between TERA and members of potentially affected Aboriginal communities to discuss the role of the local plants for local peoples and cultures, and to document traditional values and observations regarding vegetation aspects of the local and regional landscape. The collection of TEK, which focused on Aboriginal experiential knowledge of the land and field reconnaissance, was conducted along Crown lands as well as some private lands potentially disturbed by Project construction, including associated physical works and activities.

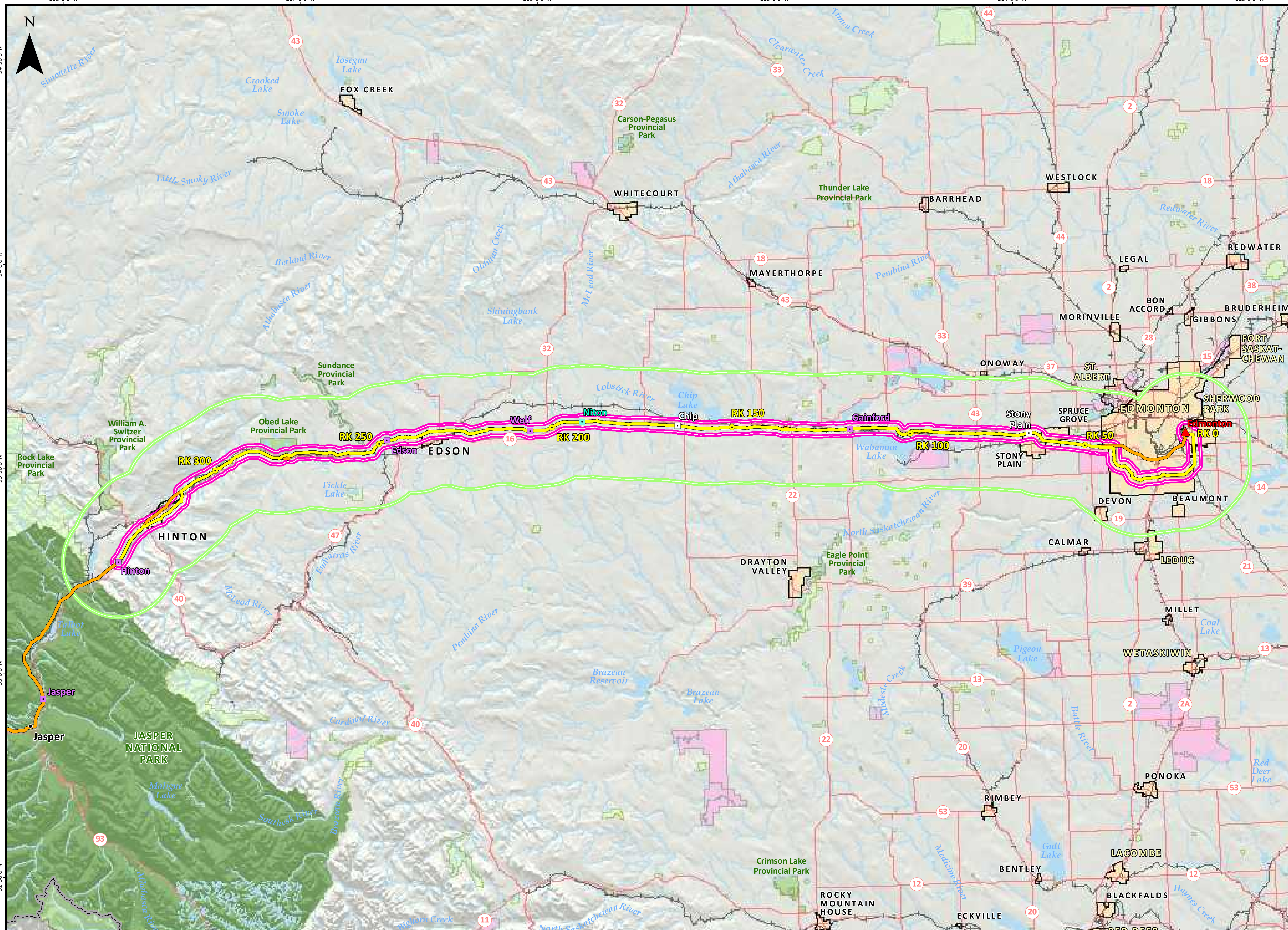
During the field surveys, traditional methods of resource procurement were discussed, as well as modern methods currently employed. Seasonality of resource harvesting, species of traditional importance, identification of traditionally harvested plants, description of uses and preparation techniques, as well as plant rarity and abundance was also important information shared by the Aboriginal participants. Geographical locations were identified, as were areas that are not used and the reasons why. Potential mitigation measures to reduce any Project-related effects on a resource were also discussed during the vegetation field surveys.

Concerns identified during engagement include clearing of vegetation, contamination of plants through use of herbicides and pesticides and loss or alteration of traditional use sites for plant gathering. The locations and uses of the medicinal plants and the locations of important harvesting areas is knowledge held by the TEK participants and proprietary to the community. Detailed TEK results and methodologies can be found within the Vegetation Technical Report of Volume 5C.

5.10 Wildlife and Wildlife Habitat

This subsection discusses the existing conditions for wildlife and wildlife habitat within the Wildlife RSA (Figures 5.10-1 to 5.10-4). The Wildlife RSA encompasses the Project Footprint, the LSA and the broader surrounding area where there is potential for cumulative and/or wider-spread Project effects. The RSA is a 30 km band generally centred on the proposed pipeline corridor (*i.e.*, extending 15 km on both sides from the centre of the pipeline corridor). The existing conditions, including shared ATK and TEK, are characterized for each of the five proposed pipeline segments based on the literature and desktop review in Sections 5.10.1 to 5.10.5.

TEK was collected in partnership between TERA and members of participating Aboriginal communities. During the wildlife field surveys, traditional methods of resource procurement were discussed, as well as modern methods currently employed. Seasonality of resource harvesting was also important information shared by the Aboriginal participants. Geographical locations were identified, as were areas that are not used and the reasons why. Potential mitigation measures to reduce any Project-related effects on a resource were also discussed during the biophysical field studies.



TRANS MOUNTAIN

FIGURE 5.10-1

WILDLIFE STUDY AREAS - EDMONTON TO HINTON

TRANS MOUNTAIN EXPANSION PROJECT

- Village / Hamlet
- Reference Kilometre Post (RK)
- Trans Mountain Pipeline (TMPL)
- Trans Mountain Expansion Project Proposed Pipeline Corridor
- Terminal
- Pump Station (Pump Additions, Station Modifications and/or Scraper Facilities)
- New Pump Station (Proposed)
- Pump Station (Reactivated)
- Existing Pump Station
- Highway
- Railway
- Wildlife 2 km LSA
- Wildlife 30 km RSA
- City / Town / District Municipality
- Indian Reserve / Métis Settlement
- National Park
- Provincial Park
- Protected Area / Natural Area / Provincial Recreation Area / Wilderness Provincial Park / Conservancy Area
- Provincial Boundary

Projection: NAD83 UTM Zone 11N. Baseline TMPL & Facilities: provided by KMC, 2012; Proposed Pipeline Corridor V6: provided by UPI, Aug. 23, 2013; Transportation: IHS Inc., 2013, BC Forests, Lands and Natural Resource Operations, 2012 & Natural Resources Canada, 2012; Geopolitical Boundaries: Natural Resources Canada, 2003, AltaLIS, 2013, IHS Inc., 2011, BC FLNRO, 2007 & ESRI, 2005; First Nation Lands: Government of Canada, 2013, AltaLIS, 2010 & IHS Inc., 2011; Hydrology: Natural Resources Canada, 2007 & BC Crown Registry and Geographic Base Branch, 2008; Parks and Protected Areas: Natural Resources Canada, 2012, AltaLIS, 2012 & BC FLNRO, 2008; ATS Grid: AltaLIS, 2009; Edmonton TUC: Alberta Infrstructure, 2011; Canadian Hillshade: TERA Environmental Consultants, 2008; US Hillshade: ESRI, 2009.

tera ENVIRONMENTAL CONSULTANTS

Although there is no reason to believe that there are any errors associated with the data used to generate this product or in the product itself, users of these data are advised that errors in the data may be present.

MAP NUMBER		PAGE
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ALL LOCATIONS APPROXIMATE

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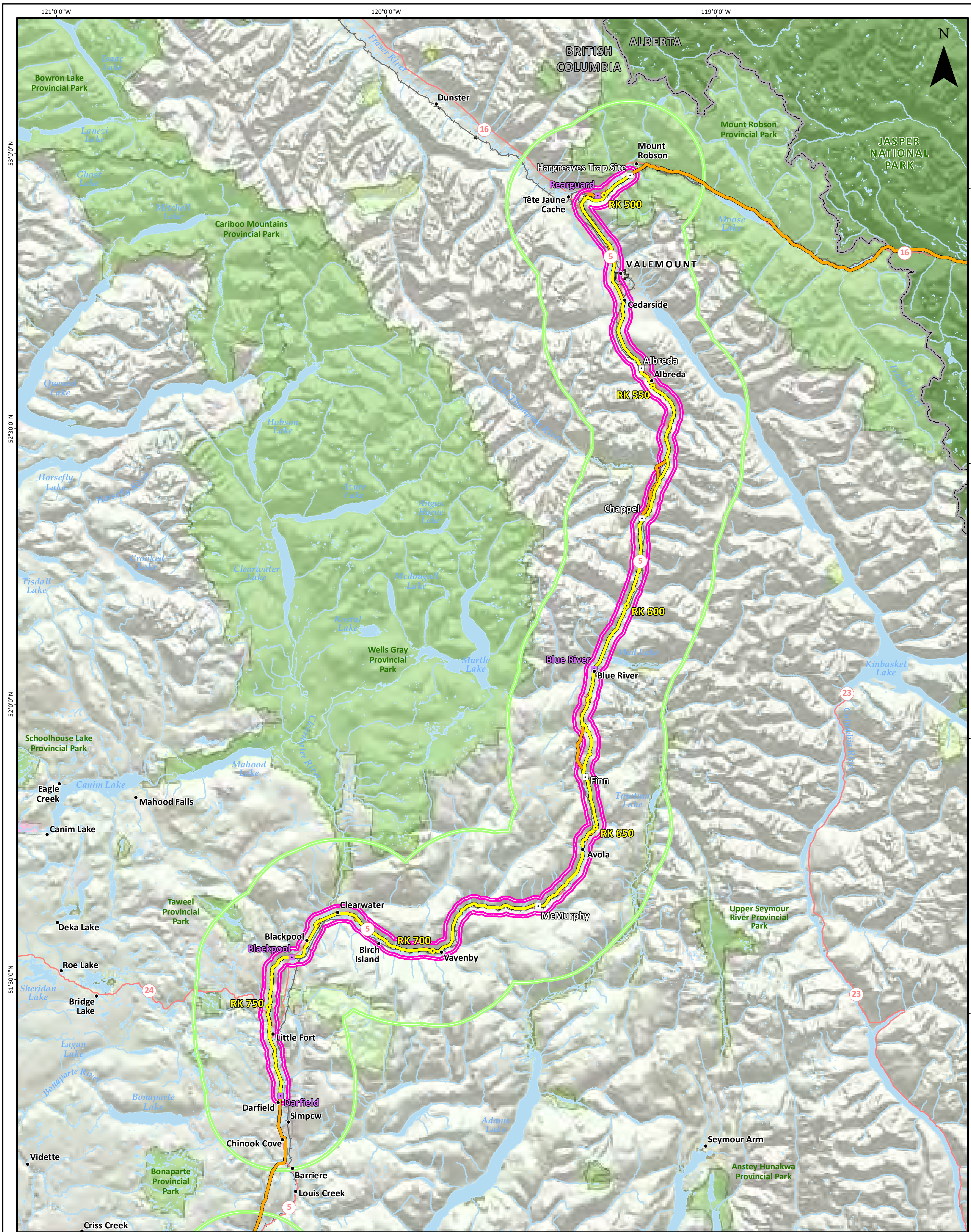

Village / Hamlet
Reference Kilometre Post (RK)
Trans Mountain Pipeline (TMPL)
Trans Mountain Expansion Project Proposed Pipeline Corridor
Terminal
Pump Station (Pump Additions, Station Modifications and/or Scraper Facilities)
New Pump Station (Proposed)
Pump Station (Reactivated)
Existing Pump Station
Highway
Railway
Wildlife 2 km LSA
Wildlife 30 km RSA
City / Town / District Municipality
Indian Reserve / Métis Settlement
National Park
Provincial Park
Protected Area / Natural Area / Provincial Recreation Area / Wilderness Provincial Park / Conservancy Area
Provincial Boundary

Projection: NAD 1983 UTM 11N. Routing: Baseline TMPL & Facilities: provided by KMC, 2012; Proposed Pipeline Corridor V6: provided by UPI, Aug. 23, 2013; Transportation: IHS Inc., 2013, BC Forests, Lands and Natural Resource Operations, 2012 & Natural Resources Canada, 2012; Geopolitical Boundaries: Natural Resources Canada, 2003, AltaLIS, 2013, IHS Inc., 2011, BC FLNRO, 2007 & ESRI, 2005; First Nation Lands: Government of Canada, 2013, AltaLIS, 2010 & IHS Inc., 2011; Hydrology: Natural Resources Canada, 2007 & BC Crown Registry and Geographic Base Branch, 2008; Parks and Protected Areas: Natural Resources Canada, 2012, AltaLIS, 2012 & BC FLNRO, 2008; ATS Grid: AltaLIS, 2009; Edmonton TUC: Alberta Infrstructure, 2011; Canadian Hillshade: TERA Environmental Consultants, 2008; US Hillshade: ESRI, 2009.

TERA ENVIRONMENTAL CONSULTANTS

TRANS MOUNTAIN

FIGURE 5.10-2

WILDLIFE STUDY AREAS - HARGREAVES TO DARFIELD

TRANS MOUNTAIN EXPANSION PROJECT

MAP NUMBER		PAGE
201310_MAP_TERA_WL_00449_REV0_02		SHEET 2 OF 4
DATE: December 2013	TERA REF.: 7894	REVISION: 0
SCALE: 1:750,000	PAGE SIZE: 11x17	DISCIPLINE: WL
DRAWN: AJS	CHECKED: TGG	DESIGN: TGG

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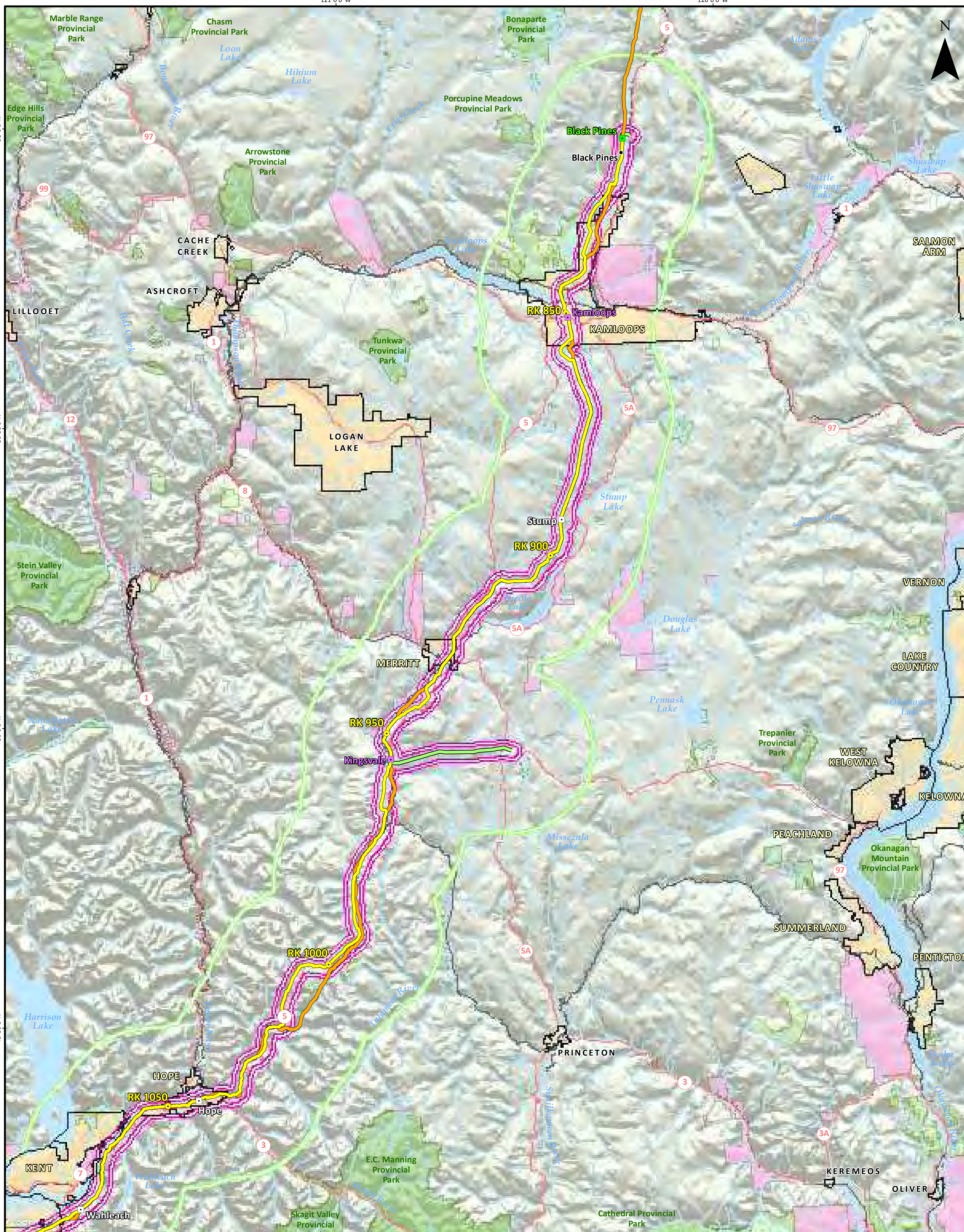
ALL LOCATIONS APPROXIMATE



Legend

- Village / Hamlet
- Reference Kilometre Post (RK)
- Trans Mountain Pipeline (TMPL)
- Trans Mountain Expansion Project Proposed Pipeline Corridor
- Proposed Power Line
- Terminal
- Pump Station (Pump Additions, Station Modifications and/or Scraper Facilities)
- New Pump Station (Proposed)
- Pump Station (Reactivated)
- Existing Pump Station
- Highway
- Railway
- Wildlife 2 km LSA
- Wildlife 30 km RSA
- City / Town / District Municipality
- Indian Reserve / Métis Settlement
- National Park
- Provincial Park
- Protected Area / Natural Area / Provincial Recreation Area / Wilderness Provincial Park / Conservancy Area

TRANS MOUNTAIN

FIGURE 5.10-3

WILDLIFE STUDY AREAS - BLACK PINES TO HOPE

TRANS MOUNTAIN EXPANSION PROJECT

Projection: NAD 1983 UTM 11N. Baseline TMPL & Facilities: provided by KMC, 2012; Proposed Pipeline Corridor V6: provided by UPI, Aug. 23, 2013; Transportation: IHS Inc., 2013, BC Forests, Lands and Natural Resource Operations, 2012 & Natural Resources Canada, 2012; Geopolitical Boundaries: Natural Resources Canada, 2003, AltaLIS, 2013, IHS Inc., 2011, BC FLNRO, 2007 & ESRI, 2005; First Nation Lands: Government of Canada, 2013, AltaLIS, 2010 & IHS Inc., 2011; Hydrology: Natural Resources Canada, 2007 & BC Crown Registry and Geographic Base Branch, 2008; Parks and Protected Areas: Natural Resources Canada, 2012, AltaLIS, 2012 & BC FLNRO, 2008; ATS Grid: AltaLIS, 2009; Edmonton TUC: Alberta Infrstructure, 2011; Canadian Hillshade: TERA Environmental Consultants, 2008; US Hillshade: ESRI, 2009.

MAP NUMBER		PAGE
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DATE: December 2013	TERA REF.: 7894	REVISION: 0
SCALE: 1:700,000	PAGE SIZE: 11x17	DISCIPLINE: WL
DRAWN: AJS	CHECKED: TGG	DESIGN: TGG

0 10 20 30 Km

ALL LOCATIONS APPROXIMATE

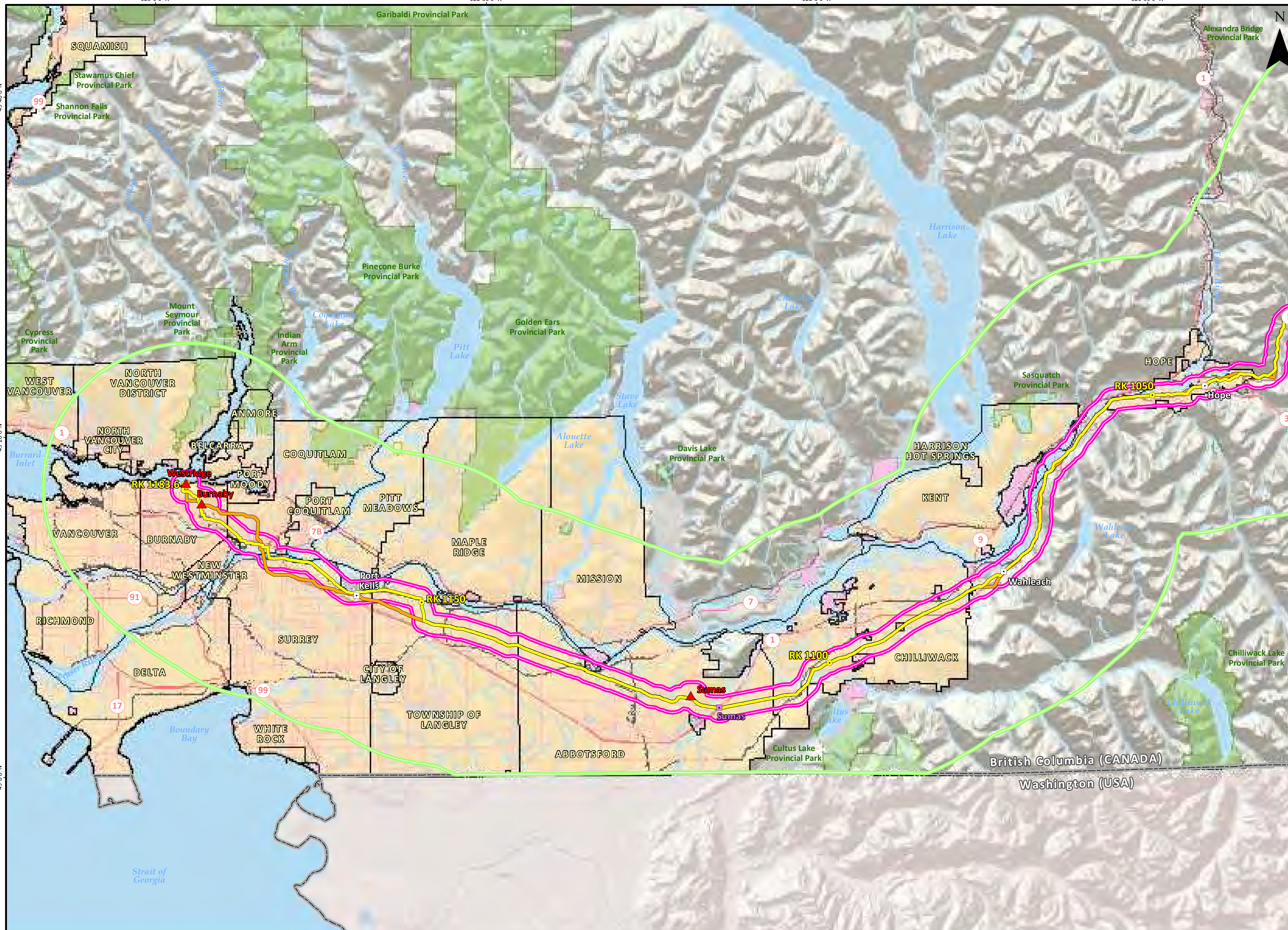
tera ENVIRONMENTAL CONSULTANTS

TRANS MOUNTAIN

FIGURE 5.10-4

WILDLIFE STUDY AREAS - HOPE TO WESTRIDGE

TRANS MOUNTAIN EXPANSION PROJECT



	Reference Kilometre Post (RK)
	Trans Mountain Pipeline (TMPL)
	Trans Mountain Expansion Project Proposed Pipeline Corridor
	Terminal
	Pump Station (Pump Additions, Station Modifications and/or Scraper Facilities)
	New Pump Station (Proposed)
	Pump Station (Reactivated)
	Existing Pump Station
	Highway
	Railway
	Wildlife 2 km LSA
	Wildlife 30 km RSA
	City / Town / District Municipality
	Indian Reserve / Métis Settlement
	National Park
	Provincial Park
	Protected Area / Natural Area / Provincial Recreation Area / Wilderness Provincial Park / Conservancy Area
	International Boundary

Projection: NAD83 UTM Zone 11N. Routing: Baseline TMPL & Facilities: provided by KMC, 2012; Proposed Pipeline Corridor V6: provided by UPI, Aug. 23, 2013; Transportation: IHS Inc., 2013, BC Forests, Lands and Natural Resource Operations, 2012 & Natural Resources Canada, 2012; Geopolitical Boundaries: Natural Resources Canada, 2003, AltaLIS, 2013, IHS Inc., 2011, BC FLNRO, 2007 & ESRI, 2005; First Nation Lands: Government of Canada, 2013, AltaLIS, 2010 & IHS Inc., 2011; Hydrology: Natural Resources Canada, 2007 & BC Crown Registry and Geographic Base Branch, 2008; Parks and Protected Areas: Natural Resources Canada, 2012, AltaLIS, 2012 & BC FLNRO, 2008; ATS Grid: AltaLIS, 2009; Edmonton TUC: Alberta Infrstructure, 2011; Canadian Hillshade: TERA Environmental Consultants, 2008; US Hillshade: Service Layer Credits: Copyright:© 2013 Esri.

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Although there is no reason to believe that there are any errors associated with the data used to generate this product or in the product itself, users of these data are advised that errors in the data may be present.

MAP NUMBER		PAGE
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DATE December 2013	TERA REF. 7894	REVISION 0
SCALE 1:400,000	PAGE SIZE 11x17	DISCIPLINE WL
DRAWN AJS	CHECKED TGG	DESIGN TGG

0 5 10 15 km

ALL LOCATIONS APPROXIMATE

201310_MAP_TERA_WL_00449_Rev0_04.mxd

The indicators selected for this element are listed below:

- grizzly bear;
- moose;
- woodland caribou;
- forest furbearers;
- coastal riparian small mammals;
- bats;
- grassland/shrub steppe birds;
- mature/old forest birds;
- early seral forest birds;
- riparian and wetland birds;
- wood warblers;
- short-eared owl;
- rusty blackbird;
- flammulated owl;
- Lewis's woodpecker;
- Williamson's sapsucker;
- western screech owl;
- great blue heron;
- spotted owl;
- bald eagle;
- common nighthawk;
- northern goshawk;
- olive-sided flycatcher;
- pond-dwelling amphibians;
- stream-dwelling amphibians; and
- arid habitat snakes.

The rationale for the selection of indicators is provided in Section 7.2.10. The potential Project-related effects and mitigation pertaining to wildlife and wildlife habitat are discussed in Section 7.2.10. Refer to the Wildlife Technical Report of Volume 5C for additional details on existing conditions for wildlife and wildlife habitat.

Detailed species accounts were prepared and wildlife habitat models were completed to estimate wildlife habitat effectiveness within the Wildlife LSA. The full report can be found in the Wildlife Modelling and Species Accounts Technical Report (Volume 5C).

5.10.1 Edmonton to Hinton Segment

The Edmonton to Hinton Segment crosses a mosaic of land uses and habitat types, including suburban areas associated with cities and towns, agricultural fields (*i.e.*, cultivation and hay fields), pasture and forested areas. Suburban and agricultural areas are predominant along the east end of this segment, whereas forested areas are predominant along the west end. These areas include sections of deciduous, coniferous and mixedwood forest consisting of trembling aspen, white spruce, black spruce, jack pine, balsam fir and less commonly balsam poplar and paper birch. Forest harvesting activities have occurred in upland mixedwood forests and these areas are at various stages of regeneration. The Edmonton to Hinton Segment crosses two wildfire burns that occurred within the last 40 years: 2009 (RK 188.7 to RK 189.4); and 2010 (RK 135.9 to 136.3) (AESRD 2013f). Most of the wetlands crossed or located in the vicinity of the proposed pipeline segment are surrounded by cultivation or tame pasture with larger expanses of treed bogs and fens encountered towards the western half of the proposed pipeline segment. Terrain is generally level to gently undulating along the Edmonton to Hinton Segment with moderate to steep slopes encountered at watercourse crossings (*i.e.*, the North Saskatchewan, Pembina and McLeod rivers) and gently to moderately undulating terrain within the Lower Foothills and Montane natural subregions.

The following subsections describe the provincially identified wildlife areas, Environmentally Significant Areas, parks and protected areas, PNTs, species with special conservation status and ATK and TEK along the Edmonton to Hinton Segment.

5.10.1.1 Provincially Identified Wildlife Areas

A summary of provincially identified wildlife areas in relation to the Edmonton to Hinton Segment is provided in Table 5.10-1.

TABLE 5.10-1

PROVINCIALLY IDENTIFIED WILDLIFE AREAS – EDMONTON TO HINTON SEGMENT

Wildlife Area	Detail	Legal Location	RK Range	Approximate Length (km)
Key Wildlife and Biodiversity Zone	North Saskatchewan River	3 and 4-52-25 W4M	32.8 to 34.1	1.3
	North Saskatchewan River	NW 8-52-25 W4M	36.6 to 37.1	0.5
	Athabasca River	1-10-52-24 W5M to 16-32-51-24 W5M	307.5 to 311.5	3.7
Special Access Area	--	7-4-53-22 W5M to 12-36-52-23 W5M	286.8 to 292.5	5.9
		16-25-50-26 W5M to 11-33-49-26 W5M	329.0 to 339.6	10.6
Grizzly Bear Secondary Area	Grande Cache Population Unit	4-27-52-23 W5M to 11-33-49-26 W5M	297.2 to 339.6	40.4
Sensitive Raptor Range	Bald Eagle	4-5-53-23 W4M to 11-2-53-1 W5M	0.0 to 68.8	68.8
Sharp-Tailed Grouse Range	--	4-5-53-23 W4M to 14-2-53-1 W5M	0.0 to 68.8	68.8
Trumpeter Swan Waterbody	Unnamed Lake (400 m from pipeline corridor)	SW 22-53-18 W5M	241.4 to 243.1	1.7
	Annabel Lake (700 m from pipeline corridor)	34-52-19 W5M	253.9 to 254.6	0.7
	Unnamed Lake (200 m from pipeline corridor)	W 5-53-19 W5M	256.8 to 258.6	1.8

Source: AESRD 2013g

5.10.1.2 Environmentally Significant Areas

The proposed Edmonton to Hinton Segment is located within five provincial Environmentally Significant Areas (70, 99, 441, 442, 690) (Fiera Biological Consulting 2009). The details are provided in the Wildlife Technical Report of Volume 5C. Environmentally Significant Areas do not have regulatory guidelines or development restrictions.

5.10.1.3 Parks and Protected Areas

The proposed pipeline corridor is not located within a provincial park in this segment but is located near to Wabamun Lake and Obed Lake provincial parks and the Yates Natural Area. It is also located within the DUC Level 1 Priority Landscapes, Prairie Pothole Region and Western Boreal Forest. The Prairie Pothole Region is a primary breeding area for waterfowl and the Western Boreal Forest provides breeding, migration, moulting and staging habitat for waterfowl (DUC 2013). The proposed pipeline corridor is not located within or adjacent to an IBA, Migratory Bird Sanctuary, National Wildlife Area, Western Hemisphere Shorebird Reserve, Ramsar wetland or Biosphere Reserve (AltaLIS 2008, Bird Studies Canada and Nature Canada 2012, Bureau of the Convention on Wetlands 2013, Environment Canada 2012n, United Nations Educational, Scientific and Cultural Organization [UNESCO] 2012, WHSRN 2013).

5.10.1.4 Protective Notation

A search of the GLIMPS for wildlife-related Crown dispositions identified 10 PNTs that are crossed by the Edmonton to Hinton Segment (Alberta Energy 2013). Table 5.10-2 describes the PNTs that are held by the AESRD Fish and Wildlife Division pertaining to habitat conservation.

TABLE 5.10-2

PNTS FOR WILDLIFE HABITAT – EDMONTON TO HINTON SEGMENT

Code	Type	Legal Location	RK Range	Activity Detail Information and Relevance to the Project[1]
PNT 980061	PNT (Fragmented Land Pattern)	NW 13-53-6 W5M	118.1 to 118.9	Activity Detail Information: N/A Relevance to Project: Forested. Railway runs southeast to northwest across quarter-section. Proposed corridor parallels the existing TMPL right-of-way.
PNT 870456	PNT (Ungulate Winter Range [UWR])	NW 22-53-10 W5M	161.0 to 161.8	Activity Detail Information: N/A Relevance to Project: Forested. Proposed corridor parallels the existing TMPL right-of-way.
PNT 780290	PNT (Fish and Wildlife Resource Management Area)	SW 35-53-13 W5M	189.1 to 189.9	Activity Detail Information: N/A Relevance to Project: Forested. Proposed corridor parallels the existing TMPL right-of-way.
PNT 980160	PNT (Research Site Structure)	NE 12-51-25 W5M	319.3 to 319.9	Activity Detail Information: Exclosure established to determine the effects of wildlife and horse grazing on tree regeneration and species composition in a regenerating black spruce-white spruce forest. Relevance to Project: Forested. New clearing required.
PNT 020232	PNT (Rare and Endangered Species Habitat Protection Area)	NW 3-50-26 W5M	336.9 to 337.8	Activity Detail Information: Fish and Wildlife Division recommends the following conditions be applied near long-toed salamander breeding ponds through the land use permit system: 1) April 1 to Sept 30 (breeding season), no activity within 100 m of the water's edge of identified ponds; 2) no roads, wells, or pipelines within 100 m of the water's edge of identified ponds; 3) seismic lines must be hand-cut within 100 m of the water's edge of identified ponds; 4) no timber harvesting within 100 m of the water's edge of identified ponds; and 5) no grazing or range improvements. Contact: Regional Endangered species specialist in Edson. Relevance to Project: Forested. Proposed corridor parallels the existing TMPL right-of-way.

TABLE 5.10-2 Cont'd

Code	Type	Legal Location	RK Range	Activity Detail Information and Relevance to the Project[1]
PNT 970253	PNT (Habitat Management Area)	SE 4-50-26 W5M	337.8	Activity Detail Information: "Wildlife Study Plots of Camp 1. Clear cuts and mature forests." Project monitors vegetation changes over time. No development which vegetation will be altered. Note: This study is no longer active and the PNT will likely be removed (Hobson, pers. comm.) Relevance to Project: Forested. Proposed corridor parallels the existing TMPL right-of-way.

Source: Alberta Energy 2013

Note: 1 Activity detail information as provided in the PNT (Alberta Energy 2013), N/A = no activity detail information provided.

5.10.1.5 Species with Special Conservation Status

A desktop review of the potential wildlife species of concern list found that species with special conservation status that are provincially-listed (AESRD 2012b) or federally-listed on Schedule 1 of *SARA* (Environment Canada 2013o) or by COSEWIC (2013a) that have potential to occur along the Edmonton to Hinton Segment are listed in Table 5.10-3. A search of the Fisheries and Wildlife Management Information System (FWMIS) records identified occurrences of provincially and federally-listed wildlife species of concern (AESRD 2012c) (Table 5.10-3).

TABLE 5.10-3

SPECIES WITH SPECIAL CONSERVATION STATUS – EDMONTON TO HINTON SEGMENT

Common Name	Provincial Designations	Federal Designations
BIRDS		
Bank swallow	S5[1] Secure[3]	Threatened[5]
Barn swallow	S4 (W)[1] Sensitive[3]	Threatened[5]
Barred owl	S3S4 (W)[1] Special Concern[2] Sensitive[3]	--
Bobolink	S2S3 (W)[1] Sensitive[3]	Threatened[5]
Canada warbler	S3S4 (T)[1] Sensitive[3]	Threatened[4,5]
Common nighthawk	S4 (T)[1] Sensitive[3]	Threatened[4,5]
Harlequin duck	S3 (T)[1] Special Concern[2] Sensitive[3]	--
Horned grebe	S3 (W)[1] Sensitive[3]	Special Concern[5]
Lewis's woodpecker	SU (W)[1] Sensitive[3]	Threatened[4,5]
Loggerhead shrike	S3 (T)[1] Special Concern[2] Sensitive[3]	Threatened[4,5]
Olive-sided flycatcher	S3 (T)[1] May Be at Risk[3]	Threatened[4,5]
Peregrine falcon, *anatum* ssp.	S2S3[1] Threatened[2] At Risk[3]	Special Concern[4,5]
Rusty blackbird	S4 (T)[1] Sensitive[3]	Special Concern[4,5]
Short-eared owl	S3 (T)[1] May Be at Risk[3]	Special Concern[4,5]
Sprague's pipit	S3S4 (T)[1] Special Concern[2] Sensitive[3]	Threatened[4,5]
Trumpeter swan	S2S3 (T)[1] Threatened[2] At Risk[3]	Not at Risk[5]
Western grebe	S3 (W)[1] Special Concern[2] Sensitive[3]	--
White-winged scoter	S3S4 (W)[1] Special Concern[2] Sensitive[3]	--
Yellow rail	SU (T)[1]	Special Concern[4,5]
MAMMALS		
American badger, *taxus* ssp.	S4[1] Sensitive[3]	Special Concern[5]
Grizzly bear, western population	S2 (T)[1] Threatened[2] At Risk[3]	Special Concern[5]
Little brown myotis	S5 (T.h)[1] Secure[3]	Endangered[5]
Northern myotis	S2S3 (T.h)[1] May Be at Risk[3]	Endangered[5]

TABLE 5.10-3 Cont'd

Common Name	Provincial Designations	Federal Designations
Vagrant shrew	S1 (T)[1] May Be at Risk[3]	--
Wolverine	S3 (T)[1] May Be at Risk[3]	Special Concern[5]
REPTILES AND AMPHIBIANS		
Canadian toad	S3 (T)[1] May Be at Risk[3]	Not at Risk[5]
Long-toed salamander	S3 (T)[1] Special Concern[2] Sensitive[3]	--
Tiger salamander	S4[1] Secure[3]	Special Concern[5]
Western toad	S3 (T)[1] Sensitive[3]	Special Concern[4,5]
INVERTEBRATES		
Monarch	S3[1] Sensitive[3]	Special Concern[4,5]

Notes: Definitions of Status Designations are provided in Appendix C of the Wildlife Technical report of Volume 5C. Federal ratings are current to November 2013.

1 Provincial (S) rank assigned by ACIMS (2013).

2 Species listed under the Alberta *Wildlife Act* and *Wildlife Regulation* (AESRD 2012d).

3 Status designation assigned in *The 2010 General Status of Alberta Wild Species* (ASRD 2011).

4 Species listed under Schedule 1 of *SARA* (Environment Canada 2013o).

5 Species listed under COSEWIC (2013a).

5.10.1.6 Traditional Ecological Knowledge

Evidence of ungulate species was observed by TEK participants during the field studies along the Edmonton to Hinton Segment. Deer, elk and moose, historically and today, remain a traditional food source of Aboriginal people. Participants described that these ungulates use mineral licks to ingest salt from the mud, to retain water and prevent dehydration. Mineral licks are often found in wetlands and, in general, game trails will lead to mineral licks.

Moose will often travel long distances to find food preferring wetland habitat, but also have the ability to adapt to new habitats when there are limited resources or when industrial and commercial development occurs. During the rutting season in September and October, moose seek low-lying areas with water. Moose travel upwind when looking for food and travel downwind when injured, also seeking out higher ground to pick up scents from the wind to determine where to feed or bed. Participants report that contaminated vegetation is leading to contaminated moose meat, as well as moose that appear thinner and sickly. Participants stated that human health will be affected by animal health since everything is connected and that the health of the animals depends on the health of the land.

Evidence of gray wolf, fox and coyote were identified along the Edmonton to Hinton Segment and included tracks, scat, fur, dens and kill sites. Participants explained that these canines typically den on higher ground, below tree roots (to avoid cave-ins), in remote locations with abundant food sources and water nearby. Sometimes hollowed out trees are used as dens and shelter. Wolf and fox dens generally have two holes, thought to be emergency exits to escape predators. Coyotes and foxes will use their dens for long periods of time and will only abandon the den if disturbed. Abandoned fox dens may sometimes be used by coyotes and badgers. Fox and coyote eat small mammals such as mice, ducklings, duck and grouse. In the winter, the canines will forage for pine needles and dig up food from the ground. Participants noted that a change in weather is coming when coyotes howl. There is a healthy wolf population in the region and participants believe wolves are responsible for the decrease in elk and deer populations. Participants shared that wolves have a varied diet and prey upon geese, ducks, small mammals, plants, moose calves, coyote and even other wolves. On occasion, wolves are known to scavenge other animals' kills. Wolves migrate as a pack and typically hunt alone, except when hunting large animals. The wolf plays a part in Cree tradition representing the hunter and, historically, wolf skins were worn while hunting to sneak up on game.

Participants observed evidence of black bear and grizzly bear along the Edmonton to Hinton Segment, including scat, tracks, dens, chewed or clawed logs and claw marks on trees. Typically, claw marks on trees indicate a den is nearby, since bears do not tend to wander far from where they mark. Clawing trees is a way for bears to mark their territories and sharpen their claws. These claw marks can reach 9 m up the trunk. Black bears will also dig up spots at the bases of trees to mark their territory. Black bears prefer to den on ridges, while grizzlies are found in lower-lying, valley lands of the Rocky Mountains. Grizzly bears travel long distances to hibernate and will mate at higher elevations. Hibernation begins with the first frost in the fall and ends in the spring. Bears are considered sacred animals and while rarely hunted today, bear hides were once traditionally worn while hunting or worn for protection and decorated with feathers and beads.

Participants reported that both beaver and muskrat are reluctant to travel far on land for fear of predators, therefore, they tend to eat berries and vegetation that grow close to the ground and in aquatic environments. Wetlands are ideal habitat for these mammals, since they are close to the water and are abundant in lush vegetation to eat such as young willow and bulrush. Both animals can be dangerous when threatened and will spring up on their tails to bite. Beavers, known in Stoney as “chaba”, will also use their tails to slap the water to warn of predators. Felled trees, teeth marks on the ends of trees and beaver stumps are evidence of beaver habitat. The felled trees are dragged to the beaver dam to establish and build up their dams, often inhabiting the same area for up to 5 years. Participants shared that the length of winter can be predicted by the amount of food beavers collect. Typically, if a beaver dam is torn down in the spring, the beaver will relocate and make a new dam. Fall is thought to be the worst time to tear down a dam, since the beaver will have nowhere to rebuild in time for winter.

Members of the weasel family were identified during the field studies along the Edmonton to Hinton Segment, including marten, mink, wolverine, otter, badger and skunk. These mammals are carnivorous and, on some occasions, scavenge for food. Participants shared that these animals are not trapped very often anymore since fur prices and demand are low. Ideal habitat for these mammals is characterized by larger spruce trees and areas with abundant squirrel activity. Marten fur is the thickest in spring and fall since they tend to prey on grouse and squirrel. Martens and mink prey on beavers as well. Wolverines remain close to forested habitats to hunt small prey. Badgers will make their homes near water if there is abundant prey to hunt, bark to eat and trees for shade.

Signs of squirrel were identified during the field studies along the Edmonton to Hinton Segment, including middens, lodges, holes and nests. Squirrel lodges consist of holes scattered throughout the forest floor, indicating underground tunnels and evidence of the squirrel’s search for pine and spruce cones, seeds and nuts. These small furbearers will stock pile cones, nuts and mushrooms in their tunnels under the snow. Participants reported that squirrels also eat antlers that have been shed on the forest floor since antlers provide needed dietary minerals. Nests are found at the base of trees or high in the branches and are easily recognizable by piles of pine cones nearby. Squirrel middens are piles of leaves and pine, and spruce cone pieces left by squirrels, becoming quite large and indicating the presence of several generations of squirrels. Squirrels also use middens to stockpile food and the length of winter can be predicted by the size of a squirrel’s midden. Squirrels are a traditional food source for Cree people and are eaten when large game is not available. Squirrels are also important for conducting certain traditional ceremonies.

Evidence of rabbit signs, including trails, droppings and fur, were identified during field studies along the Edmonton to Hinton Segment. Moist, open areas near water with soft moss on the ground and tree cover characterize ideal rabbit habitat. Tree cover is used to hide from predators, the lush vegetation for sustenance and the soft, mossy ground to den. Rabbit diets consist of mushrooms, tree bark, roots, grass, Labrador tea, spruce and pine bark, and willow and poplar branches. Rabbits eat tree bark and branches in the winter when vegetation is sparse. Participants shared that watching which mushrooms a rabbit consumes helps to determine which mushrooms are poisonous, since rabbits will not eat poisonous varieties. Rabbits dig their own rabbit holes instead of using existing holes from other animals, protecting the rabbit from predators that may return. Rabbits are preyed on by coyotes and lynx.

Cougar tracks were identified during the field studies along the Edmonton to Hinton Segment and participants reported that cougars travel over a broad range of habitat, including grasslands, water, forest, hills and ridges. Cougars will dig out their dens on the side of ridges and their diet consists of large and small prey. Cougar tracks are heavier in snow than lynx or bobcat and cougars typically do not “drag tail”, unless the snow is deep. When sick or injured, cougars are sometimes spotted near residential areas. Lynx and bobcat signs were also observed and, like cougars, these cats prefer habitats with an ample water supply, grasslands and forest.

Birds of prey, including golden and bald eagle, red-tailed hawk and osprey, were identified during the field studies along the Edmonton to Hinton Segment. Participants reported that these birds tend make their nests high in pine trees along river banks. Eggs will hatch in spring and the young eaglets will leave the nest by mid-July, often returning to the same area where they were hatched, later in life. Osprey and eagle hunt for fish along large watercourses, especially when fish are spawning. Hawks are territorial birds and fiercely defend their territories from other birds like the raven. Hawks prefer to nest near water and open fields ideal for hunting rodents. Not all hawks will migrate in the winter, instead they will take shelter in thick trees. Red-tailed hawks typically make their nests in poplar trees since the trees have strong branches. When a hawk feels threatened, it circles and chirps a warning. Participants reported that the most important bird, for cultural reasons, is the bald eagle. If a dead eagle is found, the bird must be placed in a fire in order for its spirit to rise. While rarely hunted, a ceremony will be held before the eagle is hunted and a bald eagle sighting represents good luck. The eagle symbolizes the thunder bird and the feather can represent the initiation to womanhood or wisdom. Eagle feathers are used as a decorative detail in dance regalia. Different feathers are used for different parts of the regalia. Traditionally, the feathers from only one bird are used so the dress looks uniform. The feathers play an important role in ceremonies and powwows. Eagle bones have customary uses also, for example, the smaller bones under the wing are used for traditional jewellery. The bones are filed down and soaked in bleach. The larger, longer bones are used as whistles for ceremonial gatherings.

Several birds, including ducks and geese species such as woodpecker, owls, swallows, red-winged black birds, wrens, chickadees, Wilson snipes/rain birds, herons and cranes, grouse/bush chicken, Canada geese, mallard ducks, loons and mud hens, were observed during the field studies along the Edmonton to Hinton Segment. Participants reported that the numerous sightings are due to the abundance of watercourses and tree species, including spruce, that make for good nesting sites. “Nee-pin” in Cree means spring and chickadees are called spring birds since their call sounds like “nee-pin”. Participants shared that great horned owls are considered important messengers in Cree culture. Owls do not store food for the winter and, instead, hunt year-round. Grouse or bush chickens nest in muskeg areas and are able to travel effectively through mossy terrain. Their diet includes cranberries, blueberries and gooseberries. Like the partridge, grouse lay their eggs on the ground at the base of trees. Dyed grouse feathers are used in regalia decoration and women will decorate their braids with grouse feathers.

Downy, red-headed and pileated woodpeckers were identified during the field studies along the Edmonton to Hinton Segment and participants report that woodpeckers are important in Cree culture; they are believed to be spiritual messengers. The woodpecker’s diet consist of ants, pine beetles, termites and worms found in a variety of tree species, however, woodpeckers prefer softwood trees like poplar to make their homes.

Detailed TEK methods and results are provided in the Wildlife Technical Report (Volume 5C).

5.10.2 Hargreaves to Darfield Segment

The Hargreaves to Darfield Segment crosses a mosaic of land uses and habitat types, including suburban areas associated with cities and towns, agricultural fields, pasture and forested areas. Agricultural areas are generally located within the vicinity of towns and cities. Forested areas generally consist of Douglas-fir, Engelmann spruce, white spruce, lodgepole pine and trembling aspen with PP encountered on warm dry slopes towards the southern end of the proposed pipeline segment. There are a number of cutblocks in various stages of regeneration along this segment and selective harvesting occurs in many areas. The Hargreaves to Darfield Segment crosses two wildfire burns that occurred within the last 40 years: 1998 (RK 639.6 to RK 647.3); and 2007 (RK 706.4 to RK 706.5) (BC MFLNRO 2013). Wetlands encountered along the Hargreaves to Darfield Segment are generally associated with streams and oxbow lakes, with a small number of shrubby/treed fens and bogs. Terrain varies from flat to gently undulating on wide valley bottoms to moderately undulating hills and steeper slopes along some watercourses and narrow valleys.

The following subsections describe the provincially identified wildlife areas, parks and protected areas, species with special conservation status, and ATK and TEK along the Hargreaves to Darfield Segment.

5.10.2.1 Provincially Identified Wildlife Areas

A summary of provincially identified wildlife areas that are crossed by the Hargreaves to Darfield Segment is provided in Table 5.10-4.

TABLE 5.10-4

PROVINCIALLY IDENTIFIED WILDLIFE AREAS ALONG THE HARGREAVES TO DARFIELD SEGMENT

Wildlife Area	Legal Location	RK Range	Approximate Length (km)
Caribou Range – Wells Gray[1]	b-53-G/83-D-11 to a-42-G/83-D-11	550.0 to 551.6	1.6
	b-41-J/83-D-6 to d-49-J/83-D-3	573.1 to 602.7	29.6
Caribou Range – Groundhog[1]	d-86-K/82-M-14 to c-26-K/82-M-14	629.8 to 635.8	6.0
	a-7-K/82-M-14 to c-65-F/82-M-14	638.8 to 642.3	3.5
	c-24-F/82-M-14 to a-24-F/82-M-14	645.9 to 646.3	0.4
	c-93-C/82-M-14 to b-93-C/82-M-14	649.1 to 649.4	0.3
UWR (u-3-004 for mountain caribou)[2] Located within Wells Gray Caribou Range	a-75-B/83-D-6 to b-75-B/83-D-6	590.0 to 590.2	0.2
	d-26-B/83-D-6 to b-16-B/83-D-6	594.4 to 595.9	1.5
	a-7-B/83-D-6 to a-78-J/83-D-3	597.3 to 600.0	2.7

Notes: 1 Caribou herd ranges defined by BC MOE (2010).
2 UWRs defined by BC MOE (2012a).

5.10.2.2 Parks and Protected Areas

The proposed pipeline corridor is located within the Finn Creek and North Thompson River provincial parks and is adjacent to the Jackman Flats and Blue River Black Spruce provincial parks. The proposed pipeline corridor is not located within or adjacent to an IBA, DUC Priority Area, Migratory Bird Sanctuary, National Wildlife Area, Western Hemisphere Shorebird Reserve, Ramsar wetland or Biosphere Reserve (Bird Studies Canada and Nature Canada 2012, Bureau of the Convention on Wetlands 2013, DUC 2013, Environment Canada 2013n, UNESCO 2012, WHSRN 2013).

5.10.2.3 Species with Special Conservation Status

A desktop review of the potential wildlife species of concern list found that species with special conservation status that are provincially-listed (BC CDC 2013a,b) or federally-listed on Schedule 1 of *SARA* (Environment Canada 2013o) or by COSEWIC (2013a) that have potential to occur along the Hargreaves to Darfield Segment are listed in Table 5.10-5. A search of the BC CDC records identified occurrences of provincially and federally-listed wildlife species of concern (BC CDC 2013b) (Table 5.10-5).

TABLE 5.10-5

SPECIES WITH SPECIAL CONSERVATION STATUS – HARGREAVES TO DARFIELD SEGMENT

Common Name	Provincial Designations	Federal Designations
BIRDS		
American avocet	S2S3B[1] Blue[3] Priority 2[4] Goal 3[4]	--

TABLE 5.10-5 Cont'd

Common Name	Provincial Designations	Federal Designations
American bittern	S3B[1] Blue[3] Priority 2[4] Goal 2[4]	--
Bank swallow	S4S5B[1] Yellow[3] Priority 5[4] Goal 1,3[4]	Threatened[6]
Barn swallow	S3S4B[1] Blue[3] Priority 2[4] Goal 2[4]	Threatened[6]
California gull	S3B[1] Blue[3] Priority 4[4] Goal 3[4]	--
Common nighthawk	S4B[1] Yellow[3] Priority 2[4] Goal 2[4]	Threatened[5,6]
Horned grebe	S4B[1] Yellow[3] Priority 4[4] Goal 1,2[4]	Special Concern[6]
Horned lark, *merrilli* subspecies	S3S4B[1] Blue[3] Priority 4[4] Goal 2,3[4]	--
Long-billed curlew	S3B[1] Blue[3] Priority 2[4] Goal 2[4]	Special Concern[5,6]
Long-tailed duck	S2S3B,S4N[1] Blue[3] Priority 2[4] Goal 3[4]	--
Olive-sided flycatcher	S3S4B[1] Blue[3] Priority 2[4] Goal 2[4]	Threatened[5,6]
Rusty blackbird	S3S4B[1] Blue[3] Priority 2[4] Goal 2[4]	Special Concern[5,6]
Short-eared owl	S3B,S2N[1] Blue[3] Priority 2[4] Goal 2[4]	Special Concern[5,6]
Surf scoter	S3B,S4N[1] Blue[3] Priority 4[4] Goal 2,3[4]	--
Upland sandpiper	S1S2B[1] Red[3] Priority 1[4] Goal 3[4]	--
Western grebe	S1B,S2N[1] Red[3] Priority 1[4] Goal 3[4]	--

TABLE 5.10-5 Cont'd

Common Name	Provincial Designations	Federal Designations
MAMMALS		
Fisher	S2S3[1] Blue[3] Priority 2[4] Goal 3[4]	--
Grizzly bear, western population	S3[1] Blue[3] Priority 2[4] Goal 2[4]	Special Concern[6]
Little brown myotis	S4[1] Yellow[3] Priority 5[4] Goal 3[4]	Endangered[6]
Northern myotis	S2S4[1] Blue[3] Priority 2[4] Goal 3[4]	Endangered[6]
Townsend's big-eared bat	S3[1] Blue[3] Priority 2[4] Goal 2[4]	--
Wolverine, *luscus* ssp.	S3[1] Blue[3] Priority 2[4] Goal 2[4]	Special Concern[6]
Woodland caribou, southern mountain population	S1[1] Red[3] Priority 2[4] Goal 1,3[4]	Threatened[5,6]
REPTILES AND AMPHIBIANS		
Great Basin gopher snake, *deserticola* ssp.	S2S3[1] Blue[3] Priority 2[4] Goal 3[4]	Threatened[5,6]
Painted turtle, Intermountain-Rocky Mountain population	S2S3[1] Blue[3] Priority 2[4] Goal 3[4]	Special Concern[5,6]
Northern rubber boa	S4[1] Yellow[3] Priority 1[4] Goal 2[4]	Special Concern[5,6]
Western toad	S3S4[1] Blue[3] Priority 2[4] Goal 2[4]	Special Concern[5,6]
INVERTEBRATES		
Magnum mantleslug	S2S3[1] Blue[3] Priority 2[4] Goal 3[4]	Special Concern[6]
Monarch	S3B[1] Blue[3] Priority 2[4] Goal 2[4]	Special Concern[5,6]

Notes: Definitions of Status Designations are provided in Appendix C of the Wildlife Technical report of Volume 5C. Federal ratings are current to November 2013.

1 Provincial (S) rank assigned by the BC CDC (2013a).

2 Species listed under the BC *Wildlife Act* (BC CDC 2013a).

TABLE 5.10-5 Cont'd

3 Provincial Red and Blue designations assigned by BC CDC (2013b).

4 Conservation goals and priorities established under the BC Conservation Framework (BC MOE 2009b,c).

5 Species listed under Schedule 1 of *SARA* (Environment Canada 2013o).

6 Species listed under COSEWIC (2013a).

5.10.2.4 Traditional Ecological Knowledge

During the field studies along the Hargreaves to Darfield Segment, participants described that interconnectedness exists in the forest between all elements of the ecosystem, including humans. Most wildlife will spend most of their time in the hills and mountains, moving to lower elevations if in need of food.

In September, large game like moose, elk and deer are mating. Large game will be aggressive during the fall rut and they will also be aggressive during the spring when their offspring are born. Before the fall rut, bull elk, moose and deer can be seen with velvet hanging off of their antlers. Mineral licks are used by ungulates like sheep, goats, elk and deer. Participants shared that Elders will not usually hunt at salt licks since it is unfair to hunt easy prey. Predators will hunt at mineral licks which are usually found in soils with heavy clay and calcium content. Animals will frequent mineral licks all year long.

Participants reported that the valley along the North Thompson River is a wildlife corridor. Animals make dens underground, in hollow trees and under boulders. Animals that use dens and wildlife trees include bats, chipmunks, owls, squirrels, flying squirrels, badgers, woodpeckers, bears, rabbits, hares, voles, porcupines, lynx, wolves, coyotes, wolverines and martens. Scaly bark is an indication of a wildlife tree, since scaly bark is good for bats and perching birds. Perching trees, used by hawks and owls, have more branches and leaves than wildlife trees. It is possible to identify an active cavity nest by the presence of whitewash around the hole. Birds often try to lead predators away from their nests by pretending that they are injured.

Shrubs, bark, willow, spruce, wild rhubarb, fireweed, skunk cabbage and lilies are eaten by moose. Moose eat the bark and cambium of trees like balsam fir. Foliage that has been grazed upon by moose can be identified by the height and roughness of foliage chewed. The amount of grazing in an area can indicate whether moose use the area regularly. Moose will not normally eat smaller aspen, however, they will when there is not much else to eat. A participant reported that moose tend to go to high ground during the day or during the summer since it is cooler and at dusk they come down for water. Other participants reported that moose will rest near creeks to cool down and that they move to lower elevations during the winter. Moose would not likely bed in an open area, preferring, instead, areas like wetlands for water and riparian vegetation, like willow and tall grasses, because wetter ground conditions also inhibit predators. The open trees make a good location for the animals to rest out of the sun during summer. In the winter, the trees shade them from snow. Snow accumulation is notably less in areas with green trees. Participants noted that man-made paths and rights-of-way can be good corridors for wildlife like moose, however, moose would only use such clearings for travel if there was not a waterbody or wetland nearby. Calving moose also prefer tall grass near swamps to hide from predators and to access water for the calves. Moose is a traditional source of food for Aboriginal communities that is still consumed today.

White-tailed deer and mule deer were identified during the field studies along the Hargreaves to Darfield Segment. Participants reported that there used to be more white-tailed deer than mule deer in this region, however, this dynamic has since reversed. Good deer (and elk) habitat will have abundant plants and shrubs for browsing, including kinnikinnick, rosehips, fireweed, aspen tree tips and thimbleberry leaves. Both kinds of deer, as well as elk, are traditional food sources for Aboriginal communities. Deer will rub their antlers against trees and will rattle trees to alert other males nearby. Rubbing trees leaves an identifying scent on them. Mule deer antlers fork, while white-tailed deer antlers have all points coming off of one branch. Antlers can be used by people to dig up roots like potatoes, carrots and wild ginger. Deer will travel along slopes and challenging terrain to avoid predators. Slopes allow for a better line-of-sight and prevent predators from attacking from behind.

Participants reported that the local caribou population has decreased since the use of snowmobiles, industrial and urban development, overhunting and climate changes have increased over time. Lands along the Hargreaves to Darfield Segment were once an important part of caribou ranges. Mountain caribou would travel in small herds and, in the winter, remain in their alpine habitat to eat moss, descending from the mountains in the summer. When caribou eat frecklepelt lichen, their meat will be very tender. Participants also reported that caribou would not be found near Valemount, however, there are many different herds located near Jasper. Large herds of caribou have not been seen in the Valemount region for decades. The valley crossed at RK 669.3 and surrounding lands was at one time populated by caribou. In the 1930s and 1940s, caribou were so abundant that traffic had to be stopped when caribou were crossing. Participants commented that herds in this valley now have only 8 to 10 individuals.

During the field studies along the Hargreaves to Darfield Segment, participants explained that bears are constantly on the move throughout their extensive ranges. Bears may travel along existing rights-of-way, preferring open areas during spring and summer when berries are abundant. Good habitat for bears will be well away from human activity. Lands with abundant ground cover provide bears, especially sows and their young, with protection from the elements and predators. While bears are omnivores, most of their meat-eating is opportunistic, more often consuming berries, insects, grass, fish and grubs. Bears prefer eating berries to pulling apart rotten logs to find grubs. Participants shared that bears play an important role in local culture and are sacred animals.

Carnivorous predators identified during the field studies along the Hargreaves to Darfield Segment include coyotes, wolves, cougars and other large cats. Coyotes prefer open lands along the banks of watercourses and will frequent the banks to communicate with other coyotes since the water carries their voices farther. Participants reported that up until the 1940s, wolves were culled to protect livestock and humans. Wolves are nomadic and travel according to the season and available game. Wolves run in packs with a single alpha male and pack sizes depend on prey abundance. Wolves will eat deer and sometimes even small bears. Cougars are unlikely to hunt where the forest is quite open and where there is not much cover, avoiding human activity and preferring to live high in the mountains. Cougars will only venture into more populated and developed areas if food is scarce elsewhere.

Many small and medium-sized mammals were identified by participants during the field studies along the Hargreaves to Darfield Segment and most were reported to be hunted by local Aboriginal communities. Porcupine quills can be used to make jewellery such as earrings and necklaces, artisanal works and ceremonial garb. However, participants reported that porcupines are not very common along this segment. Rabbit meat is a source of food and the fur is used for traditional purposes. Squirrels are a traditional food source and the fur is also used. Squirrels will eat songbird eggs and young nestlings, mushrooms and apples. Ground squirrels often den close to cedar or hemlock roots. A sloping, open field is good habitat for ground squirrels since the slope would allow for drainage of their tunnel systems.

Many bird species were identified by participants during the field studies along the Hargreaves to Darfield Segment including woodpeckers, flickers, owls and eagles. Woodpeckers are compulsive birds that will knock and drill holes on the same tree for years. A pileated woodpecker will call out to signal that humans are approaching. Flickers have distinct orange under their wings and fly in a “flitty” manner. Owls eat voles, birds and bats and are thought to be messengers of death. Characteristics of golden eagles and bald eagles were described by participants; eagles eat fish, gophers and ground hogs and tend to nest in big trees, either living or dead, making their nests out of sticks and returning to the same nest for many years. Participants report that the local population of eagles is growing. Eagles represent protection to local communities and Aboriginal people will carry eagle feathers for this reason.

Blue, ruffled and willow grouse were also identified by participants during the field studies along the Hargreaves to Darfield Segment. The sound of a blue grouse drumming can be differentiated from a ruffled grouse drumming by the way the blue grouse starts drumming slowly and the sound can be felt in the heart. Grouse drum to attract females and to defend and identify their territory. Willow grouse make a thumping noise. Participants reported that this thumping noise may be used to scare predators since the thumping is heard before the bird takes flight.

Detailed TEK methods and results are provided in the Wildlife Technical Report (Volume 5C).

5.10.3 Black Pines to Hope Segment

The Black Pines to Hope Segment crosses a mosaic of land uses and habitat types, including suburban areas associated with cities and towns, agricultural fields (*i.e.*, cultivation and hay fields), pasture, grasslands and forested areas. The grasslands north and south of Kamloops show signs of human disturbance in the form of trails, access roads and cattle grazing. Forested areas are generally dominated by Douglas-fir and PP with open, grassy understories, particularly in PP stands. Areas of PP forest also contain large open grassland areas interspersed with big sage brush. Selective forest harvest is common along this segment, as evidenced by old stumps on the forest floor and sporadic large veteran Douglas-fir trees. The Black Pines to Hope Segment crosses three wildfire burns that occurred within the last 40 years: 1987 (RK 830.1 to RK 830.7); 2008 (RK 826.5 to RK 826.6); and 2009 (RK 826.3 to RK 826.7) (BC MFLNRO 2013). Wetlands encountered along the Black Pines to Hope Segment are generally associated with streams and oxbow lakes, with a number of shrubby/treed fens and bogs. Terrain along the proposed pipeline segment varies from flat to gently undulating in large valley bottoms to moderately and steeply undulating hills through the grasslands and forested areas north and south of Kamloops. Steeper slopes are encountered along some watercourses and narrow valleys (*e.g.*, Coquihalla Valley).

The following subsections describe the provincially identified wildlife areas, parks and protected areas, species with special conservation status, and ATK and TEK along the Black Pines to Hope Segment.

5.10.3.1 Provincially Identified Wildlife Areas

A summary of provincially identified wildlife areas in relation to the Black Pines to Hope Segment is provided in Table 5.10-6.

TABLE 5.10-6

PROVINCIALLY IDENTIFIED WILDLIFE AREAS ALONG THE BLACK PINES TO HOPE SEGMENT

Wildlife Area	Legal Location	RK Range	Approximate Length (km)
UWR (u-3-003 for mule deer)[1]	c-96-D/92-I-8 to b-86-D/92-I-8	892.0 to 893.4	1.4
	c-27-D/92-I-8 to d-28-D/92-I-8	898.9 to 899.1	0.2
	c-28-D/92-I-8 to d-73-I/92-I-2	899.5 to 906.0	6.5
	b-78-I/92-I-2 to b-79-I/92-I-2	911.2 to 912.0	0.8
	d-61-J/92-I-2	913.6 to 913.6	< 0.1
	c-51-J/92-I-2 to b-51-J/92-I-2	914.7 to 915.0	0.3
	d-42-J/92-I-2 to b-42-J/92-I-2	915.8 to 916.3	0.5
	a-93-C/92-I-2 to b-74-C/92-I-2	933.7 to 935.9	2.2
	c-65-C/92-I-2 to b-20-C/92-I-2	937.1 to 945.3	8.2
	a-84-L/92-H-15 to a-74-L/92-H-15	949.6 to 950.4	0.8
	c-64-L/92-H-15 to b-23-L/92-H-15	950.9 to 955.7	4.8
	c-13-L/92-H-15 to b-13-L/92-H-15	956.1 to 956.8	0.7
	b-94-E/92-H-15 to b-85-D/92-H-15	959.1 to 970.0	10.9
UWR (u-2-006 for mule deer and black-tailed deer)[1]	a-25-K/92-H-6 to c-5-K/92-H-6	1030.0 to 1031.4	1.4
Wildlife Habitat Area (WHA) (2-498 for spotted owl)[2]	d-61-K/92-H-6 to d-32-K/92-H-6	1023.3 to 1026.9	3.6
	c-24-K/92-H-6 to a-96-F/92-H-6	1029.2 to 1032.6	3.4
	a-96-F/92-H-6 to c-57-F/92-H-6	1033.0 to 1037.1	4.1
	d-59-F/92-H-6 to a-69-F/92-H-6	1038.2 to 1038.6	0.4

Notes: 1 UWRs defined by BC MOE (2012a).
2 WHAs defined by BC MOE (2005a).

5.10.3.2 Parks and Protected Areas

The proposed pipeline corridor is located within Lac du Bois Grasslands Protected Area and the Coquihalla Summit Recreation Area and is adjacent to the Coldwater River, Coquihalla River and Coquihalla Canyon provincial parks. It is also located within the Douglas Lake Plateau IBA (BC172) (Bird

Studies Canada and Nature Canada 2012) and the DUC Level 3 Priority Landscape, Eastern Boreal Forest, which encompasses areas rich in wetlands, lakes, ponds, rivers, and streams and supports breeding, migrating, mounting, and staging waterfowl (DUC 2013). The proposed pipeline corridor is not located within or adjacent to a Migratory Bird Sanctuary, National Wildlife Area, Western Hemisphere Shorebird Reserve, Ramsar wetland or Biosphere Reserve (Bureau of the Convention on Wetlands 2013, Environment Canada 2013n, UNESCO 2012, WHSRN 2013).

5.10.3.3 Species with Special Conservation Status

A desktop review of the potential wildlife species of concern list found that species with special conservation status that are provincially-listed (BC CDC 2013a,b) or federally-listed on Schedule 1 of *SARA* (Environment Canada 2013o) or by COSEWIC (2013a) that have potential to occur along the Black Pines to Hope Segment are listed in Table 5.10-7. A search of the BC CDC records identified occurrences of provincially and federally-listed wildlife species of concern (BC CDC 2013b) (Table 5.10-7).

TABLE 5.10-7

SPECIES WITH SPECIAL CONSERVATION STATUS – BLACK PINES TO HOPE SEGMENT

Common Name	Provincial Designations	Federal Designations
BIRDS		
American avocet	S2S3B[1] Blue[3] Priority 2[4] Goal 3[4]	--
American bittern	S3B[1] Blue[3] Priority 2[4] Goal 2[4]	--
Band-tailed pigeon	S3S4B[1] Blue[3] Priority 2[4] Goal 2[4]	Special Concern[5,6]
Bank swallow	S4S5B[1] Yellow[3] Priority 5[4] Goal 1,3[4]	Threatened[6]
Barn owl	S3[1] Blue[3] Priority 2[4] Goal 2[4]	Special Concern[5] Threatened[6]
Barn swallow	S3S4B[1] Blue[3] Priority 2[4] Goal 2[4]	Threatened[6]
Bobolink	S3B[1] Blue[3] Priority 2[4] Goal 2[4]	Threatened[6]
Brewer's sparrow, *breweri* ssp.	S2B[1] Red[3] Priority 2[4] Goal 3[4]	--
Burrowing owl	S1B[1] Endangered[2] Red[3] Priority 2[4] Goal 3[4]	Endangered[5,6]

TABLE 5.10-7 Cont'd

Common Name	Provincial Designations	Federal Designations
California gull	S3B[1] Blue[3] Priority 4[4] Goal 3[4]	--
Canyon wren	S3[1] Blue[3] Priority 4[4] Goal 2,3[4]	Not at Risk[6]
Common nighthawk	S4B[1] Yellow[3] Priority 2[4] Goal 2[4]	Threatened[5,6]
Ferruginous hawk	SNRN[1]	Threatened[5,6]
Flammulated owl	S3S4B[1] Blue[3] Priority 2[4] Goal 2[4]	Special Concern[5,6]
Grasshopper sparrow	S1S2B[1] Red[3] Priority 1[4] Goal 3[4]	--
Great blue heron, *herodias* ssp.	S3B,S4N[1] Blue[3] Priority 2[4] Goal 2[4]	--
Gyrfalcon	S3S4B[1] Blue[3] Priority 4[4] Goal 3[4]	Not at Risk[6]
Horned grebe	S4B[1] Yellow[3] Priority 4[4] Goal 1,2[4]	Special Concern[6]
Horned lark, *merrilli* ssp.	S3S4B[1] Blue[3] Priority 4[4] Goal 2,3[4]	--
Lark sparrow	S2B[1] Red[3] Priority 2[4] Goal 3[4]	--
Lewis's woodpecker	S2B[1] Red[3] Priority 2[4] Goal 3[4]	Threatened[5,6]
Long-billed curlew	S3B[1] Blue[3] Priority 2[4] Goal 2[4]	Special Concern[5,6]
Long-tailed duck	S2S3B,S4N[1] Blue[3] Priority 2[4] Goal 3[4]	--
Olive-sided flycatcher	S3S4B[1] Blue[3] Priority 2[4] Goal 2[4]	Threatened[5,6]

TABLE 5.10-7 Cont'd

Common Name	Provincial Designations	Federal Designations
Prairie falcon	S1S2B[1] Red[3] Priority 2[4] Goal 3[4]	--
Rusty blackbird	S3S4B[1] Blue[3] Priority 2[4] Goal 2[4]	Special Concern[5,6]
Sharp-tailed grouse, *columbianus* ssp.	S2S3[1] Blue[3] Priority 2[4] Goal 1,3[4]	--
Short-eared owl	S3B,S2N[1] Blue[3] Priority 2[4] Goal 2[4]	Special Concern[5,6]
Sooty grouse	S3S4[1] Blue[3] Priority 2[4] Goal 2[4]	--
Spotted owl	S1[1] Red[3] Priority 2[4] Goal 3[4]	Endangered[5,6]
Surf scoter	S3B,S4N[1] Blue[3] Priority 4[4] Goal 2,3[4]	--
Swainson's hawk	S2B[1] Red[3] Priority 2[4] Goal 3[4]	--
Upland sandpiper	S1S2B[1] Red[3] Priority 1[4] Goal 3[4]	--
Western grebe	S1B,S2N[1] Red[3] Priority 1[4] Goal 3[4]	--
Western screech-owl, *macfarlanei* ssp.	S2[1] Red[3] Priority 1[4] Goal 3[4]	Endangered[5] Threatened[6]
Williamson's sapsucker	S3B[1] Blue[3] Priority 2[4] Goal 2[4]	Endangered[5,6]
Yellow-breasted chat, *auricollis* ssp.	S1S2B[1] Red[3] Priority 1[4] Goal 3[4]	Endangered[5,6]
MAMMALS		
American badger, *jeffersonii* ssp.	S1[1] Red[3] Priority 1[4] Goal 3[4]	Endangered[5,6]

TABLE 5.10-7 Cont'd

Common Name	Provincial Designations	Federal Designations
Bighorn sheep	S3[1] Blue[3] Priority 3[4] Goal 2[4]	--
Fisher	S2S3[1] Blue[3] Priority 2[4] Goal 3[4]	--
Fringed myotis	S3[1] Blue[3] Priority 3[4] Goal 3[4]	Data Deficent[6]
Great Basin pocket mouse	S2[1] Red[3] Priority 2[4] Goal 3[4]	--
Grizzly bear, western population	S3[1] Blue[3] Priority 2[4] Goal 2[4]	Special Concern[6]
Little brown myotis	S4[1] Yellow[3] Priority 5[4] Goal 3[4]	Endangered[6]
Mountain beaver, *rainieri* ssp.	S3[1] Blue[3] Priority 1[4] Goal 2[4]	Special Concern[5,6]
Mountain beaver, *rufa* ssp.	S3[1] Blue[3] Priority 2[4] Goal 2[4]	Special Concern[5,6]
Northern myotis	S2S4[1] Blue[3] Priority 2[4] Goal 3[4]	Endangered[6]
Spotted bat	S3S4[1] Blue[3] Priority 2[4] Goal 2[4]	Special Concern[5,6]
Townsend's big-eared bat	S3[1] Blue[3] Priority 2[4] Goal 2[4]	--
Trowbridge's shrew	S3[1] Blue[3] Priority 2[4] Goal 2[4]	--
Western small-footed myotis	S2S3[1] Blue[3] Priority 3[4] Goal 3[4]	--
Wolverine, *luscus* ssp.	S3[1] Blue[3] Priority 2[4] Goal 2[4]	Special Concern[6]

TABLE 5.10-7 Cont'd

Common Name	Provincial Designations	Federal Designations
REPTILES AND AMPHIBIANS		
Coastal tailed frog	S3S4[1] Blue[3] Priority 1[4] Goal 2[4]	Special Concern[5,6]
Great Basin gopher snake, *deserticola* ssp.	S2S3[1] Blue[3] Priority 2[4] Goal 3[4]	Threatened[5,6]
Great Basin spadefoot	S3[1] Blue[3] Priority 1[4] Goal 2[4]	Threatened[5,6]
North American racer	S3[1] Blue[3] Priority 2[4] Goal 2[4]	Special Concern[5,6]
Northern rubber boa	S4[1] Yellow[3] Priority 1[4] Goal 2[4]	Special Concern[5,6]
Painted turtle, Intermountain-Rocky Mountain population	S2S3[1] Blue[3] Priority 2[4] Goal 3[4]	Special Concern[5,6]
Western rattlesnake	S3[1] Blue[3] Priority 2[4] Goal 2[4]	Threatened[5,6]
Western toad	S3S4[1] Blue[3] Priority 2[4] Goal 2[4]	Special Concern[5,6]
INVERTEBRATES		
Monarch	S3B[1] Blue[3] Priority 2[4] Goal 2[4]	Special Concern[5,6]
Olive clubtail	S1S2[1] Red[3] Priority 1[4] Goal 3[4]	Endangered[6]

Notes: Definitions of Status Designations are provided in Appendix C of the Wildlife Technical report of Volume 5C. Federal ratings are current to November 2013.

1 Provincial (S) rank assigned by the BC CDC (2013b).

2 Species listed under the BC *Wildlife Act* (BC CDC 2013b).

3 Provincial Red and Blue designations assigned by BC CDC (2013b).

4 Conservation goals and priorities established under the BC Conservation Framework (BC MOE 2009a,b).

5 Species listed under Schedule 1 of *SARA* (Environment Canada 2013o).

6 Species listed under COSEWIC (2013).

5.10.3.4 Traditional Ecological Knowledge

During the field studies along the Black Pines to Hope Segment, participants identified wildlife signs including tracks, browse and scat of ungulates such as mule deer, white-tailed deer and moose. Moose and deer are present in the hills near the City of Merritt, BC. The hills on the north side of Nicola Lake are considered excellent habitat since there is good foraging with the presence of willow and rose bushes, water sources and a healthy, wooded landscape. In the past, white-tailed deer were less common than mule deer, however, white-tailed deer are starting to move in from the east. White-tailed deer carry a disease or parasite that affects mule deer, which in turn has negatively affected the mule deer population. Elk are more common towards Brooksmuir. Participants reported that the proposed pipeline corridor encounters lands previously disturbed by power lines, fibre optic cables and other pipeline rights-of-way, and that wildlife in the region have already adjusted. There is a lot of browse for moose and deer to eat, like alder, grasses and willow, and the existing rights-of-way are like cleared paths which encourage wildlife movement. Good wildlife habitat will include trees like Douglas-fir, trembling aspen, spruce and lodgepole pine with a source of water nearby, as well as a generally healthy ecosystem with few pine beetles or spruce bud worms and ample vegetation and berry plants.

Game trails, primarily used by moose, deer and bear, were identified along the Black Pines to Hope Segment. Game trails are often used to access existing rights-of-way, watercourses and rest or bedding areas. Bear claw marks were identified on trees during the field studies, some recent and some several years old. The size of the marks is an indicator of the size of the bear that created them. Participants described how cubs cannot gouge the tree, but can scamper up a tree. Participants noted that in the past, bears likely foraged for berries in nearby farmers' fields, however, the installation of an electric fence has likely caused bears to retreat to the hills. Abundant blackberry bushes that grow at higher elevations and cherry trees that grow in the valleys provide food sources for black bears. Bears also fish for coho salmon from small watercourses in the region. Good habitat for bears will be close to water, berries and a path. Good grizzly bear habitat was identified near Juliet Creek due to the presence of salmon, the abundance of denning habitat and berry plants, and minimal human presence. TEK participants have noted that over the past 20 years, there has been decline in the regional grizzly population and they attribute this to a decline in salmon. Bears are moving further south and west for food sources at higher elevations. Bears once frequented the Fraser and Thompson rivers, however, participants believe that increased human presence in the region prevent bears from returning.

Coyote, wolf and cougar signs were identified by participants during field studies along the Black Pines for Hope Segment. Participants reported that wolves were once the dominant predator in the region, but have since been hunted nearly to extinction and are only recently beginning to show signs of rebounding. Coyotes were traditionally trapped for their fur and are central figures in many traditional stories of Aboriginal communities in BC.

Participants reported that marten, otters, beavers, muskrat, lynx and rabbits are commonly observed along the Black Pines to Hope Segment and that all of these animals are traditionally harvested. These fur-bearing animals are used for clothing and other accessories. Beaver dams and habitat are prevalent along the Nicola River and its smaller tributaries. Participants noted that beavers will eat a varied diet and are traditionally trapped by Aboriginal communities. Participants also reported that beavers are a nuisance since they block salmon from migrating upstream. Groundhog holes were identified along Mine Creek and participants report that groundhogs will live anywhere with other groundhogs in colonies. Groundhogs are common animals and are not traditionally hunted by communities in this region.

Birds are important to communities along the Black Pines to Hope Segment. Birds indicate when spring has arrived, whereby eagles arrive first, ducks will follow as will cranes. Once cranes have arrived, it is confirmed that spring has started. Grouse are plentiful and wild grouse were observed and heard by participants during the field studies. Ruffled, blue and spruce grouse are found in the forest while sharp-tailed grouse prefer grasslands. Grouse are sometimes hunted by Aboriginal communities in the fall.

Detailed TEK methods and results are provided in the Wildlife Technical Report (Volume 5C).

5.10.4 Hope to Burnaby Segment

There is a high level of anthropogenic disturbance along the Hope to Burnaby Segment, which is characterized by agricultural fields and urban, residential and industrial complexes. Throughout this area are residual pockets of suitable habitat for several species, which are of increasing importance with the level of disturbance. Forested areas typically have open understories and are dominated by Douglas-fir, western hemlock and western redcedar. Riparian areas are dominated by black cottonwood. Wetlands encountered along this segment are generally associated with streams and oxbow lakes, with a number of shrubby/treed fens and bogs. The Hope to Burnaby Segment follows south of the Fraser River and the terrain is generally flat with some undulating hills.

The following subsections describe the provincially identified wildlife areas, parks and protected areas, species with special conservation status, and ATK and TEK along the Hope to Burnaby Segment.

5.10.4.1 Provincially Identified Wildlife Areas

The Hope to Burnaby Segment is not located within or adjacent to a provincially identified wildlife area (BC MOE 2005a, 2010, 2012a).

5.10.4.2 Parks and Protected Areas

The proposed pipeline corridor is located within the F.H. Barber Provincial Park from RK 1062.8 (d-62-B/92-H-5) to RK 1062.8 (d-62-B/92-H-5), which is situated in the CWH BGC Zone with vegetation representative of the undisturbed Fraser flood plain and provides habitat for birds and small mammals (BC MOE 2012b). The Hope to Burnaby Segment is also located within the DUC Priority 2 Landscape, BC Coastal Areas and Estuaries, which provides important migration and winter habitat that supports a wintering population of over one million waterfowl (DUC 2013). The proposed pipeline corridor is not located within or adjacent to an IBA, Migratory Bird Sanctuary, National Wildlife Area, Western Hemisphere Shorebird Reserve, Ramsar wetland or Biosphere Reserve (Bird Studies Canada and Nature Canada 2012, Bureau of the Convention on Wetlands 2013, Environment Canada 2013n, UNESCO 2012, WHSRN 2013).

The Hope to Burnaby Segment is located within or adjacent to several regional parks and locally important areas, including Cheam Lake Wetlands Regional Park, Mountain View Conservation and Breeding Centre, Sumas Mountain Interregional Park and Surrey Bend Regional Park (City of Abbotsford 2012, FVRD 2008b, Metro Vancouver and City of Surrey 2010, Mountain View Conservation and Breeding Centre 2013).

5.10.4.3 Species with Special Conservation Status

A desktop review of the potential wildlife species of concern list found that species with special conservation status that are provincially-listed (BC CDC 2013a,b) or federally-listed on Schedule 1 of *SARA* (Environment Canada 2013o) or by COSEWIC (2013a) that have potential to occur along the Hope to Burnaby Segment are listed in Table 5.10-8. A search of the BC CDC records identified occurrences of provincially and federally-listed wildlife species of concern (BC CDC 2013b) (Table 5.10-8).

TABLE 5.10-8

SPECIES WITH SPECIAL CONSERVATION STATUS – HOPE TO BURNABY SEGMENT

Common Name	Provincial Designations	Federal Designations
BIRDS		
American bittern	S3B[1] Blue[3] Priority 2[4] Goal 2[4]	--
Band-tailed pigeon	S3S4B[1] Blue[3] Priority 2[4] Goal 2[4]	Special Concern[5,6]
Barn owl	S3[1] Blue[3] Priority 2[4] Goal 2[4]	Special Concern[5] Threatened[6]
Barn swallow	S3S4B[1] Blue[3] Priority 2[4] Goal 2[4]	Threatened[6]

TABLE 5.10-8 Cont'd

Common Name	Provincial Designations	Federal Designations
California gull	S3B[1] Blue[3] Priority 4[4] Goal 3[4]	--
Canada goose, *occidentalis* ssp.	S2M[1] Red[3] Priority 2[4] Goal 3[4]	--
Common nighthawk	S4B[1] Yellow[3] Priority 2[4] Goal 2[4]	Threatened[5,6]
Double-crested cormorant	S3S4B[1] Blue[3] Priority 2[4] Goal 2[4]	--
Ferruginous hawk	SNRN[1]	Threatened[5,6]
Great blue heron, *fannini* ssp.	S2S3B,S4N[1] Blue[3] Priority 1[4] Goal 3[4]	Special Concern[5,6]
Green heron	S3S4B[1] Blue[3] Priority 4[4] Goal 3[4]	--
Gyrfalcon	S3S4B[1] Blue[3] Priority 4[4] Goal 3[4]	--
Horned lark, *strigata* ssp.	SXB[1] Red[3] Priority 1[4] Goal 3[4]	Endangered[5,6]
Long-tailed duck	S2S3B,S4N[1] Blue[3] Priority 2[4] Goal 3[4]	--
Marbled murrelet	S3B,S3N[1] Blue[3] Priority 1[4] Goal 1,2[4]	Threatened[5,6]
Northern goshawk, *laingi* ssp.	S2B[1] Red[3] Priority 1[4] Goal 1,3[4]	Threatened[5,6]
Olive-sided flycatcher	S3S4B[1] Blue[3] Priority 2[4] Goal 2[4]	Threatened[5,6]
Peregrine falcon, *anatum* ssp.	S2?B[1] Red[3] Priority 2[4] Goal 3[4]	Special Concern[5,6]
Short-eared owl	S3B,S2N[1] Blue[3] Priority 2[4] Goal 2[4]	Special Concern[5,6]

TABLE 5.10-8 Cont'd

Common Name	Provincial Designations	Federal Designations
Sooty grouse	S3S4[1] Blue[3] Priority 2[4] Goal 2[4]	--
Surf scoter	S3B,S4N[1] Blue[3] Priority 4[4] Goal 2,3[4]	--
Western grebe	S1B,S2N[1] Red[3] Priority 1[4] Goal 3[4]	--
Western screech-owl, *kennicottii* ssp.	S3[1] Blue[3] Priority 1[4] Goal 2[4]	Special Concern[5] Threatened[6]
MAMMALS		
Eastern red bat	S1[1] Red[3]	--
Keen's myotis	S2S3[1] Blue[3] Priority 1[4] Goal 1,3[4]	Data Deficient[6]
Little brown myotis	S4[1] Yellow[3] Priority 5[4] Goal 3[4]	Endangered[6]
Long-tailed weasel, *altifrontalis* ssp.	SH[1] Red[3]	--
Mountain beaver, *rufa* ssp.	S3[1] Blue[3] Priority 2[4] Goal 2[4]	Special Concern[5,6]
Olympic shrew	S1S2[1] Red[3] Priority 1[4] Goal 3[4]	--
Pacific water shrew	S1S2[1] Red[3] Priority 1[4] Goal 3[4]	Endangered[5,6]
Snowshoe hare, *washingtonii* ssp.	S1[1] Red[3] Priority 1[4] Goal 3[4]	--
Southern red-backed vole, *occidentalis* ssp.	S1[1] Red[3] Priority 1[4] Goal 3[4]	--
Townsend's big-eared bat	S3[1] Blue[3] Priority 2[4] Goal 2[4]	--
Townsend's mole	S1[1] Red[3] Priority 1[4] Goal 3[4]	Endangered[5,6]

TABLE 5.10-8 Cont'd

Common Name	Provincial Designations	Federal Designations
Trowbridge's shrew	S3[1] Blue[3] Priority 2[4] Goal 2[4]	--
REPTILES AND AMPHIBIANS		
Coastal tailed frog	S3S4[1] Blue[3] Priority 1[4] Goal 2[4]	Special Concern[5,6]
Northern red-legged frog	S3S4[1] Blue[3] Priority 1[4] Goal 2[4]	Special Concern[5,6]
Northern rubber boa	S4[1] Yellow[3] Priority 1[4] Goal 2[4]	Special Concern[5,6]
Oregon spotted frog	S1[1] Red[3] Priority 1[4] Goal 1,3[4]	Endangered[5,6]
Pacific giant salamander	S2[1] Red[3] Priority 1[4] Goal 3[4]	Threatened[5,6]
Painted turtle, Pacific Coast population	S2[1] Red[3] Priority 2[4] Goal 3[4]	Endangered[5,6]
Western toad	S3S4[1] Blue[3] Priority 2[4] Goal 2[4]	Special Concern[5,6]
INVERTEBRATES		
Dun skipper	S3[1] Blue[3] Priority 2[4] Goal 2[4]	Threatened[5,6]
Monarch	S3B[1] Blue[3] Priority 2[4] Goal 2[4]	Special Concern[5,6]
Oregon forestsnail	S1S2[1] Red[3] Priority 1[4] Goal 3[4]	Endangered[5,6]

Notes: Definitions of Status Designations are provided in Appendix C of the Wildlife Technical report of Volume 5C. Federal ratings are current to November 2013.

1 Provincial (S) rank assigned by the BC CDC (2013a).

2 Species listed under the BC *Wildlife Act* (BC CDC 2013a).

3 Provincial Red and Blue designations assigned by BC CDC (2013b).

4 Conservation goals and priorities established under the BC Conservation Framework (BC MOE 2009b,c).

5 Species listed under Schedule 1 of *SARA* (Environment Canada 2013o).

6 Species listed under COSEWIC (2013a).

5.10.4.4 Traditional Ecological Knowledge

Participants identified evidence of deer along the Hope to Burnaby Segment, including tracks, scat, beds, browse and game trails, reporting that deer tend to be wide-ranging animals, adaptable and already accustomed to human disturbance due to the existing highways, power lines and pipeline rights-of-way within the proposed pipeline corridor. Deer are most commonly found on lands with a water source nearby and plenty of vegetative cover to provide shelter from the weather and predators. Deer can move quietly though tall grass due to their small stature, following the same trails each year and showing their young the same trails, unless the trails become disturbed by humans or environmental changes such as erosion. Deer will eat grasses and shrubs, such as alfalfa, and wild mushrooms, such as pine mushrooms. Deer are commonly hunted for food and hides.

Evidence of black bears were also observed during the field studies along the Hope to Burnaby Segment, including tracks, scat, claw marks on trees, beds and trails. Sawdust under a bear-dug log indicates that the dig is relatively fresh because sawdust will eventually wash away over the course of the year. Black bears dig at stumps for grubs, ants and termites in the early spring following hibernation and also feed on berries and grasses in the spring and early summer, and salmon during the late summer and fall. Participants reported that bears are seen more commonly near their communities; an indication that they are getting hungrier. Bear claws are commonly used as regalia in smokehouses, typically taken from a found carcass rather than through hunting. Grizzly bear tracks and scat were also identified by participants and it was reported that bears are likely using the existing right-of-way for habitat and food sources.

Cougar tracks, scat and appropriate habitat were observed by participants during the field studies along the Hope to Burnaby Segment. Cougars spend their summers in alpine environments, migrating to lower elevations during the winter. Cougars are wide-ranging mammals that are able to travel more than 30 km in a day and existing rights-of-way function as travel corridors. Signs of coyote were also observed and participants noted that coyotes appear to be using an existing fibre optic cable right-of-way as a travel corridor, evidenced by scat along the right-of-way. An inactive coyote den might have grass in the tunnel passage and, generally, when humans find a coyote's den, the animal will move for the safety of the pups. The coyote is a central character in the stories, mythology and beliefs of the local cultures and is known to be good and bad; a trickster.

Birds of prey were identified during the field studies including eagle, osprey and red-tailed hawk. Eagle and hawk feathers are used in smokehouse ceremonies and eagle feathers and claws are used for decorations and drumsticks. Feathers are also used to make headdresses for powwow dancing and hand fans and are used in sweetgrass ceremonies for cleansing. Eagle feathers are said to be good luck, whereas white owls are thought to mean bad luck. Participants reported that hawks will abandon their nests and even their young if there is excessive noise pollution. Other birds identified by participants during the field studies along the Hope to Burnaby Segment include woodpeckers, turkey vultures, grouse and a hummingbird. Woodpeckers are not a common sight or sound throughout the region and are heard only a few times a year.

Detailed TEK methods and results are provided in the Wildlife Technical Report (Volume 5C).

5.10.5 Burnaby to Westridge Segment

The Burnaby to Westridge Segment is characterized by residential neighbourhoods and industrial complexes within Burnaby. There is a small residual forest stand that is dominated by western redcedar, western hemlock and Douglas-fir.

The following subsections describe the provincially identified wildlife areas, parks and protected areas, species with special conservation status, and ATK and TEK along the Burnaby to Westridge Segment.

5.10.5.1 Provincially Identified Wildlife Areas

The Burnaby to Westridge Segment is not located within or adjacent to a provincially identified wildlife area (BC MOE 2005a, 2010, 2012a).

5.10.5.2 Parks and Protected Areas

The proposed pipeline corridor is located within the English Bay and Burrard Inlet IBA (BC020) from RK 3.2 (b-47-D/92-G-7) to RK 3.6 (d-47-D/92-G-7), which includes the shores of Burrard Inlet and English Bay. The IBA was designated primarily to protect western grebe, Barrow's goldeneye, surf scoter and great blue heron (*fannini* subspecies). The area also provides nesting habitat for pelagic and double-crested cormorants, osprey and bald eagle and the purple martin is commonly found nesting in nest-boxes along the shores (Bird Studies Canada and Nature Canada 2012). The proposed pipeline corridor is also located within the DUC Priority 2 Landscape, BC Coastal Areas and Estuaries, which provides important migration and winter habitat that supports a wintering population of over one million waterfowl (DUC 2013). The Burnaby to Westridge Segment is not located within or adjacent to a provincial park or protected area, Migratory Bird Sanctuary, National Wildlife Area, Western Hemisphere Shorebird Reserve, Ramsar wetland or Biosphere Reserve (BC MOE 2012b, Bureau of the Convention on Wetlands 2013, Environment Canada 2013n, UNESCO 2012, WHSRN 2013). The Burnaby to Westridge Segment is located within the Burnaby Mountain Conservation Area (City of Burnaby 2013).

5.10.5.3 Species with Special Conservation Status

A desktop review of the potential wildlife species of concern list found that species with special conservation status that are provincially-listed (BC CDC 2013a,b) or federally-listed on Schedule 1 of *SARA* (Environment Canada 2013o) or by COSEWIC (2013a) that have potential to occur along the Burnaby to Westridge Segment are listed in Table 5.10-9. A search of the BC CDC records identified occurrences of provincially and federally-listed wildlife species of concern (BC CDC 2013b) (Table 5.10-9).

TABLE 5.10-9

SPECIES WITH SPECIAL CONSERVATION STATUS – BURNABY TO WESTRIDGE SEGMENT

Common Name	Provincial Designations	Federal Designations
BIRDS		
American bittern	S3B[1] Blue[3] Priority 2[4] Goal 2[4]	--
Band-tailed pigeon	S3S4B[1] Blue[3] Priority 2[4] Goal 2[4]	Special Concern[5,6]
Barn owl	S3[1] Blue[3] Priority 2[4] Goal 2[4]	Special Concern[5] Threatened[6]
Barn swallow	S3S4B[1] Blue[3] Priority 2[4] Goal 2[4]	Threatened[6]
California gull	S3B[1] Blue[3] Priority 4[4] Goal 3[4]	--
Common nighthawk	S4B[1] Yellow[3] Priority 2[4] Goal 2[4]	Threatened[5,6]
Double-crested cormorant	S3S4B[1] Blue[3] Priority 2[4] Goal 2[4]	--

TABLE 5.10-9 Cont'd

Common Name	Provincial Designations	Federal Designations
Great blue heron, *fannini* ssp.	S2S3B,S4N[1] Blue[3] Priority 1[4] Goal 3[4]	Special Concern[5,6]
Green heron	S3S4B[1] Blue[3] Priority 4[4] Goal 3[4]	--
Gyrfalcon	S3S4B[1] Blue[3] Priority 4[4] Goal 3[4]	--
Horned lark, *strigata* ssp.	SXB[1] Red[3] Priority 1[4] Goal 3[4]	Endangered[5,6]
Long-tailed duck	S2S3B,S4N[1] Blue[3] Priority 2[4] Goal 3[4]	--
Marbled murrelet	S3B,S3N[1] Blue[3] Priority 1[4] Goal 1,2[4]	Threatened[5,6]
Northern goshawk, *laingi* ssp.	S2B[1] Red[3] Priority 1[4] Goal 1,3[4]	Threatened[5,6]
Olive-sided flycatcher	S3S4B[1] Blue[3] Priority 2[4] Goal 2[4]	Threatened[5,6]
Short-eared owl	S3B,S2N[1] Blue[3] Priority 2[4] Goal 2[4]	Special Concern[5,6]
Sooty grouse	S3S4[1] Blue[3] Priority 2[4] Goal 2[4]	--
Surf scoter	S3B,S4N[1] Blue[3] Priority 4[4] Goal 2,3[4]	--
Western grebe	S1B,S2N[1] Red[3] Priority 1[4] Goal 3[4]	--
Western screech-owl, *kennicottii* ssp.	S3[1] Blue[3] Priority 1[4] Goal 2[4]	Special Concern[5] Threatened[6]
MAMMALS		
Keen's myotis	S2S3[1] Blue[3] Priority 1[4] Goal 1,3[4]	Data Deficient[6]

TABLE 5.10-9 Cont'd

Common Name	Provincial Designations	Federal Designations
Little brown myotis	S4[1] Yellow[3] Priority 5[4] Goal 3[4]	Endangered[6]
Pacific water shrew	S1S2[1] Red[3] Priority 1[4] Goal 3[4]	Endangered[5,6]
Snowshoe hare, *washingtonii* ssp.	S1[1] Red[3] Priority 1[4] Goal 3[4]	--
REPTILES AND AMPHIBIANS		
Northern red-legged frog	S3S4[1] Blue[3] Priority 1[4] Goal 2[4]	Special Concern[5,6]
Northern rubber boa	S4[1] Yellow[3] Priority 1[4] Goal 2[4]	Special Concern[5,6]
Western toad	S3S4[1] Blue[3] Priority 2[4] Goal 2[4]	Special Concern[5,6]
INVERTEBRATES		
Monarch	S3B[1] Blue[3] Priority 2[4] Goal 2[4]	Special Concern[5,6]

Notes: Definitions of Status Designations are provided in Appendix C of the Wildlife Technical report of Volume 5C. Federal ratings are current to November 2013.

1 Provincial (S) rank assigned by the BC CDC (2013a).

2 Species listed under the BC *Wildlife Act* (BC CDC 2013a).

3 Provincial Red and Blue designations assigned by BC CDC (2013b).

4 Conservation goals and priorities established under the BC Conservation Framework (BC MOE 2009b,c).

5 Species listed under Schedule 1 of *SARA* (Environment Canada 2013o).

6 Species listed under COSEWIC (2013a).

5.10.5.4 Aboriginal Traditional Knowledge

Available ATK related to wildlife along the Hope to Burnaby Segment is limited. However, concerns and recommendations identified on other proposed projects within the Tsleil-Waututh Nation traditional territory include concerns about the terrestrial effects resulting from oil tankers traveling off the coast (Northern Gateway Pipelines Partnership Ltd. 2010).

5.11 Species at Risk

Five fish species that are listed under Schedule 1 of *SARA* are found in the Aquatics RSA. White sturgeon (Upper Fraser River population) is Endangered (Environment Canada 2013o) and is found in the Aquatics RSA along the Hargreaves to Darfield Segment. The Hope to Burnaby Segment contains four *SARA*-listed fish species: green sturgeon (Special Concern); Salish sucker (Endangered); Nooksack dace (Endangered); and westslope cutthroat trout (Special Concern) (Environment Canada 2013o). However, westslope cutthroat trout are introduced to drainages in the Hope to Burnaby Segment and, therefore, are not considered to be a conservation concern within the Aquatics RSA. Two fish species that are listed by COSEWIC, lake sturgeon (Endangered) and bull trout (Threatened [Saskatchewan-

Nelson population] and Special Concern [Western Arctic population]) are found in the Aquatics RSA in the Edmonton to Hinton Segment (COSEWIC 2013a). The Aquatics RSA in the Hargreaves to Darfield Segment contains three fish species listed by COSEWIC: bull trout (Special Concern); mountain sucker (Special Concern); and interior Fraser River coho salmon (Endangered) (COSEWIC 2013a). One COSEWIC-listed species (bull trout [Special Concern] and interior Fraser River coho salmon [Endangered]) are found in the Aquatics RSA in the Black Pines to Hope Segment (COSEWIC 2013a). The Aquatics RSA in the Hope to Burnaby and Burnaby to Westridge segments contains five fish species listed under COSEWIC (2013a): bull trout (Special Concern); Lower Fraser River population of white sturgeon (Threatened); mountain sucker (Special Concern); eulachon (Endangered); and Cultus Lake population of sockeye salmon (Endangered). Federal ratings are current to November 2013. See Section 4.1.4 of the Fisheries (British Columbia) Technical Report of Volume 5C for additional details about the fish species at risk in the Aquatics RSA.

A search of the ACIMS and BC CDC databases identified two species (Mexican mosquito fern and Haller's apple moss) listed as Threatened under COSEWIC and *SARA* (COSEWIC 2013a, Environment Canada 2013o) in the Vegetation RSA along the Hargreaves to Darfield Segment. Mexican mosquito fern was also potentially observed during the 2013 vegetation surveys within the Hargreaves to Darfield Segment, with identification to be confirmed (see Section 9.0 Supplemental Studies for details). No other COSEWIC or *SARA*-listed species were identified by ACIMS or the BC CDC, or observed during the 2013 vegetation surveys along the proposed pipeline corridor. Federal ratings are current to November 2013. Additional details on the results of the 2013 vegetation surveys are provided in Section 6.9 and in the Vegetation Technical Report of Volume 5C.

Federally-listed wildlife species (*i.e.*, COSEWIC or *SARA* Schedule 1 designation) identified as having potential to occur along the proposed pipeline segments (based on known ranges and preferred habitat availability) are discussed in Section 5.10. Species at risk identified as indicators for the Project include grizzly bear, woodland caribou, short-eared owl, rusty blackbird, flammulated owl, Lewis's woodpecker, Williamson's sapsucker, western screech-owl, great blue heron (*fannini* ssp.), spotted owl, common nighthawk, northern goshawk (*laingi* ssp.) and olive-sided flycatcher. In addition, many of the habitat-based species communities and species groups identified as indicators included species at risk. Federal ratings are current to November 2013.

5.12 Line Facilities

The locations of line facilities (*e.g.*, automated MLBV, scraper traps) will be located within the permanent easement, the setting of which has been described in Sections 5.1 to 5.11. Many automated MLBVs will be accessed by existing access roads, however, permanent access roads may be required at yet unspecified locations.

5.13 Reactivated Pipeline Segments

The reactivated segments from Hinton to Hargreaves and Darfield to Black Pines parallel the existing active TMPL system. The existing TMPL easement through Jasper National Park and Mount Robson Provincial Park is 6.1 m and 18 m wide, respectively. Outside the parks, the existing right-of-way along the two segments is generally 18 m wide. Surface disturbance along the reactivated segments will be limited to locations where automated MLBVs will be installed, where existing valves will be automated or where integrity digs are conducted.

5.13.1 Hinton to Hargreaves Segment

The existing Hinton to Hargreaves pipeline segment extends from NW 33-49-26 W5M (RK 339.4) to 20-B/083-E-3 (RK 489.6). Surface disturbance along this segment is anticipated to be confined to the existing easement and will be limited to locations where automated MLBVs will be installed, where existing valves will be automated or where integrity digs are conducted. These locations have yet to be determined. Table 5.13-1 provides a summary of the biophysical elements and considerations for the reactivation of the Hinton to Hargreaves Segment pursuant to Guide A.2.4 as well as Table A-2 of the NEB *Filing Manual*.

TABLE 5.13-1

SUMMARY OF ENVIRONMENTAL ELEMENTS AND CONSIDERATIONS FOR THE HINTON TO HARGREAVES REACTIVATED SEGMENT

Environmental Elements	Summary of Considerations
Physical and Meteorological Environment	• The eastern portion of the Alberta side of the Hinton to Hargreaves Segment is located within the Southern Alberta Uplands Physiographic Region, which is characterized by hummocky terrain, rolling uplands, gently undulating terraces and incised river valleys (Pettapiece 1986, Natural Regions Committee 2006a). • Entering Jasper National Park and in BC, the Hinton to Hargreaves Segment is located within the Rocky Mountains Physiographic Region, which is characterized by structurally-controlled moderately wide valleys surrounded by rugged alpine mountains featuring relict glacial landforms (Holland 1976, Pettapiece 1986). • The Hinton to Hargreaves Segment is underlain by sedimentary rock including sandstones, siltstones, shales, dolomite and limestone (BC ILMB 2013b, Hamilton *et al.* 1999). • Surficial materials along much of the Hinton to Hargreaves Segment are characterized by colluvial, fluvial and till deposits, and bedrock (BGC Engineering Inc. 2013a, Pettapiece 1986). • There are no areas of permafrost along the Hinton to Hargreaves Segment (refer to Section 5.1.1). • Rock falls and debris avalanches have the potential to occur along the Hinton to Hargreaves Segment, particularly along narrow areas of the Fraser River valley in BC, where snow avalanches may also occur. • The earthquake ground shaking hazard is low on lands crossed by the Hinton to Hargreaves Segment. PGA is between 0.1 g and 0.2 g at a 1:2475 APE (BGC Engineering Inc. 2013c). The segment crosses a zone of suspected post-glacial fault activity within the Rocky Mountain Trench, where the historical earthquake record shows clusters of small to moderate magnitude (up to magnitude 6) earthquakes. The largest of these include a 6 magnitude earthquake near Valemount in 1918 and a 5.6 magnitude earthquake near Prince George in 1986 (Halchuk 2009, Lamontagne *et al.* 2007). • Topography along the segment ranges from gentle to steep slopes along the valley bottom and lower valley slope areas. • Elevations range from 1,110 m asl at the Hinton Pump Station to 990 m asl in the Athabasca River valley and to 1,060 m asl at the Jasper townsite. The Yellowhead Pass lies at an elevation of 1,140 m and the Hargreaves tie-in lies at 860 m asl. • In Alberta, the reactivated segment is located within the Montane Natural Subregion (Natural Regions Committee 2006a). A description of the climate for the Montane Natural Subregion is provided in Section 5.1.1. • In BC, the reactivated segment is predominantly in the SBS BGC Zone, with the westernmost approximately 7 km of the segment located within the ICH BGC Zone (Meidinger and Pojar 1991). A description of the climate for both BGC zones is provided in Section 5.1.2. • The following meteorological data were obtained from an Environment Canada meteorological station (3053520) in Jasper, Alberta (Environment Canada 2013a). The data was taken approximately 8 km south-southwest of Jasper Pump Station. – Average monthly rainfall for Jasper is 25.4 mm and the average monthly rainfall from June to August is 59.6 mm. In August of 1969, Jasper recorded its highest daily rainfall of 107.7 mm, which is above the monthly average of 64.6 mm for the month of August. – Average monthly snowfall for Jasper is 10 cm and the average monthly snowfall from November to February is 21 cm. In February of 1948, Jasper recorded its highest daily snowfall of 51.6 cm, well above the 14.7 cm average for the month of February. – Average daily temperature for Jasper is 3.6°C, with the warmest month in July, averaging 15.2°C and coolest month in December, averaging -9.1°C. In July of 1941, Jasper experienced its warmest day of 36.7°C and in January of 1935, its coolest day at -46.7 °C. – No major tornadoes or hailstorms have been recorded in the vicinity of the segment (NRCan 2010b,c).
Soil and Soil Productivity	• The existing Hinton to Hargreaves Segment travels through Jasper National Park and Mount Robson Provincial Park. Surface disturbance to soils caused by reactivating this segment is expected to be confined to the existing easement and will be limited to locations where valves will be installed or automated, or where integrity digs are conducted. • A soil survey along the existing Hinton to Hargreaves Segment was conducted in 2005 for the TMX Anchor Loop Project. Soils along the existing pipeline segment in Alberta are very strongly to extremely calcareous and have a substantial depth of topsoil while soils in the eastern portion of Jasper National Park have thinner topsoil depths but are still very strongly to extremely calcareous. Calcareous Melanic Brunisols developed on eolian veneers and blankets as well as Calcareous Orthic and Cumulic Regosols developed on fluvial fans occur throughout the eastern portion of the existing pipeline segment. These soils occur in rapidly to imperfectly drained positions. Orthic and Eutric Brunisols with little or no topsoil (Ah, Ahe, or Ap horizons) and developed on glaciofluvial sands and gravels, glaciolacustrine silts, fluvial fans and coarse-textured till materials are also prevalent along the existing pipeline segment. These soils mainly occur in the central and western portions of Jasper National Park and eastern portion of Mount Robson Provincial Park. Carbonates were detected at 50 cm to 80 cm below the surface in some of these soils (Mentiga 2005). • Potential soil contaminants of concern include gasoline, diesel fuel, lubricants and hydraulic fuels.

TABLE 5.13-1 Cont'd

Environmental Elements	Summary of Considerations
Water Quality and Quantity	• The Hinton to Hargreaves Segment lies within the Athabasca River Basin in Alberta and the Fraser River Basin in BC. • Flow regimes along this segment are generally dominated by snowmelt, with some influence from shrinking glaciers. Over winter months, precipitation stored as snowpack accumulates. During spring, increased temperatures combined with rainfall results in high volume freshets, which typically peak from May to July. • There are approximately 220 waterbodies along the reactivated pipeline segment (TERA 2005). • Source test water for the Hinton to Hargreaves Segment is likely to be drawn from the Athabasca, Snaring, Miette and Fraser rivers, as well as Moose Lake.
Air Emissions	• Existing air quality along the Hinton to Hargreaves Segment is expected to be good. • The largest emission sources are vehicle traffic along Highway 16, Jasper Airport, and a power generation plant near Jasper Pump Station.
GHG Emissions	• The main source of GHG emissions are aerial patrols which are conducted for maintenance purposes.
Acoustic Environment	• The largest sources of sound in the ambient acoustical environment along this segment are forestry activities, small airport flight paths, train activities on railways and recreational and tourist activities. • The Hinton to Hargreaves Segment loosely parallels the Highway 16 transportation corridor. The ambient environment in close proximity to the highway will be elevated due to the presence of vehicle traffic. In general, if a heavily travelled roadway is within the Acoustic Environment LSA, then an elevated acoustic ambient environment may exist. AER *Directive 038: Noise Control Directive* (ERCB 2007) indicates that traffic affects ASLs at up to 500 m from the roadway, which is a consideration for assessing receptors within the Acoustic Environment LSA. • This segment only passes through the single moderately urbanized community of the Town of Jasper. The remainder of this pipeline segment is located in undeveloped, rural lands where natural sounds dominate existing background. Some human activity may occur, but would not appreciably affect sound levels. • The only applicable noise bylaw for this segment is the Municipality of Jasper Bylaw No. 108. The bylaw permits construction activities from 7:30 AM to 9 PM, 7 days a week with the exception of holidays in which case no construction activity is allowed.
Fish and Fish Habitat	• The Hinton to Hargreaves Segment lies within the Athabasca River Basin in Alberta and the Fraser River Basin in BC. • There are 220 waterbodies along the reactivated pipeline segment, of which 49 are fish-bearing (TERAWestland 2005). • The section of the Athabasca River in Jasper National Park was designated as a Canadian Heritage River in 1989 (Canadian Heritage Rivers System 2011c). • Source test water for the Hinton to Hargreaves Segment is likely to be drawn from the Athabasca, Snaring, Miette and Fraser rivers, as well as Moose Lake. If hydrostatic test water is withdrawn from a nearby river or creek, an interaction with fish and fish habitat may occur. Fish species that may be found in the Athabasca and Fraser river basins are inferred based on fish species found in the Athabasca and Upper Fraser river watersheds (see Fisheries [Alberta] Technical Report and Fisheries [British Columbia] Technical Report of Volume 5C). • Provincially and federally-listed species of concern are inferred based on listed species found in the Athabasca and Upper Fraser river watersheds (see Table 4.3 of the Fisheries [Alberta] Technical Report of Volume 5C and Tables 4.4 and 4.5 of the Fisheries [British Columbia] Technical Report of Volume 5C). • White sturgeon is found in the Upper Fraser River Basin and is listed as Endangered under Schedule 1 of *SARA* (Environment Canada 2013o) and is Red-listed in BC (BC CDC 2013a). White sturgeon may reside in the upper Fraser River mainstem; their distribution is assumed to be low and they are not expected to inhabit smaller tributaries (Fisheries [British Columbia] Technical Report of Volume 5C). • Bull trout in the Athabasca and Fraser river basins near the reactivated pipeline segment are listed as a Species of Special Concern under COSEWIC (2013b). It is also designated Special Concern by the Alberta ESCC (AESRD 2012d) and is Blue-listed in BC (BC CDC 2013a). Bull trout is also an indicator species in Alberta. • Athabasca rainbow trout is considered to be At Risk in Alberta (ASRD 2011) and is in the process of being listed under the Alberta *Wildlife Act* and *Wildlife Regulation*. (AESRD 2012d). • Spiny sculpin is listed as May be At Risk in Alberta (ASRD 2011).

TABLE 5.13-1 Cont'd

Environmental Elements	Summary of Considerations
Wetland Loss or Alteration	• The Hinton to Hargreaves Segment is located within the Western Alberta Upland and Eastern Continental Ranges ecoregions. Within the Western Alberta Upland, wet areas are characterized by black spruce and tamarack, whereas within the Eastern Continental Ranges, wetlands are not common (Ecological Stratification Working Group 1995). • The Hinton to Hargreaves Segment is situated within three Wetland Regions of Canada. These regions are the South Rocky Mountain, Continental Mid-boreal and the South Interior Mountain regions (Government of Canada 1986). Common wetland types found within the South Rocky Mountain Wetland Region include flat bogs, horizontal fens and flood plain marshes with shallow basin marshes, while small basin fens and basin bogs occur in alpine areas. Treed bogs and fens, floating fens, shore swamps and marshes are often found within the Continental Mid-boreal Wetland Region. The wetlands found within the South Interior Mountain Wetland Region are characterised by flat bogs, basin bogs and shallow basin marshes with small basin fens and basin bogs found in alpine areas (Government of Canada 1986). • In Alberta, the Hinton to Hargreaves Segment is located within the Montane Natural Subregion of the Rocky Mountain Natural Region. Wetlands are rare in the Montane Natural Subregion, with fens and marshes occupying approximately 2% of the total Subregion area (Natural Regions Committee 2006b). • The Hinton to Hargreaves Segment is also located within two BGC zones of BC including the ICH and SBS zones (BC MFLNRO 2012, Meidinger and Pojar 1991). Wetlands comprise a small portion of the ICH Zone and are limited to valley bottoms where they are often associated with lakes and streams and include small swamps, and non-forested or sparsely forested wetlands (BC MOF 1996a). Within the SBS Zone, wetlands are commonly sedge marshes, shrub fens, swamps, treed fens and bogs (BC MOF 1998a, Meidinger and Pojar 1991). • Wetlands provide habitat for native plants and wildlife species, including nesting and foraging habitat for bird species and cover for ungulates. • There are no Ramsar Wetlands of International Importance along the Hinton to Hargreaves Segment (Bureau of the Convention on Wetlands 2013). This segment of the existing pipeline corridor does not cross any Western Hemisphere Shorebird Reserves (WHSRN 2013), IBAs (Bird Studies Canada and Nature Canada 2012), Migratory Bird Sanctuaries (Environment Canada 2013n) or DUC Priority Areas (DUC 2013).
Vegetation	• The Hinton to Hargreaves Segment is situated within Environmentally Significant Areas 20 and 23 (Fiera Biological Consulting Ltd. 2009), Mount Robson Provincial Park as well as Jasper National Park. This segment does not encounter any legal OGMAs but encounters one non-legal OGMA (BC MFLNRO 2009a,b). • In Alberta, the Hinton to Hargreaves Segment is located within the Montane Natural Subregion of the Rocky Mountain Natural Region of Alberta. Vegetation communities in the Montane Natural Subregion are mainly comprised of closed forest communities dominated by lodgepole pine, Douglas-fir, trembling aspen and white spruce. Deciduous forests occur on fluvial fans, terraces and flood plains. Open grasslands occur on dry and exposed sites, and are dominated by various grasses including June grass, northern wheatgrass, western wheatgrass, Kentucky bluegrass and slender wheatgrass (Natural Regions Committee 2006a). • The Hinton to Hargreaves Segment is also located within two BGC zones of BC, including the ICH and SBS zones (BC MFLNRO 2012, Meidinger and Pojar 1991). The ICH BGC Zone has the highest diversity of tree species of any zone in BC. Western redcedar and western hemlock dominate mature climax forests, while lodgepole pine, trembling aspen and paper birch are common in all areas (Meidinger and Pojar 1991). The SBS BGC Zone dominates the central interior of BC. The climate in this zone is one of extremes; the winter is severe and snowy and the summers are relatively warm and moist. However, the winters are slightly shorter and the growing season is slightly longer than those of other boreal zones. The zone is characterized by upland coniferous forests of subalpine fir and hybrid white spruce. Major streams and rivers are bordered by alluvial forests that are dominated by black cottonwood and occasionally spruce (Meidinger and Pojar 1991). • A search of the ACIMS database and the BC CDC identified 101 occurrences of rare plant and lichen species within the Vegetation RSA in this segment (ACIMS 2012, BC CDC 2012). There are 35 vascular plant species, 43 moss species, 6 liverwort species, 14 lichen species and 3 vegetation communities of concern. • The only ground disturbance planned along this segment is where MLBVs will be installed or locations of potential integrity digs. The location of these MLBVs was not finalized when vegetation surveys were conducted in 2013 and, therefore, no vegetation surveys were conducted along this segment. Once the locations of the MLBVs are finalized, the need for vegetation surveys will be revisited. See Section 9.0 for information regarding supplemental studies. • This segment crosses Yellowhead County, Jasper National Park, Mount Robson Provincial Park and the RDFFG. Representatives from Yellowhead County were contacted, the Yellowhead County website was consulted, the NWIPC website was consulted for information about the RDFFG and the Non-Native Plants of Jasper Park Weed Identification Guide was reviewed regarding invasive non-native species of concern. For this segment, Noxious weed species of concern include: Canada thistle; common burdock; common tansy; dalmation toadflax; field scabious; leafy spurge; oxeye daisy; perennial sow thistle; scentless chamomile; tall buttercup; white cockle; yellow clematis; and yellow (common) toadflax (Pichette pers. comm., Parks Canada 2010). Prohibited Noxious weed species of concern include: orange, meadow and tall hawkweed; Himalayan balsam; spotted knapweed and big headed knapweed (Pichette pers. comm., Parks Canada 2010). Regionally-listed weeds include burdock and marsh plume thistle (NWIPC 2013). For a complete list of weed species of concern, see Section 4.4 of the Vegetation Technical Report of Volume 5C.

TABLE 5.13-1 Cont'd

Environmental Elements	Summary of Considerations
Wildlife and Wildlife Habitat	• The Hinton to Hargreaves Segment crosses grizzly bear secondary habitat from approximately KP 317.6 to KP 321.9 and grizzly bear core habitat from approximately KP 321.9 to KP 326.9 (AESRD 2013g). • The Hinton to Hargreaves Segment crosses the South Jasper caribou range from approximately KP 387.0 to KP 404.6 (AESRD 2013g). • The Hinton to Hargreaves Segment is located in an international Environmentally Significant Area (No. 23) from approximately KP 326.7 to KP 405.8 (ATPR 2009). • The Hinton to Hargreaves Segment is located in Jasper National Park from approximately KP 326.7 to KP 405.8 (ATPR 2012) and Mount Robson Provincial Park from approximately KP 405.8 to Hargreaves at approximately KP 468.0 (BC MFLNRO 2008b). • The proposed Project activities associated with pipeline reactivation are not expected to have a measurable effect on wildlife and wildlife habitat and, therefore, a detailed effects assessment for this element is not warranted for this component of the Project.
Species at Risk or Species of Special Status and Related Habitat	• Federally (*i.e.*, *SARA* and COSEWIC)-listed fish species that may be found in the basins crossed by the Hinton to Hargreaves Segment include: white sturgeon (listed under Schedule 1 of *SARA* [Environment Canada 2013o] and bull trout (considered a Species of Special Concern under COSEWIC [2013b]). • A search of the ACIMS database and the BC CDC identified two plant species listed as Threatened by COSEWIC and *SARA*: Haller's apple moss; and Porsild's Bryum moss (ACIMS 2012, BC CDC 2012, COSEWIC 2013b, Environment Canada 2013o). One species, whitebark pine, is listed as Endangered by COSEWIC and the Alberta *Wildlife Act* (AESRD 2012b, COSEWIC 2013b). • The Project activities associated with pipeline reactivation are not expected to have a measurable effect on wildlife and wildlife habitat and, therefore, a detailed effects assessment for this element is not warranted for this component of the Project.

5.13.2 Darfield to Black Pines Segment

The existing Darfield to Black Pines pipeline segment extends from 75-B/092-P-8 (RK 769.0) to 41-K/092-I-16 (RK 811.9). Surface disturbance along this segment is anticipated to be confined to the existing easement and will be limited to locations where automated MLBVs will be installed, where existing valves will be automated or where integrity digs are conducted. These locations have yet to be determined. Table 5.13-2 provides a summary of the biophysical elements and considerations for the reactivation of the Darfield to Black Pines Segment pursuant to Guide A.2.4 as well as Table A-2 of the NEB *Filing Manual*.

TABLE 5.13-2

SUMMARY OF ENVIRONMENTAL ELEMENTS AND CONSIDERATIONS FOR THE DARFIELD TO BLACK PINES REACTIVATED SEGMENT

Environmental Elements	Summary of Considerations
Physical and Meteorological Environment	• The Darfield to Black Pines Segment is located within the Interior Plateau Physiographic Region, which is characterized by gentle to moderately sloping rolling uplands with rounded ridges and summits, valleys deeply dissecting the plateau, terraces, fluvial plains, fans and cones (Demarchi 2011, Holland 1976). • The Darfield to Black Pines Segment is predominantly underlain by igneous and metamporhic rock, in addition to sandstones and carbonates (BC ILMB 2013b, Monger and McMillan 1989). • Surficial materials along most of the Darfield to Black Pines Segment are characterized by till deposits along valley walls and upland surfaces, colluvial deposits along valley slopes and in fans and cones, and fluvial, glaciofluvial and glaciolacustrine deposits on plains and terraces (BGC Engineering Inc. 2013a). • There are no areas of permafrost along the Darfield to Black Pines Segment (refer to Section 5.1.1). • Debris flows and debris floods have the potential occur along the Darfield to Black Pines Segment. • The earthquake ground shaking hazard is low on lands crossed by the Darfield to Black Pines Segment. PGA is between 0.1 g and 0.2 g at a 1:2475 APE (BGC Engineering Inc. 2013c). • Topography along the segment ranges from gentle to moderate slopes along the valley bottom and lower valley slope areas and steeper hills where the segment deviates from the valley bottom.

TABLE 5.13-2 Cont'd

Environmental Elements	Summary of Considerations
Physical and Meteorological Environment (cont'd)	• Elevations range from 390 m asl at the Darfield Pump Station to 700 m asl at the highest point west of Barrier, decreasing to 380 m asl at the Black Pines Pump Station. • The Darfield to Black Pines Segment is predominantly in the IDF BGC Zone, with the southernmost approximately 6 km of the segment located within the PP BGC Zone (Meidinger and Pojar 1991). A description of the climate for the IDF and PP BGC zones is provided in Sections 5.1.2 and 5.1.3, respectively. • Meteorological data from Environment Canada's Darfield Station, located approximately 1.8 km south of Darfield Pump Station, are provided in Section 5.1.2. • No major tornadoes or hailstorms have been recorded in the vicinity of the segment (NRCan 2010b,c).
Soil and Soil Productivity	• Surface disturbance to soils caused by reactivating the existing Darfield to Black Pines Segment is expected to be confined to the existing easement and will be limited to locations where valves will be installed or automated, or where integrity digs are conducted. • Soils in the Darfield to Black Pines Segment are dominated by Gray Luvisolic soils (Valentine *et al*. 1978). Luvisolic soils generally have light-coloured, eluvial horizons and have illuvial B horizons in which silicate clay has accumulated. These soils develop characteristically in well to imperfectly-drained sites, in sandy loam to clay, base-saturated parent materials under forest vegetation in subhumid to humid, mild to very cold climates (Agriculture and Agri-Food Canada 1998). • Potential soil contaminants of concern include gasoline, diesel fuel, lubricants and hydraulic fuels.
Water Quality and Quantity	• The Darfield to Black Pines Segment lies within the Lower North Thompson River Watershed. • Flow regimes along this segment are generally dominated by snowmelt. The North Thompson River, the major watercourse along the segment, is primarily influenced by climate patterns in the Columbia Mountains resulting in high spring freshet flows, while smaller watercourses have more variable flow regimes influenced by the transition from wetter climates to the north and dryer climates to the south. • Source test water for the Darfield to Black Pines Segment is likely to be drawn from the North Thompson River.
Air Emissions	• Existing air quality along the Darfield to Black Pines Segment is expected to be good. • The largest emission sources are vehicle traffic along Highway 5, forestry activities, and residential sources from the District of Barriere.
GHG Emissions	• The main source of GHG emissions are aerial patrols which are conducted for maintenance purposes.
Acoustic Environment	• The largest sources of sound within the ambient acoustical environment, along this segment of the proposed pipeline corridor, are forestry activities, highway traffic and rail traffic. • This segment generally parallels the Highway 5 transportation corridor. The ambient environment in close proximity to the highway will be elevated due to the presence of vehicle traffic. In general, if a heavily travelled roadway is within the Acoustic Environment LSA, then an elevated acoustic ambient environment may exist. BC OGC *Noise Control Best Practices Guideline* (BC OGC 2009) indicates that traffic affects ASLs at up to 500 m from the roadway, which is a consideration for assessing receptors within the Acoustic Environment LSA. • Part of the Town of Barriere falls within the Acoustic Environment LSA for this segment. The density of development in the town would result in ASLs being elevated by human activity. The ASL for homes in Barriere would be 38 dBA at night and 48 dBA during the day. • The Hamlets of Darfield, Chinook Cove, McClure, and the Hamlet of Black Pines are all found within this segment. Based on available mapping, these hamlets do not have populations large enough to modify the ASL, as per the BC OGC *Noise Control Best Practices Guideline* (BC OGC 2009). The remainder of the pipeline segment is located in undeveloped, rural lands where natural sounds dominate existing background. Some human activity may occur, but would not appreciably affect sound levels. As a result, except near Barriere, existing sound levels follow the rural ASL of 35 dBA at night and 45 dBA during the day as found in the BC OGC *Noise Control Best Practices Guideline* (BC OGC 2009).
Fish and Fish Habitat	• The Darfield to Black Pines Segment lies within the Lower North Thompson River Watershed. • Source test water for the Darfield to Black Pines Segment is likely to be drawn from the North Thompson River. If hydrostatic test water is withdrawn from a nearby river or creek, an interaction with fish and fish habitat may occur. Of the five indicator species in BC, four (rainbow trout/steelhead, bull trout/Dolly Varden, coho salmon and Chinook salmon) are found in the Lower North Thompson River Watershed (Table 5.7-2 of Section 5.7) and may be found in watercourses crossed by the reactivated pipeline segment. • Bull trout and mountain sucker may be found in the Lower North Thompson Watershed and are both listed as a Species of Special Concern under COSEWIC (2013b) and are Blue-listed in BC (BC CDC 2013a) (see Table 4.5 of the Fisheries [British Columbia] Technical Report of Volume 5C). • Interior Fraser River coho salmon are Endangered under COSEWIC (2013b) and may be found in the Lower North Thompson River Watershed (Table 4.5 of the Fisheries [British Columbia] Technical Report of Volume 5C).

TABLE 5.13-2 Cont'd

Environmental Elements	Summary of Considerations
Wetland Loss or Alteration	• The Darfield to Black Pines Segment is located within the Columbia Highlands and the Thompson-Okanagan Plateau ecoregions. Wetlands are not very common within these ecoregions and many of those wetlands have been disturbed by urbanization and agriculture (Ecological Stratification Working Group 1995). • This segment is situated within the Intermountain Prairie Wetland Region of Canada. Common wetland types found within this wetland region include marshes bordering fresh to saline ephemeral or semi-permanent shallow waters (Government of Canada 1986). • The Darfield to Black Pines Segment is located within the IDF and PP BGC zones of BC (BC MFLNRO 2012, Meidinger and Pojar 1991). Common wetland types found within the IDF BGC Zone include fens, marshes dominated by cattails, sedges and bulrushes as well as shrubby swamps dominated by willows and birches, and occasionally saline meadow wetlands dominated by saltgrasses (BC MOF 1996b, Meidinger and Pojar 1991). Wetlands within the PP BGC Zone are not common, however, hydrophytic plants can be found in seepages and in riparian areas. Marshes associated with alkaline ponds may occur within restricted drainage depressions and basins (BC MOF 1998b, Meidinger and Pojar 1991). • Wetlands provide habitat for native plants and wildlife species, including nesting and foraging habitat for bird species and cover for ungulates. • There are no Ramsar Wetlands of International Importance along the Darfield to Black Pines Segment (Bureau of the Convention on Wetlands 2013). This segment of the proposed pipeline corridor does not cross any Western Hemisphere Shorebird Reserves (WHSRN 2013), IBAs (Bird Studies Canada and Nature Canada 2012), Migratory Bird Sanctuaries (Environment Canada 2013n) or DUC Priority Areas (DUC 2013).
Vegetation	• This segment does not cross any provincial parks or recreation areas (BC MOE 2012b). This segment encounters 16 legal OGMAs and no non-legal OGMAs (BC MFLNRO 2009a,b). Of these OGMAs, five are crossed by the existing pipeline to be reactivated. • The Darfield to Black Pines Segment is located within the IDF and PP BGC zones of BC (BC MFLNRO 2012, Meidinger and Pojar 1991). The landscape of the IDF BGC Zone consists largely of open to closed, mature forests of Douglas-fir. Pure Douglas-fir climax stands are common. Mixed stands of Douglas-fir and lodgepole pine are often present in areas frequently affected by fire. Extensive grassland communities also occur in parts of the zone due to a combination of edaphic and topographic conditions and fire history. Non-forested wetlands are common in this zone and include marshes, sedge and shrub fens, shrub-carrs and saline meadows. Willow swamps often occur along small streams and drainages (Meidinger and Pojar 1991). The PP BGC Zone is the driest and has the warmest summer temperatures of all the forested zones in BC. The forests in this zone are dominated by very open PP stands with an understory consisting largely of bluebunch wheatgrass. Grasslands are commonly scattered throughout the zone. Fires have played an important role in the ecology of the zone. Alkaline ponds can occur in depressional areas (Meidinger and Pojar 1991). • The only ground disturbance planned along this segment is where MLBVs will be installed or locations of potential integrity digs. The location of these MLBVs was not finalized when vegetation surveys were conducted in 2013 and, therefore, no vegetation surveys were conducted along this segment. Once the locations of the MLBVs are finalized, the need for vegetation surveys will be revisited. See Section 9.0 for information regarding supplemental studies. • This segment crosses the TNRD, and representatives from this area were contacted regarding invasive non-native species of concern. Regionally-listed weeds include: blueweed; burdock; field scabious; hoary cress; orange hawkweed; oxeye daisy; perennial pepperweed; and sulphur cinquefoil (SIWMC 2013). Local invasive species include: blueweed; bull thistle; Canada thistle; common burdock; diffuse knapweed; dalmatian toadflax; hoary alyssum; hound's tongue; leafy spurge; orange hawkweed; spotted knapweed; sulphur cinquefoil; and scentless chamomile. Potentially invasive species of concern include: field scabious; marsh plume thistle; perennial pepperweed; rush skeletonweed; scotch thistle; and yellow starthistle (SIWMC 2013).
Wildlife and Wildlife Habitat	• The Darfield to Black Pines Segment does not cross any WHAs, UWR or designated caribou range (BC MOE 2005a,b, 2008). • The proposed Project activities associated with pipeline reactivation are not expected to have a measurable effect on wildlife and wildlife habitat and, therefore, a detailed effects assessment for this element is not warranted for this component of the Project.
Species at Risk or Species of Special Status and Related Habitat	• Bull trout and mountain sucker are both considered to be Species of Special Concern under COSEWIC (2013b). Interior Fraser River coho salmon are Endangered under COSEWIC (2013b). All three species may be found in the Lower North Thompson River Watershed. • A search of the BC CDC identified one occurrence of a rare plant or lichen species within the Vegetation RSA in this segment (BC CDC 2012). The species, Mexican mosquito fern, is listed as Threatened by COSEWIC and *SARA* (COSEWIC 2013b, Environment Canada 2013o). • The proposed Project activities associated with pipeline reactivation are not expected to have a measurable effect on wildlife and wildlife habitat and, therefore, a detailed effects assessment for this element is not warranted for this component of the Project.

5.14 References

5.14.1 Personal Communications

TERA wishes to acknowledge those people identified in the Personal Communications for their assistance in supplying information and comments incorporated into this report.

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APPENDIX 5.1

CURRENT SURFACE WATER LICENCES 5 km DOWNSTREAM OF WATERCOURSES CROSSED BY THE PROPOSED PIPELINE CORRIDOR IN BC

Watercourse/Drainage Crossing	RK of Watercourse/Drainage Crossing	Location	Purpose	Licence Number
Hargreaves to Darfield Segment				
Fraser River	506.3	C-065-L/083-D-14	Domestic	C117707
Fraser River	506.3	C-065-L/083-D-14	Domestic	C117706
Fraser River	506.3	C-065-L/083-D-14	Domestic	C117708
Hordeae Creek	510.5	C-091-E/083-D-14	Stockwatering	C123194
Hordeae Creek	510.5	C-091-E/083-D-14	Irrigation	C123194
Hordeae Swamp	512.2	A-099-F/083-D-14	Land Improve	C062605
Hogan Creek	514.3	D-077-F/083-D-14	Domestic	C113075
Hogan Creek	514.3	D-077-F/083-D-14	Conserv.-Stored Water	C115697
Hogan Creek	514.3	D-077-F/083-D-14	Domestic	C119835
Hogan Creek	514.4	D-077-F/083-D-14	Domestic	C113073
Hogan Creek	514.4	D-077-F/083-D-14	Domestic	C122078
Teepee Creek	515.6	A-076-F/083-D-14	Domestic	C124067
Fitzgerald Brook	517.9	D-045-F/083-D-14	Domestic	C112921
Crooked Creek	518	C-044-F/083-D-14	Irrigation	C113155
Crooked Creek	518	C-044-F/083-D-14	Domestic	C113155
Crooked Creek	518.1	C-044-F/083-D-14	Domestic	C113156
Knutson Spring	519.3	B-035-F/083-D-14	Domestic	C123641
Swift Creek	521.5	C-014-F/083-D-14	Watering	C068920
Cranberry Creek	522.8	A-004-F/083-D-14	Irrigation	C123913
Cranberry Creek	522.8	A-004-F/083-D-14	Domestic	C123913
Cranberry Creek	522.9	A-004-F/083-D-14	Irrigation	C123912
Cranberry Creek	523.1	A-004-F/083-D-14	Irrigation	C104418
Cranberry Creek	523.1	A-004-F/083-D-14	Domestic	C104418
Canoe River	529.8	B-049-B/083-D-14	Fire Protection	C122160
Canoe River	529.8	B-049-B/083-D-14	Conserv.-Use Of Water	C107215
Canoe River	529.8	B-049-B/083-D-14	Processing	C122160
Camp Creek	531.7	C-020-B/083-D-14	Irrigation	C113226
Camp Creek	531.7	C-020-B/083-D-14	Enterprise	C113226
Camp Creek	544.6	D-097-G/083-D-11	Domestic	C118748
Switch Creek	577.7	D-093-G/083-D-06	Domestic	C027767
Blue River	613.9	D-034-F/083-D-03	Enterprise	C040411
Eleanor Lake	614.3	A-035-F/083-D-03	Conserv.-Use Of Water	C068599
North Thompson River	649.8	A-094-C/082-M-14	Domestic	C125631
Roddy Creek	653.8	C-056-C/082-M-14	Domestic	F011515
North Thompson River	679.9	B-005-I/082-M-12	Irrigation	C063565
Blackberg Creek	688.7	B-094-G/082-M-12	Irrigation	C025308
Blackberg Creek	688.8	B-094-G/082-M-12	Domestic	C025308
North Thompson River	689	D-084-G/082-M-12	Irrigation	C057376
Bolton Creek	690.7	C-075-G/082-M-12	Domestic	F003218
Guisbourne Spring	691.7	D-066-G/082-M-12	Domestic	C109032
North Thompson River	694.6	B-035-G/082-M-12	Irrigation	C123318
East Bella Vista Creek	695.4	C-026-G/082-M-12	Irrigation	F128219
East Bella Vista Creek	695.4	C-026-G/082-M-12	Irrigation	C031034
East Bella Vista Creek	695.7	B-026-G/082-M-12	Irrigation	C031034
Bella Vista Creek	695.7	B-026-G/082-M-12	Irrigation	F128219
Bella Vista Creek	695.7	B-026-G/082-M-12	Irrigation	C031034
East Bella Vista Creek	695.7	B-026-G/082-M-12	Irrigation	F128219
Bella Vista Creek	695.8	B-026-G/082-M-12	Irrigation	C031034
Bella Vista Creek	695.8	B-026-G/082-M-12	Irrigation	C065194
Bella Vista Creek	695.8	B-026-G/082-M-12	Irrigation	F128219
North Thompson River	698.3	A-008-G/082-M-12	Domestic	C036251

Watercourse/Drainage Crossing	RK of Watercourse/Drainage Crossing	Location	Purpose	Licence Number
North Thompson River	698.3	A-008-G/082-M-12	Domestic	C036469
North Thompson River	698.3	A-008-G/082-M-12	Domestic	C036247
North Thompson River	698.3	A-008-G/082-M-12	Domestic	C036258
North Thompson River	698.3	A-008-G/082-M-12	Domestic	C056116
North Thompson River	698.3	A-008-G/082-M-12	Domestic	C056114
North Thompson River	698.3	A-008-G/082-M-12	Domestic	C036257
North Thompson River	698.3	A-008-G/082-M-12	Domestic	C036252
North Thompson River	698.8	D-099-B/082-M-12	Waterworks (Other)	C035240
North Thompson River	698.8	D-099-B/082-M-12	Waterworks Local Auth	C046138
North Thompson River	698.8	D-099-B/082-M-12	Domestic	C102945
North Thompson River	698.8	C-099-B/082-M-12	Domestic	C104561
North Thompson River	698.9	C-099-B/082-M-12	Domestic	C059932
North Thompson River	698.9	C-099-B/082-M-12	Domestic	C059937
North Thompson River	698.9	C-099-B/082-M-12	Domestic	C059933
North Thompson River	700.8	A-092-C/082-M-12	Fire Protection	C038732
North Thompson River	700.8	A-092-C/082-M-12	Work Camps	C038732
Finley Creek	701.2	C-082-C/082-M-12	-	F018327
Finley Creek	701.2	C-082-C/082-M-12	-	F005554
North Thompson River	702.2	D-093-C/082-M-12	Irrigation	C127547
Hannibal Spring	702.6	B-003-F/082-M-12	Domestic	C055686
North Thompson River	702.6	C-093-C/082-M-12	Irrigation	C065194
Hannibal Spring	702.6	B-003-F/082-M-12	Irrigation	C055686
Hampden Spring	702.8	D-004-F/082-M-12	Irrigation	C055687
Hampden Spring	702.8	D-004-F/082-M-12	Domestic	C055687
North Thompson River	704.1	D-095-C/082-M-12	Irrigation	C065194
Baker Creek	704.4	B-095-C/082-M-12	Irrigation	C129352
North Thompson River	705.1	B-096-C/082-M-12	Irrigation	C051297
North Thompson River	706.4	A-008-F/082-M-12	Irrigation	C051296
Sara Jane Spring	707.8	B-019-F/082-M-12	Stockwatering	C067012
Crossing Creek	707.9	B-019-F/082-M-12	Domestic	C067014
Crossing Creek	707.9	B-019-F/082-M-12	Stockwatering	C067014
North Thompson River	708.6	B-020-F/082-M-12	Irrigation	C051164
North Thompson River	708.8	A-011-E/082-M-12	Irrigation	C067132
North Thompson River	713.3	A-035-E/082-M-12	Irrigation	C051865
Raft River	716.9	C-058-E/082-M-12	Irrigation	C055861
Raft River	717	B-068-E/082-M-12	Domestic	C046357
Raft River	717	B-068-E/082-M-12	Irrigation	C046357
Raft River	717.2	B-068-E/082-M-12	Conserv.-Use Of Water	C111211
Raft River	717.4	B-068-E/082-M-12	Domestic	C063643
Raft River	717.7	D-069-E/082-M-12	Domestic	C067292
Raft River	717.8	B-069-E/082-M-12	Irrigation	C130018
North Thompson River	720.2	D-061-H/092-P-09	Irrigation	C063556
North Thompson River	725.5	A-067-H/092-P-09	Stockwatering	C115159
North Thompson River	725.5	A-067-H/092-P-09	Irrigation	C115159
North Thompson River	728.4	D-038-H/092-P-09	Domestic	C111778
North Thompson River	729.8	C-028-H/092-P-09	Irrigation	C056503
North Thompson River	736.6	D-043-B/092-P-09	Irrigation	C129349
Lemieux Creek	748.1	C-088-J/092-P-08	Irrigation	C029171
Lemieux Creek	751.2	A-058-J/092-P-08	Domestic	F044081
Lemieux Creek	752.6	A-048-J/092-P-08	Irrigation	C118824
Lemieux Creek	752.7	A-048-J/092-P-08	Irrigation	C118824
North Thompson River	752.8	D-045-J/092-P-08	Irrigation	C063555
Lemieux Creek	752.9	D-038-J/092-P-08	Irrigation	C118824
Lemieux Creek	753	D-038-J/092-P-08	Irrigation	C118822
Lemieux Creek	753	D-038-J/092-P-08	Irrigation	C118823
Lemieux Creek	753.1	D-038-J/092-P-08	Irrigation	C063030
Lemieux Creek	753.1	D-038-J/092-P-08	Irrigation	C063015

Watercourse/Drainage Crossing	RK of Watercourse/Drainage Crossing	Location	Purpose	Licence Number
Lemieux Creek	753.5	A-038-J/092-P-08	Irrigation	F011121
Lemieux Creek	754.4	B-027-J/092-P-08	Irrigation	C112304
Lemieux Creek	754.4	B-027-J/092-P-08	Irrigation	C112384
Lemieux Creek	754.8	D-017-J/092-P-08	Irrigation	C104541
North Thompson River	754.8	D-016-J/092-P-08	Irrigation	C106030
Lemieux Creek	754.8	D-017-J/092-P-08	Irrigation	C117064
Lemieux Creek	754.8	D-017-J/092-P-08	Stockwatering	C117064
Spokane Creek	755.3	A-018-J/092-P-08	Irrigation	C117649
Spokane Creek	755.3	A-018-J/092-P-08	Domestic	C056035
North Thompson River	756.7	A-007-J/092-P-08	Irrigation	F044082
North Thompson River	756.9	D-097-G/092-P-08	Irrigation	C057618
Montigny Creek	757.8	C-087-G/092-P-08	Domestic	F044290
Montigny Creek	757.8	C-087-G/092-P-08	Irrigation	F044083
Montigny Creek	757.8	C-087-G/092-P-08	Domestic	C054605
Montigny Creek	757.8	C-087-G/092-P-08	Irrigation	F112888
Montigny Creek	757.9	C-087-G/092-P-08	Domestic	C033864
North Thompson River	758	D-087-G/092-P-08	Irrigation	C106328
North Thompson River	759.9	C-066-G/092-P-08	Irrigation	C126032
North Thompson River	760.6	B-066-G/092-P-08	Irrigation	C110406
Thuya Creek	761.1	C-056-G/092-P-08	Stockwatering	C117253
Thuya Creek	761.1	C-056-G/092-P-08	Irrigation	C117253
North Thompson River	761.9	D-046-G/092-P-08	Irrigation	C110400
North Thompson River	762.3	A-046-G/092-P-08	Irrigation	C126421
North Thompson River	762.9	D-036-G/092-P-08	Irrigation	C121395
North Thompson River	765	A-024-G/092-P-08	Irrigation	C104258
North Thompson River	766.1	C-004-G/092-P-08	Irrigation	C117385
Sanborn Creek	767.6	A-095-B/092-P-08	Stockwatering	C128196
Sanborn Creek	767.6	A-095-B/092-P-08	Irrigation	C034363
Sanborn Creek	767.6	A-095-B/092-P-08	Domestic	C128196
Dwyer Creek	767.7	D-085-B/092-P-08	Domestic	C059939
Darlington Creek	768.2	A-085-B/092-P-08	Ponds	C104389
Darlington Creek	768.2	A-085-B/092-P-08	Irrigation	C108299
Darlington Creek	768.2	A-085-B/092-P-08	Ponds	C108299
North Thompson River	769.03	B-023-B/092-P-08	Irrigation	C106210
North Thompson River	769.03	B-033-B/092-P-08	Irrigation	C030401
Black Pines to Hope Segment				
North Thompson River	811.85	C-069-J/092-I-16	Irrigation	C070710
North Thompson River	811.85	C-089-J/092-I-16	Irrigation	F020035
North Thompson River	811.85	C-079-J/092-I-16	Irrigation	C070711
North Thompson River	811.85	B-009-B/092-P-01	Irrigation	F020035
North Thompson River	811.85	D-080-J/092-I-16	Irrigation	F020035
North Thompson River	811.85	C-079-J/092-I-16	Irrigation	C061157
North Thompson River	812.2	B-049-J/092-I-16	Irrigation	C063678
North Thompson River	812.2	B-049-J/092-I-16	Irrigation	C068598
North Thompson River	812.2	B-049-J/092-I-16	Irrigation	C068596
North Thompson River	812.2	B-049-J/092-I-16	Domestic	C068505
North Thompson River	812.2	B-049-J/092-I-16	Irrigation	C068594
North Thompson River	812.2	B-049-J/092-I-16	Domestic	C068507
North Thompson River	812.2	B-049-J/092-I-16	Irrigation	C068592
North Thompson River	812.2	B-049-J/092-I-16	Domestic	C068509
North Thompson River	812.2	B-049-J/092-I-16	Irrigation	C068595
North Thompson River	812.2	B-049-J/092-I-16	Domestic	C068508
North Thompson River	812.5	C-039-J/092-I-16	Domestic	C065007
North Thompson River	812.5	C-039-J/092-I-16	Irrigation	C065007
North Thompson River	812.8	C-039-J/092-I-16	Irrigation	C110875
North Thompson River	812.9	D-040-J/092-I-16	Irrigation	C110950
North Thompson River	813	B-039-J/092-I-16	Irrigation	C115364

Watercourse/Drainage Crossing	RK of Watercourse/Drainage Crossing	Location	Purpose	Licence Number
North Thompson River	813.1	B-039-J/092-I-16	Irrigation	C066907
North Thompson River	813.5	D-030-J/092-I-16	Irrigation	C041520
North Thompson River	813.6	C-030-J/092-I-16	Irrigation	C114408
North Thompson River	813.6	C-030-J/092-I-16	Irrigation	C114409
North Thompson River	813.7	D-030-J/092-I-16	Irrigation	C126809
North Thompson River	813.8	D-030-J/092-I-16	Irrigation	C067328
North Thompson River	813.9	B-030-J/092-I-16	Irrigation	C127089
North Thompson River	813.9	B-030-J/092-I-16	Irrigation	C127088
North Thompson River	813.9	B-030-J/092-I-16	Irrigation	C127090
North Thompson River	813.9	B-030-J/092-I-16	Irrigation	C127087
North Thompson River	814.6	D-011-K/092-I-16	Irrigation	C057021
North Thompson River	814.7	D-011-K/092-I-16	Irrigation	C110981
North Thompson River	814.7	D-011-K/092-I-16	Irrigation	C110982
North Thompson River	814.9	A-011-K/092-I-16	Waterworks Local Auth	C125750
North Thompson River	814.9	D-011-K/092-I-16	Irrigation	C128166
North Thompson River	815.2	A-011-K/092-I-16	Irrigation	C120909
North Thompson River	815.2	A-011-K/092-I-16	Irrigation	C037468
North Thompson River	815.3	D-001-K/092-I-16	Irrigation	C119670
North Thompson River	815.3	D-001-K/092-I-16	Irrigation	C129737
North Thompson River	815.3	D-001-K/092-I-16	Irrigation	C129736
North Thompson River	815.3	A-011-K/092-I-16	Domestic	C120909
North Thompson River	815.5	D-001-K/092-I-16	Irrigation	C120912
North Thompson River	815.6	D-001-K/092-I-16	Domestic	C120912
North Thompson River	815.8	A-001-K/092-I-16	Irrigation	C114537
North Thompson River	816.1	C-100-G/092-I-16	Domestic	C117338
North Thompson River	816.2	C-100-G/092-I-16	Irrigation	C120394
North Thompson River	816.3	B-100-G/092-I-16	Domestic	C128910
North Thompson River	817.6	D-081-F/092-I-16	Irrigation	C050385
North Thompson River	817.6	A-081-F/092-I-16	Domestic	C050385
North Thompson River	817.6	D-081-F/092-I-16	Domestic	C050385
North Thompson River	817.6	A-081-F/092-I-16	Irrigation	C050385
North Thompson River	817.8	B-081-F/092-I-16	Irrigation	C122484
North Thompson River	818.4	D-072-F/092-I-16	Stockwatering	C117054
North Thompson River	818.4	D-072-F/092-I-16	Irrigation	C117054
North Thompson River	818.6	C-071-F/092-I-16	Irrigation	C129962
North Thompson River	819.7	B-061-F/092-I-16	Irrigation	C105135
North Thompson River	820.5	A-052-F/092-I-16	Irrigation	C067050
North Thompson River	820.5	B-042-F/092-I-16	Irrigation	C067050
North Thompson River	820.5	D-032-F/092-I-16	Waterworks Local Auth	C120336
North Thompson River	822.2	D-043-F/092-I-16	Stockwatering	C105133
McCulley Spring	822.5	C-043-F/092-I-16	Domestic	C068439
North Thompson River	822.8	A-033-F/092-I-16	Irrigation	C115687
North Thompson River	823	C-033-F/092-I-16	Irrigation	C106803
North Thompson River	823.2	D-034-F/092-I-16	Domestic	C046143
North Thompson River	823.4	A-034-F/092-I-16	Domestic	C040011
North Thompson River	823.6	C-023-F/092-I-16	Irrigation	C111946
North Thompson River	823.8	D-024-F/092-I-16	Irrigation	C111947
North Thompson River	823.9	D-024-F/092-I-16	Irrigation	C055690
North Thompson River	824.2	A-024-F/092-I-16	Enterprise	C127178
North Thompson River	824.2	D-014-F/092-I-16	Irrigation	C067217
North Thompson River	824.2	A-024-F/092-I-16	Irrigation	C112143
North Thompson River	824.2	A-024-F/092-I-16	Irrigation	C067218
North Thompson River	824.2	A-024-F/092-I-16	Domestic	C112143
North Thompson River	824.2	D-014-F/092-I-16	Irrigation	C067216
John Stanton Creek	824.3	B-024-F/092-I-16	Stockwatering	C105452
North Thompson River	825.3	A-014-F/092-I-16	Irrigation Local Auth	C127118
North Thompson River	825.4	D-094-C/092-I-16	Irrigation	C034287

Watercourse/Drainage Crossing	RK of Watercourse/Drainage Crossing	Location	Purpose	Licence Number
North Thompson River	825.4	A-004-F/092-I-16	Nurseries	C068630
North Thompson River	825.4	A-004-F/092-I-16	Nurseries	C068630
North Thompson River	825.4	A-004-F/092-I-16	Irrigation	C032567
Lanes Creek	825.5	C-005-F/092-I-16	Stockwatering	C126306
Lanes Creek	825.5	C-005-F/092-I-16	Domestic	C126306
North Thompson River	827.2	B-094-C/092-I-16	Irrigation	C034287
Dairy Creek	827.3	D-096-C/092-I-16	Stockwatering	C112990
Dairy Creek	827.3	D-096-C/092-I-16	Domestic	C058785
Dairy Creek	827.3	D-096-C/092-I-16	Stockwatering	C114215
Dairy Creek	827.3	D-096-C/092-I-16	Domestic	C115836
Dairy Creek	827.3	D-096-C/092-I-16	Domestic	C058786
Dairy Creek	827.4	D-096-C/092-I-16	Ponds	C116873
North Thompson River	829	A-085-C/092-I-16	Irrigation	C034287
McQueen Creek	829	D-087-C/092-I-16	Domestic	F065083
North Thompson River	831.4	C-074-C/092-I-16	Enterprise	C041214
North Thompson River	831.4	D-075-C/092-I-16	Domestic	C045586
North Thompson River	831.4	D-075-C/092-I-16	Domestic	C045587
North Thompson River	831.4	C-074-C/092-I-16	Irrigation	C046962
North Thompson River	831.4	C-074-C/092-I-16	Domestic	C046962
North Thompson River	831.4	D-065-C/092-I-16	Irrigation	C109595
North Thompson River	831.4	C-074-C/092-I-16	Irrigation	C108115
North Thompson River	831.4	B-076-C/092-I-16	Waterworks Local Auth	C114611
North Thompson River	831.4	D-065-C/092-I-16	Domestic	F017874
North Thompson River	831.4	D-065-C/092-I-16	Irrigation	F017874
North Thompson River	831.4	B-076-C/092-I-16	Irrigation	F040523
North Thompson River	831.5	B-066-C/092-I-16	Irrigation	C037467
North Thompson River	831.6	C-056-C/092-I-16	Irrigation	F040522
North Thompson River	831.9	D-057-C/092-I-16	Irrigation Local Auth	C127121
North Thompson River	832.6	C-046-C/092-I-16	Irrigation	C055692
North Thompson River	832.8	B-046-C/092-I-16	Watering	C128019
North Thompson River	832.8	B-046-C/092-I-16	Irrigation	C128022
North Thompson River	832.8	B-046-C/092-I-16	Irrigation	C125883
North Thompson River	836.7	D-018-C/092-I-16	Waterworks Local Auth	C127130
North Thompson River	836.7	D-018-C/092-I-16	Waterworks Local Auth	C127120
North Thompson River	838.8	B-098-K/092-I-09	Irrigation	F011510
North Thompson River	839.1	A-089-K/092-I-09	Irrigation	C033300
North Thompson River	839.1	A-089-K/092-I-09	Stockwatering	C031250
North Thompson River	839.5	C-079-K/092-I-09	Irrigation	C055693
North Thompson River	840.1	D-069-K/092-I-09	Waterworks Local Auth	C127116
North Thompson River	840.1	D-069-K/092-I-09	Waterworks Local Auth	C127117
North Thompson River	840.1	D-069-K/092-I-09	Waterworks Local Auth	C127124
North Thompson River	840.3	C-048-K/092-I-09	Irrigation	C034647
Thompson River	846.5	B-044-L/092-I-09	Watering	C109675
Thompson River	847.6	C-032-L/092-I-09	Waterworks Local Auth	C127133
Thompson River	848.3	B-031-L/092-I-09	Land Improve	C107713
Peterson Creek	852.2	C-067-F/092-I-09	Irrigation	F049860
Peterson Creek	852.2	C-077-F/092-I-09	Storage - Non-Power	C035561
Peterson Creek	852.2	D-067-F/092-I-09	Domestic	F045464
Peterson Creek	852.2	C-067-F/092-I-09	Irrigation	F045464
Gamble Spring	852.2	C-067-F/092-I-09	Domestic	C037564
Peterson Creek	852.2	C-067-F/092-I-09	-	F049859
Peterson Creek	852.2	C-077-F/092-I-09	Domestic	C035560
Peterson Creek	852.2	D-067-F/092-I-09	-	F045463
Peterson Creek	852.2	D-067-F/092-I-09	Irrigation	F045464
Peterson Creek	852.2	C-077-F/092-I-09	Domestic	C035096
Peterson Creek	852.2	C-067-F/092-I-09	-	F045463
Peterson Creek	852.2	C-077-F/092-I-09	-	C036058

Watercourse/Drainage Crossing	RK of Watercourse/Drainage Crossing	Location	Purpose	Licence Number
Gamble Spring	852.2	C-067-F/092-I-09	Irrigation	C037564
Peterson Creek	852.2	C-067-F/092-I-09	Domestic	F045464
Peterson Creek	852.2	C-077-F/092-I-09	Irrigation	C035096
Peterson Creek	852.2	C-067-F/092-I-09	Irrigation	F065640
Peterson Creek	852.2	D-067-F/092-I-09	Domestic	F045464
Peterson Creek	852.2	C-067-F/092-I-09	-	F065638
Peterson Creek	852.2	D-067-F/092-I-09	Irrigation	F045464
Peterson Creek	859.7	C-023-E/092-I-09	Storage - Non-Power	F065641
Peterson Creek	859.7	C-023-E/092-I-09	Storage - Non-Power	C045895
Peterson Creek	859.7	C-023-E/092-I-09	Storage - Non-Power	F019450
Peterson Creek	859.7	C-023-E/092-I-09	Storage - Non-Power	F019453
Peterson Creek	859.7	C-023-E/092-I-09	Conserv.-Stored Water	C102917
Peterson Creek	859.7	C-023-E/092-I-09	Storage - Non-Power	C045898
Peterson Creek	859.7	C-023-E/092-I-09	Storage - Non-Power	F021539
Peterson Creek	861.4	D-027-F/092-I-09	Irrigation	C118287
Peterson Creek	861.4	D-027-F/092-I-09	Irrigation	C118288
Peterson Creek	861.4	D-027-F/092-I-09	Domestic	C118289
Peterson Creek	861.4	D-027-F/092-I-09	Irrigation	C118289
Peterson Creek	861.4	D-027-F/092-I-09	Domestic	C118288
Ray Spring	864.2	D-096-C/092-I-09	Domestic	F018161
Roberts Spring	864.7	C-086-C/092-I-09	Domestic	F010430
Anderson Creek	865.2	C-078-C/092-I-09	Storage - Non-Power	F065639
Anderson Creek	865.2	C-078-C/092-I-09	Storage - Non-Power	C045887
Anderson Creek	865.2	C-078-C/092-I-09	Irrigation	F007306
Anderson Creek	865.2	C-078-C/092-I-09	Irrigation	F045463
Anderson Creek	865.2	C-078-C/092-I-09	Storage - Non-Power	F007307
Anderson Creek	865.2	C-078-C/092-I-09	Storage - Non-Power	F019451
Anderson Creek	865.2	C-078-C/092-I-09	Irrigation	C045896
Anderson Creek	865.2	C-078-C/092-I-09	Irrigation	C036058
Anderson Creek	865.2	C-078-C/092-I-09	Storage - Non-Power	C045897
Anderson Creek	865.2	C-078-C/092-I-09	Storage - Non-Power	F019452
Anderson Creek	865.2	C-078-C/092-I-09	Storage - Non-Power	F021540
Anderson Creek	865.2	C-078-C/092-I-09	Irrigation	F049859
Anderson Creek	865.2	C-078-C/092-I-09	Irrigation	C045886
Anderson Creek	865.2	C-078-C/092-I-09	Irrigation	F065638
Nichol Lake	870.2	D-027-C/092-I-09	Irrigation	C036076
Nichol Lake	870.2	D-027-C/092-I-09	Domestic	C036076
Pamela Pond	870.2	B-026-C/092-I-09	Irrigation	C036079
Brigade Lake	873.4	C-065-K/092-I-08	Storage - Non-Power	F048848
Brigade Lake	873.4	C-065-K/092-I-08	Storage - Non-Power	C050379
Luke Creek	874.0	B-078-K/092-I-08	Irrigation	F017212
Luke Creek	874.0	B-078-K/092-I-08	Irrigation	C024328
Brigade Creek	874.9	A-055-K/092-I-08	Domestic	C050378
Brigade Creek	874.9	A-055-K/092-I-08	Domestic	F048847
Brigade Creek	874.9	A-055-K/092-I-08	Irrigation	C050378
Brigade Creek	874.9	A-055-K/092-I-08	Irrigation	F048847
Droppingwater Creek	875.2	A-070-K/092-I-08	Storage - Non-Power	F124578
Droppingwater Creek	875.2	A-070-K/092-I-08	Storage - Non-Power	F124579
Droppingwater Creek	875.5	C-059-K/092-I-08	Irrigation	F015816
Droppingwater Creek	876.2	B-059-K/092-I-08	Domestic	F006064
Droppingwater Creek	876.2	B-059-K/092-I-08	Irrigation	F006064
Droppingwater Creek	876.7	A-049-K/092-I-08	Domestic	F006064
Droppingwater Creek	876.7	A-049-K/092-I-08	Irrigation	F006064
Droppingwater Creek	876.8	A-049-K/092-I-08	Irrigation	F005946
Droppingwater Creek	876.8	A-049-K/092-I-08	Domestic	F005946
Droppingwater Creek	876.9	A-049-K/092-I-08	Irrigation	F005946
Droppingwater Creek	876.9	A-049-K/092-I-08	Domestic	F005946

Watercourse/Drainage Crossing	RK of Watercourse/Drainage Crossing	Location	Purpose	Licence Number
Droppingwater Creek	877.8	B-038-K/092-I-08	Domestic	F005946
Droppingwater Creek	877.8	B-038-K/092-I-08	Storage - Non-Power	F015819
Droppingwater Creek	877.8	B-038-K/092-I-08	Storage - Non-Power	C029900
Droppingwater Creek	877.8	B-038-K/092-I-08	Irrigation	F015818
Droppingwater Creek	877.8	B-038-K/092-I-08	Irrigation	F005946
Droppingwater Creek	877.8	B-038-K/092-I-08	Irrigation	C029899
Droppingwater Creek	878.6	A-028-K/092-I-08	Irrigation	C029899
Luke Creek	878.7	A-028-K/092-I-08	Irrigation	F008494
Luke Creek	878.7	A-028-K/092-I-08	Domestic	F008494
Droppingwater Creek	881.0	C-097-F/092-I-08	Irrigation	F008211
Droppingwater Creek	881.0	C-097-F/092-I-08	Irrigation	F014103
Droppingwater Creek	881.5	A-097-F/092-I-08	Irrigation	F008211
Droppingwater Creek	881.5	A-097-F/092-I-08	Storage - Non-Power	F014104
Droppingwater Creek	881.5	A-097-F/092-I-08	Irrigation	F014103
Droppingwater Creek	881.5	A-097-F/092-I-08	Irrigation	F014103
Droppingwater Creek	881.5	A-097-F/092-I-08	Irrigation	F008211
Moore Creek	883.6	A-084-E/092-I-08	Irrigation	C025183
Drew Brook	884.2	A-061-E/092-I-08	Irrigation	F021084
Drew Brook	884.6	D-051-E/092-I-08	Stockwatering	C031819
Moore Creek	885.7	D-054-E/092-I-08	Irrigation	F006250
Moore Creek	885.7	D-054-E/092-I-08	Irrigation	F006249
Moore Creek	885.7	D-054-E/092-I-08	Domestic	F006249
Moore Creek	885.7	D-054-E/092-I-08	Irrigation	F008823
Moore Creek	887.9	C-035-E/092-I-08	Irrigation	F006250
Moore Creek	887.9	C-035-E/092-I-08	Irrigation	F008823
Moore Creek	887.9	C-035-E/092-I-08	Irrigation	F006250
Moore Creek	888.4	A-036-E/092-I-08	Irrigation	F008823
Moore Creek	889.9	C-016-E/092-I-08	Irrigation	F006252
Moore Creek	891.6	D-097-D/092-I-08	Domestic	F005510
Moore Creek	891.6	D-097-D/092-I-08	Irrigation	F005510
Moore Creek	891.6	D-097-D/092-I-08	Irrigation	C012744
Peter Hope Creek	892.7	C-071-D/092-I-08	Stockwatering	C112173
Peter Hope Creek	892.7	C-071-D/092-I-08	Irrigation	C112173
Cultus Creek	893.5	D-077-D/092-I-08	Stockwatering	C027897
Moore Creek	894.3	A-076-D/092-I-08	Irrigation	F005510
Moore Creek	894.3	A-076-D/092-I-08	Domestic	F005510
Stumplake Creek	895.3	A-062-D/092-I-08	Irrigation	F011586
Moore Creek	896.0	A-056-D/092-I-08	-	F006192
Moore Creek	896.0	A-056-D/092-I-08	Irrigation	F010100
Moore Creek	896.0	A-056-D/092-I-08	-	C067057
Moore Creek	896.0	A-056-D/092-I-08	Domestic	F006190
Moore Creek	896.0	A-056-D/092-I-08	Irrigation	F006190
Moore Creek	896.9	B-046-D/092-I-08	Domestic	F006190
Moore Creek	896.9	B-046-D/092-I-08	-	C067057
Moore Creek	896.9	B-046-D/092-I-08	-	F006192
Moore Creek	896.9	B-046-D/092-I-08	Irrigation	F006190
Moore Creek	898.3	C-026-D/092-I-08	Irrigation	F010100
Moore Creek	898.3	C-026-D/092-I-08	Irrigation	F006190
Moore Creek	898.3	C-026-D/092-I-08	-	F006192
Moore Creek	898.3	C-026-D/092-I-08	Domestic	F006190
Moore Creek	898.4	A-027-D/092-I-08	Domestic	F006190
Moore Creek	898.4	A-027-D/092-I-08	Irrigation	F006190
Moore Creek	898.4	A-027-D/092-I-08	-	C067057
Stumplake Creek	898.4	C-015-D/092-I-08	Conserv.-Construct.Works	C067143
Moore Creek	898.4	A-027-D/092-I-08	-	F006192
Moore Creek	898.4	A-027-D/092-I-08	Irrigation	F006301
Moore Creek	898.4	A-027-D/092-I-08	Irrigation	F006190

Watercourse/Drainage Crossing	RK of Watercourse/Drainage Crossing	Location	Purpose	Licence Number
Moore Creek	898.4	A-027-D/092-I-08	Domestic	F006190
Moore Creek	898.4	A-027-D/092-I-08	-	C067057
Stumplake Creek	898.4	C-015-D/092-I-08	Storage - Non-Power	C067142
Moore Creek	898.4	A-027-D/092-I-08	-	C067057
Moore Creek	898.4	A-027-D/092-I-08	-	F006192
Moore Creek	898.4	A-027-D/092-I-08	Irrigation	F010100
Stumplake Creek	898.5	B-006-D/092-I-08	Irrigation	C056308
Stumplake Creek	898.5	B-006-D/092-I-08	Storage - Non-Power	C056311
Stumplake Creek	898.5	B-006-D/092-I-08	Irrigation	C056310
Moore Creek	898.6	A-017-D/092-I-08	-	C067057
Moore Creek	898.6	A-017-D/092-I-08	Domestic	F006190
Moore Creek	898.6	A-017-D/092-I-08	-	F006192
Moore Creek	898.6	A-017-D/092-I-08	Irrigation	F006190
Rocky Gulch	900.0	D-008-D/092-I-08	Domestic	C027902
Rocky Gulch	900.3	D-019-D/092-I-08	Stockwatering	C027901
Rocky Gulch	900.6	D-008-D/092-I-08	Irrigation	F006191
Klup Creek	901.5	C-099-L/092-I-01	Stockwatering	C027899
Klup Creek	902.4	B-100-L/092-I-01	Stockwatering	C027899
Klup Creek	903.3	D-091-I/092-I-02	Stockwatering	C027899
Nicola Lake	918.2	C-092-G/092-I-02	Irrigation	C110654
Nicola Lake	918.2	C-092-G/092-I-02	Irrigation	C110655
Shuta Creek	918.3	C-024-J/092-I-02	Irrigation	C110656
Clapperton Creek	918.4	D-014-J/092-I-02	Domestic	F009003
Clapperton Creek	918.4	D-014-J/092-I-02	Irrigation	F009003
Clapperton Creek	918.4	D-014-J/092-I-02	Irrigation	C110656
Clapperton Creek	919.2	B-014-J/092-I-02	Domestic	F009003
Clapperton Creek	919.2	B-014-J/092-I-02	Irrigation	F009003
Nicola Lake	919.3	C-092-G/092-I-02	Irrigation	C110655
Nicola Lake	919.3	C-092-G/092-I-02	Irrigation	C110654
Clapperton Creek	919.4	C-004-J/092-I-02	Irrigation	F011771
Clapperton Creek	919.4	C-004-J/092-I-02	Irrigation	C110656
Nicola Lake	920.0	C-093-G/092-I-02	Irrigation	C110654
Nicola Lake	920.0	C-093-G/092-I-02	Irrigation	C110655
Nicola River	920.2	D-094-G/092-I-02	Conserv.-Use of Water	C064716
Nicola River	920.2	D-094-G/092-I-02	Storage - Non-Power	C064716
Nicola River	920.2	D-094-G/092-I-02	Storage - Non-Power	C064717
Nicola River	920.6	B-094-G/092-I-02	Stockwatering	C068663
Nicola River	920.6	B-094-G/092-I-02	Irrigation	C068659
Nicola River	920.6	B-094-G/092-I-02	Conserv.-Use Of Water	C109746
Nicola River	920.6	B-094-G/092-I-02	Irrigation	C068656
Nicola River	920.6	B-094-G/092-I-02	Irrigation	C068661
Nicola River	920.6	B-094-G/092-I-02	Irrigation	C068660
Nicola River	920.6	B-094-G/092-I-02	Irrigation	C068658
Nicola River	920.6	B-094-G/092-I-02	Stockwatering	C068657
Nicola River	920.6	B-094-G/092-I-02	Stockwatering	C068664
Nicola River	920.6	B-094-G/092-I-02	Storage - Non-Power	C109746
Nicola River	920.6	B-094-G/092-I-02	Irrigation	C050394
Nicola River	921.3	D-085-G/092-I-02	Irrigation	C050394
Brant Springs	923.0	C-075-G/092-I-02	Conserv.-Stored Water	C109747
Brant Springs	923.0	C-075-G/092-I-02	Storage - Non-Power	C109747
Nicola River	925.0	D-058-G/092-I-02	Conserv.-Stored Water	C109745
Nicola River	926.8	B-058-G/092-I-02	Conserv.-Stored Water	C109745
Nicola River	929.7	B-031-F/092-I-02	Irrigation	C061111
Nicola River	929.8	C-032-F/092-I-02	Irrigation	C061110
Nicola River	929.9	C-032-F/092-I-02	Irrigation	C037183
Godey Creek	930.9	D-012-F/092-I-02	Domestic	C110444
Godey Creek	930.9	D-012-F/092-I-02	Res. Lawn/Garden	C110444

Watercourse/Drainage Crossing	RK of Watercourse/Drainage Crossing	Location	Purpose	Licence Number
Nicola River	931.0	D-035-F/092-I-02	Processing	C129778
Nicola River	931.0	D-035-F/092-I-02	Processing	C129776
Coldwater River	931.3	B-023-F/092-I-02	Waterworks Local Auth	C025311
Nicola River	931.3	B-045-F/092-I-02	Irrigation	F114234
Coldwater River	931.3	B-023-F/092-I-02	Waterworks Local Auth	C030751
Nicola River	931.3	B-045-F/092-I-02	-	C120570
Nicola River	931.3	A-046-F/092-I-02	Irrigation	F017315
Coldwater River	931.3	B-023-F/092-I-02	Waterworks Local Auth	C026589
Coldwater River	931.3	B-023-F/092-I-02	Waterworks Local Auth	C030750
Ruby Gulch	931.4	B-046-F/092-I-02	Irrigation	C107797
Nicola River	931.4	A-046-F/092-I-02	Irrigation	C107802
Nicola River	931.4	A-046-F/092-I-02	Irrigation	C107803
Ruby Gulch	931.5	B-046-F/092-I-02	Irrigation	C107797
Coldwater River	931.6	C-024-F/092-I-02	Irrigation	C120570
Ruby Gulch	931.7	D-047-F/092-I-02	Domestic	C107799
Diamond Vale Brook	931.7	C-002-F/092-I-02	Domestic	F050530
Ruby Gulch	931.7	B-046-F/092-I-02	Irrigation	C107798
Chapman Slough	931.8	C-036-F/092-I-02	Irrigation	C030474
Coldwater River	937.6	C-058-C/092-I-02	Irrigation	F011230
Kwinshatin Creek	941.6	C-027-C/092-I-02	Irrigation	F019457
Coldwater River	942.4	B-058-C/092-I-02	Irrigation	F011230
Kwinshatin Creek	942.4	B-038-C/092-I-02	Irrigation	F019457
Kwinshatin Creek	942.5	C-039-C/092-I-02	Irrigation	F019457
Kwinshatin Creek	942.5	D-039-C/092-I-02	Irrigation	F019457
Coldwater River	942.5	B-059-C/092-I-02	Irrigation	F011230
Kwinshatin Creek	942.5	D-039-C/092-I-02	Irrigation	F019457
Kwinshatin Creek	942.5	B-038-C/092-I-02	Irrigation	F019457
Kwinshatin Creek	942.5	D-039-C/092-I-02	Waterworks (Other)	F049866
Coldwater River	943.2	B-049-C/092-I-02	Irrigation	F011230
Skuagam Creek	943.4	C-029-C/092-I-02	Irrigation	F019456
Skuagam Creek	943.4	C-029-C/092-I-02	Waterworks (Other)	F049867
Coldwater River	944.3	B-040-C/092-I-02	Irrigation	F011230
Castillion Creek	946.2	B-001-D/092-I-02	Irrigation	F005666
Castillion Creek	946.2	B-001-D/092-I-02	Domestic	F005666
Castillion Creek	946.2	B-001-D/092-I-02	-	F007464
Castillion Creek	946.3	D-002-D/092-I-02	Domestic	F005666
Castillion Creek	946.3	D-002-D/092-I-02	-	F007464
Castillion Creek	946.3	D-002-D/092-I-02	Irrigation	F005666
Coldwater River	946.4	D-012-D/092-I-02	Irrigation	C119907
Castillion Creek	946.4	D-002-D/092-I-02	Domestic	F005666
Castillion Creek	946.4	D-002-D/092-I-02	Irrigation	F005666
Coldwater River	946.4	D-012-D/092-I-02	Stockwatering	C119906
Coldwater River	946.4	D-012-D/092-I-02	Irrigation	C119906
Castillion Creek	946.4	D-002-D/092-I-02	-	F007464
Matilda Spring	947.9	A-093-L/092-H-15	Stockwatering	C068319
Matilda Spring	947.9	A-093-L/092-H-15	Irrigation	C068319
Matilda Spring	947.9	A-093-L/092-H-15	Irrigation	C103141
Coldwater River	948.1	C-093-L/092-H-15	Irrigation	C110921
Salem Creek	949.2	A-084-L/092-H-15	Irrigation	F021362
Coldwater River	949.2	B-084-L/092-H-15	Irrigation	C110922
Midday Creek	950.2	C-075-L/092-H-15	Irrigation	C063657
Midday Creek	950.2	C-075-L/092-H-15	Domestic	C063657
Coldwater River	951.2	C-065-L/092-H-15	Irrigation	F011229
Coldwater River	952.5	D-045-L/092-H-15	Irrigation	C119905
Olsen Creek	953.4	B-043-L/092-H-15	Stockwatering	C030023
Coldwater River	954.8	C-024-L/092-H-15	Domestic	F020032
Coldwater River	955.8	C-014-L/092-H-15	Conserv.-Use Of Water	C117033

Watercourse/Drainage Crossing	RK of Watercourse/Drainage Crossing	Location	Purpose	Licence Number
Coldwater River	955.8	C-014-L/092-H-15	Irrigation	C118893
Gillis Creek	958.2	C-094-E/092-H-15	Domestic	C028275
Gillis Creek	958.2	C-094-E/092-H-15	Irrigation	C028275
Coldwater River	958.4	D-084-E/092-H-15	Irrigation	C053596
Coldwater River	958.6	D-084-E/092-H-15	Irrigation	F015575
Coldwater River	958.6	D-084-E/092-H-15	Irrigation	C053595
Gary Spring	958.7	A-084-E/092-H-15	Domestic	C120309
Camp Brook	1037.7	C-058-F/092-H-06	Domestic	C045691
Triplet Springs	1040.3	B-061-E/092-H-06	Waterworks Local Auth	C058360
Triplet Springs	1040.3	B-061-E/092-H-06	Waterworks Local Auth	C058360
Triplet Springs	1040.3	B-061-E/092-H-06	Waterworks Local Auth	C058360
Sucker Creek	1042.3	B-063-E/092-H-06	Domestic	F052066
Sucker Creek	1042.3	B-063-E/092-H-06	Domestic	F052066
University Spring	1042.3	B-063-E/092-H-06	Domestic	F019491
Sucker Creek	1042.5	A-064-E/092-H-06	Land Improve	C051064
Coquihalla River	1042.5	B-053-E/092-H-06	Domestic	C119954
Coquihalla River	1042.5	B-053-E/092-H-06	Domestic	C119953
Sucker Creek	1043.0	B-064-E/092-H-06	Conserv.-Construct. Works	C124517
Sucker Creek	1043.0	B-064-E/092-H-06	Conserv.-Construct. Works	F020007
Sucker Creek	1043.0	B-064-E/092-H-06	Conserv.-Use Of Water	C124517
Coquihalla River	1043.2	C-065-E/092-H-06	Watering	C055099
Coquihalla River	1043.2	A-076-E/092-H-06	Watering	C055099
Coquihalla River	1043.2	B-075-E/092-H-06	Watering	C055099
Hope to Burnaby and Burnaby to Westridge Segment				
Charles Creek	1045.5	B-046-E/092-H-06	Domestic	F016362
Charles Creek	1045.5	B-046-E/092-H-06	Domestic	C023232
Charles Creek	1045.5	B-046-E/092-H-06	Domestic	C070656
Silverhope Creek	1047.0	B-047-E/092-H-06	Domestic	C065240
Hunter Creek	1055.2	C-026-H/092-H-05	Domestic	C127520
Hunter Creek	1055.2	C-026-H/092-H-05	Domestic	C127520
Hunter Creek	1055.5	C-026-H/092-H-05	Enterprise	C102395
Hunter Creek	1055.5	C-026-H/092-H-05	Domestic	C102395
Hunter Creek	1055.7	B-026-H/092-H-05	Enterprise	C102395
Hunter Creek	1055.7	B-026-H/092-H-05	Domestic	C102395
Mayfalls Creek	1063.9	A-063-B/092-H-05	Irrigation	C107080
Mayfalls Creek	1063.9	A-063-B/092-H-05	Ponds	C107080
Frank Creek	1064.4	D-053-B/092-H-05	Irrigation	C107075
Frank Creek	1064.4	D-053-B/092-H-05	Stockwatering	C107075
Maria Slough	1065.6	B-067-B/092-H-05	Irrigation	F041025
Maria Slough	1065.6	A-067-B/092-H-05	Irrigation	C057071
Maria Slough	1065.6	B-066-B/092-H-05	Irrigation	C057070
Phillips Creek	1066.5	D-034-B/092-H-05	Domestic	C060846
Maria Slough	1067.8	B-048-B/092-H-05	Irrigation	C037190
Hall Creek	1069.6	B-020-B/092-H-05	Land Improve	C041613
Maria Slough	1069.6	D-020-B/092-H-05	Irrigation	C047193
Hall Creek	1069.6	B-020-B/092-H-05	Domestic	C041613
Leland Brook	1069.7	D-005-B/092-H-05	Domestic	C032105
Viola Spring	1069.7	D-005-B/092-H-05	Domestic	C121571
Viola Spring	1069.7	D-005-B/092-H-05	Domestic	C121576
Viola Spring	1069.7	D-005-B/092-H-05	Domestic	F020179
Viola Spring	1069.7	D-005-B/092-H-05	Domestic	F020205
Wahleach Spring	1071.9	A-085-J/092-H-04	Enterprise	C053087
Dogwood Spring	1072.3	C-099-J/092-H-04	Domestic	F020124
Cheam Creek	1078.0	A-050-J/092-H-04	Domestic	F018764
Cheam Creek	1079.6	A-031-K/092-H-04	Conserv.-Stored Water	C102053
Helmer Creek	1079.8	C-030-J/092-H-04	Irrigation	C121491

Watercourse/Drainage Crossing	RK of Watercourse/Drainage Crossing	Location	Purpose	Licence Number
Bridal Creek	1080.0	D-021-K/092-H-04	Ponds	C062117
Karr Creek	1080.1	A-021-K/092-H-04	Ponds	C069216
Karr Creek	1080.3	A-021-K/092-H-04	Ponds	C069216
Fraser River	1081.6	B-043-K/092-H-04	Conserv.-Construct. Works	C057066
Dunville Creek	1083.9	C-004-K/092-H-04	Domestic	F006725
Nevin Creek	1083.9	B-014-K/092-H-04	Irrigation	C070654
Nevin Creek	1084.1	A-015-K/092-H-04	Irrigation	C070655
Dunville Creek	1084.6	C-005-K/092-H-04	Irrigation	C114830
Dunville Creek	1084.6	C-005-K/092-H-04	Irrigation	F053793
Dunville Creek	1085.0	B-005-K/092-H-04	Irrigation	C121446
Dunville Creek	1085.5	D-006-K/092-H-04	Stockwatering	C121451
Hope Slough	1086.4	A-018-K/092-H-04	Irrigation	C108406
Hope Slough	1086.4	A-018-K/092-H-04	Irrigation	C053128
Hope Slough	1087.3	A-019-K/092-H-04	Irrigation Local Auth	C020756
Hope Slough	1087.7	A-019-K/092-H-04	Irrigation	C119051
Hope Slough	1088.4	C-020-K/092-H-04	Irrigation	C025047
Hope Slough	1088.4	B-030-K/092-H-04	Nurseries	C114586
Hope Slough	1088.4	B-019-K/092-H-04	Irrigation	F017098
Hope Slough	1089.3	A-022-L/092-H-04	Irrigation	C118798
Hope Slough	1089.6	B-022-L/092-H-04	Irrigation	C118799
Hope Slough	1089.6	B-022-L/092-H-04	Irrigation	C118800
Hope Slough	1089.7	B-022-L/092-H-04	Irrigation	F016582
Hope Slough	1089.9	C-012-L/092-H-04	Irrigation	F019826
Hope Slough	1089.9	B-022-L/092-H-04	Watering	F038921
Semmihault Creek	1093.2	D-064-E/092-H-04	Irrigation	F017250
Semmihault Creek	1094.0	D-075-E/092-H-04	Land Improve	F019563
Semmihault Creek	1094.0	D-075-E/092-H-04	Irrigation	C068170
Semmihault Creek	1094.0	D-075-E/092-H-04	Irrigation	C035268
Bailey Ditch	1094.1	A-054-E/092-H-04	Domestic	F014720
Interception Ditch	1094.1	A-054-E/092-H-04	Irrigation	C033331
Semmihault Creek	1094.6	B-085-E/092-H-04	Irrigation	F019753
Semmihault Creek	1094.9	D-086-E/092-H-04	Irrigation	F019753
Chilliwack Creek	1095.6	C-076-E/092-H-04	Irrigation	C063451
Chilliwack Creek	1095.6	A-076-E/092-H-04	Irrigation	C125371
Chilliwack Creek	1095.6	A-076-E/092-H-04	Irrigation	C125370
Chilliwack Creek	1095.6	A-076-E/092-H-04	Irrigation	C125369
Chilliwack Creek	1095.7	B-087-E/092-H-04	Irrigation	C063453
Chilliwack Creek	1095.7	A-087-E/092-H-04	Irrigation	C063449
Chilliwack Creek	1095.7	B-086-E/092-H-04	Irrigation	F019753
Chilliwack Creek	1095.7	D-088-E/092-H-04	Irrigation	C064722
Chilliwack Creek	1095.7	A-088-E/092-H-04	Irrigation	C110814
Chilliwack Creek	1095.7	A-087-E/092-H-04	Irrigation	C063452
Chilliwack Creek	1095.8	A-088-E/092-H-04	Land Improve	C026119
Chilliwack Creek (New Channel)	1096.0	A-088-E/092-H-04	Irrigation	C110814
Chilliwack Creek (New Channel)	1096.0	A-088-E/092-H-04	Irrigation	F050911
Vedder River	1104.0	C-003-H/092-G-01	Irrigation	F020104
Vedder River	1104.0	C-003-H/092-G-01	Irrigation	F019953
Sumas Lake Canal	1109.5	C-029-H/092-G-01	Irrigation	F020729
Sumas River	1109.7	A-040-H/092-G-01	Irrigation	C107747
Sumas Lake Canal	1110.2	A-020-H/092-G-01	Irrigation Local Auth	C122479
Sumas Lake Canal	1110.3	D-010-H/092-G-01	Irrigation	C064485
Sumas River	1110.6	C-020-H/092-G-01	Irrigation	C064480
Sumas River	1110.6	C-020-H/092-G-01	Irrigation	C064487
Sumas River	1110.6	C-020-H/092-G-01	Irrigation	C064488
Sumas Lake Canal	1110.6	D-090-A/092-G-01	Irrigation	C064474
Sumas River	1110.6	C-020-H/092-G-01	Irrigation	C064484
Sumas River	1110.6	C-020-H/092-G-01	Irrigation	C121667

Watercourse/Drainage Crossing	RK of Watercourse/Drainage Crossing	Location	Purpose	Licence Number
Sumas River	1110.6	C-020-H/092-G-01	Irrigation	C064489
Sumas River	1110.6	C-020-H/092-G-01	Irrigation	C109523
Sumas Lake Canal	1110.7	D-090-A/092-G-01	Irrigation	C064474
Sumas River	1110.7	C-020-H/092-G-01	Irrigation	C107747
Traill Brook	1112.3	A-002-G/092-G-01	Conserv.-Stored Water	C060930
Mawson Pit Brook	1114.1	C-093-B/092-G-01	Domestic	F018825
Sumas River	1114.2	B-093-B/092-G-01	Irrigation	C072160
Sumas River	1114.2	B-093-B/092-G-01	Irrigation	C072188
Sumas River	1114.2	B-093-B/092-G-01	Irrigation	C072159
Sumas River	1114.2	B-093-B/092-G-01	Irrigation	C072189
Sumas River	1114.2	B-093-B/092-G-01	Irrigation	C072146
Sumas River	1114.2	B-093-B/092-G-01	Irrigation	C121716
Sumas River	1114.2	B-093-B/092-G-01	Irrigation	C072162
Sumas River	1114.2	B-093-B/092-G-01	Irrigation	C072163
Sumas River	1114.2	B-093-B/092-G-01	Irrigation	C064486
Sumas River	1114.2	B-093-B/092-G-01	Irrigation	C110533
Sumas River	1114.2	B-093-B/092-G-01	Irrigation	C072145
Sumas River	1114.2	B-093-B/092-G-01	Irrigation	C072152
Sumas River	1114.2	B-093-B/092-G-01	Irrigation	C072156
Sumas River	1114.2	B-093-B/092-G-01	Irrigation	C072177
Sumas River	1114.2	B-093-B/092-G-01	Irrigation	C072151
Sumas River	1114.2	B-093-B/092-G-01	Irrigation	C072153
Sumas River	1114.2	B-093-B/092-G-01	Irrigation	C072154
Sumas River	1114.2	B-093-B/092-G-01	Irrigation	C072167
Sumas River	1114.2	B-093-B/092-G-01	Irrigation	C072170
Sumas River	1114.2	B-093-B/092-G-01	Irrigation	C072173
Sumas River	1114.2	B-093-B/092-G-01	Irrigation	C072186
Sumas River	1114.2	B-093-B/092-G-01	Irrigation	C072150
Sumas River	1114.2	B-093-B/092-G-01	Irrigation	C072183
Sumas River	1114.2	B-093-B/092-G-01	Irrigation	C072174
Sumas River	1114.2	B-093-B/092-G-01	Irrigation	C064473
Sumas River	1114.2	B-093-B/092-G-01	Irrigation	C072155
Sumas River	1114.2	B-093-B/092-G-01	Irrigation	C072147
Sumas River	1114.2	B-093-B/092-G-01	Irrigation	C072149
Sumas River	1114.2	B-093-B/092-G-01	Irrigation	C072157
Sumas River	1114.2	B-093-B/092-G-01	Irrigation	C072161
Sumas River	1114.2	B-093-B/092-G-01	Irrigation	C072180
Sumas River	1114.2	B-093-B/092-G-01	Irrigation	C072758
Sumas River	1114.2	B-093-B/092-G-01	Irrigation	C072148
Sumas River	1114.2	B-093-B/092-G-01	Irrigation	C072181
Sumas River	1114.2	B-093-B/092-G-01	Irrigation	C072182
Sumas River	1114.2	B-093-B/092-G-01	Irrigation	C059589
Sumas River	1114.2	B-093-B/092-G-01	Irrigation	C072158
Sumas River	1114.2	B-093-B/092-G-01	Irrigation	C072175
Sumas River	1114.2	B-093-B/092-G-01	Irrigation	C072178
Sumas River	1114.2	B-093-B/092-G-01	Irrigation	C072168
Sumas River	1114.2	B-093-B/092-G-01	Irrigation	C121715
Sumas River	1114.2	B-093-B/092-G-01	Irrigation	C072164
Sumas River	1114.2	B-093-B/092-G-01	Irrigation	C072179
Sumas River	1114.2	B-093-B/092-G-01	Irrigation	C072144
Varia Spring	1114.3	A-094-B/092-G-01	Domestic	C106369
Bowell Brook	1114.4	A-094-B/092-G-01	Domestic	F020613
Bowell Brook	1114.4	A-094-B/092-G-01	Domestic	C111724
Michael Brook	1115.2	A-075-B/092-G-01	Domestic	C061658
Bristo Creek	1115.9	A-076-B/092-G-01	Domestic	C112593
MacCallum Brook	1116.0	A-086-B/092-G-01	Domestic	C070087
MacCallum Brook	1116.0	A-086-B/092-G-01	Domestic	F068002

Watercourse/Drainage Crossing	RK of Watercourse/Drainage Crossing	Location	Purpose	Licence Number
Bristo Creek	1116.1	D-076-B/092-G-01	Cooling	C059535
Bristo Creek	1116.1	D-076-B/092-G-01	Cooling	C059536
MacCallum Brook	1116.1	A-086-B/092-G-01	Domestic	C070085
Bristo Creek	1116.1	D-076-B/092-G-01	Processing	C059537
Bristo Creek	1116.1	D-076-B/092-G-01	Sewage Disposal	C059535
MacCallum Brook	1116.1	A-086-B/092-G-01	Domestic	F019698
Bristo Creek	1116.1	D-076-B/092-G-01	Sewage Disposal	C059536
Bristo Creek	1116.1	D-076-B/092-G-01	Sewage Disposal	C059537
Clayburn Creek	1121.2	D-091-C/092-G-01	Domestic	C052615
Clayburn Creek	1121.2	D-091-C/092-G-01	Irrigation	C052615
Clayburn Creek	1121.4	D-091-C/092-G-01	Irrigation	C052617
Clayburn Creek	1121.4	D-091-C/092-G-01	Irrigation	C052195
Clayburn Creek	1121.6	C-091-C/092-G-01	Nurseries	C115666
Clayburn Creek	1122.1	D-092-C/092-G-01	Irrigation	C111576
Clayburn Creek	1122.5	D-092-C/092-G-01	Irrigation	C069870
Clayburn Creek	1123.7	D-013-F/092-G-01	Irrigation	C065345
Clayburn Creek	1123.7	D-013-F/092-G-01	Irrigation	C065342
Clayburn Creek	1123.7	D-013-F/092-G-01	Irrigation	C065347
Clayburn Creek	1123.7	D-013-F/092-G-01	Irrigation	C065376
Clayburn Creek	1123.7	D-013-F/092-G-01	Irrigation	C065341
Clayburn Creek	1123.7	D-013-F/092-G-01	Irrigation	C065348
Clayburn Creek	1123.7	D-013-F/092-G-01	Nurseries	C065349
Matsqui Slough	1124.7	B-033-F/092-G-01	Irrigation	C028704
Gifford Slough	1125.7	A-006-F/092-G-01	Irrigation	C055096
Fraser River	1126.1	A-054-F/092-G-01	Irrigation	C061792
Gifford Slough	1128.1	D-018-F/092-G-01	Irrigation	C054901
Gifford Slough	1128.2	D-028-F/092-G-01	Irrigation	C118788
Gifford Slough	1128.3	A-028-F/092-G-01	Irrigation	C116559
Schaeffer Spring	1129.2	D-100-C/092-G-01	Domestic	F049531
Faulkner Creek	1129.2	A-010-F/092-G-01	Land Improve	C053610
Faulkner Creek	1129.2	A-010-F/092-G-01	Land Improve	C053610
Faulkner Creek	1129.2	A-010-F/092-G-01	Land Improve	C053797
Faulkner Creek	1129.2	A-010-F/092-G-01	Irrigation	C053610
McLennan Creek	1129.2	A-010-F/092-G-01	Domestic	F049532
Faulkner Creek	1129.2	A-010-F/092-G-01	Irrigation	C053610
Edgeworth Brook	1133.0	B-042-E/092-G-01	Land Improve	C053190
Eden Brook	1133.0	A-043-E/092-G-01	Land Improve	C053190
Edgeworth Brook	1133.0	B-042-E/092-G-01	Land Improve	C053190
Eden Brook	1133.1	A-043-E/092-G-01	Land Improve	C053190
Orth Brook	1135.5	A-036-E/092-G-01	Domestic	F017040
Fraser River	1137.3	C-095-E/092-G-01	Frost Protection	C113466
Fraser River	1137.3	C-095-E/092-G-01	Irrigation	C113466
Fraser River	1137.3	C-095-E/092-G-01	Flood Harvesting	C113466
Nathan Creek	1140.2	B-089-E/092-G-01	Ponds	C061686
Nathan Creek	1140.2	B-089-E/092-G-01	Irrigation	C061686
County Line Creek	1140.8	A-100-E/092-G-01	Frost Protection	C102088
Barkley Brook	1140.9	A-100-E/092-G-01	Domestic	F045482
West Creek	1143.2	A-083-H/092-G-02	Irrigation	F019180
Bowyer	1143.3	B-083-H/092-G-02	Ponds	C118816
West Creek	1143.3	D-083-H/092-G-02	Ponds	F020016
West Creek	1143.4	A-093-H/092-G-02	Irrigation	C061751
West Creek	1143.5	A-093-H/092-G-02	Irrigation	C070093
Fraser River	1145.3	B-005-I/092-G-02	Irrigation	C102063
Davidson Creek	1145.5	D-086-H/092-G-02	Res. Lawn/Garden	C129510
Davidson Creek	1145.6	D-076-H/092-G-02	Irrigation	C052726
Davidson Creek	1145.6	D-076-H/092-G-02	Irrigation	C065403
Davidson Creek	1147.0	C-087-H/092-G-02	Domestic	C021891

Watercourse/Drainage Crossing	RK of Watercourse/Drainage Crossing	Location	Purpose	Licence Number
Davidson Creek	1147.0	C-087-H/092-G-02	Irrigation	C021891
Sparrow Creek	1147.2	B-087-H/092-G-02	Conserv.-Stored Water	C110983
Salmon River	1147.3	D-078-H/092-G-02	Irrigation	C044934
Salmon River	1147.3	D-078-H/092-G-02	Irrigation	F046766
Salmon River	1147.4	D-078-H/092-G-02	Irrigation	F047120
Salmon River	1147.4	A-088-H/092-G-02	Irrigation	C035638
Salmon River	1149.0	C-098-H/092-G-02	Irrigation	C070701
Salmon River	1149.2	C-098-H/092-G-02	Irrigation	C070701
Salmon River	1149.3	C-098-H/092-G-02	Irrigation	C069933
Salmon River	1149.4	C-098-H/092-G-02	Irrigation	C070701
Salmon River	1149.6	B-008-I/092-G-02	Irrigation	C069933
Salmon River	1149.8	B-008-I/092-G-02	Irrigation	C036016
Salmon River	1149.9	B-008-I/092-G-02	Irrigation	C069936
Salmon River	1150.3	A-018-I/092-G-02	Watering	F045480
Fraser River	1163.7	C-061-K/092-G-02	Conserv.-Construct. Works	C047706
Brunette River	1172.9	A-071-L/092-G-02	Land Improve	C065434
Stoney Creek	1176.5	B-003-D/092-G-07	Conserv.-Construct. Works	C115512

6.0 ENVIRONMENTAL SETTING FOR FACILITIES

The following subsections present a summary of the environmental setting of the proposed facilities, including pump stations and associated power lines, tank terminals, Westridge Marine Terminal, pump stations to be reactivated and deactivated, and temporary facilities, pursuant to Guide A.2.4 of the National Energy Board (NEB) *Filing Manual* (NEB 2013). A summary of the proposed activities at these facilities is provided in Section 2.0, while a detailed description is provided in Volume 2. The following elements from the NEB *Filing Manual* are discussed in the tables below: physical and meteorological environment; soil and soil productivity; water quality and quantity; air emissions; greenhouse gas (GHG) emissions; acoustic environment; fish and fish habitat; wetland loss or alteration; vegetation; wildlife and wildlife habitat; and species at risk. In addition, the following elements are discussed in Table 6.2-1 for the Westridge Marine Terminal: marine sediment and water quality; marine fish and fish habitat; marine mammals; marine birds, and marine species at risk. The environmental setting was compiled based on the following sources:

- geotechnical, soil, groundwater, air, GHG, acoustic, fish, wetland, vegetation, wildlife and marine studies conducted for the Project (Volume 5C);
- existing published literature including topographic maps, aerial photography, scientific papers and reference books, as well as municipal, provincial and federal government maps, reports, interactive websites, guides, information letters, fact sheets, and databases; and
- consultation and engagement with Aboriginal communities (including Aboriginal Traditional Knowledge [ATK] and Traditional Ecological Knowledge [TEK]), landowners, regulatory authorities, stakeholders and the general public.

Methods of obtaining resource material included searching libraries, internet searches and documents from regulatory authorities. References used in the preparation of the environmental setting are cited in Section 6.5. Detailed methodology for the collection of information on existing conditions is provided in the applicable supporting studies in Volume 5C.

The settings for each element discuss the existing conditions for each indicator or set of indicators selected for the element. A summary of the indicators selected for the following elements is provided in Table 5-1: physical and meteorological environment; soil and soil productivity; water quality and quantity; air emissions; GHG emissions; acoustic environment; fish and fish habitat; wetland loss or alteration; vegetation; wildlife and wildlife habitat; and species at risk. A summary of the indicators selected for marine sediment and water quality, marine fish and fish habitat, marine mammals, marine birds and marine species at risk in the context of the Westridge Marine Terminal is provided in Table 6-1. The rationales for the selection of all indicators are provided in Section 7.0.

TABLE 6-1

SELECTED INDICATORS FOR MARINE ELEMENTS AT THE WESTRIDGE MARINE TERMINAL

Element	Indicators
Marine Sediment and Water Quality	• Marine sediment quality. • Marine water quality.
Marine Fish and Fish Habitat	• Marine riparian habitat. • Intertidal habitat. • Subtidal habitat. • Dungeness crab. • Inshore rockfish. • Pacific salmon (all five species).
Marine Mammals	• Pacific harbour seal.

TABLE 6-1 Cont'd

Element	Indicators
Marine Birds	• Bald eagle. • Great blue heron. • Pelagic cormorant. • Barrow's goldeneye. • Glaucous-winged gull. • Spotted sandpiper.
Marine Species at Risk	• Marine fish species at risk (*i.e.*, inshore rockfish). • Marine mammal species at risk (*i.e.*, Steller sea lion, harbour porpoise, northern fur seal and various whale species). • Marine bird species at risk (*i.e.*, pelagic cormorant and great blue heron).

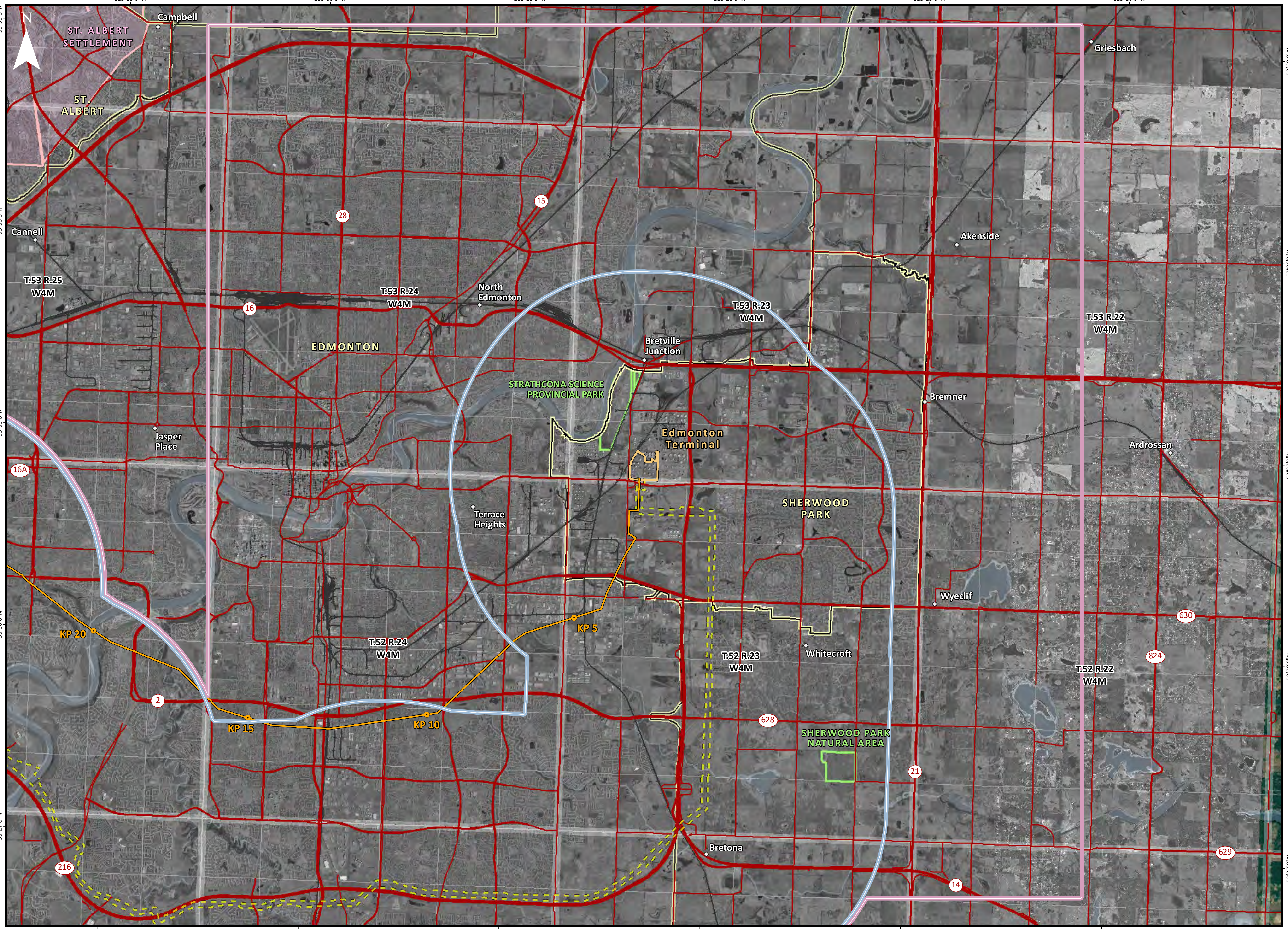
The potential Project-related effects and mitigation are presented in Section 7.0. The spatial boundaries of elements discussed in the environmental setting are described in Section 5.0, with the exception of the marine spatial boundaries which are used in the context of the Westridge Marine Terminal and described in Section 6.2.

6.1 Pump Stations and Tank Terminals

Pump stations are positioned along the length of the existing Trans Mountain pipeline to maintain pressure, move the product along the line and monitor flow. To accommodate expansion activities, the Project will include construction and operation of new pump stations, and modification and/or replacement of existing pumps. In addition, 20 new storage tanks will be constructed at the Edmonton (5), Sumas (1) and Burnaby (14) terminals, respectively.

6.1.1 Edmonton Terminal

The existing Edmonton Terminal is located at SW 5-53-23 W4M at RK 0.0. The Edmonton Terminal is located on lands owned by Trans Mountain within Strathcona County and adjacent to the City of Edmonton. Adjacent lands are privately owned by various industrial companies. No disturbance of previously undisturbed lands is proposed at the Edmonton Terminal and all work will be conducted within the existing disturbed fenced area. Four 5,000 HP pump units will be added to the site, as well as one spare 5,000 HP pump unit. A new substation at the Edmonton Terminal will require a new power line. At the time of writing, the routing of the power line had yet to be determined by the Alberta Electric System Operator (AESO). Two new 34,980 m^3 (220,000 bbl) storage tanks, two new 63,600 m^3 (400,000 bbl) storage tanks and one new 11,920 m^3 (75,000 bbl) storage tank will be installed at the Edmonton Terminal. An existing 12,720 m^3 (80,000 bbl) storage tank will be dismantled and replaced by the new 11,920 m^3 (75,000 bbl) tank. Access to the Edmonton Terminal is via Baseline Road and 17th Street. Table 6.1-1 provides a summary of the environmental elements and considerations for the Edmonton Terminal pursuant to Guide A.2.4 and Table A-2 of the NEB *Filing Manual*. The location of the Edmonton Terminal is shown on Figure 6.1-1.



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TRANS MOUNTAIN

FIGURE 6.1-1

EDMONTON TERMINAL

TRANS MOUNTAIN EXPANSION PROJECT

- Kilometre Post (KP)
- Hamlet / Village / Community
- Trans Mountain Pipeline (TMPL)
- Trans Mountain Expansion Project Proposed Pipeline Corridor
- Subject Property Facility Boundary
- Acoustic Environment RSA
- Air Quality RSA Boundary
- Highway
- Paved Road
- Railway
- City / Town
- National / Provincial Park
- Indian Reserve / Métis Settlement

Projection: NAD 1983 UTM Zone 12N. Routing: Baseline TMPL & Facilities: provided by KMC 2012; Proposed Pipeline Corridor V6: provided by UPI Aug. 23, 2013; Transportation: IHS Inc., 2013, Natural Resources Canada, 2011; Geopolitical Boundaries: Natural Resources Canada, 2003, Altalis, 2012, IHS Inc., 2011, ESRI, 2005; First Nation Lands: Government of Canada, 2013; Parks and Protected Areas: Natural Resources Canada, 2013, Altalis, 2013, Alberta Tourism, Parks and Recreation, 2012, BC FLNRO, 2008; Imagery: Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

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tera ENVIRONMENTAL CONSULTANTS

Although there is no reason to believe that there are any errors associated with the data used to generate this product or in the product itself, users of these data are advised that errors in the data may be present.

MAP NUMBER			PAGE
201310_MAP_TERA_SE_00442_REV0_01			SHEET 1 OF 16
DATE: December 2013	TERA REF.: 7894		REVISION: 0
SCALE: 1:100,000	PAGE SIZE: 11x17		DISCIPLINE: ESA
DRAWN: AJS	CHECKED: HS		DESIGN: TGG

0 1 2 3 4 km

ALL LOCATIONS APPROXIMATE

TABLE 6.1-1

SUMMARY OF ENVIRONMENTAL ELEMENTS AND CONSIDERATIONS FOR THE EDMONTON TERMINAL

Environmental Elements	Summary of Considerations
Physical and Meteorological Environment	• The Edmonton Terminal is located within the Eastern Alberta Plains Physiographic Region, characterized by undulating plains, hummocky terrain, steep valley walls, active fluvial channels and glaciofluvial deltas (Natural Regions Committee 2006a, Pettapiece 1986). • The Edmonton Terminal is underlain by the Horseshoe Canyon Formation, which is characterized as interbedded non-marine sandstone, siltstone, shale, and numerous coal and bentonite beds (Hamblin 1998). • The surficial geology beneath the site is mapped as lacustrine fine sediment silt and clay in the northwest half; the southwest half is underlain by a stagnation moraine glacial till of uneven thickness (Shetsen 1990). • There are no areas of permafrost within the area of the Edmonton Terminal (refer to Section 5.1.1). • No areas of potential terrain instability are known to occur in the vicinity of the Edmonton Terminal. • The site is located in a zone of low seismic activity (Natural Resources Canada [NRCan] 2010a). Peak ground acceleration with a 1:2475 annual probability of exceedance is less than 0.1 g (NRCan 2013a). No earthquakes have been recorded in the area (NRCan 2013b). • The topography in the area of Edmonton Terminal is relatively flat and the elevation is approximately 680 m above sea level. • Where activities are planned within Edmonton Terminal, soils have been disturbed for industrial use and construction of the new infrastructure will be conducted within the boundaries of the existing station. • The Edmonton Terminal is located in an agricultural area considered to have low to moderate soil erosion risk (Alberta Agriculture and Rural Development [AARD] 2005a). Wind erosion risk, which assesses the risk of soil degradation by wind on bare, unprotected mineral soil, is considered low at the Edmonton Terminal (AARD 2005b). Water erosion risk, which assesses the risk of soil degradation by water on bare, unprotected mineral soil, is considered moderate to high in the vicinity of the site (AARD 2005c). • A description of the climate for the Central Parkland Natural Subregion is provided in Section 5.1.1. • The following meteorological data were obtained from an Environment Canada meteorological station (3012205) at Edmonton International Airport (Environment Canada 2013a). The data were taken approximately 29 km southwest of the Edmonton Terminal. – Average monthly rainfall for Edmonton Airport is 28.2 mm and the average monthly rainfall from June to August is 74.4 mm. In July of 1990, Edmonton Airport recorded its highest daily rainfall of 75.6 mm, which is below the monthly average of 95.6 mm for the month of July. – Average monthly snowfall for Edmonton Airport is 9.8 cm and the average monthly snowfall from November to February is 17.1 cm. In April of 1991, Edmonton Airport recorded its highest daily snowfall of 36.2 cm, well above the 14.4 cm average for the month of April. – Average daily temperature for Edmonton Airport is 2.6°C, with the warmest month in July, averaging 16.2°C and coolest month in January, averaging -12.1°C. In August of 2008, Edmonton Airport experienced its warmest day of 35.6°C and in January of 1972, its coolest day at -48.3°C. • One major tornado was recorded in the Edmonton area on July 31, 1987. It caused 27 deaths, 600 injuries, 1,700 evacuations and $300 million in damage (NRCan 2010b). Two major hailstorms were recorded in close proximity to the terminal: one in 1988 that caused $48 million in damage, and one in 1901 that produced 8 cm diameter hailstones (NRCan 2010c).
Soil and Soil Productivity	• Activities at the Edmonton Terminal will be conducted within an existing fenced, industrial site lacking topsoil and, therefore, detailed soil information is not warranted as per Table A-2 of the NEB *Filing Manual*. • The Canada Land Inventory (CLI) (1967) has rated the soils in the vicinity of the Edmonton Terminal as having no limitations to crop production (Class 1). • Historical spills have occurred at the Edmonton Terminal. Trans Mountain currently monitors soil and groundwater at the site. Monitoring will continue and any remedial action will be conducted, as necessary, as part of ongoing operations. The Contamination Discovery Contingency Plan (Appendix B of the Facilities Environmental Protection Plan [EPP] of Volume 6C) will be implemented if needed during construction. • Potential soil contaminants of concern include gasoline, diesel fuel, lubricants and hydraulic fuels.
Water Quality and Quantity	• The Edmonton Terminal is located within the Lower North Saskatchewan Watershed of the North Saskatchewan River Basin. • No work will occur within 30 m of any waterbodies and, therefore, detailed information on surface water quality and quantity is not warranted as per Table A-1 of the NEB *Filing Manual*. • Hydrostatic testing is planned for the piping and new tanks to be installed within the Edmonton Terminal. Water may be withdrawn and released from Trans Mountain's existing fire water pond at the Edmonton Terminal. Alternatively, test water may be diverted from a nearby river, subject to obtaining a water withdrawal permit, or purchased from municipalities depending on availability from natural sources. Following testing, water will be tested for contaminants before being treated and either discharged back into the fire water pond, trucked away, or released to a natural waterbody or the municipal sewer system. • Four domestic water wells are located more than 500 m but less than 1,500 m from the terminal. • Potential surface or groundwater quality contaminants associated with construction activities at the Edmonton Terminal include spillage of gasoline, diesel fuel, lubricating fluids and antifreeze.

TABLE 6.1-1 Cont'd

Environmental Elements	Summary of Considerations
Water Quality and Quantity (cont'd)	• The terrain at the Edmonton Terminal is reported to be generally level and groundwater flow likely follows topography towards the North Saskatchewan River which lies 1,100 m to the northwest of the site. • At the site, groundwater flow direction was noted by EBA Engineering Consultants Ltd. (2012) to the northwest with local southwest directed groundwater flow in the southwest corner of the site. • The surficial geology beneath the site is mapped as lacustrine fine sediment silt and clay in the northwest half; the southwest half is underlain by a stagnation moraine glacial till of uneven thickness (Shetsen 1990). • One water well record indicated a spring is located in or near the site at SW 5-53-23 W4M (Alberta Environment and Sustainable Resource Development [AESRD] 2013a). No water supply wells are mapped within the site boundary and no wells are located within the surrounding Water Quality and Quantity Local Study Area (LSA) (AESRD 2013a). • The Edmonton Terminal does not overlie any mapped aquifers. • Studies completed by EBA Engineering Consultants Ltd. between 2006 and 2012 indicate that at the south tank farm at Edmonton Terminal, hydrocarbon contamination is noted in soil (at tanks 5, 12, 14, 18 and D-3 area) and in the groundwater (at tanks 12, 14 and D-3 area) at low concentrations possibly because the wells were installed in highly plastic dense clay. Groundwater depth was noted as 0.2-3.6 m below ground level (bgl). Groundwater at the Edmonton Terminal site is currently monitored. • Four areas of localized recharge were noted (EBA Engineering Consultants Ltd. 2008). • In 2011, an increase in benzene concentration was noted at Tank 6 in monitoring wells 07MW07 and 07ME11; ethylbenzene concentration increased in 2011 and exceeded criteria. At Tank 12, benzene and ethylbenzene decreased since 2008; continued monitoring was recommended (EBA Engineering Consultants Ltd. 2012).
Air Emissions	• Continuous volatile organic compound (VOC), hydrogen sulfide (H_2S) and mercaptan emissions are primarily due to standing and working losses from existing product storage tanks at the Edmonton Terminal. • Fugitive emissions from leaks are expected to be a small contributor relative to emissions from existing tanks. • All existing pumps are electrically driven and are not direct sources of criteria air contaminants (CACs). • CAC and VOC emissions from regular testing of emergency diesel generators and fire water pumps are infrequent. • The largest sources of CAC emissions, except particulate matter (PM), in the Air Quality Regional Study Area (RSA) are vehicle traffic, non-road engines, heating, large industrial facilities such as oil refineries and electrical power generation. The largest sources of PM emissions in the area are industrial combustion, road dust and construction activities. The largest sources of VOC emissions are storage tank facilities, refineries, non-road motor vehicles and solvent evaporation. • Predicted VOC, H_2S and mercaptan concentrations in the Air Quality RSA due to existing operations at the Edmonton Terminal, as well as Enbridge Pipelines Inc. (South) Terminal, the Suncor refinery and other existing anthropogenic sources are presented in the Air Quality and Greenhouse Gas Technical Report of Volume 5C.
Greenhouse Gas Emissions	• Indirect GHG emissions due to electric power consumption by the existing pumps at the Edmonton Terminal are the main emissions. These include emissions from fossil fuel combustion, unallocated energy from power line losses, metering differences and other losses, and emissions of sulfur hexafluoride (SF_6) from gas handling and transferring operations, electrical equipment operation, and from equipment mechanical failures. • Products handled and stored in existing tanks contain trace levels of GHGs; small amounts might be released through fugitive or process emissions (*e.g.,* methane [CH_4] and formation of carbon dioxide [CO_2]). • Small amounts of direct GHG emissions will be released due to the space heating of the existing buildings at the Edmonton Terminal. • Small amounts of indirect GHG emissions will be released due to electricity use for equipment other than pumps. • Small amounts of GHG emissions will be released from the motor vehicles used by operations/maintenance staff.
Acoustic Environment	• Sources of existing sound in the Acoustic Environment LSA and RSA are refineries that surround the Edmonton Terminal location, major vehicle roadways, public recreation areas and urban residential sound. • No receptors were identified within the Acoustic Environment LSA. A worst case location along the 1.5 km Acoustic Environment LSA boundary will be used for assessment of compliance with Alberta Energy Regulator (AER) *Directive 038* (Alberta Energy Resources Conservation Board [ERCB] 2007). The nearest receptors are located approximately 1.9 km both northwest and southeast of the Edmonton Terminal fenceline. These receptors are within the Acoustic Environment RSA and will be evaluated in Sections 7.0 and 8.0 due to the potential for cumulative noise levels, as defined in AER *Directive 038,* to be affected. • The ambient sound level (ASL) over the Acoustic Environment RSA for the Edmonton terminal in the absence of regulated energy facilities ranges between 41-51 decibels (dBA) at night and 51-61 dBA during the day based on AER *Directive 038* (ERCB 2007). • Due to the density of development and high number of existing energy facilities in the area, a measurement program to define specific sound level contributions from the existing facilities was not practical as sound from each facility would cross-contaminate the next. The existing sound levels for the Edmonton Terminal have been determined by reviewing available existing ERCB and AER applications for noise impact assessments that define the conditions. • A noise model was generated based on existing conditions located at the Edmonton Terminal. Applicable buildings and shelters were modelled along with their appropriate insertion losses and screening effects. • The noise modelling results indicate that sound from the existing Edmonton Terminal is expected to comply with the AER *Directive 038* permissible sound levels for the Acoustic Environment LSA and surrounding RSA receptors. • Detailed noise prediction results are available in the Terrestrial Noise and Vibration Technical Report of Volume 5C.

TABLE 6.1-1 Cont'd

Environmental Elements	Summary of Considerations
Fish and Fish Habitat	• The Edmonton Terminal is located within the Lower North Saskatchewan Watershed of the North Saskatchewan River Basin. • No work will occur within 30 m of any fish-bearing waterbodies and, therefore, detailed information on fish and fish habitat is not deemed warranted as per Table A-1 of the NEB *Filing Manual*. • Hydrostatic testing is planned for the piping and new tanks to be installed within the Edmonton Terminal. Water may be withdrawn and released from Trans Mountain's existing fire water pond at the Edmonton Terminal. Test water may be diverted from a nearby river or creek, or purchased from municipalities depending on availability from natural sources. Refer to Sections 5.7.1 and 5.7.5.5 for a description of the fish and fish habitat that may be found in the vicinity of the Edmonton Terminal in the event that hydrostatic test water is withdrawn from a nearby river or creek. • Lake sturgeon, found in the North Saskatchewan River, have a general status of Undetermined in Alberta (Alberta Sustainable Resource Development [ASRD] 2010), but are considered Threatened under the Alberta *Wildlife Act* and *Wildlife Regulation* and Endangered under the Committee on the Status of Endangered Wildlife in Canada (COSEWIC 2013).
Wetland Loss or Alteration	• The Edmonton Terminal expansion is situated within the Aspen Parkland Ecoregion, a component of the Prairies Ecozone. Wetlands comprise approximately half of this ecoregion and consist of small lakes and ponds (Ecological Stratification Working Group 1995). • The Edmonton Terminal is also situated within the Transitional Mid-boreal Wetland Region (Government of Canada 1986). In this region, common wetlands include basin fens, bogs, swamps and marshes. Horizontal fens and floating fens also occur along drainageways and lakeshores (Government of Canada 1986). • The Edmonton Terminal is located in the Central Parkland Natural Subregion of the Parkland Natural Region. The typical wetland types include marshes, willow scrublands and seasonal ponds in the southern part of the subregion. Treed fens with shallow organic soils occur in the northwest (Natural Regions Committee 2006b). • Wetlands provide habitat for native plants and wildlife species, including nesting and foraging habitat for bird species, and also provide storage and natural filtering of water. • No wetlands were identified within or adjacent to the Edmonton Terminal during the helicopter reconnaissance and satellite imagery review. As a result, a ground-based wetland survey was determined not to be required. • There are no Ramsar Wetlands of International Importance (Bureau of the Convention on Wetlands 2013), Important Bird Areas (IBAs) (Bird Studies Canada and Nature Canada 2012), Western Hemisphere Shorebird Reserves (Western Hemisphere Shorebird Reserve Network [WHSRN] 2013) or Migratory Bird Sanctuaries (Environment Canada 2013b) located within the Wetland LSA surrounding the Edmonton Terminal. • The Edmonton Terminal is located within a Ducks Unlimited Canada (DUC) Level 1 Priority Area, the Prairie Pothole Region and Western Boreal Forest (DUC 2013). • The Edmonton Terminal is not located within the 1,000 m setback of provincially identified colonial nesting bird waterbodies or the 800 m setback of provincially identified trumpeter swan waterbodies (AESRD 2010-2012).
Vegetation	• The Edmonton Terminal is situated within the Aspen Parkland Ecoregion, a component of the Prairie Ecozone. In its native state, this ecoregion is characterized by trembling aspen, bur oak, shrubs and discontinuous fescue grasslands. Poorly-drained areas support communities dominated by willow and sedge species (Ecological Stratification Working Group 1995). • The Edmonton Terminal is located in the Central Parkland Natural Subregion of the Parkland Natural Region which is dominated by plains rough fescue in the southern and eastern areas of the subregion, while trembling aspen-dominated communities occur in moister habitats. (Natural Regions Committee 2006a). • A national Environmentally Significant Area (No. 690; North Saskatchewan River) is located approximately 0.2 km northwest of the Edmonton Terminal (Alberta Tourism, Parks and Recreation [ATPR] 2009). • Records of rare plant observations within 5 km of the Edmonton Terminal were acquired from the Alberta Conservation Information Management System (ACIMS 2013) database. No provincially-listed (ACIMS) species records were found within the boundaries of the Vegetation LSA. • It was determined with satellite imagery interpretation that no native vegetation would be directly disturbed within the site boundaries and, therefore, a ground-based vegetation survey was deemed unnecessary. • Consultation with local agricultural authorities was conducted to determine weed species of concern for the region. See Section 4.4 of the Vegetation Technical Report of Volume 5C for a summary of these communications.

TABLE 6.1-1 Cont'd

Environmental Elements	Summary of Considerations
Wildlife and Wildlife Habitat	• The Edmonton Terminal is situated on disturbed industrial lands. • The Edmonton Terminal is not located within or adjacent to any Environmentally Significant Areas (ATPR 2009), provincial parks or protected areas (ATPR 2012), IBAs (Bird Studies Canada and Nature Canada 2012), Migratory Bird Sanctuaries (Environment Canada 2013b), National Wildlife Areas (Environment Canada 2013b), Western Hemisphere Shorebird Reserves (WHSRN 2013), Ramsar Wetlands of International Importance (Bureau of the Convention on Wetlands 2013) or World Biosphere Reserves (United Nations Educational, Scientific and Cultural Organization [UNESCO] 2013). • The Edmonton Terminal is located in a DUC Level 1 Priority Area, the Prairie Pothole Region and Western Boreal Forest (DUC 2013). • The Edmonton Terminal is located in a Bald Eagle Sensitive Raptor Range and Sharp-tailed Grouse Range (AESRD 2013b). The Terminal is located in a disturbed industrial area is not considered suitable habitat for bald eagle or sharp-tailed grouse. • A national Environmentally Significant Area (No. 690; associated with the North Saskatchewan River) is located approximately 0.2 km northwest of the Edmonton Terminal (ATPR 2009). • A Key Wildlife and Biodiversity Zone (North Saskatchewan River) is located approximately 0.5 km northwest of the Edmonton Terminal (AESRD 2013b). • Strathcona Science Provincial Park is located approximately 1.1 km northwest of the Edmonton Terminal. • The Edmonton Terminal is located in Wildlife Management Unit (WMU) 248 (AESRD 2012b). • Project activities will be located within an existing previously disturbed industrial site which is not considered to be suitable wildlife habitat.
Species at Risk or Species of Special Status and Related Habitat	• Lake sturgeon, found in the North Saskatchewan River, are considered Threatened under the Alberta *Wildlife Act* (AESRD 2012a) and Endangered under COSEWIC (2013). • Records of rare plant observations within 5 km of the Edmonton Terminal were acquired from the ACIMS (2013) database. No federally-listed (*Species at Risk Act* [*SARA*] or COSEWIC) species records were found within these boundaries. • Based on known species range and habitat preferences, the following federally-listed (*SARA* Schedule 1 or COSEWIC) and/or provincially-listed (At Risk, May be at Risk, or under Alberta's *Wildlife Act* and *Wildlife Regulation*) wildlife species were identified as having the potential to occur in the vicinity of the Edmonton Terminal (ASRD 2010, AESRD 2012a, COSEWIC 2013, Environment Canada 2012): – peregrine falcon (*SARA*: Special Concern, COSEWIC: Special Concern, provincial: At Risk, Alberta *Wildlife Act* and *Wildlife Regulation:* Threatened); – little brown myotis (*SARA*: no status, COSEWIC: Endangered, provincial: Secure); and – tiger salamander (COSEWIC: Special Concern). • A search of the AESRD Fisheries and Wildlife Management Information System (FWMIS) database identified the following federally-listed (*SARA* Schedule 1 or COSEWIC) and/or provincially-listed (At Risk, May be at Risk, or under Alberta's *Wildlife Act* and *Wildlife Regulation*) wildlife species within 2 km of the Edmonton Terminal (AESRD 2013c): – peregrine falcon (*SARA*: Special Concern, COSEWIC: Special Concern, provincial: At Risk, Alberta *Wildlife Act* and *Wildlife Regulation*: Threatened); and – tiger salamander (COSEWIC: Special Concern). • Given that the Edmonton Terminal is an existing facility and all work will occur within the existing fenced area on previously disturbed land, the Edmonton Terminal is not considered suitable habitat for wildlife or plant species at risk.

6.1.2 Gainford Pump Station

The existing Gainford Pump Station is located at NE 13-53-6 W5M at RK 117.5. The Gainford Pump Station is located on lands owned by Trans Mountain in Parkland County. Current land use at this facility site is industrial and the surrounding land is forested. Some treed lands will be disturbed within the existing boundary of the Gainford Pump Station. Three 5,000 HP pump units will be installed at the site. Access to the Gainford Pump Station is via Highway 16. Table 6.1-2 provides a summary of the environmental elements and considerations for the Gainford Pump Station pursuant to Guide A.2.4 and Table A-2 of the NEB *Filing Manual*. The location of the Gainford Pump Station is shown on Figure 6.1-2.

FIGURE 6.1-2

GAINFORD PUMP STATION

TRANS MOUNTAIN EXPANSION PROJECT

- Kilometre Post (KP)
- Hamlet / Village / Community
- Trans Mountain Pipeline (TMPL)
- Trans Mountain Expansion Project Proposed Pipeline Corridor
- Subject Property Facility Boundary
- Acoustic Environment RSA
- Vegetation RSA Boundary
- Highway
- Paved Road
- Railway
- National / Provincial Park

Projection: NAD 1983 UTM Zone 11N. Routing: Baseline TMPL & Facilities: provided by KMC 2012; Proposed Pipeline Corridor V6: provided by UPI Aug. 23, 2013; Transportation: IHS Inc., 2013, Natural Resources Canada, 2011; Geopolitical Boundaries: Natural Resources Canada, 2003, Altalis, 2012, IHS Inc., 2011, ESRI, 2005; First Nation Lands: Government of Canada, 2013; Parks and Protected Areas: Natural Resources Canada, 2013, Altalis, 2013, Alberta Tourism, Parks and Recreation, 2012, BC FLNRO, 2008; Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

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Although there is no reason to believe that there are any errors associated with the data used to generate this product or in the product itself, users of these data are advised that errors in the data may be present.

MAP NUMBER 201310_MAP_TERA_SE_00442_REV0_02		PAGE SHEET 2 OF 16
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TABLE 6.1-2

SUMMARY OF ENVIRONMENTAL ELEMENTS AND CONSIDERATIONS FOR THE GAINFORD PUMP STATION

Environmental Elements	Summary of Considerations
Physical and Meteorological Environment	• The Gainford Pump Station is located within the Eastern Alberta Plains Physiographic Region, characterized by undulating plains, hummocky terrain, steep valley walls, active fluvial channels and glaciofluvial deltas (Natural Regions Committee 2006a, Pettapiece 1986). • The Gainford Pump Station is underlain by the Scollard Formation, which is characterized by two units: the lower “barren” member and the upper coal-bearing member. The lower member is characterized as thick greenish-grey shales and thin sandstones. The upper member is characterized as dark grey, bentonitic mudstones with coals (Hamblin 2010). • The surficial geology beneath the site is mapped stagnation moraine glacial till of uneven thickness (Shetsen 1990). • There are no areas of permafrost within the area of the Gainford Pump Station (refer to Section 5.1.1). • No areas of potential terrain instability are known to occur in the vicinity of the Gainford Pump Station. • The site is located in a zone of low seismic activity (NRCan 2010a). Peak ground acceleration with a 1:2475 annual probability of exceedance is 0.04 g (NRCan 2013a). No earthquakes have been record in the area (NRCan 2013b). • The topography in the area of Gainford Pump Station is relatively flat but with a slight grade change from north to south and the elevation is approximately 760 m above sea level. • Where activities are planned within Gainford Pump Station, construction of the new infrastructure will be conducted within the boundaries of the existing station, however, some of the required land is forested. NRCan considers unprotected soils in the vicinity of Gainford Pump Station to have low wind erosion risk with low climatic sensitivity (NRCan 2010d). • The Gainford Pump Station is located in an agricultural area considered to have low soil erosion risk (AARD 2005a). Wind erosion risk, which assesses the risk of soil degradation by wind on bare, unprotected mineral soil, is considered negligible to low at the pump station (AARD 2005b). Water erosion risk, which assesses the risk of soil degradation by water on bare, unprotected mineral soil, is considered high to severe in the vicinity of the site (AARD 2005c). • A description of the climate for the Dry Mixedwood Natural Subregion is provided in Section 5.1.1. • Meteorological data from Environment Canada’s Entwistle Station, located approximately 15 km west of the Gainford Pump Station, are provided in Section 5.1.1. • No major tornadoes or hailstorms have been recorded in the vicinity of Gainford Pump Station (NRCan 2010b,c).
Soil and Soil Productivity	• Project activities will cause some disturbance outside of the fenceline of the Gainford Pump Station but within the existing property boundary. The current Gainford Pump Station has been previously disturbed and contains pumps, buildings and other equipment. • The Gainford Pump Station is located in the Dry Mixedwood Natural Subregion. Typical soils in the Dry Mixedwood Natural Subregion are Orthic Gray Luvisols under moderately well-drained aspen forests (Natural Regions Committee 2006a). • The CLI (1971) has rated the soils in the vicinity of the Gainford Pump Station as having moderately severe limitations to crop production (Class 3) due to undesirable soil structure and/or low permeability. • No spills have been recorded at the Gainford Pump Station. If any contamination is encountered during construction, the Contamination Discovery Contingency Plan (Appendix B of the Facilities EPP of Volume 6C) will be implemented. • Clubroot is a soil-borne disease that affects canola and other crops in the mustard family. It is considered a pest under the *Agricultural Pests Act*. Occurrences of clubroot have been identified in Parkland County (Leskiw pers. comm.), however, no occurrences have been identified within the Gainford Pump Station.
Water Quality and Quantity	• The Gainford Pump Station is located within the Upper North Saskatchewan River Watershed of the North Saskatchewan River Basin. • No work will occur within 30 m of any waterbodies and, therefore, detailed information on surface water quality and quantity is not warranted as per Table A-1 of the NEB *Filing Manual*. • The terrain is reported to be generally level at the Gainford Pump Station. • Groundwater flow likely follows topography towards Wabamun Lake which lies 1,800 m to the southeast of the site. • The surficial geology beneath the site is mapped stagnation moraine glacial till of uneven thickness (Shetsen 1990). • No water supply wells are mapped within the site boundary (AESRD 2013a). • Four water well records are indicated within NE 13-53-6 W5M designated as domestic use (AESRD 2013a). Additional water well records are noted to the east in 13-18-53-5 W5M with depths of 36 m and water levels ranging from 7.9-8.2 m bgl. These wells are all deeper than 30 m with water levels in the range of 0.9-23 m bgl (AESRD 2013a). • The Gainford Pump Station does not overlie any mapped aquifers.
Air Emissions	• All existing pumps are electrically driven and are not direct sources of CACs. • Fugitive VOC emissions from leaks at the Gainford Pump Station are estimated to be 2.5 tonnes per year. • Air quality in the area surrounding the Gainford Pump Station is primarily a function of anthropogenic source emissions arising from power generation plants in the area and vehicle traffic on nearby roads.
Greenhouse Gas Emissions	• Indirect GHG emissions due to electric power consumption by the existing pumps at the Gainford Pump Station are the main emissions. These include emissions from fossil fuel combustion, unallocated energy from power line losses, metering differences and other losses, and emissions of SF_6 from gas handling and transferring operations, electrical equipment operation, and from equipment mechanical failures. • Small amounts of direct GHG emissions will be released due to the space heating of the existing buildings at the Gainford Pump Station. • Small amounts of indirect GHG emissions will be released due to electricity use for equipment other than pumps. • Small amounts of GHG emissions will be released from the motor vehicles used by operations/maintenance staff.

TABLE 6.1-2 Cont'd

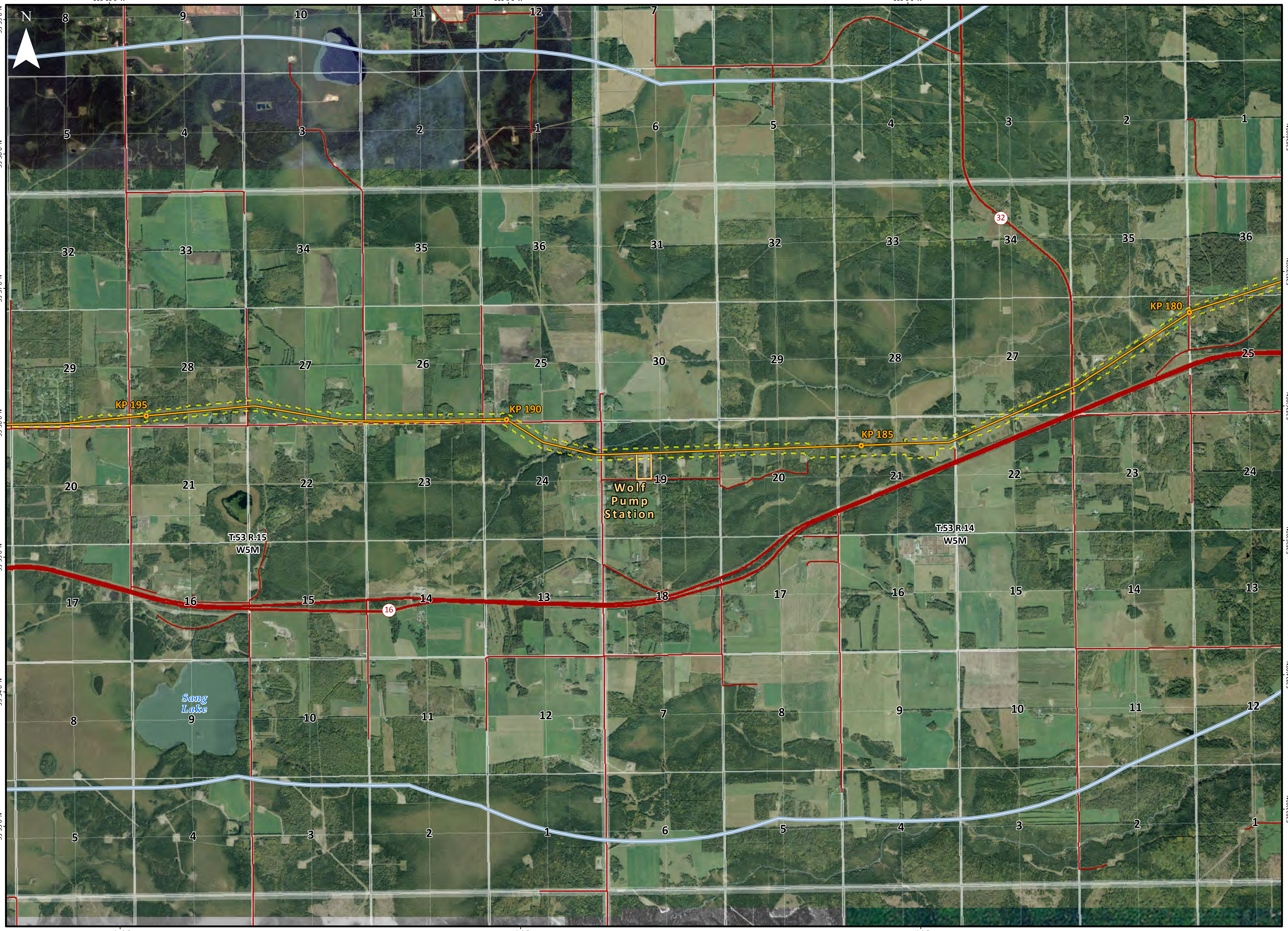
Environmental Elements	Summary of Considerations
Acoustic Environment	• Sources of existing sound in the Acoustic Environment LSA are traffic travelling along Highway 16 and natural sound (*e.g.*, wind, wildlife). • Receptors were identified within the Acoustic Environment LSA. The nearest receptor is located approximately 140 m to the east of the fenceline of the Gainford Pump Station. • ASL in the absence of regulated energy facilities is approximately 40 dBA at night and 50 dBA during the day based on AER *Directive 038* (ERCB 2007). • A measurement program to define sound emissions from the existing facility was conducted. • A noise model was generated based on existing conditions observed and measurements of the major on-site sources of sound. Specifications of equipment not operating during the site visit were used to estimate sound levels. Applicable buildings and shelters were modelled along with the appropriate insertion losses and screening effects. • The noise modelling results indicate that sound from the existing Gainford Pump Station complies with the AER *Directive 038* permissible sound levels for all surrounding receptors. • Contoured noise prediction results are available in the Terrestrial Noise and Vibration Technical Report of Volume 5C.
Fish and Fish Habitat	• The Gainford Pump Station is located within the Upper North Saskatchewan River Watershed of the North Saskatchewan River Basin. • No work will occur within 30 m of any fish-bearing waterbodies and, therefore, detailed information on fish and fish habitat is not deemed warranted as per Table A-1 of the NEB *Filing Manual*.
Wetland Loss or Alteration	• The Gainford Pump Station is situated within the Aspen Parkland Ecoregion, a component of the Prairies Ecozone. Wetlands comprise approximately half of this ecoregion and consist of small lakes and ponds (Ecological Stratification Working Group 1995). • The Gainford Pump Station is also located within the Transitional Mid-boreal Wetland Region, a component of the Boreal Wetland Region of Canada. In this region, common wetlands include basin fens, bogs, swamps and marshes. Horizontal fens and floating fens also occur along drainageways and lakeshores (Government of Canada 1986). • The Gainford Pump Station is located in the Dry Mixedwood Natural Subregion of the Boreal Forest Natural Region of Alberta. Treed, shrubby or sedge-dominated fens are common to this area (Natural Regions Committee 2006b). • Wetlands provide habitat for native plants and wildlife species, including nesting and foraging habitat for bird species, and also provide storage and natural filtering of water. • No wetlands were identified within or adjacent to the Gainford Pump Station during the helicopter reconnaissance and satellite imagery review. As a result, a ground-based wetland survey was determined not to be required. • There are no Ramsar Wetlands of International Importance (Bureau of the Convention on Wetlands 2013), IBAs (Bird Studies Canada and Nature Canada 2012), Western Hemisphere Shorebird Reserves (WHSRN 2013) or Migratory Bird Sanctuaries (Environment Canada 2013b) located within the Wetland LSA surrounding the Gainford Pump Station. • The Gainford Pump Station is located within a DUC Level 1 Priority Area, the Prairie Pothole Region and Western Boreal Forest (DUC 2013). • The Gainford Pump Station is not located within the 1,000 m setback of provincially identified colonial nesting bird waterbodies or the 800 m setback of provincially identified trumpeter swan waterbodies (AESRD 2010-2012).
Vegetation	• The Gainford Pump Station is situated within the Aspen Parkland Ecoregion, a component of the Prairie Ecozone. In its native state, this ecoregion is characterized by trembling aspen, bur oak, shrubs and discontinuous fescue grasslands. Poorly-drained areas support communities dominated by willow and sedge species (Ecological Stratification Working Group 1995). • The Gainford Pump Station is located in the Dry Mixedwood Natural Subregion of the Boreal Forest Natural Region of Alberta. Aspen forests with understories dominated by shrubs are typical of the uplands. Treed, shrubby or sedge-dominated fens are common in wet areas. Jack pine typically dominates dry, well-drained areas (Natural Regions Committee 2006a). • Two provincial Environmentally Significant Areas (No. 441 and No. 442) with important rare plant habitat are located approximately 1 km northwest and 0.9 km southeast, respectively, from the Gainford Pump Station (ATPR 2009). • Records of rare plant observations within 5 km of the Gainford Pump Station were acquired from the ACIMS (2013) database. One provincially-listed (ACIMS) species record was found within the boundaries of the Vegetation LSA, marsh muhly, but not within the boundaries of the facility site. • A ground-based vegetation survey was conducted on July 18, 2013. Dominant communities observed during the 2013 vegetation survey consist of a deciduous forest dominated by trembling aspen, and a seeded area dominated by agronomic grasses and herbs. No rare plants or rare ecological communities were observed at the Gainford Pump Station during the 2013 vegetation survey. • Consultation with local agricultural authorities was conducted to determine weed species of concern for the region. See Section 4.4 of the Vegetation Technical Report of Volume 5C for a summary of these communications. • During the 2013 vegetation survey, five Noxious weed species were observed: Canada thistle; common tansy; ox-eye daisy; perennial sow-thistle; and tall buttercup. No Prohibited Noxious weeds were observed.

TABLE 6.1-2 Cont'd

Environmental Elements	Summary of Considerations
Wildlife and Wildlife Habitat	• The Gainford Pump Station is located adjacent to an existing pump station on industrial and forested lands. Dominant communities consist of a deciduous forest dominated by trembling aspen and a seeded area dominated by agronomic grasses and herbs. • The Gainford Pump Station is not located within or adjacent to any Environmentally Significant Areas (ATPR 2009), provincial parks or protected areas (ATPR 2012), IBAs (Bird Studies Canada and Nature Canada 2012), Migratory Bird Sanctuaries (Environment Canada 2013b), National Wildlife Areas (Environment Canada 2013b), Western Hemisphere Shorebird Reserves (WHSRN 2013), Ramsar Wetlands of International Importance (Bureau of the Convention on Wetlands 2013), World Biosphere Reserves (UNESCO 2013), or provincially identified wildlife areas (AESRD 2013b). • The Gainford Pump Station is located in a DUC Level 1 Priority Area, the Prairie Pothole Region and Western Boreal Forest (DUC 2013). • Two provincial Environmentally Significant Areas (No. 441 and No. 442) with important wildlife habitat are located approximately 1 km northwest and 0.9 km southeast, respectively, from the Gainford Pump Station (ATPR 2009). • The Gainford Pump Station is located in WMU 336 (AESRD 2012b). • A supplemental wildlife survey will be conducted (see Section 9.0).
Species at Risk or Species of Special Status and Related Habitat	• No work will occur within 30 m of any fish-bearing waterbodies and, therefore, detailed information on fish and fish species at risk is not deemed warranted as per Table A-1 of the NEB *Filing Manual*. • Records of rare plant observations within 5 km of the Gainford Pump Station were acquired from the ACIMS (2013) database. No federally-listed (*SARA* or COSEWIC) species records were found within these boundaries. • Based on known species range and habitat preferences, the following federally-listed (*SARA* Schedule 1 or COSEWIC) and/or provincially-listed (At Risk, May be at Risk, or under Alberta's *Wildlife Act* and *Wildlife Regulation*) wildlife species was identified as having the potential to occur in the vicinity of the Gainford Pump Station (ASRD 2010, COSEWIC 2013, Environment Canada 2012): − little brown myotis (COSEWIC: Endangered, provincial: Secure). • A search of the AESRD FWMIS database did not identify any federally-listed (*SARA* Schedule 1 or COSEWIC) and/or provincially-listed (At Risk, May be at Risk, or under Alberta's *Wildlife Act* and *Wildlife Regulation*) wildlife species within 2 km of the Gainford Pump Station (AESRD 2013c). • Given that new clearing of forested lands will be required for the Gainford Pump Station, the Gainford Pump Station has the potential to be suitable habitat for wildlife and plant species at risk. • A supplemental survey for wildlife species at risk will be conducted (see Section 9.0).

6.1.3 Wolf Pump Station

The existing Wolf Pump Station is located at NW 19-53-14 W5M at RK 206.2. The Wolf Pump Station is located on lands owned by Trans Mountain in Yellowhead County. Current land use at and around this facility site is industrial and forested. No disturbance of previously undisturbed lands is proposed at the Wolf Pump Station (*i.e.,* no native vegetation would be directly disturbed within the site boundaries). Two 5,000 HP pump units will be added at the site. The existing pump building will be deactivated. Access to the Wolf Pump Station is via Highway 16. Table 6.1-3 provides a summary of the environmental elements and considerations for the Wolf Pump Station pursuant to Guide A.2.4 and Table A-2 of the NEB *Filing Manual*. The location of the Wolf Pump Station is shown on Figure 6.1-3.



TRANS MOUNTAIN

FIGURE 6.1-3

WOLF PUMP STATION

TRANS MOUNTAIN EXPANSION PROJECT

Kilometre Post (KP)

Hamlet / Village / Community

Trans Mountain Pipeline (TMPL)

Trans Mountain Expansion Project Proposed Pipeline Corridor

Subject Property Facility Boundary

Acoustic Environment RSA

Highway

Paved Road

Railway

Projection: NAD 1983 UTM Zone 11N. Routing: Baseline TMPL & Facilities: provided by KMC 2012; Proposed Pipeline Corridor V^: provided by UPI Aug. 23, 2013; Transportation: IHS Inc., 2013, Natural Resources Canada, 2011; Geopolitical Boundaries: Natural Resources Canada, 2003, Altalis, 2012, IHS Inc., 2011, ESRI, 2005; First Nation Lands: Government of Canada, 2013; Parks and Protected Areas: Natural Resources Canada, 2013, Altalis, 2013, Alberta Tourism, Parks and Recreation, 2012, BC FLNRO, 2008; Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

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Although there is no reason to believe that there are any errors associated with the data used to generate this product or in the product itself, users of these data are advised that errors in the data may be present.

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ALL LOCATIONS APPROXIMATE

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TABLE 6.1-3

SUMMARY OF ENVIRONMENTAL ELEMENTS AND CONSIDERATIONS FOR THE WOLF PUMP STATION

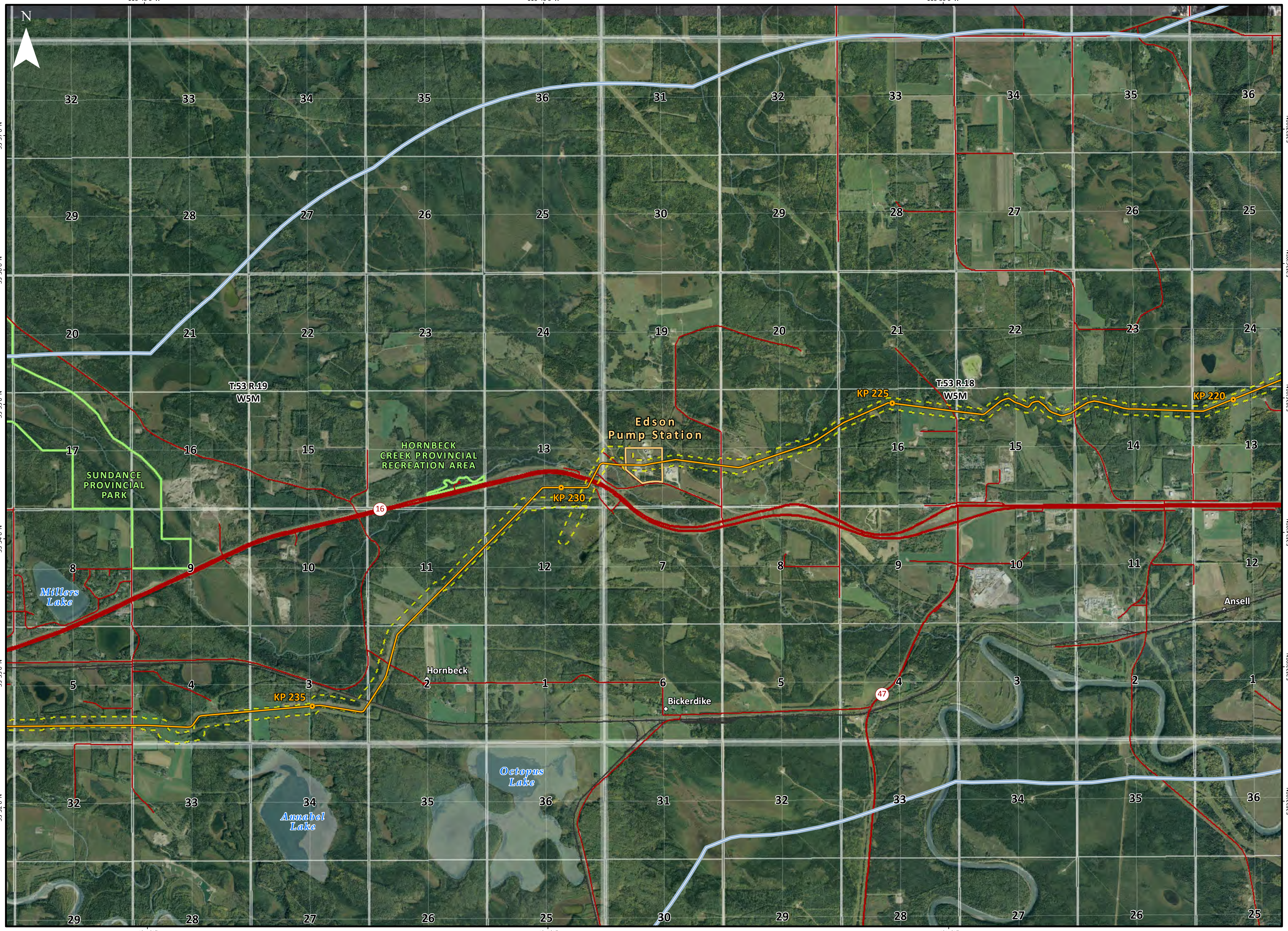
Environmental Elements	Summary of Considerations
Physical and Meteorological Environment	• The Wolf Pump Station is located within the Western Alberta Plains Physiographic Region, characterized by undulating plains, less abundant hummocky terrain and incised river valleys (Natural Regions Committee 2006a, Pettapiece 1986). • The Wolf Pump Station is underlain by the Paskapoo Formation, which is characterized by a thick sequence of Paleocene sand and siltstones, consisting of buff medium-grained sandstone overlain by interbedded light grey soft sandy siltstone and mudstones (Dawson *et al*. 1994, Hamblin 2004). • The surficial geology beneath the site is mapped as Edson Till consisting of moraine deposits of stones in a silty clay matrix (Roed 1970). • There are no areas of permafrost within the area of the Wolf Pump Station (refer to Section 5.1.1). • No areas of potential terrain instability are known to occur in the vicinity of the Wolf Pump Station. • The site is located in a zone of low seismic activity (NRCan 2010a). Peak ground acceleration with a 1:2475 annual probability of exceedance is less than 0.1 g (NRCan 2013a). No earthquakes have been recorded in the area (NRCan 2013b). • The topography in the area of Wolf Pump Station is generally flat with a slight grade change from south to north. Elevation is approximately 880 m above sea level. • Where activities are planned within Wolf Pump Station, soils have been disturbed for industrial use and construction of the new infrastructure will be conducted within the boundaries of the existing station. NRCan considers unprotected soils in the vicinity of Wolf Pump Station to have low wind erosion risk with low climatic sensitivity (NRCan 2010d). • The Wolf Pump Station is located in an agricultural area considered to have low soil erosion risk (AARD 2005a). Wind erosion risk, which assesses the risk of soil degradation by wind on bare, unprotected mineral soil, is considered low at the pump station (AARD 2005b). Water erosion risk, which assesses the risk of soil degradation by water on bare, unprotected mineral soil, is considered severe in the vicinity of the site (AARD 2005c). • A description of the climate for the Lower Foothills Natural Subregion is provided in Section 5.1.1. • Meteorological data from Environment Canada's Edson Station, located approximately 30 km west of Wolf Pump Station, are provided in Section 5.1.1. • No major tornadoes or hailstorms have been recorded in the vicinity of Wolf Pump Station (NRCan 2010b,c).
Soil and Soil Productivity	• Activities at the Wolf Pump Station will be conducted within an existing fenced, industrial site lacking topsoil and, therefore, detailed soil information is not warranted as per Table A-2 of the NEB *Filing Manual*. • A soil survey at the Wolf Pump Station was conducted in 2005 for the TMX Anchor Loop Project. Imperfectly-drained gleyed gray Luvisols developed on stone-free to slightly stony, silty clay to clay textured glaciolacustrine material (Lendrum soils) occur throughout the site. There is little to no topsoil present at the site (Mentiga 2005a). • The CLI (1973a) has rated soils at the Wolf Pump Station as having severe (Class 4) limitations to agriculture due to undesirable soil structure and excess moisture. • No contamination is anticipated at the Wolf Pump Station. If any contamination is encountered during construction, the Contamination Discovery Contingency Plan (Appendix B of the Facilities EPP of Volume 6C) will be implemented.
Water Quality and Quantity	• The Wolf Pump Station is located within the Lower McLeod River Watershed of the Athabasca River Basin. • No work will occur within 30 m of any waterbodies and, therefore, detailed information on surface water quality and quantity is not warranted as per Table A-1 of the NEB *Filing Manual*. • The terrain is reported as sloping slightly from south to north and groundwater flow likely follows topography towards January Creek located 160 m to the northwest. • The surficial geology beneath the site is mapped as Edson Till consisting of moraine deposits stones in a silty clay matrix (Roed 1970). • Water well records indicate three flowing shot-holes within the Water Quality and Quantity LSA; two nearby water wells have water levels of approximately 4-6 m bgl. • No water supply wells are mapped within the site boundary (AESRD 2013a). • The Wolf Pump Station does not overlie any mapped aquifers.
Air Emissions	• All existing pumps are electrically driven and are not direct sources of CACs. • Fugitive VOC emissions from leaks at the Wolf Pump Station are estimated to be 1.7 tonnes per year. • Air quality in the area surrounding the Wolf Pump Station is expected to be primarily influenced by vehicle traffic emissions along Highway 16, nearby oil and gas facilities, and agricultural activity in the area.
Greenhouse Gas Emissions	• Indirect GHG emissions due to electric power consumption by the existing pumps at the Wolf Pump Station are the main emissions. These include emissions from fossil fuel combustion, unallocated energy from power line losses, metering differences and other losses, and emissions of SF_6 from gas handling and transferring operations, electrical equipment operation, and from equipment mechanical failures. • Small amounts of direct GHG emissions will be released due to the space heating of the existing buildings at the Wolf Pump Station. • Small amounts of indirect GHG emissions will be released due to electricity use for equipment other than pumps. • Small amounts of GHG emissions will be released from the motor vehicles used by operations/maintenance staff.
Acoustic Environment	• Although two new pump units are being added, existing pump units of equivalent sound emission will be deactivated. No increase in sound emissions is expected from the Project at the Wolf Pump Station during operations and, therefore, detailed information on sound emissions is not warranted as per Table A-1 of the NEB *Filing Manual*.

TABLE 6.1-3 Cont'd

Environmental Elements	Summary of Considerations
Fish and Fish Habitat	• The Wolf Pump Station is located within the Lower McLeod River Watershed of the Athabasca River Basin. • No work will occur within 30 m of any fish-bearing waterbodies and, therefore, detailed information on fish and fish habitat is not deemed warranted as per Table A-1 of the NEB *Filing Manual*.
Wetland Loss or Alteration	• The Wolf Pump Station is situated within the boundaries of the Boreal Transition Ecoregion of the Boreal Plains Ecozone. Small lakes, ponds and marshes occupy shallow depressions within this ecoregion (Ecological Stratification Working Group 1995). • The Wolf Pump Station is also located in the Continental Mid-boreal Wetland Region. Wetlands characteristic of this region include flat and basin bogs often associated with horizontal and ribbed fens. Plateau bogs occur occasionally in large fens. Marshes can be found along gently sloping lakeshores (Government of Canada 1986). • The Wolf Pump Station is located within the Lower Foothills Natural Subregion of the Foothills Natural Region. Wetlands are predominantly treed fens, bogs and open fens (Natural Regions Committee 2006b). • No wetlands were identified within or adjacent to the Wolf Pump Station during the helicopter reconnaissance and satellite imagery review. As a result, a ground-based wetland survey was determined not to be required. • There are no Ramsar Wetlands of International Importance (Bureau of the Convention on Wetlands 2013), IBAs (Bird Studies Canada and Nature Canada 2012), Western Hemisphere Shorebird Reserves (WHSRN 2013) or Migratory Bird Sanctuaries (Environment Canada 2013b) located within the Wetland LSA surrounding the Wolf Pump Station. • The Wolf Pump Station is located within a DUC Level 1 Priority Area, the Prairie Pothole Region and Western Boreal Forest (DUC 2013). • The Wolf Pump Station is not located within the 1,000 m setback of provincially identified colonial nesting bird waterbodies or the 800 m setback of provincially identified trumpeter swan waterbodies (AESRD 2010-2012).
Vegetation	• The Wolf Pump Station is located within the boundaries of the Boreal Transition Ecoregion of the Boreal Plains Ecozone. In its native state, this ecoregion is characterized by trembling aspen, balsam poplar, white spruce, balsam fir and a thick understory of tall shrubs and herbs. Poorly-drained areas support communities of willow species and sedges, with black spruce and tamarack occurring occasionally (Ecological Stratification Working Group 1995). • The Wolf Pump Station is located in the Lower Foothills Natural Subregion of the Foothills Natural Region. The Lower Foothills Natural Subregion is dominated by mixed stands of trembling aspen, lodgepole pine, white spruce and balsam poplar. Understory communities are dominated by shrubs and herbs (Natural Regions Committee 2006a). • There are no national parks, provincial parks, provincial recreation areas, Environmentally Significant Areas or other protected areas located within the Vegetation LSA around the Wolf Pump Station. • Records of rare plant observations within 5 km of the Wolf Pump Station were acquired from the ACIMS (2013) database. No provincially-listed (ACIMS) species records were found within the boundaries of the Vegetation LSA. • It was determined with satellite imagery interpretation that no native vegetation would be directly disturbed within the site boundaries and, therefore, a ground-based vegetation survey was deemed unnecessary. • Consultation with local agricultural authorities was conducted to determine weed species of concern for the region. See Section 4.4 of the Vegetation Technical Report of Volume 5C for a summary of these communications.
Wildlife and Wildlife Habitat	• The Wolf Pump Station is located on industrial and forested lands. • The Wolf Pump Station is not located within or adjacent to any Environmentally Significant Areas (ATPR 2009), provincial parks or protected areas (ATPR 2012), IBAs (Bird Studies Canada and Nature Canada 2012), Migratory Bird Sanctuaries (Environment Canada 2013b), National Wildlife Areas (Environment Canada 2013b), Western Hemisphere Shorebird Reserves (WHSRN 2013), Ramsar Wetlands of International Importance (Bureau of the Convention on Wetlands 2013), World Biosphere Reserves (UNESCO 2013), or provincially identified wildlife areas (AESRD 2013b). • The Wolf Pump Station is located in a DUC Level 1 Priority Area, the Prairie Pothole Region and Western Boreal Forest (DUC 2013). • The Wolf Pump Station is located in WMU 346 (AESRD 2012b). • Project activities will be located within an existing previously disturbed industrial site which is not considered to be suitable wildlife habitat.
Species at Risk or Species of Special Status and Related Habitat	• No work will occur within 30 m of any fish-bearing waterbodies and, therefore, detailed information on fish and fish species at risk is not deemed warranted as per Table A-1 of the NEB *Filing Manual*. • Records of rare plant observations within 5 km of the Wolf Pump Station were acquired from the ACIMS (2013) database. No federally-listed (*SARA* or COSEWIC) species records were found within these boundaries. • Based on known species range and habitat preferences, the following federally-listed (*SARA* Schedule 1 or COSEWIC) and/or provincially-listed (At Risk, May be at Risk, or under Alberta's *Wildlife Act* and *Wildlife Regulation*) wildlife species was identified as having the potential to occur in the vicinity of the Wolf Pump Station (ASRD 2010, COSEWIC 2013, Environment Canada 2012): – little brown myotis (COSEWIC: Endangered, provincial: Secure). • A search of the AESRD FWMIS database did not identify any federally-listed (*SARA* Schedule 1 or COSEWIC) and/or provincially-listed (At Risk, May be at Risk, or under Alberta's *Wildlife Act* and *Wildlife Regulation*) wildlife species within 2 km of the Wolf Pump Station (AESRD 2013c). • Given that the Wolf Pump Station is an existing facility and all work will occur on previously disturbed cleared land, the Wolf Pump Station is not considered suitable habitat for wildlife or plant species at risk.

6.1.4 Edson Pump Station

The existing Edson Pump Station is located at SW 18-53-18 W5M at RK 247.1. The Edson Pump Station is located on lands owned by Trans Mountain in Yellowhead County. Current land use at and around this facility site is industrial. All work will be conducted within the existing disturbed fenced area at the Edson Pump Station. No native vegetation would be directly disturbed within the site boundaries. Three 5,000 HP pump units will be added at the site. A new power line will be required to service Project upgrades to the existing substation at the Edson Pump. At the time of writing, the routing of the power line had yet to be determined by the AESO. Access to the Edson Pump Station is via Highway 16. Table 6.1-4 provides a summary of the environmental elements and considerations for the Edson Pump Station pursuant to Guide A.2.4 and Table A-2 of the NEB *Filing Manual*. The location of the Edson Pump Station is shown on Figure 6.1-4.



TRANS MOUNTAIN

FIGURE 6.1-4

EDSON PUMP STATION

TRANS MOUNTAIN EXPANSION PROJECT

- Kilometre Post (KP)
- Hamlet / Village / Community
- Trans Mountain Pipeline (TMPL)
- Trans Mountain Expansion Project Proposed Pipeline Corridor
- Subject Property Facility Boundary
- Acoustic Environment RSA
- Highway
- Paved Road
- Railway
- National / Provincial Park

Projection: NAD 1983 UTM Zone 11N. Routing: Baseline TMPL & Facilities: provided by KMC 2012; Proposed Pipeline Corridor V6: provided by UPI Aug. 23, 2013; Transportation: IHS Inc., 2013, Natural Resources Canada, 2011; Geopolitical Boundaries: Natural Resources Canada, 2003, Altalis, 2012, IHS Inc., 2011, ESRI, 2005; First Nation Lands: Government of Canada, 2013; Parks and Protected Areas: Natural Resources Canada, 2013, Altalis, 2013, Alberta Tourism, Parks and Recreation, 2012, BC FLNRO, 2008.

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Although there is no reason to believe that there are any errors associated with the data used to generate this product or in the product itself, users of these data are advised that errors in the data may be present.

MAP NUMBER		PAGE
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DRAWN AJS	CHECKED HS	DESIGN TGG

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ALL LOCATIONS APPROXIMATE

201310_MAP_TERA_SE_00442_Rev0_05.mxd

TABLE 6.1-4

SUMMARY OF ENVIRONMENTAL ELEMENTS AND CONSIDERATIONS FOR THE EDSON PUMP STATION

Environmental Elements	Summary of Considerations
Physical and Meteorological Environment	• The Edson Pump Station is located within the Western Alberta Plains Physiographic Region, characterized by undulating plains, less abundant hummocky terrain and incised river valleys (Natural Regions Committee 2006a, Pettapiece 1986). • The Edson Pump Station is underlain by the Paskapoo Formation, which is characterized by a thick sequence of Paleocene sand and siltstones, consisting of buff medium-grained sandstone overlain by interbedded light grey soft sandy siltstone and mudstones (Dawson *et al*. 1994, Hamblin 2004). • The surficial geology beneath the site is mapped as Marlboro Till consisting of moraine deposits stones in a silty clay matrix and the underlying materials in the southwest half of the site consist of glaciolacustrine lake sediments (Roed 1970). • There are no areas of permafrost within the area of the Edson Pump Station (refer to Section 5.1.1). • No areas of potential terrain instability are known to occur in the vicinity of the Edson Pump Station. • The site is located in a zone of low seismic activity (NRCan 2010a). Peak ground acceleration with a 1:2475 annual probability of exceedance is less than 0.1 g (NRCan 2013a). Several minor earthquakes (magnitude 3) have been recorded in the vicinity of the pump station (NRCan 2013b). • The topography in the area of Edson Pump Station is relatively flat to gently sloping and the elevation is approximately 940 m above sea level. • Where activities are planned within Edson Pump Station, soils have been disturbed for industrial use. Construction of the new infrastructure will be conducted within the boundaries of the existing station. NRCan considers unprotected soils in the vicinity of Edson Pump Station to be low or negligible (NRCan 2010d). • The Edson Pump Station is located in an agricultural area considered to have low soil erosion risk (AARD 2005a). Wind erosion risk, which assesses the risk of soil degradation by wind on bare, unprotected mineral soil, is considered negligible at the pump station (AARD 2005b). Water erosion risk, which assesses the risk of soil degradation by water on bare, unprotected mineral soil, is considered severe in the vicinity of the site (AARD 2005c). • A description of the climate for the Lower Foothills Natural Subregion is provided in Section 5.1.1. • Meteorological data from Environment Canada's Edson Station, located approximately 10 km east of the Edson Pump Station, are provided in Section 5.1.1. • No major tornadoes or hailstorms have been recorded in the vicinity of Edson Pump Station (NRCan 2010b,c).
Soil and Soil Productivity	• Activities at the Edson Pump Station will be conducted within an existing fenced, industrial site lacking topsoil and, therefore, detailed soil information is not warranted as per Table A-2 of the NEB *Filing Manual*. • The CLI (1973b) has rated the soils in the vicinity of the Edson Pump Station as having moisture and adverse climate limitations (Class 6) and are only capable of producing perennial forage crops. • No contamination is anticipated at the Edson Pump Station. If any contamination is encountered during construction, the Contamination Discovery Contingency Plan (Appendix B of the Facilities EPP of Volume 6C) will be implemented.
Water Quality and Quantity	• The Edson Pump Station is located within the Upper McLeod River Watershed of the Athabasca River Basin. • No work will occur within 30 m of any waterbodies and, therefore, detailed information on surface water quality and quantity is not warranted as per Table A-1 of the NEB *Filing Manual*. • The terrain is reported as generally level with a gentle slope from north to south. Groundwater flow likely follows topography towards Sundance Creek approximately 150 m to the south. • The surficial geology beneath the site is mapped as Marlboro Till consisting of moraine deposits stones in a silty clay matrix and the underlying materials in the southwest half of the site consist of glaciolacustrine lake sediments (Roed 1970). • Water wells, for which information is available, are completed in bedrock. • No water supply wells are mapped within the site boundary (AESRD 2013a). • The Edson Pump Station does not overlie any mapped aquifers.
Air Emissions	• All existing pumps are electrically driven and are not direct sources of CACs. • Fugitive VOC emissions from leaks at the Edson Pump Station are estimated to be 5.6 tonnes per year. • Air quality in the area surrounding the Edson Pump Station is influenced by residential sources, rail station activity emissions, oil and gas and forestry industrial sources, and potential long-range transport of PM emissions from forest fires in the region.
Greenhouse Gas Emissions	• Indirect GHG emissions due to electric power consumption by the existing pumps at the Edson Pump Station are the main emissions. These include emissions from fossil fuel combustion, unallocated energy from power line losses, metering differences and other losses, and emissions of SF_6 from gas handling and transferring operations, electrical equipment operation, and from equipment mechanical failures. • Small amounts of direct GHG emissions will be released due to the space heating of the existing buildings at the Edson Pump Station. • Small amounts of indirect GHG emissions will be released due to electricity use for equipment other than pumps. • Small amounts of GHG emissions will be released from the motor vehicles used by operations/maintenance staff.

TABLE 6.1-4 Cont'd

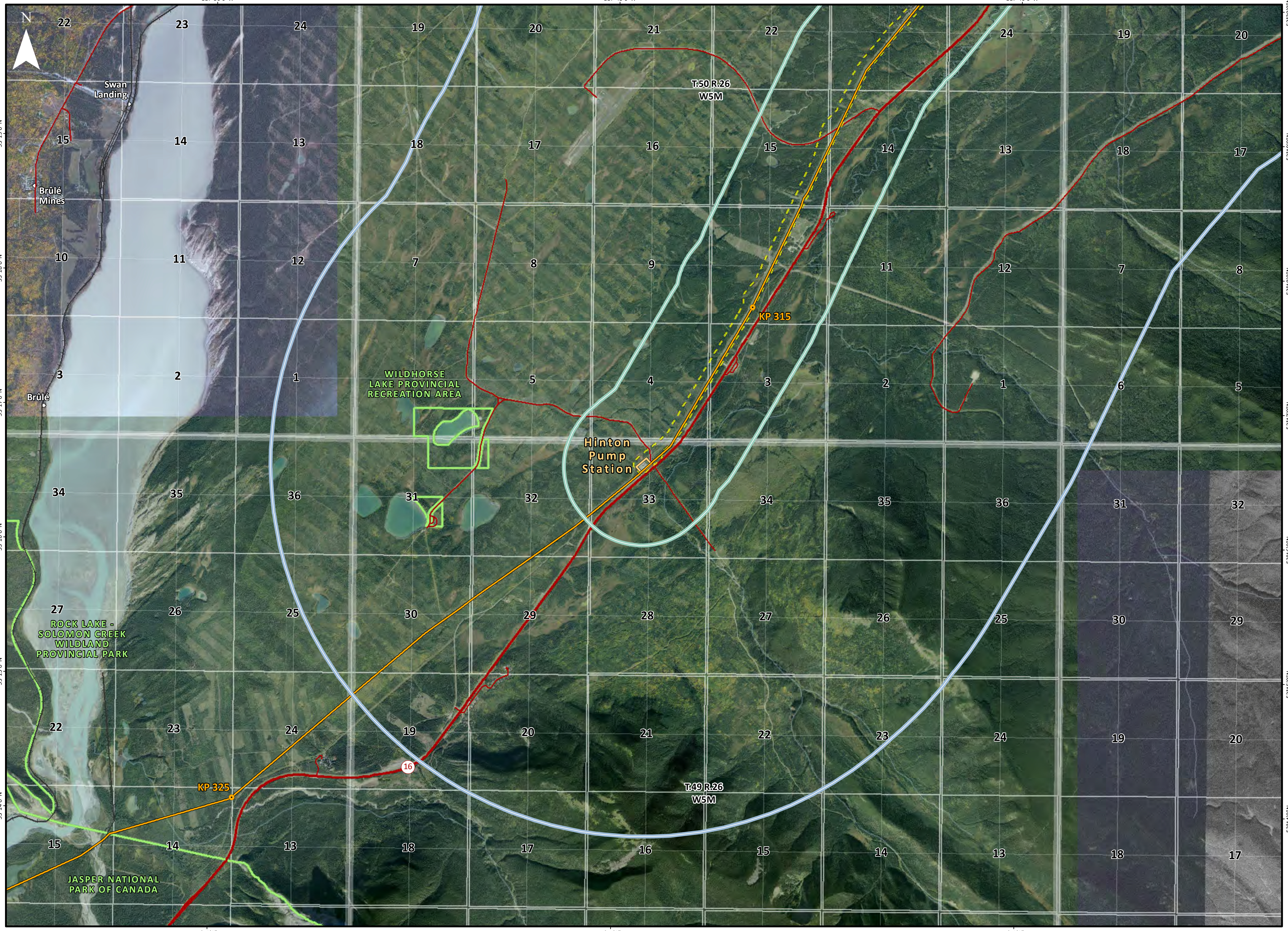
Environmental Elements	Summary of Considerations
Acoustic Environment	• Sources of existing sound in the Acoustic Environment LSA are traffic travelling along Highway 16, surrounding arterial roadways and natural sound (*e.g.*, wind, wildlife). • Receptors were identified within the Acoustic Environment LSA. The nearest receptor is located approximately 360 m to the west of the fenceline of the Edson Pump Station. • ASL in the absence of regulated energy facilities ranges between 35-40 dBA at night and 45-50 dBA during the day based on AER *Directive 038* (ERCB 2007). • A measurement program to define sound emissions from the existing facility was conducted. • A noise model was generated based on existing conditions observed and measurements of the major on-site sources of sound. Specifications of equipment not operating during the site visit were used to estimate sound levels. Applicable buildings and shelters were modelled along with the appropriate insertion losses and screening effects. • The noise modelling results indicate that sound from the existing Edson Pump Station complies with the AER *Directive 038* permissible sound levels for all surrounding receptors. • Contoured noise prediction results are available in the Terrestrial Noise and Vibration Technical Report of Volume 5C.
Fish and Fish Habitat	• The Edson Pump Station is located within the Upper McLeod River Watershed of the Athabasca River Basin. • No work will occur within 30 m of any fish-bearing waterbodies and, therefore, detailed information on fish and fish habitat is not deemed warranted as per Table A-1 of the NEB *Filing Manual*.
Wetland Loss or Alteration	• The Edson Pump Station is situated within the boundaries of the Boreal Transition Ecoregion of the Boreal Plains Ecozone. Small lakes, ponds and marshes occupy shallow depressions within this ecoregion (Ecological Stratification Working Group 1995). • The Edson Pump Station is also located within the Continental Mid-boreal Wetland Region. Wetlands characteristic of this region include flat and basin bogs often associated with horizontal and ribbed fens. Plateau bogs occur occasionally in large fens. Marshes can be found along gently sloping lakeshores (Government of Canada 1986). • The Edson Pump Station and associated power lines are located in the Lower Foothills Natural Subregion of the Foothills Natural Region. Wetlands characteristic of this natural subregion include treed fens with some bogs and open fens (Natural Regions Committee 2006b). • Wetlands provide habitat for native plants and wildlife species, including nesting and foraging habitat for bird species as well as provide storage and natural filtering of water. • No wetlands were identified within or adjacent to the Edson Pump Station during the helicopter reconnaissance and satellite imagery review. As a result, a ground-based wetland survey was determined not to be required. • There are no Ramsar Wetlands of International Importance (Bureau of the Convention on Wetlands 2013), IBAs (Bird Studies Canada and Nature Canada 2012), Western Hemisphere Shorebird Reserves (WHSRN 2013) or Migratory Bird Sanctuaries (Environment Canada 2013b) located within the Wetland LSA surrounding the Edson Pump Station. • The Edson Pump Station is located within a DUC Level 1 Priority Area, the Prairie Pothole Region and Western Boreal Forest (DUC 2013). • The Edson Pump Station is not located within the 1,000 m setback of provincially identified colonial nesting bird waterbodies or the 800 m setback of provincially identified trumpeter swan waterbodies (AESRD 2010-2012).
Vegetation	• The Edson Pump Station is located within the boundaries of the Boreal Transition Ecoregion of the Boreal Plains Ecozone. In its native state, this ecoregion is characterized by trembling aspen, balsam poplar, white spruce, balsam fir and a thick understory of tall shrubs and herbs. Poorly-drained areas support communities of willow species and sedges, with black spruce and tamarack occurring occasionally (Ecological Stratification Working Group 1995). • The Edson Pump Station is located in the Lower Foothills Natural Subregion of the Foothills Natural Region. The Lower Foothills Natural Subregion is dominated by mixed stands of trembling aspen, lodgepole pine, white spruce and balsam poplar. Understory communities are dominated by shrubs and herbs (Natural Regions Committee 2006a). • There are no national parks, provincial parks, provincial recreation areas, Environmentally Significant Areas or other protected areas located within the Vegetation LSA near the Edson Pump Station. • Records of rare plant observations within 5 km of the Edson Pump Station were acquired from the ACIMS (2013) database. No provincially-listed (ACIMS) species records were found within the boundaries of the Vegetation LSA. • It was determined with satellite imagery interpretation that no native vegetation would be directly disturbed within the site boundaries and, therefore, a ground-based vegetation survey was deemed unnecessary. • Consultation with local agricultural authorities was conducted to determine weed species of concern for the region. See Section 4.4 of the Vegetation Technical Report of Volume 5C for a summary of these communications.
Wildlife and Wildlife Habitat	• The Edson Pump Station is located on industrial lands. • The Edson Pump Station is not located within or adjacent to any Environmentally Significant Areas (ATPR 2009), provincial parks or protected areas (ATPR 2012), IBAs (Bird Studies Canada and Nature Canada 2012), Migratory Bird Sanctuaries (Environment Canada 2013b), National Wildlife Areas (Environment Canada 2013), Western Hemisphere Shorebird Reserves (WHSRN 2013), Ramsar Wetlands of International Importance (Bureau of the Convention on Wetlands 2013), World Biosphere Reserves (UNESCO 2013), or provincially identified wildlife areas (AESRD 2013b). • The Edson Pump Station is located in a DUC Level 1 Priority Area, the Prairie Pothole Region and Western Boreal Forest (DUC 2013). • Hornbeck Creek Provincial Recreation Area is approximately 1.9 km southwest of the Edson Pump Station (APTR 2012). • A provincial Environmentally Significant Area (No. 72) with important wildlife habitat is located approximately 1.9 km southwest of the Edson Pump Station (ATPR 2009). • The Edson Pump Station is located in WMU 346 (AESRD 2012b).

TABLE 6.1-4 Cont'd

Environmental Elements	Summary of Considerations
Species at Risk or Species of Special Status and Related Habitat	• No work will occur within 30 m of any fish-bearing waterbodies and, therefore, detailed information on fish and fish species at risk is not deemed warranted as per Table A-1 of the NEB *Filing Manual*. • Records of rare plant observations within 5 km of the Edson Pump Station were acquired from the ACIMS (2013) database. No federally-listed (*SARA* or COSEWIC) species records were found within these boundaries. • Based on known species range and habitat preferences, the following federally-listed (*SARA* Schedule 1 or COSEWIC) and/or provincially-listed (At Risk, May be at Risk, or under Alberta's *Wildlife Act* and *Wildlife Regulation*) wildlife species was identified as having the potential to occur in the vicinity of the Edson Pump Station (ASRD 2010, COSEWIC 2013, Environment Canada 2012): – little brown myotis (COSEWIC: Endangered, provincial: Secure). • A search of the AESRD FWMIS database did not identify any federally-listed (*SARA* Schedule 1 or COSEWIC) and/or provincially-listed (At Risk, May be at Risk, or under Alberta's *Wildlife Act* and *Wildlife Regulation*) wildlife species within 2 km of the Edson Pump Station (AESRD 2013c). • Given that the Edson Pump Station is an existing facility and all work will occur within the existing fenced area on previously disturbed land, the Edson Pump Station is not considered suitable habitat for wildlife or plant species at risk.

6.1.5 Hinton Pump Station

The existing Hinton Pump Station is located at NW 33-49-26 W5M at RK 339.4. The Hinton Pump Station is located on lands owned by Trans Mountain in Yellowhead County. Expansion of the Hinton Pump Station will require acquisition of approximately 0.32 ha of new Crown land to the west of and adjacent to existing Trans Mountain lands. Three 5,000 HP pump units will be added at the site. Access to the Hinton Pump Station is via Highway 16. Table 6.1-5 provides a summary of the environmental elements and considerations for the Hinton Pump Station pursuant to Guide A.2.4 and Table A-2 of the NEB *Filing Manual*. The location of the Hinton Pump Station is shown on Figure 6.1-5.



TRANS MOUNTAIN

FIGURE 6.1-5

HINTON PUMP STATION

TRANS MOUNTAIN EXPANSION PROJECT

- Kilometre Post (KP)
- Hamlet / Village / Community
- Trans Mountain Pipeline (TMPL)
- Trans Mountain Expansion Project Proposed Pipeline Corridor
- Subject Property Facility Boundary
- Acoustic Environment RSA
- Vegetation RSA Boundary
- Highway
- Paved Road
- Railway
- National / Provincial Park

Projection: NAD 1983 UTM Zone 11N. Routing: Baseline TMPL & Facilities: provided by KMC 2012; Proposed Pipeline Corridor V6: provided by UPI Aug. 23, 2013; Transportation: IHS Inc., 2013, Natural Resources Canada, 2011; Geopolitical Boundaries: Natural Resources Canada, 2003, Altalis, 2012, IHS Inc., 2011, ESRI, 2005; First Nation Lands: Government of Canada, 2013; Parks and Protected Areas: Natural Resources Canada, 2013, Altalis, 2013, Alberta Tourism, Parks and Recreation, 2012, BC FLNRO, 2008; Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

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DESIGN: TGG	

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ALL LOCATIONS APPROXIMATE

201310_MAP_TERA_SE_00442_Rev0_06.mxd

TABLE 6.1-5

SUMMARY OF ENVIRONMENTAL ELEMENTS AND CONSIDERATIONS FOR THE HINTON PUMP STATION

Environmental Elements	Summary of Considerations
Physical and Meteorological Environment	• The Hinton Pump Station is located within the Southern Alberta Uplands Physiographic Region, which is characterized by hummocky terrain, rolling uplands, gently undulating terraces and incised river valleys (Natural Regions Committee 2006a, Pettapiece 1986). • The Hinton Pump Station is underlain by the Alberta Group, which is composed of dominantly dark grey, silty mudstones and a prominent middle sandstone sequence (Glass 1990). • The surficial geology beneath the site is mapped as moraine silty sand till (unsorted clay to bolder size material) (Roed 1970). • There are no areas of permafrost within the area of the Hinton Pump Station (refer to Section 5.1.1). • No areas of potential terrain instability are known to occur in the vicinity of the Hinton Pump Station. • The site is located in a zone of low seismic activity (NRCan 2010a). Peak ground acceleration with a 1:2475 annual probability of exceedance is between 0.1 and 0.2 g (NRCan 2013a). Several minor earthquakes (magnitude 3) have been recorded in the vicinity of the pump station (NRCan 2013b). • The topography in the area of the Hinton Pump Station is gently sloping and the elevation is approximately 1,110 m above sea level. • Where activities are planned within the Hinton Pump Station, soils have been disturbed for industrial use, however, construction of the new infrastructure will require extending the existing fenceline to the west by approximately 35 m into a grassland/forested area, increasing the station operating area by approximately 0.3 ha. NRCan considers unprotected soils in the vicinity of the Hinton Pump Station to be low or negligible (NRCan 2010d). • A description of the climate for the Montane Natural Subregion is provided in Section 5.1.1. • The following meteorological data were obtained from an Environment Canada meteorological station (3053520) in Jasper, Alberta (Environment Canada 2013a). The data were taken approximately 50 km south-southwest of Hinton Pump Station. – Average monthly rainfall for Jasper is 25.4 mm and the average monthly rainfall from June to August is 59.6 mm. In August of 1969, Jasper recorded its highest daily rainfall of 107.7 mm, which is above the monthly average of 64.6 mm for the month of August. – Average monthly snowfall for Jasper is 10 cm and the average monthly snowfall from November to February is 21 cm. In February of 1948, Jasper recorded its highest daily snowfall of 51.6 cm, well above the 14.7 cm average for the month of February. – Average daily temperature for Jasper is 3.6°C, with the warmest month in July, averaging 15.2°C and coolest month in December, averaging -9.1°C. In July of 1941, Jasper experienced its warmest day of 36.7°C and in January of 1935, its coolest day at -46.7°C. • No major tornadoes or hailstorms have been recorded in the vicinity of Hinton Pump Station (NRCan 2010b,c).
Soil and Soil Productivity	• Project activities will cause some disturbance to soil outside of the existing fenceline of the Hinton Pump Station to the west. The current Hinton Pump Station has been previously disturbed and contains pumps, buildings and other equipment. • A soil survey at the Hinton Pump Station was conducted in 2005 for the Trans Mountain Pump Station Expansion Project. Well-drained, Calcareous Brunisolic Gray Luvisols developed on strongly calcareous, very stony Cordilleran till (Dalehurst soils) occur in the central and eastern portions while well-drained Calcareous Orthic Brunisols developed on stone-free eolian sandy loams and loams overlying very stony till (Kia Nea soils) occur in the western portion. Soils at the site are susceptible to wind erosion and to compaction and rutting when wet (Mentiga 2005b). • The forest productivity rating of soils at the site indicates an expected mean annual productivity of about 2.5 m^3/ha (Dumanski *et al.* 1972). Soil toxicity limits forest productivity due to excessive concentrations of alkalinity or lime, which impedes tree growth. • The CLI (1973b) has rated soils at the site as having such severe (Class 6) limitations due to adverse topography that they are only capable of producing perennial forage crops. • No contamination is anticipated at the Hinton Pump Station. If any contamination is encountered during construction, the Contamination Discovery Contingency Plan (Appendix B of the Facilities EPP of Volume 6C) will be implemented.
Water Quality and Quantity	• The Hinton Pump Station is located within Athabasca River Watershed of the Athabasca River Basin. • No work will occur within 30 m of any waterbodies and, therefore, detailed information on surface water quality and quantity is not warranted as per Table A-1 of the NEB *Filing Manual*. • The terrain is reported sloping from west to east. Groundwater flow likely follows topography towards Maskuta Creek located approximately 280 m to the east-southeast. • The surficial geology beneath the site is mapped as moraine silty sand till (unsorted clay to bolder size material) (Roed 1970). • No water well records are noted at the facility site or within the Water Quality and Quantity LSA. • No water supply wells are mapped within the site boundary (AESRD 2013a). • The Hinton Pump Station does not overlie any mapped aquifers.
Air Emissions	• All existing pumps are electrically driven and are not direct sources of CACs. • Fugitive VOC emissions from leaks at the Hinton Pump Station are estimated to be 1.9 tonnes per year. • Air quality in the area surrounding the Hinton Pump Station is primarily influenced by anthropogenic sources including industrial sources in the pulp and paper, oil and gas, and forestry industries.

TABLE 6.1-5 Cont'd

Environmental Elements	Summary of Considerations
Greenhouse Gas Emissions	• Indirect GHG emissions due to electric power consumption by the existing pumps at the Hinton Pump Station are the main emissions. These include emissions from fossil fuel combustion, unallocated energy from power line losses, metering differences and other losses, and emissions of SF_6 from gas handling and transferring operations, electrical equipment operation, and from equipment mechanical failures. • Small amounts of direct GHG emissions will be released due to the space heating of the existing buildings at the Hinton Pump Station. • Small amounts of indirect GHG emissions will be released due to electricity use for equipment other than pumps. • Small amounts of GHG emissions will be released from the motor vehicles used by operations/maintenance staff.
Acoustic Environment	• Sources of existing sound in the Acoustic Environment LSA are traffic travelling along Highway 16 and natural sound (*e.g.*, wind, wildlife). • Receptors were identified within the Acoustic Environment LSA. The nearest receptor is located approximately 820 m to the southwest of the fenceline of the Hinton Pump Station. • ASL in the absence of regulated energy facilities ranges between 35-40 dBA at night and 45-50 dBA during the day based on AER *Directive 038* (ERCB 2007). • A measurement program to define sound emissions from the existing facility was conducted. • A noise model was generated based on existing conditions observed and measurements of the major on-site sources of sound. Specifications of equipment not operating during the site visit were used to estimate sound levels. Applicable buildings and shelters were modelled along with the appropriate insertion losses and screening effects. • The noise modelling results indicate that sound from the existing Hinton Pump Station complies with the AER *Directive 038* permissible sound levels for all surrounding receptors. • Contoured noise prediction results are available in the Terrestrial Noise and Vibration Technical Report of Volume 5C.
Fish and Fish Habitat	• The Hinton Pump Station is located within the Athabasca River Watershed of the Athabasca River Basin. • No work will occur within 30 m of any fish-bearing waterbodies and, therefore, detailed information on fish and fish habitat is not deemed warranted as per Table A-1 of the NEB *Filing Manual*.
Wetland Loss or Alteration	• The Hinton Pump Station is situated within the boundaries of the Western Alberta Upland Ecoregion of the Boreal Plains Ecozone. Marshes and bogs are common within this ecoregion (Ecological Stratification Working Group 1995). • The Hinton Pump Station is also located within the South Rocky Mountain Wetland Region. Wetlands characteristic of this region include flat bogs, horizontal fens, floodplain marshes with shallow basin marshes occurring in valleys and small basin fens and basin bogs occurring in alpine areas (Government of Canada 1986). • The Hinton Pump Station is located in the Montane Natural Subregion of the Rocky Mountain Natural Region. Wetlands characteristic of this natural subregion include treed fens with some bogs and open fens (Natural Regions Committee 2006b). • Wetlands provide habitat for native plants and wildlife species, including nesting and foraging habitat for bird species as well as provide storage and natural filtering of water. • A ground-based wetland survey was conducted on July 29, 2013 for the Hinton Pump Station. The 2013 wetland field survey confirmed that no wetlands are located within the Hinton Pump Station. An artificially-created dugout was identified within the pump station footprint expansion but determined not to be a naturally-occurring wetland. • There are no Ramsar Wetlands of International Importance (Bureau of the Convention on Wetlands 2013), IBAs (Bird Studies Canada and Nature Canada 2012), Western Hemisphere Shorebird Reserves (WHSRN 2013) or Migratory Bird Sanctuaries (Environment Canada 2013b) located within the Wetland LSA surrounding the Hinton Pump Station. • The Hinton Pump Station is located within a DUC Level 1 Priority Area, the Prairie Pothole Region and Western Boreal Forest (DUC 2013). • The Hinton Pump Station is not located within the 1,000 m setback of provincially identified colonial nesting bird waterbodies or the 800 m setback of provincially identified trumpeter swan waterbodies (AESRD 2010-2012).
Vegetation	• The Hinton Pump Station is situated within the boundaries of the Western Alberta Upland Ecoregion of the Boreal Plains Ecozone. It is characterized by mixed forests of lodgepole pine, white spruce, balsam poplar, trembling aspen and paper birch. Conifers are more prevalent at higher elevations in the foothills, while the lower plains section is dominated by aspen (Ecological Stratification Working Group 1995). • The Hinton Pump Station is located in the Montane Natural Subregion of the Rocky Mountain Natural Region. The Montane Natural Subregion is dominated by closed forests of lodgepole pine, Douglas-fir, trembling aspen and white spruce. Typical understory communities are dominated by shrubs and grasses. Deciduous forests occur on fluvial fans, terraces and floodplains. Open grasslands occur on dry and exposed sites and are dominated by various grasses (Natural Regions Committee 2006a). • There are no national parks, provincial parks, provincial recreation areas, Environmentally Significant Areas or other protected areas located within the Vegetation LSA near the Hinton Pump Station. • Records of rare plant observations within 5 km of the Hinton Pump Station were acquired from the ACIMS (2013) database. Three provincially-listed (ACIMS) record were found within the boundaries of the Vegetation LSA: *Brachythecium frigidum*; *Bryum algovicum*; and *Desmatodon heimii*. • A ground-based vegetation survey was conducted on August 15, 2013. Dominant communities observed during the 2013 vegetation survey consist of a regenerating forest of white spruce and balsam poplar, and a seeded area dominated by agronomic grasses. No rare plants or rare ecological communities were observed at the Hinton Pump Station during the 2013 vegetation survey.

TABLE 6.1-5 Cont'd

Environmental Elements	Summary of Considerations
Vegetation (cont'd)	• Consultation with local agricultural authorities was conducted to determine weed species of concern for the region. See Section 4.4 of the Vegetation Technical Report of Volume 5C for a summary of these communications. • During the 2013 vegetation survey, three Noxious weed species were observed: Canada thistle; ox-eye daisy; and perennial sow-thistle. No Prohibited Noxious weeds were observed.
Wildlife and Wildlife Habitat	• The Hinton Pump Station is located on industrial and forested lands. Dominant communities consist of a regenerating forest of white spruce and balsam poplar, and a seeded area dominated by agronomic grasses. • The Hinton Pump Station is not located within or adjacent to any Environmentally Significant Areas (ATPR 2009), provincial parks or protected areas (ATPR 2012), IBAs (Bird Studies Canada and Nature Canada 2012), Migratory Bird Sanctuaries (Environment Canada 2013b), National Wildlife Areas (Environment Canada 2013b), Western Hemisphere Shorebird Reserves (WHSRN 2013), Ramsar Wetlands of International Importance (Bureau of the Convention on Wetlands 2013), or World Biosphere Reserves (UNESCO 2013). • The Hinton Pump Station is located in a Special Access Area (AESRD 2013b). • The Hinton Pump Station is located in a secondary Grizzly Bear Zone (Grande Cache population unit) and is located approximately 45 m northwest of a core Grizzly Bear Zone (Yellowhead population unit) (AESRD 2013b). • An artificially-created dugout was identified within the pump station footprint expansion but was determined not to be a naturally-occurring wetland. • The Hinton Pump Station is located in a DUC Level 1 Priority Area, the Prairie Pothole Region and Western Boreal Forest (DUC 2013). • A national Environmentally Significant Area (No. 20) is located approximately 2 km southeast of the Hinton Pump Station (ATPR 2009). • The Wildhorse Lake Provincial Recreation Area is approximately 2 km west of the Hinton Pump Station (ATPR 2012). • The Hinton Pump Station is located in WMU 438 (AESRD 2012b). • Long-toed salamander larvae were identified in a wetland during field work conducted for wetlands on July 29, 2013. The wetland is located 30 m north of the Hinton Pump Station and will not be disturbed by the proposed expansion. Long-toed salamander were also recorded at the Hinton Pump Station during previous work completed in 2005 (TERA Westland 2005). • Long-toed salamander breeding ponds have a recommended year-round 200 m setback (Government of Alberta 2013). Given the location of the wetland in relation to the pump station, the setback cannot be adhered to and AESRD will be consulted to discuss mitigation for the long-toed salamander breeding pond. • A supplemental wildlife survey will be conducted (see Section 9.0).
Species at Risk or Species of Special Status and Related Habitat	• No work will occur within 30 m of any fish-bearing waterbodies and, therefore, detailed information on fish and fish species at risk is not deemed warranted as per Table A-1 of the NEB *Filing Manual*. • Records of rare plant observations within 5 km of the Hinton Pump Station were acquired from the ACIMS (2013) database. No federally-listed (*SARA* or COSEWIC) species records were found within these boundaries. • Based on known species range and habitat preferences, the following federally-listed (*SARA* Schedule 1 or COSEWIC) and/or provincially-listed (At Risk, May be at Risk, or under Alberta's *Wildlife Act* and *Wildlife Regulation*) wildlife species were identified as having the potential to occur in the vicinity of the Hinton Pump Station (ASRD 2010, AESRD 2012a, COSEWIC 2013, Environment Canada 2012): – barred owl (provincial: Sensitive; Alberta Endangered Species Conservation Committee [ESCC]: Special Concern); – common nighthawk (*SARA*: Threatened, COSEWIC: Threatened, provincial: Sensitive); – olive-sided flycatcher (*SARA*: Threatened, COSEWIC: Threatened, provincial: May Be At Risk); – grizzly bear (*SARA*: no status, COSEWIC: Special Concern, provincial: At Risk, Alberta *Wildlife Act* and *Wildlife Regulation:* Threatened); – little brown myotis (COSEWIC: Endangered, provincial: Secure); – northern myotis (COSEWIC: Endangered, provincial: May be at Risk); – long-toed salamander (provincial: Sensitive, Alberta ESCC: Special Concern); and – western toad (*SARA*: Special Concern, COSEWIC: Special Concern, provincial: Sensitive). • A search of the AESRD FWMIS database identified the following federally-listed (*SARA* Schedule 1 or COSEWIC) and/or provincially-listed (At Risk, May be at Risk, or under Alberta's *Wildlife Act* and *Wildlife Regulation*) wildlife species within 2 km of the Hinton Pump Station (AESRD 2013c): – grizzly bear (*SARA*: no status, COSEWIC: Special Concern, provincial: At Risk, Alberta *Wildlife Act* and *Wildlife Regulation:* Threatened); – long-toed salamander (provincial: Sensitive, Alberta ESCC: Special Concern); and – western toad (*SARA*: Special Concern, COSEWIC: Special Concern, provincial: Sensitive). • A supplemental survey will be conducted (see Section 9.0).

6.1.6 Jasper Pump Station

The existing Jasper Pump Station is located at NW 2-46-1 W6M. This facility is located on lands leased by Trans Mountain in the Jasper National Park Region and within the boundary of the Municipality of Jasper. Current land use at and around this facility site is primarily industrial and forested. No disturbance of previously undisturbed lands is proposed at the Jasper Pump Station; all activities are confined to the existing station boundaries. Two existing 2,500 HP pump units at the Jasper Pump Station will be relocated within the station. Access to the Jasper Pump Station is via Highway 16. Table 6.1-6 provides a summary of the environmental elements and considerations for the Jasper Pump Station pursuant to Guide A.2.4 and Table A-2 of the NEB *Filing Manual*. The location of the Jasper Pump Station is shown on Figure 6.1-6.

TRANS MOUNTAIN

FIGURE 6.1-6

JASPER PUMP STATION

TRANS MOUNTAIN EXPANSION PROJECT

- Kilometre Post (KP)
- Trans Mountain Pipeline (TMPL)
- Subject Property Facility Boundary
- Highway
- Paved Road
- Railway
- National / Provincial Park

Projection: NAD 1983 UTM Zone 11N. Routing: Baseline TMPL & Facilities: provided by KMC 2012; Proposed Pipeline Corridor V6: provided by UPI Aug. 23, 2013;Transportation: IHS Inc., 2013, Natural Resources Canada, 2011; Geopolitical Boundaries: Natural Resources Canada, 2003, Altalis, 2012, IHS Inc., 2011, ESRI, 2005; First Nation Lands: Government of Canada, 2013; Parks and Protected Areas: Natural Resources Canada, 2013, Altalis, 2013, Alberta Tourism, Parks and Recreation, 2012, BC FLNRO, 2008.

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TABLE 6.1-6

SUMMARY OF ENVIRONMENTAL ELEMENTS AND CONSIDERATIONS FOR THE JASPER PUMP STATION

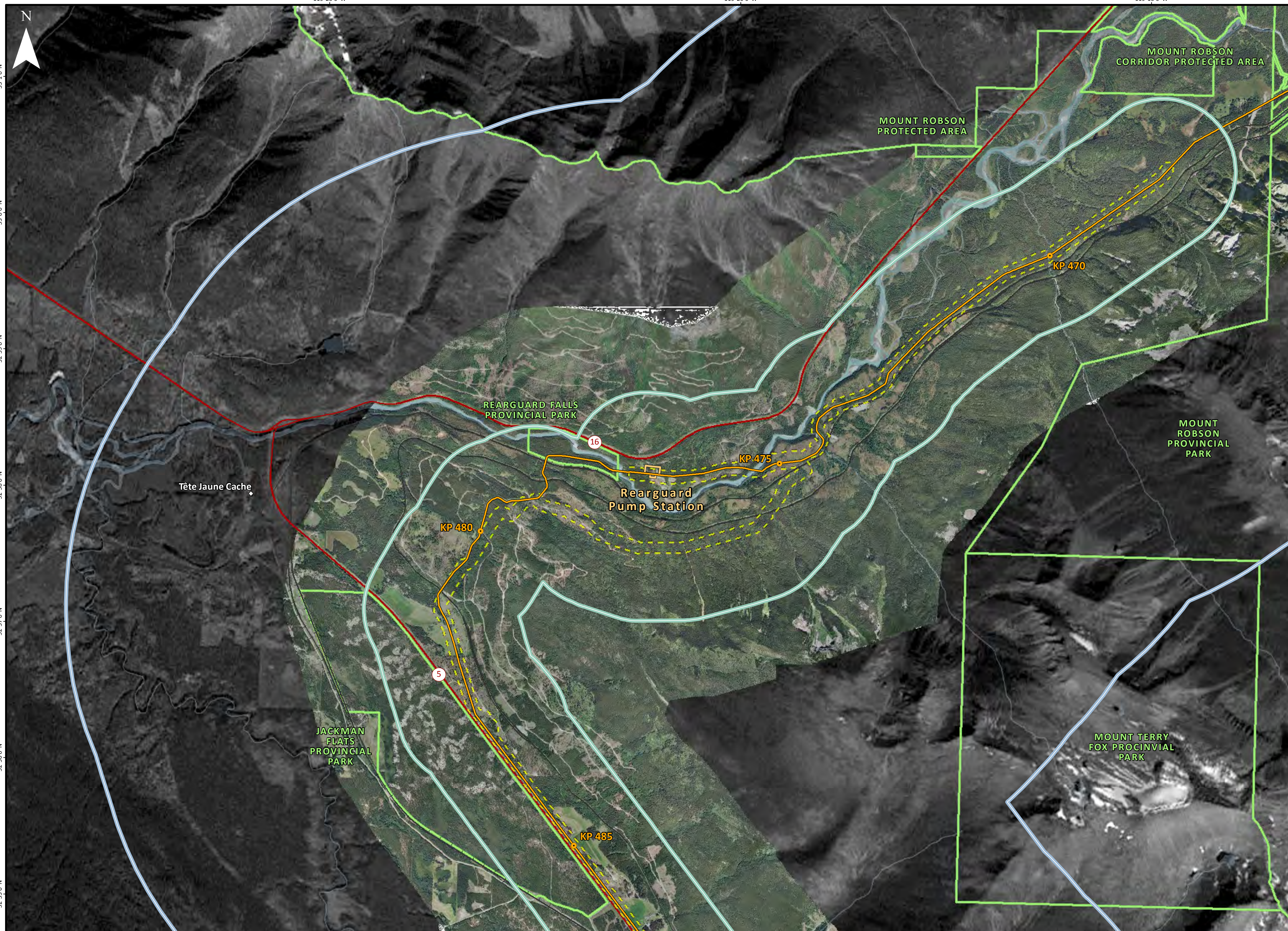
Environmental Elements	Summary of Considerations
Physical and Meteorological Environment	• The Jasper Pump Station is located within the Rocky Mountains Physiographic Region (Natural Regions Committee 2006a, Pettapiece 1986). • The Jasper Pump Station is underlain by the Fairholme Group, and Sassenach, Palliser and Banff Formations, which consist of dolomite, limestone, shale, sandstone and siltstone (Hamilton *et al.* 1999). • The surficial geology beneath the site is mapped as glaciofluvial deposits (Holland and Coen 1983). • There are no areas of permafrost within the area of Jasper Pump Station (refer to Section 5.1.1). • No areas of potential terrain instability are known to occur in the vicinity of the Jasper Pump Station. • The site is located in a zone of low seismic activity (NRCan 2010a). Peak ground acceleration with a 1:2475 annual probability of exceedance is between 0.1 and 0.2 g (NRCan 2013a). No earthquakes have been recorded in the vicinity of the pump station (NRCan 2013b). • The topography in the area of the Jasper Pump Station is relatively flat and the elevation is approximately 1,340 m above sea level. • Where activities are planned within the Jasper Pump Station, soils have been disturbed for industrial use and construction of the new infrastructure will be conducted within the boundaries of the existing station. Wind erosion risk for unprotected soils in the vicinity of the Jasper Pump Station is considered negligible and unrated by NRCan (NRCan 2010d). • A description of the climate for the Montane Natural Subregion is provided in Section 5.1.1. • Meteorological data were obtained from an Environment Canada meteorological station (3053520) in Jasper, Alberta (Environment Canada 2013a). The data was taken approximately 8 km south-southwest of Jasper Pump Station and is provided in Table 6.1-5. • No major tornadoes or hailstorms have been recorded in the vicinity of Jasper Pump Station (NRCan 2010b,c).
Soil and Soil Productivity	• Activities at the Jasper Pump Station will be conducted within an existing fenced, industrial site lacking topsoil and, therefore, detailed soil information is not warranted as per Table A-2 of the NEB *Filing Manual*. • The CLI has not rated the soils in the vicinity of the Jasper Pump Station. • Historical spills have been recorded at the Jasper Pump Station. Ongoing monitoring is being conducted by operations. Soils to be disturbed will be tested prior to construction. If contamination is encountered, the Contamination Discovery Contingency Plan (Appendix B of the Facilities EPP of Volume 6C) will be implemented. • Potential soil contaminants of concern include gasoline, diesel fuel, lubricants, hydraulic fuels and methyl tertiary butyl ether (MTBE).
Water Quality and Quantity	• The Jasper Pump Station is located within the Athabasca River Basin. • No work will occur within 30 m of any waterbodies and, therefore, detailed information on surface water quality and quantity is not warranted as per Table A-1 of the NEB *Filing Manual*. • Land use in the area is noted as industrial. The terrain is reported as sloping slightly from west to east. • Groundwater flow likely follows topography towards the Athabasca River located approximately 500 m to the east. • The surficial geology beneath the site is mapped as glaciofluvial deposits (Holland and Coen 1983). • Four water well records occur near the site and within the Water Quantity and Quality LSA; these indicate groundwater depths of 5-28 m bgl. • One water supply well (possibly ID #442074) owned by ATCO Electric Ltd. is located within the Water Quality and Quantity LSA (AESRD 2013a) withdrawing water from 37 m bgl. • The Jasper Pump Station does not overlie any mapped aquifers. • According to O'Rourke (2000), there is historical contamination from a spill of 1,200 L Jet B fuel from underground storage tank at the Jasper Pump Station in 1992 and a release of petroleum containing MTBE in 1995 resulting in apparent contamination of an ATCO well. MTBE was noted in an off-site well in 1999 (O'Rourke 2000). Remediation is ongoing and, as of 2012, MTBE concentrations were less than the detection limit in the ATCO water well (WNM Environmental 2012).
Air Emissions	• All existing pumps are electrically driven and are not direct sources of CACs. • Fugitive VOC emissions from leaks at the Jasper Pump Station are estimated to be 1.8 tonnes per year. • Air quality in the area surrounding the Jasper Pump Station is expected to be mostly influenced by vehicle traffic emissions along Highway 16, the Jasper Airport and a nearby power generation plant.
Greenhouse Gas Emissions	• Indirect GHG emissions due to electric power consumption by the existing pumps at the Jasper Pump Station are the main emissions. These include emissions from fossil fuel combustion, unallocated energy from power line losses, metering differences and other losses, and emissions of SF_6 from gas handling and transferring operations, electrical equipment operation, and from equipment mechanical failures. • Small amounts of direct GHG emissions will be released due to the space heating of the existing buildings at the Jasper Pump Station. • Small amounts of indirect GHG emissions will be released due to electricity use for equipment other than pumps. • Small amounts of GHG emissions will be released from the motor vehicles used by operations/maintenance staff.
Acoustic Environment	• No increase in sound emissions is expected from the Project at the Jasper Pump Station during operations and, therefore, detailed information on sound emissions is not warranted as per Table A-1 of the NEB *Filing Manual*.

TABLE 6.1-6 Cont'd

Environmental Elements	Summary of Considerations
Fish and Fish Habitat	• The Jasper Pump Station is located within the Athabasca River Basin. • No work will occur within 30 m of any fish-bearing waterbodies and, therefore, detailed information on fish and fish habitat is not warranted as per Table A-1 of the NEB *Filing Manual*.
Wetland Loss or Alteration	• The Jasper Pump Station is situated within the boundaries of the Western Alberta Upland Ecoregion of the Boreal Plains Ecozone. Marshes and bogs are common within this ecoregion (Ecological Stratification Working Group 1995). • The Jasper Pump Station is also located within the South Rocky Mountain Wetland Region. Wetlands characteristic of this region include flat bogs, horizontal fens, floodplain marshes with shallow basin marshes occurring in valleys and small basin fens and basin bogs occurring in alpine areas (Government of Canada 1986). • The Jasper Pump Station is located in the Montane Natural Subregion of the Rocky Mountain Natural Region. Wetlands characteristic of this natural subregion include treed fens with some bogs and open fens (Natural Regions Committee 2006b). • Wetlands provide habitat for native plants and wildlife species, including nesting and foraging habitat for bird species as well as provide storage and natural filtering of water. • No wetlands were identified within or adjacent to the Jasper Pump Station during the helicopter reconnaissance and satellite imagery review. As a result, a ground-based wetland survey was determined not to be required. • There are no Ramsar Wetlands of International Importance (Bureau of the Convention on Wetlands 2013), IBAs (Bird Studies Canada and Nature Canada 2012), Western Hemisphere Shorebird Reserves (WHSRN 2013), Migratory Bird Sanctuaries (Environment Canada 2013b) or DUC Priority Areas (DUC 2013) located within the Wetland LSA surrounding the Jasper Pump Station.
Vegetation	• The Jasper Pump Station is situated within the boundaries of the Western Alberta Upland Ecoregion of the Boreal Plains Ecozone. It is characterized by mixed forests of lodgepole pine, white spruce, balsam poplar, trembling aspen and paper birch. Conifers are more prevalent at higher elevations in the foothills, while the lower plains section is dominated by aspen (Ecological Stratification Working Group 1995). • The Jasper Pump Station is located in the Montane Natural Subregion of the Rocky Mountain Natural Region. The Montane Natural Subregion is dominated by closed forests of lodgepole pine, Douglas-fir, trembling aspen and white spruce. Typical understory communities are dominated by shrubs and grasses. Deciduous forests occur on fluvial fans, terraces and floodplains. Open grasslands occur on dry and exposed sites and are dominated by various grasses (Natural Regions Committee 2006a). • The Jasper Pump Station is located in Jasper National Park (ATPR 2012). • The Jasper Pump Station is located in an international Environmentally Significant Area (No. 23) (ATPR 2009). • Records of rare plant observations within 5 km of the Jasper Pump Station were acquired from the ACIMS (2013) database. Eleven provincially-listed (ACIMS) species record were found within the boundaries of the Vegetation LSA: *Cirriphyllum cirrosum*; Crawe's sedge; *Didymodon nigrescens*; *Geranium erianthum*; *Hygrohypnum smithii*; lens-fruited sedge; *Lophozia excisa*; *Myriospora heppii*; *Orthotrichum affine*; red leaf moss; and short-beaked rigid screw moss. • It was determined with satellite imagery interpretation that no native vegetation would be directly disturbed within the site boundaries and, therefore, a ground-based vegetation survey was deemed unnecessary. • Consultation with local agricultural authorities was conducted to determine weed species of concern for the region. See Section 4.4 of the Vegetation Technical Report of Volume 5C for a summary of these communications.
Wildlife and Wildlife Habitat	• The Jasper Pump Station is located adjacent to an existing pump house and valve assembly on industrial lands. The existing access and power supply is sufficient for Project needs. All work will occur within the existing fenced area and no native vegetation would be directly disturbed within the site boundaries. • The Jasper Pump Station is located in Jasper National Park (ATPR 2012). • The Jasper Pump Station is located in an international Environmentally Significant Area (No. 23) (ATPR 2009).
Species at Risk or Species of Special Status and Related Habitat	• No work will occur within 30 m of any fish-bearing waterbodies and, therefore, detailed information on fish and fish species at risk is not deemed warranted as per Table A-1 of the NEB *Filing Manual*. • Records of rare plant observations within 5 km of the Jasper Pump Station were acquired from the ACIMS (2013) database. No federally-listed (*SARA* or COSEWIC) species records were found within these boundaries. • A search of the AESRD FWMIS database identified the following federally-listed (*SARA* Schedule 1 or COSEWIC) and/or provincially-listed (At Risk, May be at Risk, or under Alberta's *Wildlife Act* and *Wildlife Regulation*) wildlife species within 2 km of the Jasper Pump Station (AESRD 2013c): – western toad (*SARA*: Special Concern, COSEWIC: Special Concern, provincial: Sensitive). • Given that the Jasper Pump Station is an existing facility and all work will occur within the existing fenced area on previously disturbed land, the Jasper Pump Station is not considered suitable habitat for wildlife or plant species at risk.

6.1.7 Rearguard Pump Station

The existing Rearguard Pump Station is located at d-068-K/083-D-14 at RK 498.3 on lands owned by Trans Mountain in the Regional District of Fraser-Fort George (RDFFG). The expansion of the Rearguard Pump Station will require the acquisition of approximately 0.7 ha of new Crown land adjacent to and to the east of existing Trans Mountain lands. Two 5,000 HP pump units will be added at the site. The existing access road to the Rearguard Pump Station will be modified for the Project. Table 6.1-7 provides a summary of the environmental elements and considerations for the Rearguard Pump Station pursuant to Guide A.2.4 and Table A-2 of the NEB *Filing Manual*. The location of the Rearguard Pump Station is shown on Figure 6.1-7.



TRANS MOUNTAIN

FIGURE 6.1-7

REARGUARD PUMP STATION

TRANS MOUNTAIN EXPANSION PROJECT

- Kilometre Post (KP)
- Hamlet / Village / Community
- Trans Mountain Pipeline (TMPL)
- Trans Mountain Expansion Project Proposed Pipeline Corridor
- Subject Property Facility Boundary
- Acoustic Environment RSA
- Vegetation RSA Boundary
- Highway
- Paved Road
- Railway
- National / Provincial Park

Projection: NAD 1983 UTM Zone 11N. Routing: Baseline TMPL & Facilities: provided by KMC 2012; Proposed Pipeline COrridor V6: provided by UPI Aug. 23, 2013; Transportation: IHS Inc., 2013, Natural Resources Canada, 2011; Geopolitical Boundaries: Natural Resources Canada, 2003, Altalis, 2012, IHS Inc., 2011, ESRI, 2005; First Nation Lands: Government of Canada, 2013; Parks and Protected Areas: Natural Resources Canada, 2013, Altalis, 2013, Alberta Tourism, Parks and Recreation, 2012, BC FLNRO, 2008.

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ALL LOCATIONS APPROXIMATE

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TABLE 6.1-7

SUMMARY OF ENVIRONMENTAL ELEMENTS AND CONSIDERATIONS FOR THE REARGUARD PUMP STATION

Environmental Elements	Summary of Considerations
Physical and Meteorological Environment	• The Rearguard Pump Station is located within the Rocky Mountains Physiographic Region, which is characterized by structurally-controlled moderately wide valleys surrounded by rugged alpine mountains featuring relict glacial landforms (Holland 1976). • The Rearguard Pump Station is underlain by the Middle Member of the Miette Group (Journeay *et al.* 2000a, Murphy 2007). This unit is composed of massive to graded, thick bedded, feldspathic, turbitic sandstones and conglomeratic sandstones (Glass 1990). • The surficial geology beneath the site is mapped as predominantly glaciofluvial and lacustrine sediments (BGC Engineering Inc. 2013a). • There are no areas of permafrost within the area of the Rearguard Pump Station (refer to Section 5.1.1). • No areas of potential terrain instability are known to occur in the vicinity of the Rearguard Pump Station. • No volcanoes (NRCan 2010e) have been recorded in the vicinity of the Rearguard Pump Station. • The site is located in a zone of low seismic activity (NRCan 2010a). Peak ground acceleration with a 1:2475 annual probability of exceedance is between 0.1 and 0.2 g (NRCan 2013a). The site is located near suspected post-glacial faults within the Rocky Mountain trench (BGC Engineering Inc. 2013b). The historical earthquake record shows clusters of small to moderate (up to magnitude 6) earthquakes. The largest of these include a magnitude 6 earthquake near Valemount in 1918 and a magnitude 5.6 earthquake near Prince George in 1986 (Halchuk 2009, Lamontagne *et al.* 2007). Refer to the Seismic Assessment Desktop Study of Volume 4A for additional information. • The topography in the area of the Rearguard Pump Station is relatively flat and the elevation is approximately 810 m above sea level. • Activities are planned within the Rearguard Pump Station at industrial and disturbed forested areas and require approximately 0.7 ha of new land outside existing Trans Mountain lands to the east. Wind erosion risk for unprotected soils in the vicinity of the Rearguard Pump Station is considered negligible and unrated by NRCan (NRCan 2010d). • A description of the climate for the Sub-Boreal Spruce (SBS) Biogeoclimatic (BGC) Zone is provided in Section 5.1.2. • Meteorological data from Environment Canada's Blue River Airport Station, located approximately 100 km south of Rearguard Pump Station, are provided in Section 5.1.2. • No major tornadoes or hailstorms have been recorded in the vicinity of Rearguard Pump Station (NRCan 2010b,c).
Soil and Soil Productivity	• Project activities will cause some disturbance to soil outside of the existing fenceline of the Rearguard Pump Station to the east. The current Rearguard Pump Station has been previously disturbed and contains pumps, buildings and other equipment. • A soil survey at the Rearguard Pump Station was conducted in 2005 for the Trans Mountain Pump Station Expansion Project. Well to rapidly-drained Eluviated Eutric Brunisols developed on gravelly sandy loam or gravelly loam textured glaciofluvial material (Rearguard soils) occurs throughout the site. These soils are highly disturbed south of the existing pipeline. Rearguard soils are highly susceptible to wind erosion (Mentiga 2005b). • Soil capability for agriculture is generally low (Classes 5 and 6) due to climatic and soil texture limitations as based on the BC Land Inventory (1973). • No contamination is anticipated at the Rearguard Pump Station. If any contamination is encountered during construction, the Contamination Discovery Contingency Plan (Appendix B of the Facilities EPP of Volume 6C) will be implemented.
Water Quality and Quantity	• The Rearguard Pump Station is located in the Upper Fraser River Watershed of the Fraser River Basin. • No work will occur within 30 m of any waterbodies and, therefore, detailed information on surface water quality and quantity is not warranted as per Table A-1 of the NEB *Filing Manual*. • The terrain is reported to be generally level. Groundwater flow likely follows topography southwest towards the Fraser River. • The surficial geology beneath the site is mapped as predominantly Glaciofluvial and lacustrine sediments (BGC Engineering 2013a). • No water supply wells are mapped within the site boundary or within the surrounding Water Quality and Quantity LSA (BC Ministry of Environment [MOE] 2013a). • Groundwater levels in the area are expected to be moderately deep based on water well records identified east and west of the station. • The Rearguard Pump Station does not overlie any mapped aquifers (BC MOE 2013a).
Air Emissions	• All existing pumps are electrically driven and are not direct sources of CACs. • Fugitive VOC emissions from leaks at the Rearguard Pump Station are estimated to be 1.7 tonnes per year. • Air quality in the area surrounding the Rearguard Pump Station is expected to be mostly vehicle traffic emissions along Highway 16 and Highway 5 and a nearby wood product facility.

TABLE 6.1-7 Cont'd

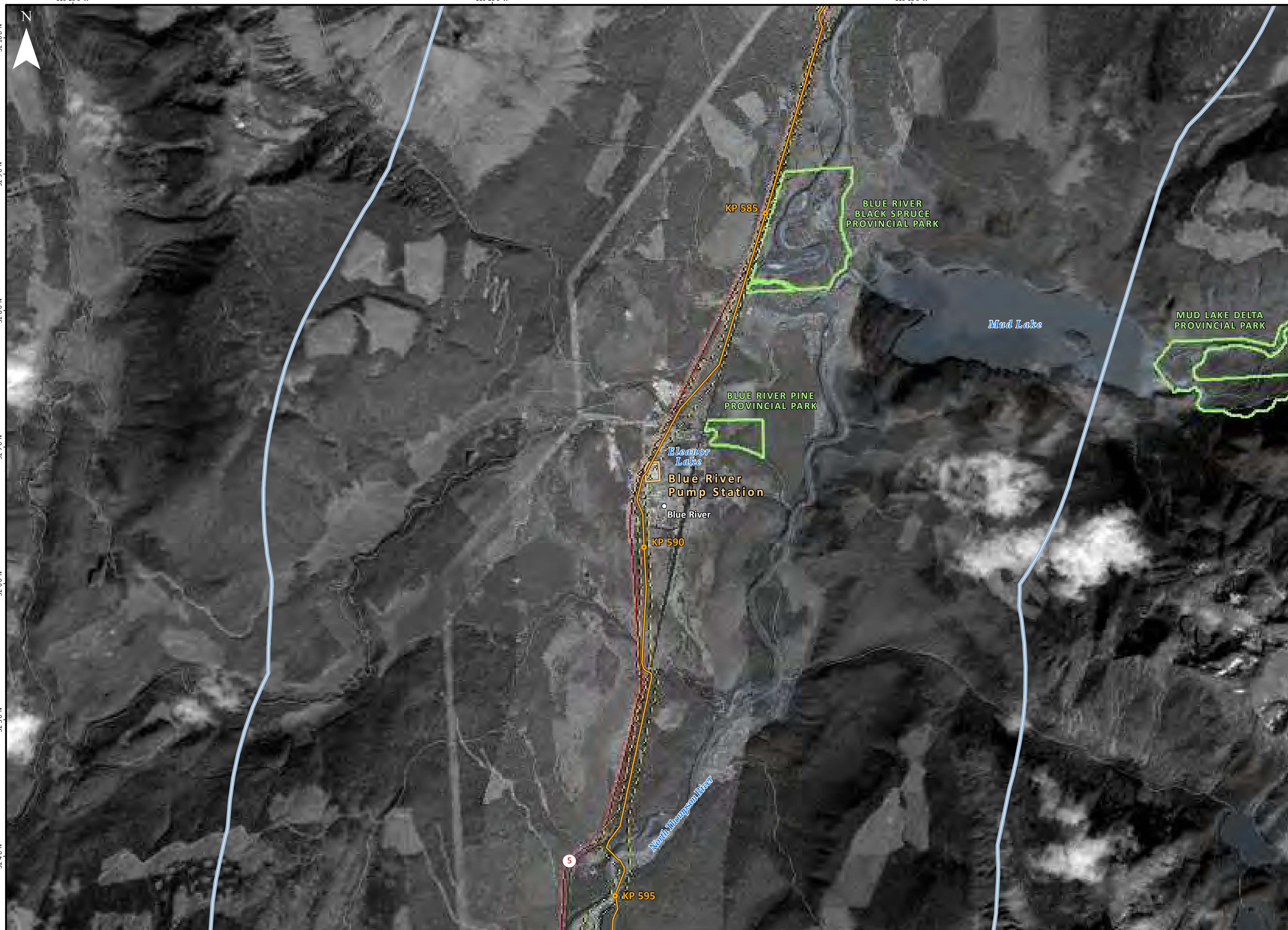
Environmental Elements	Summary of Considerations
Greenhouse Gas Emissions	• Indirect GHG emissions due to electric power consumption by the existing pumps at the Rearguard Pump Station are the main emissions. These include emissions from fossil fuel combustion, unallocated energy from power line losses, metering differences and other losses, and emissions of SF_6 from gas handling and transferring operations, electrical equipment operation, and from equipment mechanical failures. • Small amounts of direct GHG emissions will be released due to the space heating of the existing buildings at the Rearguard Pump Station. • Small amounts of indirect GHG emissions will be released due to electricity use for equipment other than pumps. • Small amounts of GHG emissions will be released from the motor vehicles used by operations/maintenance staff.
Acoustic Environment	• Sources of existing sound in the Acoustic Environment LSA are traffic travelling along Highway 16, Highway 5, surrounding arterial roadways and natural sound (*e.g.*, wind, wildlife). • No receptors were identified within the Acoustic Environment LSA. The 1.5 km LSA boundary will be used for compliance assessment. • ASL in the absence of regulated energy facilities ranges between 35-40 dBA at night and 45-50 dBA during the day based on BC Oil and Gas Commission (OGC) *Noise Control Best Practices Guideline* (BC OGC 2009). • A measurement program to define sound emissions from the existing facility was conducted. • A noise model was generated based on existing conditions observed and measurements of the major on-site sources of sound. Specifications of equipment not operating during the site visit were used to estimate sound levels. Applicable buildings and shelters were modelled along with the appropriate insertion losses and screening effects. • The noise modelling results indicate that sound from the existing Rearguard Pump Station complies with the BC OGC *Noise Control Best Practices Guideline* permissible sound levels for all surrounding receptors. • Contoured noise prediction results are available in the Terrestrial Noise and Vibration Technical Report of Volume 5C.
Fish and Fish Habitat	• The Rearguard Pump Station is located in the Upper Fraser River Watershed of the Fraser River Basin. • No work will occur within 30 m of any fish-bearing waterbodies and, therefore, detailed information on fish and fish habitat is not deemed warranted as per Table A-1 of the NEB *Filing Manual*.
Wetland Loss or Alteration	• The Rearguard Pump Station is situated within the boundaries of the Eastern Continental Ranges Ecoregion of the Montane Cordillera Ecozone. Wetlands in this ecoregion tend to be restricted to mountain slopes where non-forested bogs, marshes and swamps occur (Ecological Stratification Working Group 1995). • The Rearguard Pump Station is also located within the South Rocky Mountain Wetland Region. Wetlands characteristic of this region include flat bogs, horizontal fens, floodplain marshes with shallow basin marshes occurring in valleys and small basin fens and basin bogs occurring in alpine areas (Government of Canada 1986). • The Rearguard Pump Station is located within the SBS BGC Zone of BC. In this BGC Zone, wetlands are common and consist of marshes, shrub and treed fens, and swamps with the occasional bog (BC Ministry of Forests [MOF] 1998a, Meidinger and Pojar 1991). • Wetlands provide habitat for native plants and wildlife species, including nesting and foraging habitat for bird species as well as provide storage and natural filtering of water. • No wetlands were identified within or adjacent to the Rearguard Pump Station during the helicopter reconnaissance and satellite imagery review. As a result, a ground-based wetland survey was determined not to be required. • There are no Ramsar Wetlands of International Importance (Bureau of the Convention on Wetlands 2013), IBAs (Bird Studies Canada and Nature Canada 2012), Western Hemisphere Shorebird Reserves (WHSRN 2013), Migratory Bird Sanctuaries (Environment Canada 2013b) or DUC Priority Areas (DUC 2013) located within the Wetland LSA surrounding the Rearguard Pump Station.
Vegetation	• The Rearguard Pump Station is situated within the boundaries of the Eastern Continental Ranges Ecoregion of the Montane Cordillera Ecozone. This ecoregion is characterized by coniferous forests of lodgepole pine, Engelmann spruce and alpine fir. In the warmest and driest areas of this Ecoregion, stands of Douglas-fir intermixed with trembling aspen and grasslands are common, while in cooler areas, open stands of alpine fir are found. The alpine vegetation is characterized by dwarf shrubs with sedges and herbs occurring on warmer sites (Ecological Stratification Working Group 1995). • The Rearguard Pump Station is located within the SBS BGC Zone of BC which is dominated by upland coniferous forests of subalpine fir and hybrid white spruce. Lodgepole pine, trembling aspen, paper birch, Douglas-fir and black spruce are also dominant forest species (BC MOF 1998a, Meidinger and Pojar 1991). • Rearguard Falls Provincial Park is located within the Vegetation LSA, approximately 0.5 km from the Rearguard Pump Station. • Records of rare plant observations within 5 km of the Rearguard Pump Station were acquired from the BC Conservation Data Centre (BC CDC) (2013) database. No provincially-listed (BC CDC) species records were found within the boundaries of the Vegetation LSA. • The proposed expansion at the Rearguard Pump Station is assumed to be on native vegetation based upon a review of satellite imagery and the professional judgement of the vegetation team. Mitigation contained in the Facilities EPP of Volume 6C is considered adequate for expected conditions and a supplemental vegetation survey conducted prior to construction will confirm the predictions of potential effects on the native vegetation in this area. • Consultation with local agricultural authorities was conducted to determine weed species of concern for the region. See Section 4.4 of the Vegetation Technical Report of Volume 5C for a summary of these communications.

TABLE 6.1-7 Cont'd

Environmental Elements	Summary of Considerations
Wildlife and Wildlife Habitat	• The Rearguard Pump Station lies within the Robson Valley Land and Resource Management Plan (LRMP) region (BC Ministry of Forests, Lands and Natural Resource Operations [MFLNRO] 2008a). • The Rearguard Pump Station is located on industrial and disturbed forested lands. Activities at the Rearguard Pump Station will occur on previously cleared and disturbed land. • The Rearguard Pump Station is not located within or adjacent to any provincial parks or protected areas (BC MFLNRO 2008b), IBAs (Bird Studies Canada and Nature Canada 2012), Migratory Bird Sanctuaries (Environment Canada 2013b), National Wildlife Areas (Environment Canada 2013b), Western Hemisphere Shorebird Reserves (WHSRN 2013), Ramsar Wetlands of International Importance (Bureau of the Convention on Wetlands 2013), World Biosphere Reserves (UNESCO 2013), designated caribou range (BC MOE 2008), ungulate winter range (BC MOE 2005a), or Wildlife Habitat Areas (BC MOE 2005b). • The Rearguard Pump Station is not in a DUC Priority Area (DUC 2013). • Rearguard Falls Provincial Park is approximately 0.5 km from the Rearguard Pump Station (BC MFLNRO 2008b). • The Rearguard Pump Station is located in WMU 7-3 (BC Integrated Land Management Bureau [ILMB] 2006).
Species at Risk or Species of Special Status and Related Habitat	• No work will occur within 30 m of any fish-bearing waterbodies and, therefore, detailed information on fish and fish species at risk is not deemed warranted as per Table A-1 of the NEB *Filing Manual*. • Records of rare plant observations within 5 km of the Rearguard Pump Station were acquired from the BC CDC (2013) database. No federally-listed (*SARA* or COSEWIC) species records were found within these boundaries. • Based on known species range and habitat preferences, the following federally-listed (*SARA* Schedule 1 or COSEWIC) or provincially-listed (Red, Blue, or under BC's *Wildlife Act*) wildlife species were identified as having the potential to occur in the vicinity of the Rearguard Pump Station (BC MOE 2013b, COSEWIC 2013, Environment Canada 2012): – barn swallow (COSEWIC: Threatened, provincial: Blue); – common nighthawk (*SARA*: Threatened, COSEWIC: Threatened, provincial: Yellow); – olive-sided flycatcher (*SARA*: Threatened, COSEWIC: Threatened, provincial: Blue); – fisher (provincial: Blue); – grizzly bear (COSEWIC: Special Concern, provincial: Blue); – little brown myotis (COSEWIC: Endangered, provincial: Yellow); – northern myotis (COSEWIC: Endangered, provincial: Blue); and – wolverine (*luscus* subspecies) (COSEWIC: Special Concern, provincial: S3, Blue, Priority 2). • A search of the BC CDC database did not identify any federally-listed (*SARA* Schedule 1 or COSEWIC) or provincially-listed (Red, Blue, or under BC's *Wildlife Act*) wildlife species within 2 km of the Rearguard Pump Station (BC CDC 2012, 2013). • Given that the Rearguard Pump Station is an existing facility and that any expansion will occur onto previously-cleared and disturbed land, the Rearguard Pump Station is not considered suitable habitat for wildlife species at risk.

6.1.8 Blue River Pump Station

The existing Blue River Pump Station is located at a-035-F/083-D-03 at RK 614.7 on lands owned by Trans Mountain in the Thompson-Nicola Regional District (TNRD). Current land use at and around this facility site is industrial. All work will be conducted within the existing disturbed fenced area and no native vegetation would be directly disturbed within the site boundaries. No disturbance of previously undisturbed lands is proposed at the Blue River Pump Station. Three new 5,000 HP pump units will be added and the existing pump building at the Blue River Pump Station will be deactivated. Access to the Blue River Pump Station is via Highway 5. Table 6.1-8 provides a summary of the environmental elements and considerations for the Blue River Pump Station pursuant to Guide A.2.4 and Table A-2 of the NEB *Filing Manual*. The location of the Blue River Pump Station is shown on Figure 6.1-8.



TRANS MOUNTAIN

FIGURE 6.1-8

BLUE RIVER PUMP STATION

TRANS MOUNTAIN EXPANSION PROJECT

Kilometre Post (KP)

Hamlet / Village / Community

Trans Mountain Pipeline (TMPL)

Trans Mountain Expansion Project Proposed Pipeline Corridor

Subject Property Facility Boundary

Acoustic Environment RSA

Highway

Paved Road

Railway

National / Provincial Park

Projection: NAD 1983 UTM Zone 10N. Routing: Baseline TMPL & Facilities: provided by KMC 2012; Proposed Pipeline Corridor V6: provided by UPI Aug. 23, 2013; Transportation: IHS Inc., 2013, Natural Resources Canada, 2011; Geopolitical Boundaries: Natural Resources Canada, 2003, Altalis, 2012, IHS Inc., 2011, ESRI, 2005; First Nation Lands: Government of Canada, 2013; Parks and Protected Areas: Natural Resources Canada, 2013, Altalis, 2013, Alberta Tourism, Parks and Recreation, 2012, BC FLNRO, 2008.

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Although there is no reason to believe that there are any errors associated with the data used to generate this product or in the product itself, users of these data are advised that errors in the data may be present.

MAP NUMBER		PAGE
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ALL LOCATIONS APPROXIMATE

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TABLE 6.1-8

SUMMARY OF ENVIRONMENTAL ELEMENTS AND CONSIDERATIONS FOR THE BLUE RIVER PUMP STATION

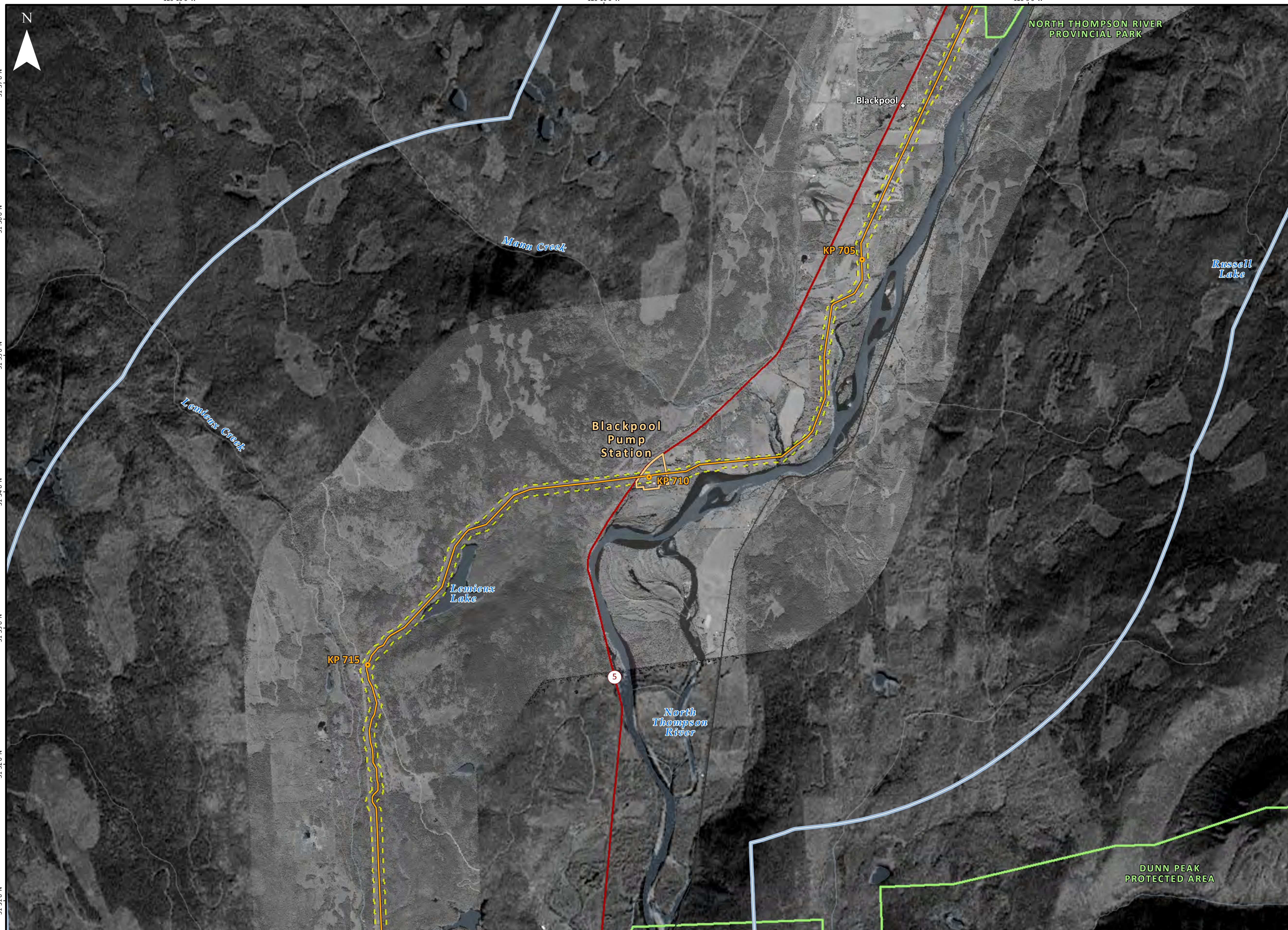
Environmental Elements	Summary of Considerations
Physical and Meteorological Environment	• The Blue River Pump Station is located within the Columbia Mountains Physiographic Region, which is characterized by wide U-shaped main valleys, narrow hanging steeply incised tributary valleys, rugged alpine ranges, fluvial terraces, fan and relict glacial landforms (Demarchi 2011, Holland 1976). • The Blue River Pump Station is predominantly underlain by gneisses and other metamorphic rocks (Journeay *et al.* 2000a, Murphy 2007). • The surficial geology beneath the site is mapped as predominantly fluvial (Tipper 1971). • There are no areas of permafrost within the area of the Blue River Pump Station (refer to Section 5.1.1). • No areas of potential terrain instability are known to occur in the vicinity of the Blue River Pump Station. • No volcanoes (NRCan 2010e) have been recorded in the vicinity of the Blue River Pump Station. • The site is located in a zone of low seismic activity (NRCan 2010a). Peak ground acceleration with a 1:2475 annual probability of exceedance is between 0.1 and 0.2 g (NRCan 2013a). Several minor earthquakes (magnitude 3) have been recorded in the area (NRCan 2013b). • The topography in the area of Blue River Pump Station is flat and the elevation is approximately 690 m above sea level. • Where activities are planned within Blue River Pump Station, soils have been disturbed for industrial use and construction of the new infrastructure will be conducted within the boundaries of the existing station. Wind erosion risk for unprotected soils in the vicinity of Blue River Pump Station is considered negligible and unrated by NRCan (NRCan 2010d). • A description of the climate for the Interior Cedar-Hemlock (ICH) BGC Zone is provided in Section 5.1.2. • Meteorological data from Environment Canada's Blue River Airport Station, located approximately 1 km northeast of Blue River Pump Station, are provided in Section 5.1.2. • No major tornadoes or hailstorms have been recorded in the vicinity of Blue River Pump Station (NRCan 2010b,c).
Soil and Soil Productivity	• Activities at the Blue River Pump Station will be conducted within an existing fenced, industrial site lacking topsoil and, therefore, detailed soil information is not warranted as per Table A-2 of the NEB *Filing Manual*. • The general area is dominated by Humo-Ferric Podzolic soils. This soil type is characterized by coarse to moderately-coarse textured, very permeable glacial till or colluvium derived mainly from igneous and metamorphic rocks such as granodiorites, gneisses and schists (Valentine *et al.* 1978). • The CLI has not rated the soils in the vicinity of the Blue River Pump Station. • No contamination is anticipated at the Blue River Pump Station. If any contamination is encountered during construction, the Contamination Discovery Contingency Plan (Appendix B of the Facilities EPP of Volume 6C) will be implemented.
Water Quality and Quantity	• The Blue River Pump Station is located in the Upper North Thompson River Watershed of the Fraser River Basin. • No work will occur within 30 m of any waterbodies and, therefore, detailed information on surface water quality and quantity is not warranted as per Table A-1 of the NEB *Filing Manual*. • The terrain is generally level. Groundwater flow direction is likely toward Eleanor Lake approximately 150 m to the east-northeast. • The surficial geology beneath the site is mapped as predominantly fluvial (Tipper 1971). • No water supply wells are mapped within the site boundary, however, one well is located within the surrounding Water Quality and Quantity LSA (BC MOE 2013a). • Groundwater levels in the area are expected to be moderately deep based on water well records identified southwest of the station. • The Blue River Pump Station does not overlie any mapped aquifers (BC MOE 2013a).
Air Emissions	• All existing pumps are electrically driven and are not direct sources of CACs. • Fugitive VOC emissions from leaks at the Blue River Pump Station are estimated to be 1.7 tonnes per year. • Air quality in the area surrounding the Blue River Pump Station, based on the nearby emission sources, is expected to be generally very good with some influence from the Community of Blue River and the Blue River Airport.
Greenhouse Gas Emissions	• Indirect GHG emissions due to electric power consumption by the existing pumps at the Blue River Pump Station are the main emissions. These include emissions from fossil fuel combustion, unallocated energy from power line losses, metering differences and other losses, and emissions of SF_6 from gas handling and transferring operations, electrical equipment operation, and from equipment mechanical failures. • Small amounts of direct GHG emissions will be released due to the space heating of the existing buildings at the Blue River Pump Station. • Small amounts of indirect GHG emissions will be released due to electricity use for equipment other than pumps. • Small amounts of GHG emissions will be released from the motor vehicles used by operations/maintenance staff.
Acoustic Environment	• Although new pump units will be added, the existing pump units of equivalent sound emissions will be deactivated. No increase in sound emissions is expected from the Project at the Blue River Pump Station during operations and, therefore, detailed information on sound emissions is not warranted as per Table A-1 of the NEB *Filing Manual*.
Fish and Fish Habitat	• The Blue River Pump Station is located in the Upper North Thompson River Watershed of the Fraser River Basin. • No work will occur within 30 m of any fish-bearing waterbodies and, therefore, detailed information on fish and fish habitat is not deemed warranted as per Table A-1 of the NEB *Filing Manual*.

TABLE 6.1-8 Cont'd

Environmental Elements	Summary of Considerations
Wetland Loss or Alteration	• The Blue River Pump Station is situated within the boundaries of the Columbia Mountains and Highlands Ecoregion of the Montane Cordillera Ecozone. Wetlands in this ecoregion tend to be restricted to mountain slopes where non-forested bogs, marshes and swamps occur (Ecological Stratification Working Group 1995). • The Blue River Pump Station is also located within the South Interior Mountain Wetland Region. Wetlands characteristic of this region include flat bogs, basin bogs and shallow basin marshes. Within alpine areas, small basin fens and basin bogs can be found (Government of Canada 1986). • The Blue River Pump Station is located within the ICH BGC Zone of BC. In this BGC Zone, wetlands are not common due to the mountainous terrain. However, marshes associated with lakes and streams in valley bottoms tend to be more common along with small swamps and transitional bogs and fens (BC MOF 1996a, Meidinger and Pojar 1991). • Wetlands provide habitat for native plants and wildlife species, including nesting and foraging habitat for bird species as well as provide storage and natural filtering of water. • No wetlands were identified within or adjacent to the Blue River Pump Station during the helicopter reconnaissance and satellite imagery review. As a result, a ground-based wetland survey was determined not to be required. • There are no Ramsar Wetlands of International Importance (Bureau of the Convention on Wetlands 2013), IBAs (Bird Studies Canada and Nature Canada 2012), Western Hemisphere Shorebird Reserves (WHSRN 2013), Migratory Bird Sanctuaries (Environment Canada 2013b) or DUC Priority Areas (DUC 2013) located within the Wetland LSA surrounding the Blue River Pump Station.
Vegetation	• The Blue River Pump Station is located within the boundaries of the Columbia Mountains and Highlands Ecoregion of the Montane Cordillera Ecozone. This ecoregion is characterized by mature forests of western hemlock and western redcedar in major valleys, with Douglas-fir, western white pine, and western larch occurring less frequently. The subalpine areas are characterized by Engelmann spruce, alpine fir and lodgepole pine stands (Ecological Stratification Working Group 1995). • The Blue River Pump Station is located within the ICH BGC Zone of BC. The ICH BGC Zone is dominated by western redcedar, western hemlock, white spruce, Engelmann spruce, spruce hybrids and subalpine fir. Western larch, Douglas-fir, lodgepole pine, trembling aspen, paper birch, ponderosa pine and western white pine are also common in the central and southern areas of this zone. Black cottonwood are common in wet areas (BC MOF 1996a, Meidinger and Pojar 1991). • The Blue River Pine Provincial Park, located within the Vegetation LSA, lies approximately 0.7 km northeast of the Blue River Pump Station. • Records of rare plant observations within 5 km of the Blue River Pump Station were acquired from the BC CDC (2013) database. No provincially-listed (BC CDC) species records were found within the boundaries of the Vegetation LSA. • It was determined with satellite imagery interpretation that no native vegetation would be directly disturbed within the site boundaries and, therefore, a ground-based vegetation survey was deemed unnecessary. • Consultation with local agricultural authorities was conducted to determine weed species of concern for the region. See Section 4.4 of the Vegetation Technical Report of Volume 5C for a summary of these communications.
Wildlife and Wildlife Habitat	• The Blue River Pump Station lies within in the Kamloops LRMP region (BC MFLNRO 2008a). • The Blue River Pump Station is located on industrial lands. • The Blue River Pump Station is not located within or adjacent to any provincial parks or protected areas (the nearest park is located 0.7 km northeast) (BC MFLNRO 2008b), IBAs (Bird Studies Canada and Nature Canada 2012), Migratory Bird Sanctuaries (Environment Canada 2013b), National Wildlife Areas (Environment Canada 2013b), Western Hemisphere Shorebird Reserves (WHSRN 2013), Ramsar Wetlands of International Importance (Bureau of the Convention on Wetlands 2013), World Biosphere Reserves (UNESCO 2013), designated caribou range (BC MOE 2008), ungulate winter range (BC MOE 2005a) or Wildlife Habitat Areas (BC MOE 2005b). • The Blue River Pump Station is not in a DUC Priority Area (DUC 2013). • The Blue River Pine Provincial Park is approximately 0.7 km northeast of the Blue River Pump Station (BC MFLNRO 2008b). • The Blue River Pump Station is located in WMU 3-40 (BC ILMB 2006).
Species at Risk or Species of Special Status and Related Habitat	• No work will occur within 30 m of any fish-bearing waterbodies and, therefore, detailed information on fish and fish species at risk is not deemed warranted as per Table A-1 of the NEB *Filing Manual*. • Records of rare plant observations within 5 km of the Blue River Pump Station were acquired from the BC CDC (2013) database. No federally-listed (*SARA* or COSEWIC) species records were found within these boundaries. • Based on known species range and habitat preferences, the following federally-listed (*SARA* Schedule 1 or COSEWIC) or provincially-listed (Red, Blue, or under BC's *Wildlife Act*) wildlife species were identified as having the potential to occur in the vicinity of the Blue River Pump Station (BC MOE 2013b, COSEWIC 2013, Environment Canada 2012): − barn swallow (COSEWIC: Threatened, provincial: Blue); and − little brown myotis (COSEWIC: Endangered, provincial: Yellow). • A search of the BC CDC database did not identify any federally-listed (*SARA* Schedule 1 or COSEWIC) or provincially-listed (Red, Blue, or under BC's *Wildlife Act*) wildlife species within 2 km of the Blue River Pump Station (BC CDC 2012, 2013). • Given that the Blue River Pump Station is an existing facility and all work will occur within the existing fenced area on previously disturbed land, the Blue River Pump Station is not considered suitable habitat for wildlife or plant species at risk.

6.1.9 Blackpool Pump Station

The existing Blackpool Pump Station is located at c-073-B/092-P-09 at RK 736.8 on lands owned by Trans Mountain in the TNRD. Current land use at and around this facility site is industrial. No disturbance of previously undisturbed lands is proposed at the Blackpool Pump Station. Three 5,000 HP pump units will be added at the site. Access to the Blackpool Pump Station is via Highway 5. Table 6.1-9 provides a summary of the environmental elements and considerations for the Blackpool Pump Station pursuant to Guide A.2.4 and Table A-2 of the NEB *Filing Manual*. The location of the Blackpool Pump Station is shown on Figure 6.1-9.



TRANS MOUNTAIN

FIGURE 6.1-9

BLACKPOOL PUMP STATION

TRANS MOUNTAIN EXPANSION PROJECT

Kilometre Post (KP)
Hamlet / Village / Community
Trans Mountain Pipeline (TMPL)
Trans Mountain Expansion Project Proposed Pipeline Corridor
Subject Property Facility Boundary
Acoustic Environment RSA
Highway
Paved Road
Railway
National / Provincial Park

Projection: NAD 1983 UTM Zone 10N. Routing: Baseline TMPL & Facilities: provided by KMC 2012; Proposed Pipeline Corridor V6: provided by UPI Aug. 23, 2013; Transportation: IHS Inc., 2013, Natural Resources Canada, 2011; Geopolitical Boundaries: Natural Resources Canada, 2003, Altalis, 2012, IHS Inc., 2011, ESRI, 2005; First Nation Lands: Government of Canada, 2013; Parks and Protected Areas: Natural Resources Canada, 2013, Altalis, 2013, Alberta Tourism, Parks and Recreation, 2012, BC FLNRO, 2008.

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ALL LOCATIONS APPROXIMATE

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TABLE 6.1-9

SUMMARY OF ENVIRONMENTAL ELEMENTS AND CONSIDERATIONS FOR THE BLACKPOOL PUMP STATION

Environmental Elements	Summary of Considerations
Physical and Meteorological Environment	• The Blackpool Pump Station is located within the Interior Plateau Physiographic Region, which is characterized by gentle to moderately sloping rolling uplands with rounded ridges and summits, valleys deeply dissecting the plateau, terraces, fluvial plains, fans, and cones (Demarchi 2011, Holland 1976). • The Blackpool Pump Station is predominantly underlain by gneisses and other metamorphic rocks (Journeay *et al.* 2000b). • The surficial geology beneath the site is mapped as predominantly fluvial (Tipper 1971). SEACOR Environmental Inc. (2005) mapped the materials beneath the site as consisting of gravel and sand fill to 1.5 m bgl then sand to 2.4 m bgl; gravel was encountered to a depth of 10.7 m bgl (depth of investigation). • There are no areas of permafrost within the area of the Blackpool Pump Station (refer to Section 5.1.1). • No areas of potential terrain instability are known to occur in the vicinity of the Blackpool Pump Station. • No volcanoes (NRCan 2010e) have been recorded in the vicinity of the Blackpool Pump Station. • The site is located in a zone of low seismic activity (NRCan 2010a). Peak ground acceleration with a 1:2475 annual probability of exceedance is between 0.1 and 0.2 g (NRCan 2013a). No earthquakes have been recorded in the area (NRCan 2013b). • The topography in the area of Blackpool Pump Station is relatively flat and the elevation is approximately 390 m above sea level. • Where activities are planned within Blackpool Pump Station, soils have been disturbed for industrial use and construction of the new infrastructure will be conducted within the boundaries of the existing station. NRCan considers unprotected soils in the vicinity of Blackpool Pump Station to have low wind erosion risk with low climatic sensitivity (NRCan 2010d). • A description of the climate for the Interior Douglas-Fir (IDF) BGC Zone is provided in Section 5.1.2. • Meteorological data from Environment Canada's Blue River Airport Station, located approximately 90 km northeast of the Blackpool Pump Station, are provided in Section 5.1.2. • No major tornadoes or hailstorms have been recorded in the vicinity of the Blackpool Pump Station (NRCan 2010b,c).
Soil and Soil Productivity	• Activities at the Blackpool Pump Station will be conducted within an existing fenced, industrial site lacking topsoil and, therefore, detailed soil information is not warranted as per Table A-2 of the NEB *Filing Manual*. • A soil survey at the Blackpool Pump Station was conducted in 2005 for the Trans Mountain Pump Station Expansion Project. Well to imperfectly-drained Orthic Regosols and Orthic Humic Regosols developed on sandy loam to loamy sand textured, stone-free fluvial sediments soils are the dominant soils in undisturbed areas (Blackpool soils). Poorly-drained depressional areas consist of Rego Gleysols developed on loam to silty clay loam textured fluvial material (Mosquito soils). These soils are of minor extent occupying a meander scar in the northeast portion of the site. A large area in the fenced compound consists of disturbed land (*i.e.,* land that has been disturbed by prior construction activities). It may have gravel added to the surface or may have been previously graded. In general, disturbed lands do not have any salvageable topsoil (Mentiga 2005b). • Soil capability for agriculture at the Blackpool Pump Station is low (Class 5) due to climatic and soil textural limitations as based upon BC Land Inventory (1973). • A historical spill was recorded at the Blackpool Pump Station. Ongoing groundwater monitoring and sampling programs are in place. Soils to be disturbed will be tested prior to construction. If contaminated soil is encountered during construction, the Contamination Discovery Contingency Plan (Appendix B of the Facilities EPP of Volume 6C) will be implemented.
Water Quality and Quantity	• The Blackpool Pump Station is located in the Lower North Thompson River Watershed of the Fraser River Basin. • No work will occur within 30 m of any waterbodies and, therefore, detailed information on surface water quality and quantity is not warranted as per Table A-1 of the NEB *Filing Manual*. • The terrain at the Blackpool Pump Station is generally level. Groundwater flow likely follows topography south and southwest towards the North Thompson River. • The surficial geology beneath the site is mapped as predominantly fluvial (Tipper 1971). SEACOR Environmental Inc. (2005) mapped the materials beneath the site as consisting of gravel and sand fill to 1.5 m bgl then sand to 2.4 m bgl; gravel was encountered to a depth of 10.7 m bgl (depth of investigation). • No water supply wells are mapped within the site boundary and one well is located within the surrounding Water Quality and Quantity LSA (BC MOE 2013a). • Monitoring wells at the site indicate groundwater levels ranged from 2.7-3.5 m bgl. • The Blackpool Pump Station does not overlie any mapped aquifers (BC MOE 2013a). • AMEC Earth & Environmental (AMEC) (2012, 2013) reported that historical sampling revealed hydrocarbon impacts were present in wells BH08-03, BH08-04, BH11-18. No defined source was indicated for the contamination (AMEC 2013). Horizontal delineation indicated that there was no off-site migration of the contamination. Recommended ongoing monitoring (AMEC 2013) has been conducted.
Air Emissions	• All existing pumps are electrically driven and are not direct sources of CACs. • Fugitive VOC emissions from leaks at the Blackpool Pump Station are estimated to be 1.7 tonnes per year. • Air quality in the area near the Blackpool Pump Station, based on the nearby emission sources, is expected to be generally very good with some influence from vehicle traffic emissions along Highway 5 and natural emissions from vegetation.

TABLE 6.1-9 Cont'd

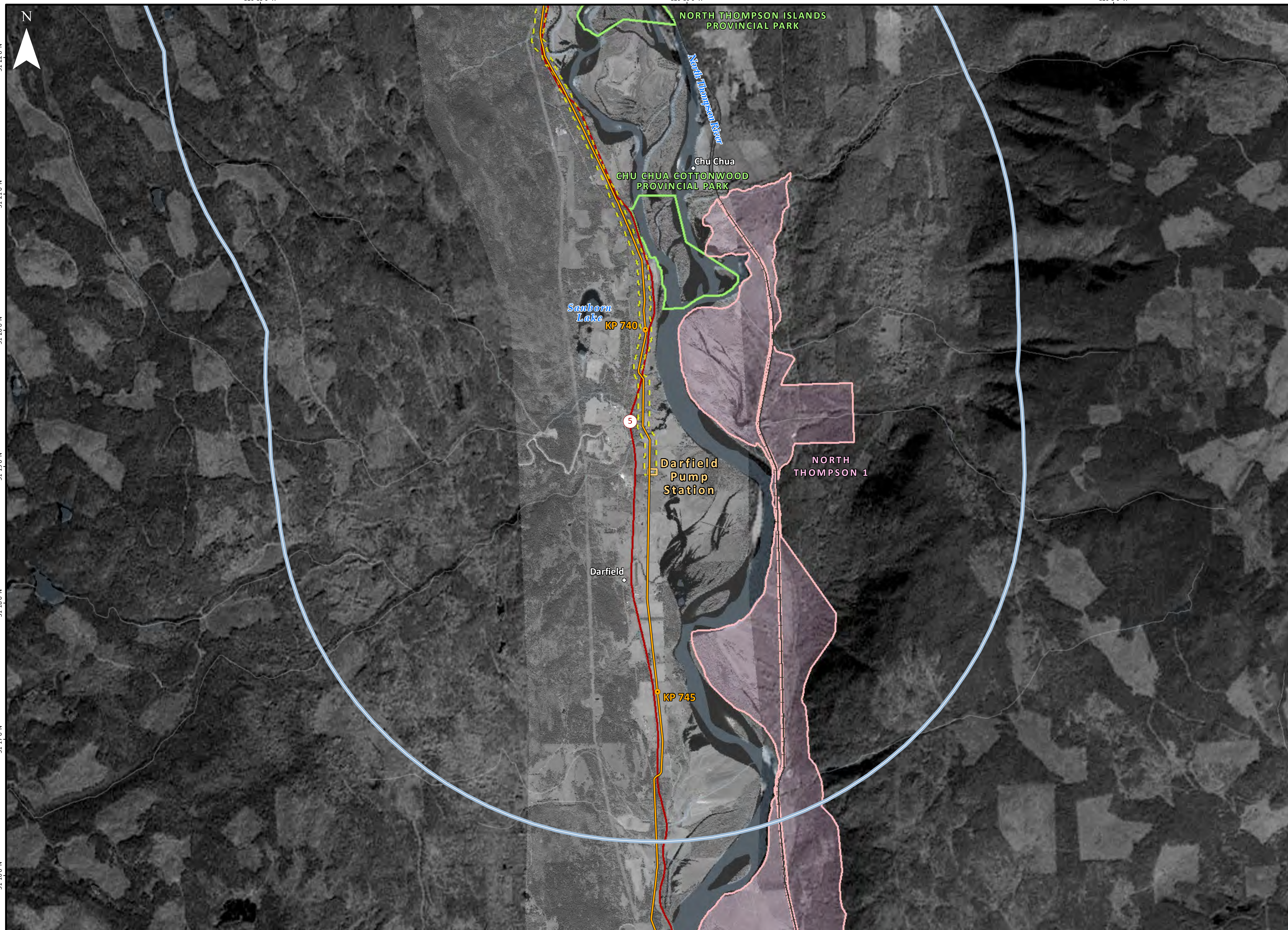
Environmental Elements	Summary of Considerations
Greenhouse Gas Emissions	• Indirect GHG emissions due to electric power consumption by the existing pumps at the Blackpool Pump Station are the main emissions. These include emissions from fossil fuel combustion, unallocated energy from power line losses, metering differences and other losses, and emissions of SF_6 from gas handling and transferring operations, electrical equipment operation, and from equipment mechanical failures. • Small amounts of direct GHG emissions will be released due to the space heating of the existing buildings at the Blackpool Pump Station. • Small amounts of indirect GHG emissions will be released due to electricity use for equipment other than pumps. • Small amounts of GHG emissions will be released from the motor vehicles used by operations/maintenance staff.
Acoustic Environment	• Sources of existing sound in the Acoustic Environment LSA are traffic travelling along Highway 5 and surrounding arterial roadways and natural sound (*e.g.*, wind, wildlife, river). • Receptors were identified within the Acoustic Environment LSA. The nearest receptor is located approximately 150 m to the north of the fenceline of the Blackpool Pump Station. • ASL in the absence of regulated energy facilities ranges between 35-40 dBA at night and 45-50 dBA during the day based on BC OGC *Noise Control Best Practices Guideline* (BC OGC 2009). • A measurement program to define sound emissions from the existing facility was conducted. • A noise model was generated based on existing conditions observed and measurements of the major on-site sources of sound. Specifications of equipment not operating during the site visit were used to estimate sound levels. Applicable buildings and shelters were modelled along with the appropriate insertion losses and screening effects. • The noise modelling results indicate that sound from the existing Blackpool Pump Station complies with the BC OGC *Noise Control Best Practices Guideline* permissible sound levels for all surrounding receptors. • Contoured noise prediction results are available in the Terrestrial Noise and Vibration Technical Report of Volume 5C.
Fish and Fish Habitat	• The Blackpool Pump Station is located in the Lower North Thompson River Watershed of the Fraser River Basin. • No work will occur within 30 m of any fish-bearing waterbodies and, therefore, detailed information on fish and fish habitat is not deemed warranted as per Table A-1 of the NEB *Filing Manual*.
Wetland Loss or Alteration	• The Blackpool Pump Station is situated within the boundaries of the Columbia Mountains and Highlands Ecoregion of the Montane Cordillera Ecozone. Wetlands in this ecoregion tend to be restricted to mountain slopes where non-forested bogs, marshes and swamps occur (Ecological Stratification Working Group 1995). • The Blackpool Pump Station is also located within the South Interior Mountain Wetland Region. Wetlands characteristic of this region include flat bogs, basin bogs and shallow basin marshes. Within alpine areas, small basin fens and basin bogs can be found (Government of Canada 1986). • The Blackpool Pump Station is located within the IDF BGC Zone of BC. In this BGC Zone, wetlands are often found in depressions, around open water, small streams and drainage channels. Wetlands types include fens, marshes as well as shrubby swamps (BC MOF 1996b, Meidinger and Pojar 1991). • Wetlands provide habitat for native plants and wildlife species, including nesting and foraging habitat for bird species as well as provide storage and natural filtering of water. • It was determined during the helicopter reconnaissance and satellite imagery interpretation that there is one wetland, a Riparian Marsh (deep marsh), located along the north boundary of the Blackpool Pump Station boundary. This wetland is not anticipated to be disturbed during the pump station construction. • There are no Ramsar Wetlands of International Importance (Bureau of the Convention on Wetlands 2013), IBAs (Bird Studies Canada and Nature Canada 2012), Western Hemisphere Shorebird Reserves (WHSRN 2013), Migratory Bird Sanctuaries (Environment Canada 2013b) or DUC Priority Areas (DUC 2013) located within the Wetland LSA surrounding the Blackpool Pump Station.
Vegetation	• The Blackpool Pump Station is located within the boundaries of the Columbia Mountains and Highlands Ecoregion of the Montane Cordillera Ecozone. This ecoregion is characterized by mature forests of western hemlock and western redcedar in major valleys, with Douglas-fir, western white pine, and western larch occurring less frequently. The subalpine areas are characterized by Engelmann spruce, alpine fir and lodgepole pine stands (Ecological Stratification Working Group 1995). • The Blackpool Pump Station is located within the IDF BGC Zone of BC. The IDF BGC Zone is dominated by closed, mature forests of Douglas-fir. Mixed stands of Douglas-fir, lodgepole pine, ponderosa pine, white spruce, western redcedar and trembling aspen are also common. Grassland communities also occur in parts of the zone (Meidinger and Pojar 1991). • There are no national parks, provincial parks, provincial recreation areas, Environmentally Significant Areas or other protected areas located within the Vegetation LSA near the Blackpool Pump Station. • Records of rare plant observations within 5 km of the Blackpool Pump Station were acquired from the BC CDC (2013) database. No provincially-listed (BC CDC) species records were found within the boundaries of the Vegetation LSA. • It was determined with satellite imagery interpretation that no native vegetation would be directly disturbed within the site boundaries and, therefore, a ground-based vegetation survey was deemed unnecessary. • Consultation with local agricultural authorities was conducted to determine weed species of concern for the region. See Section 4.4 of the Vegetation Technical Report of Volume 5C for a summary of these communications.

TABLE 6.1-9 Cont'd

Environmental Elements	Summary of Considerations
Wildlife and Wildlife Habitat	• The Blackpool Pump Station lies within the Kamloops LRMP region (BC MFLNRO 2008a). • The Blackpool Pump Station is located on industrial lands. • The Blackpool Pump Station is not located within or adjacent to any provincial parks or protected areas (BC MFLNRO 2008b), IBAs (Bird Studies Canada and Nature Canada 2012), Migratory Bird Sanctuaries (Environment Canada 2013b), National Wildlife Areas (Environment Canada 2013b), Western Hemisphere Shorebird Reserves (WHSRN 2013), Ramsar Wetlands of International Importance (Bureau of the Convention on Wetlands 2013), World Biosphere Reserves (UNESCO 2013), designated caribou range (BC MOE 2008), ungulate winter range (BC MOE 2005a), or Wildlife Habitat Areas (BC MOE 2005b). • The Blackpool Pump Station is not in a DUC Priority Area (DUC 2013). • The Blackpool Pump Station is located in WMU 3-39 (BC ILMB 2006).
Species at Risk or Species of Special Status and Related Habitat	• No work will occur within 30 m of any fish-bearing waterbodies and, therefore, detailed information on fish and fish species at risk is not deemed warranted as per Table A-1 of the NEB *Filing Manual*. • Records of rare plant observations within 5 km of the Blackpool Pump Station were acquired from the BC CDC (2013) database. No federally-listed (*SARA* or COSEWIC) species records were found within these boundaries. • Based on known species range and habitat preferences, the following federally-listed (*SARA* Schedule 1 or COSEWIC) or provincially-listed (Red, Blue, or under BC's *Wildlife Act*) wildlife species were identified as having the potential to occur in the vicinity of the Blackpool Pump Station (BC MOE 2013b, COSEWIC 2013, Environment Canada 2012): – common nighthawk (*SARA*: Threatened, COSEWIC: Threatened, provincial: Yellow); – little brown myotis (*SARA*: no status, COSEWIC: Endangered, provincial: Yellow); and – Townsend's big-eared bat (*SARA*: no status, COSEWIC: no status, provincial: Blue). • A search of the BC CDC database did not identify any federally-listed (*SARA* Schedule 1 or COSEWIC) or provincially-listed (Red, Blue, or under BC's *Wildlife Act*) wildlife species within 2 km of the Blackpool Pump Station (BC CDC 2012, 2013). • Given that the Blackpool Pump Station is an existing facility and all work will occur within the existing fenced area, the Blackpool Pump Station is not considered suitable habitat for wildlife or plant species at risk.

6.1.10 Darfield Pump Station

The existing Darfield Pump Station is located at d-075-B/092-P-08 at RK 769 on lands owned by Trans Mountain in the TNRD. Current land use at and around this facility site is industrial and agricultural. The expansion of the Darfield Pump Station will be both within the existing disturbed fenced area and west onto cultivated agricultural lands and require a small amount (0.07 ha) of land. New scraper facilities (receiving) will be installed at the site. Access to the Darfield Pump Station is via Highway 5. Table 6.1-10 provides a summary of the environmental elements and considerations for the Darfield Pump Station pursuant to Guide A.2.4 and Table A-2 of the NEB *Filing Manual*. The location of the Darfield Pump Station is shown on Figure 6.1-10.



TRANS MOUNTAIN

FIGURE 6.1-10

DARFIELD PUMP STATION

TRANS MOUNTAIN EXPANSION PROJECT

Kilometre Post (KP)

Hamlet / Village / Community

Trans Mountain Pipeline (TMPL)

Trans Mountain Expansion Project Proposed Pipeline Corridor

Subject Property Facility Boundary

Acoustic Environment RSA

Highway

Paved Road

Railway

National / Provincial Park

Indian Reserve / Métis Settlement

Projection: NAD 1983 UTM Zone 10N. Routing: Baseline TMPL & Facilities: provided by KMC 2012; Proposed Pipeline Corridor V6: provided by UPI Aug. 23, 2013; Transportation: IHS Inc., 2013, Natural Resources Canada, 2011; Geopolitical Boundaries: Natural Resources Canada, 2003, Altalis, 2012, IHS Inc., 2011, ESRI, 2005; First Nation Lands: Government of Canada, 2013; Parks and Protected Areas: Natural Resources Canada, 2013, Altalis, 2013, Alberta Tourism, Parks and Recreation, 2012, BC FLNRO, 2008.

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Although there is no reason to believe that there are any errors associated with the data used to generate this product or in the product itself, users of these data are advised that errors in the data may be present.

MAP NUMBER		PAGE
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ALL LOCATIONS APPROXIMATE

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TABLE 6.1-10

SUMMARY OF ENVIRONMENTAL ELEMENTS AND CONSIDERATIONS FOR THE DARFIELD PUMP STATION

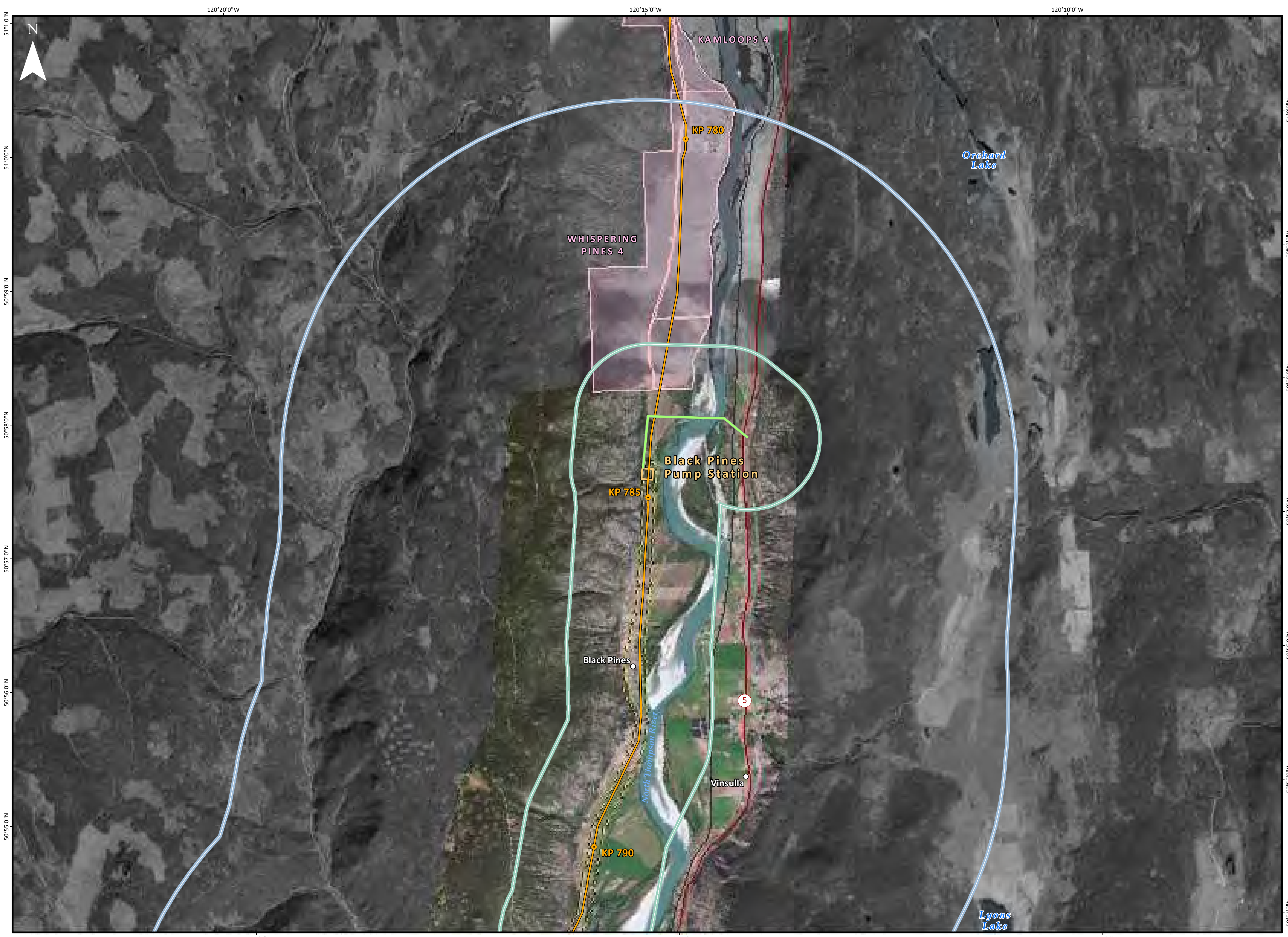
Environmental Elements	Summary of Considerations
Physical and Meteorological Environment	• The Darfield Pump Station is located within the Interior Plateau Physiographic Region, which is characterized by gentle to moderately sloping rolling uplands with rounded ridges and summits, valleys deeply dissecting the plateau, terraces, fluvial plains, fans, and cones (Demarchi 2011, Holland 1976). • The Darfield Pump Station is predominantly underlain by igneous and metamorphic as well as potential sandstones and carbonates (Monger and McMillan 1989). • The surficial geology beneath the site is mapped as predominantly fluvial (Tipper 1971). • There are no areas of permafrost within the area of the Darfield Pump Station (refer to Section 5.1.1). • No areas of potential terrain instability are known to occur in the vicinity of the Darfield Pump Station. • No volcanoes (NRCan 2010e) have been recorded in the vicinity of the Darfield Pump Station. • The site is located in a zone of low seismic activity (NRCan 2010a). Peak ground acceleration with a 1:2475 annual probability of exceedance is between 0.1 and 0.2 g (NRCan 2013a). No earthquakes have been recorded in the area (NRCan 2013b). • The topography in the area of the Darfield Pump Station is relatively flat and the elevation is approximately 390 m above sea level. • Where activities are planned within the Darfield Pump Station, most soils have been disturbed for industrial use, however, approximately 0.07 ha of new land currently under agricultural use will be required outside the existing fenceline. NRCan considers unprotected soils in the vicinity of the Darfield Pump Station to have low wind erosion risk with low climatic sensitivity (NRCan 2010d). • A description of the climate for the IDF BGC Zone is provided in Section 5.1.2. • Meteorological data from Environment Canada's Darfield Station, located approximately 1.8 km south of the Darfield Pump Station, are provided in Section 5.1.2. • No major tornadoes or hailstorms have been recorded in the vicinity of the Darfield Pump Station (NRCan 2010b,c).
Soil and Soil Productivity	• Project activities will cause some disturbance to soil outside of the existing fenceline of the Darfield Pump Station. The current Darfield Pump Station has been previously disturbed and contains pumps, buildings and other equipment. • Soils in the vicinity of the Darfield Pump Station are dominated by Gray Luvisolic soils (Valentine *et al.* 1978). Luvisolic soils generally have light-coloured, eluvial horizons and have illuvial B horizons in which silicate clay has accumulated. These soils develop characteristically in well to imperfectly-drained sites, in sandy loam to clay, base-saturated parent materials under forest vegetation in subhumid to humid, mild to very cold climates (Agriculture and Agri-Food Canada 1998). • The CLI (1981) has rated the soils in the vicinity of the Darfield Pump Station as having no limitations (Class 1) to crop production. • A historical spill has been recorded at the Darfield Pump Station. Soils to be disturbed will be tested prior to construction. If contamination is encountered, the Contamination Discovery Contingency Plan (Appendix B of the Facilities EPP of Volume 6C) will be implemented. • Potential soil contaminants of concern include gasoline, diesel fuel, lubricants and hydraulic fuels. • Clubroot is a soil-borne disease that affects canola and other crops in the mustard family. A small amount of new land currently under agricultural use will be required outside the existing fenceline, however, no occurrences of clubroot have been identified in TNRD (Joshi pers. comm.).
Water Quality and Quantity	• The Darfield Pump Station is located in the Lower North Thompson River Watershed of the Fraser River Basin. • No work will occur within 30 m of any waterbodies and, therefore, detailed information on surface water quality and quantity is not warranted as per Table A-1 of the NEB *Filing Manual*. • The terrain at the Darfield Pump Station is generally level. Groundwater flow likely follows topography east and southeast towards the North Thompson River. • The surficial geology beneath the site is mapped as predominantly fluvial (Tipper 1971). • No water supply wells are mapped within the site boundary or surrounding Water Quality and Quantity LSA (BC MOE 2013a). • Groundwater levels in the area are expected to be moderately deep based on water well records identified south of the station. • The Darfield Pump Station overlies Aquifer #293, a moderately vulnerable sand and gravel deposit (BC MOE 2013a).
Air Emissions	• All existing pumps are electrically driven and are not direct sources of CACs. • Fugitive VOC emissions from leaks at the Darfield Pump Station are estimated to be 2.9 tonnes per year. • Air quality in the area around the Darfield Pump Station is expected to be generally very good, with some influence from vehicle traffic emissions along Highway 5.
Greenhouse Gas Emissions	• Indirect GHG emissions due to electric power consumption by the existing pumps at the Darfield Pump Station are the main emissions. These include emissions from fossil fuel combustion, unallocated energy from power line losses, metering differences and other losses, and emissions of SF_6 from gas handling and transferring operations, electrical equipment operation, and from equipment mechanical failures. • Small amounts of direct GHG emissions will be released due to the space heating of the existing buildings at the Darfield Pump Station. • Small amounts of indirect GHG emissions will be released due to electricity use for equipment other than pumps. • Small amounts of GHG emissions will be released from the motor vehicles used by operations/maintenance staff.

TABLE 6.1-10 Cont'd

Environmental Elements	Summary of Considerations
Acoustic Environment	• No increase in sound emissions is expected from the Project at the Darfield Pump Station during operations and, therefore, detailed information on sound emissions is not warranted as per Table A-1 of the NEB *Filing Manual*.
Fish and Fish Habitat	• The Darfield Pump Station is located in the Lower North Thompson River Watershed of the Fraser River Basin. • No work will occur within 30 m of any fish-bearing waterbodies and, therefore, detailed information on fish and fish habitat is not deemed warranted as per Table A-1 of the NEB *Filing Manual*.
Wetland Loss or Alteration	• The Darfield Pump Station is situated within the boundaries of the Columbia Mountains and Highlands Ecoregion of the Montane Cordillera Ecozone. Wetlands in this ecoregion tend to be restricted to mountain slopes where non-forested bogs, marshes and swamps occur (Ecological Stratification Working Group 1995). • The Darfield Pump Station is also located within the South Interior Mountain Wetland Region. Wetlands characteristic of this region include flat bogs, basin bogs and shallow basin marshes. Within alpine areas, small basin fens and basin bogs can be found (Government of Canada 1986). • The Darfield Pump Station is located within the IDF BGC Zone of BC. In this BGC Zone, wetlands are often found in depressions, around open water, small streams and drainage channels. Wetlands types include fens, marshes as well as shrubby swamps (BC MOF 1996b, Meidinger and Pojar 1991). • Wetlands provide habitat for native plants and wildlife species, including nesting and foraging habitat for bird species as well as provide storage and natural filtering of water. • No wetlands were identified within or adjacent to the Darfield Pump Station during the helicopter reconnaissance and satellite imagery review. As a result, a ground-based wetland survey was determined not to be required. • There are no Ramsar Wetlands of International Importance (Bureau of the Convention on Wetlands 2013), IBAs (Bird Studies Canada and Nature Canada 2012), Western Hemisphere Shorebird Reserves (WHSRN 2013) or Migratory Bird Sanctuaries (Environment Canada 2013b) located within the Wetland LSA surrounding the Darfield Pump Station. • The Darfield Pump Station is located within a DUC Level 3 Priority Area Eastern Boreal Forest (DUC 2013).
Vegetation	• The Darfield Pump Station is located within the boundaries of the Columbia Mountains and Highlands Ecoregion of the Montane Cordillera Ecozone. This ecoregion is characterized by mature forests of western hemlock and western redcedar in major valleys, with Douglas-fir, western white pine, and western larch occurring less frequently. The subalpine areas are characterized by Engelmann spruce, alpine fir and lodgepole pine stands (Ecological Stratification Working Group 1995). • The Darfield Pump Station is located within the IDF BGC Zone of BC. The IDF BGC Zone is dominated by closed, mature forests of Douglas-fir. Mixed stands of Douglas-fir, lodgepole pine, ponderosa pine, white spruce, western redcedar and trembling aspen are also common. Grassland communities also occur in parts of the zone (Meidinger and Pojar 1991). • There are no national parks, provincial parks, provincial recreation areas, Environmentally Significant Areas or other protected areas located within the Vegetation LSA near the Darfield Pump Station. • Records of rare plant observations within 5 km of the Darfield Pump Station were acquired from the BC CDC (2013) database. No provincially-listed (BC CDC) species records were found within the boundaries of the Vegetation LSA. • It was determined with satellite imagery interpretation that no native vegetation would be directly disturbed within the site boundaries and, therefore, a ground-based vegetation survey was deemed unnecessary. • Consultation with local agricultural authorities was conducted to determine weed species of concern for the region. See Section 4.4 of the Vegetation Technical Report of Volume 5C for a summary of these communications.
Wildlife and Wildlife Habitat	• The Darfield Pump Station lies within the Kamloops LRMP region (BC MFLNRO 2008a). • The Darfield Pump Station is located on industrial and Agricultural Land Reserve (ALR) lands. • The Darfield Pump Station is not located within or adjacent to any provincial parks or protected areas (BC MFLNRO 2008b), IBAs (Bird Studies Canada and Nature Canada 2012), Migratory Bird Sanctuaries (Environment Canada 2013b), National Wildlife Areas (Environment Canada 2013b), Western Hemisphere Shorebird Reserves (WHSRN 2013), Ramsar Wetlands of International Importance (Bureau of the Convention on Wetlands 2013), World Biosphere Reserves (UNESCO 2013), designated caribou range (BC MOE 2008), ungulate winter range (BC MOE 2005a), or Wildlife Habitat Areas (BC MOE 2005b). • The Darfield Pump Station is located in a DUC Level 3 Priority Area Eastern Boreal Forest (DUC 2013). • The Darfield Pump Station is located in WMU 3-28 (BC ILMB 2006).
Species at Risk or Species of Special Status and Related Habitat	• No work will occur within 30 m of any fish-bearing waterbodies and, therefore, detailed information on fish and fish species at risk is not deemed warranted as per Table A-1 of the NEB *Filing Manual*. • Records of rare plant observations within 5 km of the Darfield Pump Station were acquired from the BC CDC (2013) database. No federally-listed (*SARA* or COSEWIC) species records were found within these boundaries. • Based on known species range and habitat preferences, the following federally-listed (*SARA* Schedule 1 or COSEWIC) or provincially-listed (Red, Blue, or under BC's *Wildlife Act*) wildlife species were identified as having the potential to occur in the vicinity of the Darfield Pump Station (BC MOE 2013b, COSEWIC 2013, Environment Canada 2012): – long-billed curlew (*SARA*: Special Concern, COSEWIC: Special Concern, provincial: Blue); – Townsend's big-eared bat (*SARA*: no status, COSEWIC: no status, provincial: Blue); and – rubber boa (*SARA*: Special Concern, COSEWIC: Special Concern, provincial: Yellow). • A search of the BC CDC database did not identify any federally-listed (*SARA* Schedule 1 or COSEWIC) or provincially-listed (Red, Blue, or under BC's *Wildlife Act*) wildlife species within 2 km of the Darfield Pump Station (BC CDC 2012, 2013). • Given that the Darfield Pump Station is an existing facility and that expansion will occur within the existing disturbed fenced area and west onto cultivated agricultural lands, the Darfield Pump Station is not considered suitable habitat for wildlife or plant species at risk.

6.1.11 Black Pines Pump Station

The proposed Black Pines Pump Station is a new site located on forested and pasture lands at d-041-K/092-I-16 at RK 811.9. The Black Pines Pump Station is located in the TNRD. The Black Pines Pump Station will require a new land base of approximately 150 m x 150 m (approximately 2.3 ha) for the pump station and substation. The new land is privately owned, treed and within the ALR. Two 2,500 HP pump units and two 5,000 HP pump units will be added at the site. A new 138 kV power line approximately 2.2 km long in a 50 m wide right-of-way will also be installed at the proposed Black Pines site. A short new access road to the site will be constructed. Table 6.1-11 provides a summary of the environmental elements and considerations for the Black Pines Pump Station pursuant to Guide A.2.4 and Table A-2 of the NEB *Filing Manual*. The location of the proposed Black Pines Pump Station and associated power line are shown on Figure 6.1-11.



TRANS MOUNTAIN

FIGURE 6.1-11

BLACK PINES PUMP STATION

TRANS MOUNTAIN EXPANSION PROJECT

- Kilometre Post (KP)
- Hamlet / Village / Community
- Trans Mountain Pipeline (TMPL)
- Trans Mountain Expansion Project Proposed Pipeline Corridor
- Proposed Power Line
- Subject Property Facility Boundary
- Acoustic Environment RSA
- Vegetation RSA Boundary
- Highway
- Paved Road
- Railway
- Indian Reserve / Métis Settlement

Projection: NAD 1983 UTM Zone 10N. Routing: Baseline TMPL & Facilities: provided by KMC 2012; Proposed pipeline Corridor V6: provided by UPI Aug. 23, 2013; Transportation: IHS Inc., 2013, Natural Resources Canada, 2011; Geopolitical Boundaries: Natural Resources Canada, 2003, Altalis, 2012, IHS Inc., 2011, ESRI, 2005; First Nation Lands: Government of Canada, 2013; Parks and Protected Areas: Natural Resources Canada, 2013, Altalis, 2013, Alberta Tourism, Parks and Recreation, 2012, BC FLNRO, 2008.

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Although there is no reason to believe that there are any errors associated with the data used to generate this product or in the product itself, users of these data are advised that errors in the data may be present.

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ALL LOCATIONS APPROXIMATE

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TABLE 6.1-11

SUMMARY OF ENVIRONMENTAL ELEMENTS AND CONSIDERATIONS FOR THE BLACK PINES PUMP STATION

Environmental Elements	Summary of Considerations
Physical and Meteorological Environment	• The proposed Black Pines Pump Station, access road and power line are located within the Interior Plateau Physiographic Region, which is characterized by gentle to moderately sloping rolling uplands with rounded ridges and summits, valleys deeply dissecting the plateau, terraces, fluvial plains, fans, and cones (Demarchi 2011, Holland 1976). • The Black Pines Pump Station is predominantly underlain by igneous and metamorphic rock as well as potential sandstones and carbonates (Monger and McMillan 1989). • The surficial geology beneath the site is mapped as predominantly fluvial (Young 1983). • There are no areas of permafrost within the area of the proposed Black Pines Pump Station (refer to Section 5.1.1). • A field reconnaissance was conducted in December 2012 to refine the location of the pump station in consideration of local terrain features and surface geology. The surface materials where the pump station is currently proposed consist of a debris fan. Therefore, further geotechnical assessments will be required at this site to determine the optimum location for the pump station site as well as to determine appropriate mitigation measures to protect the stations from a potential debris flow during operations of the Project. The surface of the preliminary site is sloped, which would require some grading to level the surface for construction and operations of the pump stations. • No volcanoes (NRCan 2010e) have been recorded in the vicinity of the proposed Black Pines Pump Station. • The site is located in a zone of low seismic activity (NRCan 2010a). Peak ground acceleration with a 1:2475 annual probability of exceedance is between 0.1 and 0.2 g (NRCan 2013a). No earthquakes have been recorded in the area (NRCan 2013b). • The topography in the area of the proposed Black Pines Pump Station is gently sloping and the elevation is approximately 380 m above sea level. • The proposed power line crosses northeast sloping terrain down to the North Thompson River, where it crosses to the east, then extends south along uneven terrain on the west side of Westsyde Road to the proposed Black Pines Pump Station. • The proposed Black Pines Pump Station and access road is located on private, forested land. The proposed power line is located predominately on forested and agricultural private land with the exception of the bed and banks of the North Thompson River. NRCan considers unprotected soils in the vicinity of Black Pines Pump Station to have low wind erosion risk with low climatic sensitivity (NRCan 2010d). • A description of the climate for the Ponderosa Pine (PP) BGC Zone is provided in Section 5.1.2. • Meteorological data from Environment Canada's Kamloops Airport Station, located approximately 30 km southwest of the proposed Black Pines Pump Station, are provided in Section 5.1.2. • No major tornadoes or hailstorms have been recorded in the vicinity of the proposed Black Pines Pump Station (NRCan 2010b,c).
Soil and Soil Productivity	• The proposed Black Pines Pump Station is a new site located on forested and tame pasture lands. • Soils in the vicinity of the Black Pines Pump Station are dominated by Gray Luvisolic soils (Valentine *et al.* 1978). Luvisolic soils generally have light-coloured, eluvial horizons and have illuvial B horizons in which silicate clay has accumulated. These soils develop characteristically in well to imperfectly-drained sites, in sandy loam to clay, base-saturated parent materials under forest vegetation in subhumid to humid, mild to very cold climates (Agriculture and Agri-Food Canada 1998). • The CLI has not rated the soils in the vicinity of the proposed Black Pines Pump Station. • No contaminated sites have been recorded at the proposed Black Pines Pump Station within the Soil LSA according to the Federal Contaminated Sites and Solid Waste Landfills Inventory (Treasury Board of Canada Secretariat 2011).
Water Quality and Quantity	• The proposed Black Pines Pump Station, access road and power line are located in the Lower North Thompson River Watershed of the Fraser River Basin. • The proposed power line associated with the pump station crosses the North Thompson River, and Otter and Voght creeks. • No work at the proposed pump station or access road will occur within 30 m of any waterbodies. • The terrain at the proposed Black Pines Pump Station is generally level. Groundwater flow likely follows topography towards east/southeast towards the North Thompson River. • The surficial geology beneath the site is mapped as predominantly fluvial (Young 1983). • No water supply wells are mapped within the proposed site boundary or surrounding Water Quality and Quantity LSA (BC MOE 2013a). • Groundwater levels in the area are expected to be deep based on water well records identified south of the station. • The proposed Black Pines Pump Station overlies Aquifer #283, defined as a moderately vulnerable, sand and gravel deposit (BC MOE 2013a).
Air Emissions	• There is currently no activity causing VOC emissions at the proposed Black Pines Pump Station. • Air quality around the area of the Black Pines Pump Station is expected to be generally very good with some influence from vehicle traffic emissions along Westsyde.
Greenhouse Gas Emissions	• There is currently no activity causing GHG emissions at the proposed Black Pines Pump Station.

TABLE 6.1-11 Cont'd

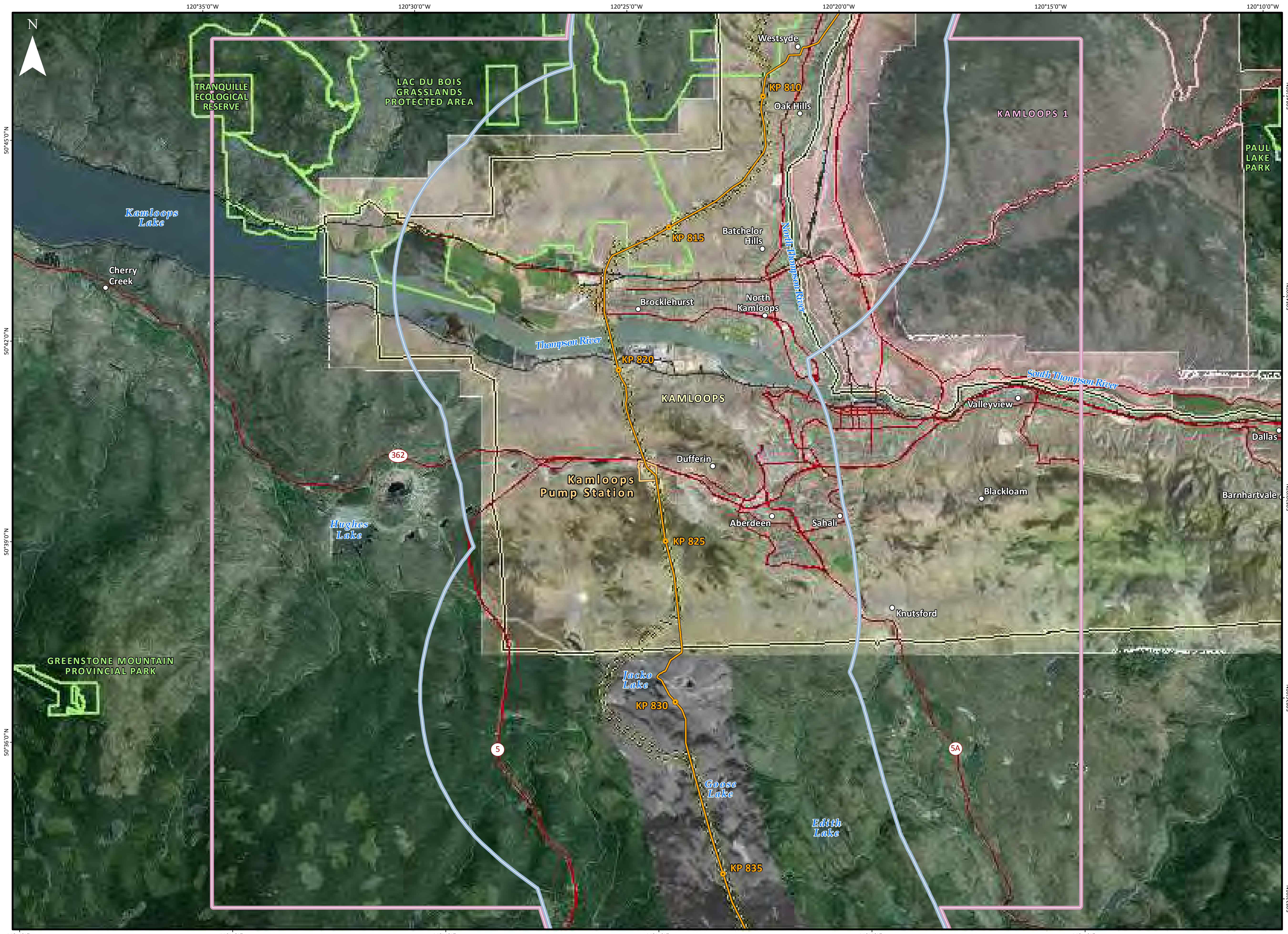
Environmental Elements	Summary of Considerations
Acoustic Environment	• The ambient acoustical environment in the area of the proposed Black Pines Pump Station is rural and there are no anticipated sources of sound other than those with respect to the sound of nature and traffic along Westsyde Road. • Receptors were identified within the Acoustic Environment LSA. The nearest receptor is located approximately 600 m to the south of the fenceline of the Black Pines Pump Station. • ASL is based on population density and proximity to road or rail lines and is expected to range between 35-40 dBA at night and 45-50 dBA during the day based on BC OGC *Noise Control Best Practices Guideline* (BC OGC 2009).
Fish and Fish Habitat	• The proposed Black Pines Pump Station and associated power line is located in the Lower North Thompson River Watershed of the Fraser River Basin. • The proposed power line associated with the pump station crosses eight potential watercourses, including the North Thompson River, and Otter and Voght creeks. Of the seven potential watercourse crossings assessed during the fisheries field program, only the North Thompson River was determined to be fish-bearing. Ongoing studies will be conducted at one potential watercourse crossing (Section 5.4 of the Fisheries [British Columbia] Technical Report of Volume 5C). • Of the five indicator species in BC, four (bull trout/Dolly Varden, Chinook salmon, coho salmon and rainbow trout/steelhead) are found in the Lower North Thompson River Watershed (Table 5.7-2 of Section 5.7). No indicators were captured during the assessment at the proposed power line crossing location; however, these four indicators have all been previously recorded in the North Thompson River. • Bull trout and mountain sucker may be found in the Lower North Thompson River Watershed and are both listed as a Species of Special Concern under COSEWIC (2013) and are Blue-listed in BC (BC CDC 2013) (see Table 4.5 of the Fisheries [British Columbia] Technical Report of Volume 5C). • Interior Fraser River coho salmon are Endangered under COSEWIC (2013) and may be found in the Lower North Thompson River Watershed (Table 4.5 of the Fisheries [British Columbia] Technical Report of Volume 5C).
Wetland Loss or Alteration	• The proposed Black Pines Pump Station and associated power line are located within the Thompson-Okanagan Plateau Ecoregion, a component of the Montane Cordillera Ecozone of Canada. Many of the wetlands within this region have been disturbed by urbanization and agriculture (Ecological Stratification Working Group 1995). • The proposed Black Pines Pump Station and associated power line are also located within the Intermountain Prairie Wetland Region. Wetlands characteristic of this region include marshes bordering fresh to saline ephemeral or semi-permanent shallow waters (Government of Canada 1986). • The proposed Black Pines Pump Station and associated power line are located within the PP BGC Zone of BC. Wetlands are not common in this BGC Zone but typical wetlands include marshes fringing alkaline ponds (BC MOF 1998b, Meidinger and Pojar 1991). • Wetlands provide habitat for native plants and wildlife species, including nesting and foraging habitat for bird species as well as provide storage and natural filtering of water. • No wetlands were identified within or adjacent to the proposed Black Pines Pump Station or associated power line during the helicopter reconnaissance and satellite imagery review. As a result, a ground-based wetland survey was determined not to be required. • There are no Ramsar Wetlands of International Importance (Bureau of the Convention on Wetlands 2013), IBAs (Bird Studies Canada and Nature Canada 2012), Western Hemisphere Shorebird Reserves (WHSRN 2013) or Migratory Bird Sanctuaries (Environment Canada 2013b) located within the Wetland LSA surrounding the proposed Black Pines Pump Station or associated power line. • The proposed Black Pines Pump Station and associated power line are located within a DUC Level 3 Priority Area, Eastern Boreal Forest (DUC 2013).
Vegetation	• The proposed Black Pines Pump Station and associated power line are located within the Thompson-Okanagan Plateau Ecoregion, a component of the Montane Cordillera Ecozone of Canada. This ecoregion is characterized by Engelmann spruce, subalpine fir, lodgepole pine, ponderosa pine, white spruce, Douglas-fir and trembling aspen. Shrub and grass communities dominate open areas and forest understories (Ecological Stratification Working Group 1995). • The proposed Black Pines Pump Station and associated power line are located within the PP BGC Zone of BC. The PP BGC Zone is dominated by ponderosa pine, with Douglas-fir, trembling aspen and black cottonwood occurring less frequently. Understory communities are dominated by grass species, with grasslands periodically scattered throughout the zone (BC MOF 1998b, Meidinger and Pojar 1991). • There are no national parks, provincial parks, provincial recreation areas, Environmentally Significant Areas or other protected areas located within the Vegetation LSA near the proposed Black Pines Pump Station and associated power line. • Records of rare plant observations within 5 km of the proposed Black Pines Pump Station and associated power line were acquired from the BC CDC (2013) database. No provincially-listed (BC CDC) species records were found within the boundaries of the Vegetation LSA. • A ground-based vegetation survey of both the proposed Black Pines Pump Station and associated power line were conducted on July 26, 2013. Dominant communities observed during the 2013 vegetation survey of the proposed Black Pines Pump Station consist of a mixedwood forest and a tame pasture. Mixedwood forest communities were observed along the associated power line. One rare plant species, riverbank anemone (*Anemone virginiana* var. *cylindroidea*), was observed during the 2013 vegetation survey within the proposed Black Pines Pump Station. It is ranked S3 provincially. No rare plant species were observed along the proposed power line. Further details are provided in Section 4.4 of the Vegetation Technical Report of Volume 5C.

TABLE 6.1-11 Cont'd

Environmental Elements	Summary of Considerations
Vegetation (cont'd)	• No rare ecological communities were observed at the proposed Black Pines Pump Station or along the associated power line. • Consultation with local agricultural authorities was conducted to determine weed species of concern for the region. See Section 4.4 of the Vegetation Technical Report of Volume 5C for a summary of these communications. • During the 2013 vegetation survey, one Provincially Noxious weed species (common burdock) was observed and one Regionally Noxious weed species (night-flowering catchfly) was observed.
Wildlife and Wildlife Habitat	• The proposed Black Pines Pump Station and the associated power line lie within the Kamloops LRMP region (BC MFLNRO 2008a). • The Black Pines Pump Station is a new pump station. Dominant communities consist of a mixedwood forest and a seeded pasture. Clearing will be required for the power line within mixedwood forest. • The proposed Black Pines Pump Station and the associated power line are not located within or adjacent to any provincial parks or protected areas (BC MFLNRO 2008b), IBAs (Bird Studies Canada and Nature Canada 2012), Migratory Bird Sanctuaries (Environment Canada 2013b), National Wildlife Areas (Environment Canada 2013b), Western Hemisphere Shorebird Reserves (WHSRN 2013), Ramsar Wetlands of International Importance (Bureau of the Convention on Wetlands 2013), World Biosphere Reserves (UNESCO 2013), designated caribou range (BC MOE 2008), or Wildlife Habitat Areas (BC MOE 2005b). • The proposed Black Pines Pump Station and the associated power line are located in a DUC Level 3 Priority Area, Eastern Boreal Forest (DUC 2013). • The proposed power line crosses the North Thompson River. • The proposed Black Pines Pump Station is located in the WMU 3-28 (BC ILMB 2006). • The proposed power line is located in WMUs 3-27 and 3-28 (BC ILMB 2006). • A ground-based wildlife habitat reconnaissance for the proposed Black Pines Pump Station and the associated power line was conducted on August 13, 2013. The habitat reconnaissance did not identify any features of concern on the Black Pines Pump Station site. Refer to the Wildlife Technical Report of Volume 5C for further details. The habitat reconnaissance for the power line was limited by land access and will be surveyed in 2014 (see Section 9.0). • A supplemental wildlife survey will be conducted for both the Black Pines Pump Station and associated power line (see Section 9.0). • A participant from Tk'emlups Te Secwepemc (Kamloops) accompanied the aquatics crews on field studies along the proposed Black Pines power line from April 8 to 12, 2013. The participant identified cottonwood trees along the proposed power line corridor and reported that this land was excellent deer habitat. No site-specific concerns were identified by the participant during the study.
Species at Risk or Species of Special Status and Related Habitat	• Bull trout and mountain sucker are both considered to be Species of Special Concern under COSEWIC (2013). Interior Fraser River coho salmon are listed as Endangered under COSEWIC (2013). All three species may be found in the Lower North Thompson River Watershed, including the North Thompson River, the only fish-bearing watercourse crossed by the proposed power line. • Records of rare plant observations within 5 km of the proposed Black Pines Pump Station and associated power line were acquired from the BC CDC (2013) database. No federally-listed (*SARA* or COSEWIC) species records were found within these boundaries. • Based on known species range and habitat preferences, the following federally-listed (*SARA* Schedule 1 or COSEWIC) or provincially-listed (Red, Blue, or under BC's *Wildlife Act*) wildlife species were identified as having the potential to occur in the vicinity of the proposed Black Pines Pump Station and associated power line (BC MOE 2013b, COSEWIC 2013, Environment Canada 2012): – Lewis's woodpecker (*SARA*: Threatened, COSEWIC: Threatened, provincial: Red); – American badger (*SARA*: Endangered, COSEWIC: Endangered, provincial: Red); – spotted bat (*SARA*: Special Concern, COSEWIC: Special Concern, provincial: Blue); – gopher snake (*deserticola* subspecies) (*SARA*: Threatened, COSEWIC: Threatened, provincial: Blue); – racer (*SARA*: Special Concern, COSEWIC: Special Concern, provincial: Blue); – rubber boa (*SARA*: Special Concern, COSEWIC: Special Concern, provincial: Yellow); and – western rattlesnake (*SARA*: Threatened, COSEWIC: Threatened, provincial: Blue). • A search of the BC CDC database identified the following federally-listed (*SARA* Schedule 1 or COSEWIC) or provincially-listed (Red, Blue, or under BC's *Wildlife Act*) wildlife species within 2 km of both the proposed Black Pines Pump Station and the associated power line (BC CDC 2012, 2013): – American badger (*SARA*: Endangered, COSEWIC: Endangered, provincial: Red). • A ground-based wildlife habitat reconnaissance for the Black Pines Pump Station and the associated power line was conducted on August 13, 2013. The habitat reconnaissance did not identify any features of concern on the Black Pines Pump Station site. Refer to the Wildlife Technical Report of Volume 5C for further details. The habitat reconnaissance for the power line was limited by land access and will be surveyed in 2014 (see Section 9.0). • Given that new clearing of previously undisturbed lands will be required for the proposed Black Pines Pump Station and the associated power line, both the Black Pines Pump Station and the associated power line have the potential to support suitable habitat for wildlife and plant species at risk. • A supplemental wildlife survey will be conducted for both the Black Pines Pump Station and associated power line (see Section 9.0).

6.1.12 Kamloops Pump Station

The existing Kamloops Pump Station is located at d-094-E/092-I-09 at RK 850.8 within the Kamloops Terminal on lands owned by Trans Mountain in the municipal boundaries of City of Kamloops. Current land use at this site is industrial. No disturbance of previously undisturbed lands is proposed at the Kamloops Pump Station. Three 5,000 HP pump units and one spare 5,000 HP pump unit will be installed at the site. Access to the Kamloops Pump Station is via Highway 5. Table 6.1-12 provides a summary of the environmental elements and considerations for the Kamloops Pump Station pursuant to Guide A.2.4 and Table A-2 of the NEB *Filing Manual*. The location of the Kamloops Pump Station is shown on Figure 6.1-12.



TRANS MOUNTAIN

FIGURE 6.1-12

KAMLOOPS PUMP STATION

TRANS MOUNTAIN EXPANSION PROJECT

- Kilometre Post (KP)
- Hamlet / Village / Community
- Trans Mountain Pipeline (TMPL)
- Trans Mountain Expansion Project Proposed Pipeline Corridor
- Subject Property Facility Boundary
- Acoustic Environment RSA
- Air Quality RSA Boundary
- Highway
- Paved Road
- Railway
- City / Town
- National / Provincial Park
- Indian Reserve / Métis Settlement

Projection: NAD 1983 UTM Zone 10N. Routing: Baseline TMPL & Facilities; provided by KMC 2012; Proposed Pipeline COrridor V6: provided by UPI Aug.23, 2013; Transportation: IHS Inc., 2013, Natural Resources Canada, 2011; Geopolitical Boundaries: Natural Resources Canada, 2003, Altalis, 2012, IHS Inc., 2011, ESRI, 2005; First Nation Lands: Government of Canada, 2013; Parks and Protected Areas: Natural Resources Canada, 2013, Altalis, 2013, Alberta Tourism, Parks and Recreation, 2012, BC FLNRO, 2008; Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

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tera ENVIRONMENTAL CONSULTANTS

Although there is no reason to believe that there are any errors associated with the data used to generate this product or in the product itself, users of these data are advised that errors in the data may be present.

MAP NUMBER		PAGE
201310_MAP_TERA_SE_00442_REV0_13		SHEET 12 OF 16
DATE December 2013	TERA REF. 7894	REVISION 0
SCALE 1:100,000	PAGE SIZE 11x17	DISCIPLINE ESA
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ALL LOCATIONS APPROXIMATE

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TABLE 6.1-12

SUMMARY OF ENVIRONMENTAL ELEMENTS AND CONSIDERATIONS FOR THE KAMLOOPS PUMP STATION

Environmental Elements	Summary of Considerations
Physical and Meteorological Environment	• The Kamloops Pump Station is located within the Interior Plateau Physiographic Region, which is characterized by gentle to moderately sloping rolling uplands with rounded ridges and summits, valleys deeply dissecting the plateau, terraces, fluvial plains, fans, and cones (Demarchi 2011, Holland 1976). • The Kamloops Pump Station is predominantly underlain by igneous and metamorphic rock as well as potential sandstones and carbonates (Monger and McMillan 1989). • The surficial geology beneath the site is mapped as ablation till (Young 1983). • There are no areas of permafrost within the area of Kamloops Pump Station (refer to Section 5.1.1). • No areas of potential terrain instability are known to occur in the vicinity of the Kamloops Terminal. • No volcanoes (NRCan 2010e) have been recorded in the vicinity of the Kamloops Terminal. • The site is located in a zone of low seismic activity (NRCan 2010a). Peak ground acceleration with a 1:2475 annual probability of exceedance is between 0.1 and 0.2 g (NRCan 2013a). Several minor earthquakes (magnitude 3) and two moderate earthquakes (magnitude 4) have been recorded in the area (NRCan 2013b). • The topography in the area of the Kamloops Pump Station is sloping from the south (high) to the north (low) and the elevation is approximately 740 m above sea level. • Where activities are planned within the Kamloops Pump Station, soils have been disturbed for industrial use and construction of the new infrastructure will be conducted within the boundaries of the existing station. NRCan considers unprotected soils in the vicinity of the Kamloops Pump Station to have low wind erosion risk with low climatic sensitivity (NRCan 2010d). • A description of the climate for the BG BGC Zone is provided in Section 5.1.2. • Meteorological data from Environment Canada's Kamloops Airport Station, located approximately 5 km north-northwest of the Kamloops Pump Station, are provided in Section 5.1.2. • No major tornadoes or hailstorms have been recorded in the vicinity of the Kamloops Pump Station (NRCan 2010b,c).
Soil and Soil Productivity	• Activities at the Kamloops Pump Station will be conducted within an existing fenced, industrial site lacking topsoil and, therefore, detailed soil information is not warranted as per Table A-2 of the NEB *Filing Manual*. • The CLI has not rated the soils in the vicinity of the Kamloops Pump Station. • Historical spills have been recorded at the Kamloops Pump Station. Soils to be disturbed will be tested prior to construction. If contamination is encountered during construction, the Contamination Discovery Contingency Plan (Appendix B of the Facilities EPP of Volume 6C) will be implemented. • Potential soil contaminants of concern include gasoline, diesel fuel, lubricants and hydraulic fuels.
Water Quality and Quantity	• The Kamloops Pump Station is located in the Thompson River Watershed of the Fraser River Basin. • No work will occur within 30 m of any waterbodies and, therefore, detailed information on surface water quality and quantity is not warranted as per Table A-1 of the NEB *Filing Manual*. • The terrain at the Kamloops Pump Station is generally level with a gentle slope to the northeast. Groundwater flow direction is likely toward the east and then northeast to the Thompson River. • The surficial geology beneath the site is mapped as ablation till (Young 1983). • Two water supply wells are defined within the site boundary (ID #18637 and #14817). Well #14817 is owned and operated by Trans Mountain. One other well is located within the surrounding Water Quality and Quantity LSA (BC MOE 2013a). • Groundwater levels in the area are not reported, but are expected to be moderate to deep. • The Kamloops Terminal does not overlie any mapped aquifers (BC MOE 2013a).
Air Emissions	• Continuous VOC, H_2S and mercaptan emissions are primarily due to standing and working losses from existing product storage tanks at the Kamloops Pump Station. • Fugitive emissions from leaks are expected to be a small contributor relative to emissions from existing tanks. • Small amount of continuous CAC emissions are associated with combustion of natural gas in-line heaters. • All existing pumps are electrically driven and are not direct sources of CACs. • CAC and VOC emissions from regular testing of emergency diesel generators and fire water pumps are infrequent. • The largest sources of CAC emissions, except PM, in the Air Quality RSA are non-road engines and vehicle traffic. The largest sources of PM emissions in the area are road dust, mining and rock quarrying. The largest sources of VOC emissions are solvent evaporation, non-road engines and vehicle traffic. • Predicted VOC, H_2S and mercaptan concentrations in the Air Quality RSA due to existing operations at the Kamloops Pump Station and other existing natural and anthropogenic sources are presented in the Air Quality and Greenhouse Gas Technical Report of Volume 5C. Maximum concentrations are expected to be below BC ambient air quality objectives and published odour thresholds.

TABLE 6.1-12 Cont'd

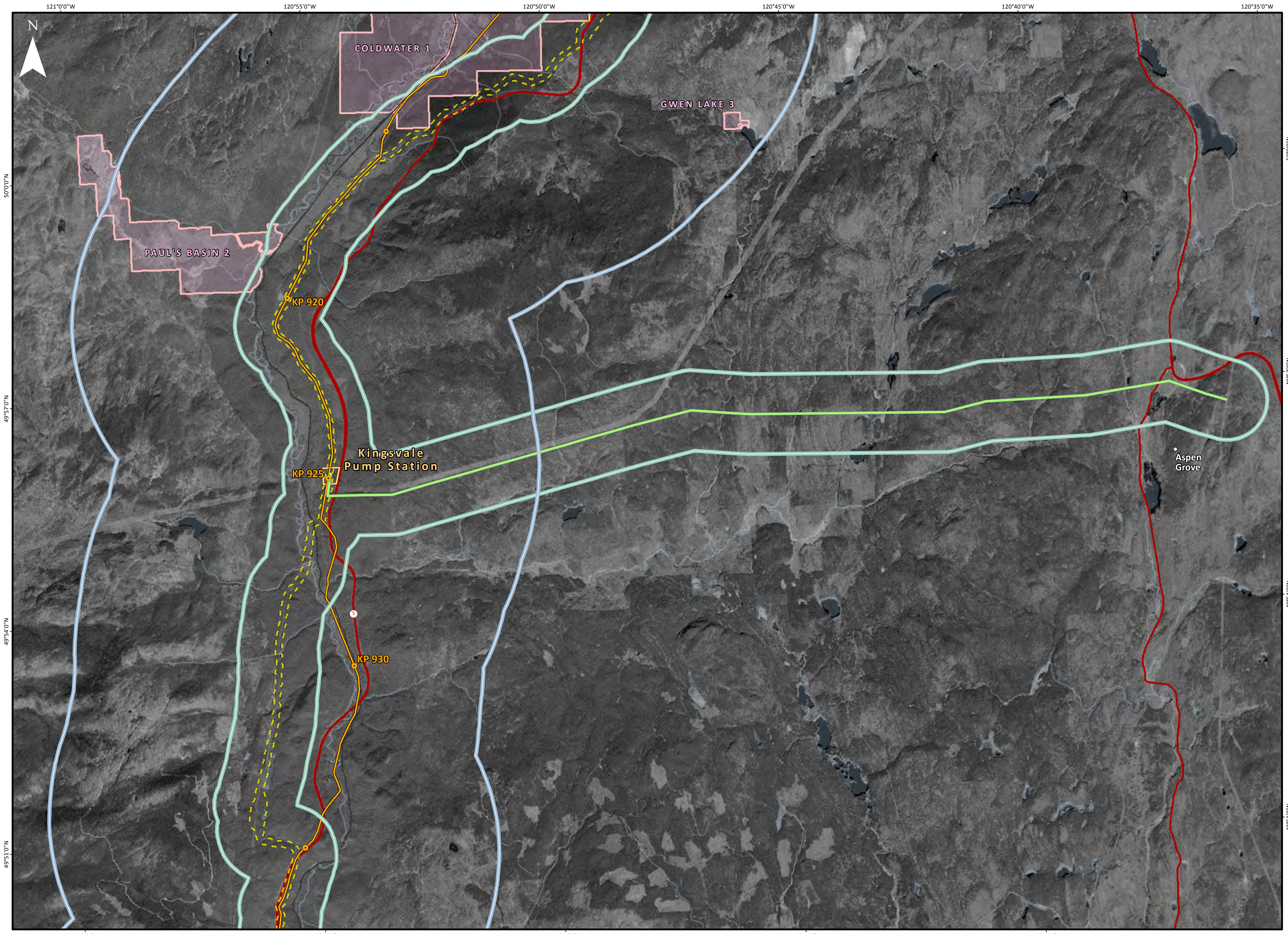
Environmental Elements	Summary of Considerations
Greenhouse Gas Emissions	• Indirect GHG emissions due to electric power consumption by the existing pumps at the Kamloops Pump Station are the main emissions. These include emissions from fossil fuel combustion, unallocated energy from power line losses, metering differences and other losses, and emissions of SF_6 from gas handling and transferring operations, electrical equipment operation, and from equipment mechanical failures. • Products handled and stored in existing tanks contain trace levels of GHGs; small amounts might be released through fugitive or process emissions (*e.g.*, CH_4 and formation CO_2). • Small amounts of direct GHG emissions will be released due to the space heating of the existing buildings at the Kamloops Pump Station. • Small amounts of indirect GHG emissions will be released due to electricity use for equipment other than pumps. • Small amounts of GHG emissions will be released from the motor vehicles used by field staff and contractors.
Acoustic Environment	• Sources of existing sound in the Acoustic Environment LSA are traffic travelling along Highway 1 and surrounding arterial roadways, local commercial businesses and natural sound (*e.g.*, wind, wildlife). • Receptors were identified within the Acoustic Environment LSA. The nearest receptor is located approximately 520 m to the southeast of the fenceline of the Kamloops Pump Station. • ASL in the absence of regulated energy facilities ranges between 38-43 dBA at night and 48-53 dBA during the day based on BC OGC *Noise Control Best Practices Guideline* (BC OGC 2009). • A measurement program to define sound emissions from the existing facility was conducted. • A noise model was generated based on existing conditions observed and measurements of the major on-site sources of sound. Specifications of equipment not operating during the site visit were used to estimate sound levels. Applicable buildings and shelters were modelled along with the appropriate insertion losses and screening effects. • The noise modelling results indicate that sound from the existing Kamloops Pump Station complies with the BC OGC *Noise Control Best Practices Guideline* permissible sound levels for all surrounding receptors. • Contoured noise prediction results are available in the Terrestrial Noise and Vibration Technical Report of Volume 5C.
Fish and Fish Habitat	• The Kamloops Pump Station is located in the Thompson River Watershed of the Fraser River Basin. • No work will occur within 30 m of any fish-bearing waterbodies and, therefore, detailed information on fish and fish habitat is not deemed warranted as per Table A-1 of the NEB *Filing Manual*.
Wetland Loss or Alteration	• The Kamloops Pump Station is located within the Thompson-Okanagan Plateau Ecoregion, a component of the Montane Cordillera Ecozone of Canada. Many of the wetlands with this region have been disturbed by urbanization and agriculture (Ecological Stratification Working Group 1995). • The Kamloops Pump Station is also located within the Intermountain Prairie Wetland Region. Wetlands characteristic of this region include marshes bordering fresh to saline ephemeral or semi-permanent shallow waters (Government of Canada 1986). • The Kamloops Pump Station is located within the Bunchgrass (BG) BGC Zone of BC. Wetlands are common in this BGC Zone and include marshes and saline meadows in shallow basins and associated with ponds and lakes (BC MOF 1998c, Meidinger and Pojar 1991). • Wetlands provide habitat for native plants and wildlife species, including nesting and foraging habitat for bird species as well as provide storage and natural filtering of water. • No wetlands were identified within or adjacent to the Kamloops Pump Station during the helicopter reconnaissance and satellite imagery review. As a result, a ground-based wetland survey was determined not to be required. • There are no Ramsar Wetlands of International Importance (Bureau of the Convention on Wetlands 2013), Western Hemisphere Shorebird Reserves (WHSRN 2013) or Migratory Bird Sanctuaries (Environment Canada 2013b) located within the Wetland LSA surrounding the Kamloops Pump Station. • The Kamloops Pump Station is located on the northern edge of the Douglas Lake Plateau IBA (Bird Studies Canada and Nature Canada 2012). • The Kamloops Pump Station is located within a DUC Level 3 Priority Area, Eastern Boreal Forest (DUC 2013).
Vegetation	• The Kamloops Pump Station is located within the Thompson-Okanagan Plateau Ecoregion, a component of the Montane Cordillera of Canada. This ecoregion is characterized by Engelmann spruce, subalpine fir, lodgepole pine, ponderosa pine, white spruce, Douglas-fir and trembling aspen. Shrub and grass communities dominate open areas and forest understories (Ecological Stratification Working Group 1995). • The Kamloops Pump Station is located within the BG BGC Zone of BC. The BG BGC Zone is dominated by bunchgrasses, with shrubs occurring throughout the range. Ponderosa pine and Douglas-fir grow on steep rocky slopes that occur infrequently, while trembling aspen can occur on wetter areas at higher elevations (BC MOF 1998c, Meidinger and Pojar 1991). • There are no national parks, provincial parks, provincial recreation areas, Environmentally Significant Areas or other protected areas located within the Vegetation LSA near the Kamloops Pump Station. • Records of rare plant observations within 5 km of the Kamloops Pump Station were acquired from the BC CDC (2013) database. No provincially-listed (BC CDC) species records were found within the boundaries of the Vegetation LSA. • It was determined with satellite imagery interpretation that no native vegetation would be directly disturbed within the site boundaries and, therefore, a ground-based vegetation survey was deemed unnecessary. • Consultation with local agricultural authorities was conducted to determine weed species of concern for the region. See Section 4.4 of the Vegetation Technical Report of Volume 5C for a summary of these communications.

TABLE 6.1-12 Cont'd

Environmental Elements	Summary of Considerations
Wildlife and Wildlife Habitat	• The Kamloops Pump Station lies within the Kamloops LRMP region (BC MFLNRO 2008a). • The Kamloops Pump Station is located adjacent to existing pigging facilities on industrial lands. • The Kamloops Pump Station is not located within or adjacent to any provincial parks or protected areas (BC MFLNRO 2008b), Migratory Bird Sanctuaries (Environment Canada 2013b), National Wildlife Areas (Environment Canada 2013b), Western Hemisphere Shorebird Reserves (WHSRN 2013), Ramsar Wetlands of International Importance (Bureau of the Convention on Wetlands 2013), World Biosphere Reserves (UNESCO 2013), designated caribou range (BC MOE 2008), ungulate winter range (BC MOE 2005a), or Wildlife Habitat Areas (BC MOE 2005b). • The Kamloops Pump Station is located on the northern edge of the Douglas Lake Plateau IBA (Bird Studies Canada and Nature Canada 2012). • The Kamloops Pump Station is located in a DUC Level 3 Priority Area, Eastern Boreal Forest (DUC 2013). • The Kamloops Pump Station is located in WMU 3-19 (BC ILMB 2006).
Species at Risk or Species of Special Status and Related Habitat	• No work will occur within 30 m of any fish-bearing waterbodies and, therefore, detailed information on fish and fish species at risk is not deemed warranted as per Table A-1 of the NEB *Filing Manual*. • Records of rare plant observations within 5 km of the Kamloops Pump Station were acquired from the BC CDC (2013) database. No federally-listed (*SARA* or COSEWIC) species records were found within these boundaries. • Based on known species range and habitat preferences, the following federally-listed (*SARA* Schedule 1 or COSEWIC) or provincially-listed (Red, Blue, or under BC's *Wildlife Act*) wildlife species were identified as having the potential to occur in the vicinity of the Kamloops Pump Station (BC MOE 2013b, COSEWIC 2013, Environment Canada 2012): – common nighthawk (*SARA*: Threatened, COSEWIC: Threatened, provincial: Yellow); – flammulated owl (*SARA*: Special Concern, COSEWIC: Special Concern, provincial: Blue); – Lewis's woodpecker (*SARA*: Threatened, COSEWIC: Threatened, provincial: Red); – sharp-tailed grouse (*columbianus* subspecies) (*SARA*: no status, COSEWIC: no status, provincial: Blue); – western screech-owl (*macfalanei* subspecies) (*SARA*: Endangered, COSEWIC: Threatened, provincial: Red); – American badger (*SARA*: Endangered, COSEWIC: Endangered, provincial: Red); – fringed myotis (provincial: Blue); – gopher snake (*deserticola* subspecies) (*SARA*: Threatened, COSEWIC: Threatened, provincial: Blue); and – rubber boa (*SARA*: Special Concern, COSEWIC: Special Concern, provincial: Yellow). • A search of the BC CDC database identified the following federally-listed (*SARA* Schedule 1 or COSEWIC) or provincially-listed (Red, Blue, or under BC's *Wildlife Act*) wildlife species within 2 km of the Kamloops Pump Station (BC CDC 2012, 2013): – American badger (*SARA*: Endangered, COSEWIC: Endangered, provincial: Red). • Given that the Kamloops Pump Station is an existing facility and all work will be conducted on previously disturbed industrial lands, the Kamloops Pump Station is not considered suitable habitat for wildlife or plant species at risk.

6.1.13 Kingsvale Pump Station

The existing Kingsvale Pump Station is located at b-023-L/092-H-15 at RK 956 on land owned by Trans Mountain. Current land use at this site is industrial. Some forested lands will be disturbed within the existing boundary of the Kingsvale Pump Station. Two 5,000 HP pump units will be installed at the site. A new 138 kV power line approximately 23.5 km long in a 50 m wide right-of-way will also be installed at the site. Access to the Kingsvale Pump Station is via Highway 5. Table 6.1-13 provides a summary of the environmental elements and considerations for the Kingsvale Pump Station pursuant to Guide A.2.4 and Table A-2 of the NEB *Filing Manual*. The location of the Kingsvale Pump Station and proposed power line are shown on Figure 6.1-13.



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TRANS MOUNTAIN

FIGURE 6.1-13

KINGSVALE PUMP STATION

TRANS MOUNTAIN EXPANSION PROJECT

Kilometre Post (KP)

Hamlet / Village / Community

Trans Mountain Pipeline (TMPL)

Proposed Power Line

Trans Mountain Expansion Project Proposed Pipeline Corridor

Subject Property Facility Boundary

Acoustic Environment RSA

Vegetation RSA Boundary

Highway

Paved Road

Railway

Indian Reserve / Métis Settlement

Projection: NAD 1983 UTM Zone 10N. Routing: Baseline TMPL & Facilities: provided by KMC 2012; Proposed Pipeline Corridor V6: provided by UPI Aug. 23, 2013; Transportation: IHS Inc., 2013, Natural Resources Canada, 2011; Geopolitical Boundaries: Natural Resources Canada, 2003, Altalis, 2012, IHS Inc., 2011, ESRI, 2005; First Nation Lands: Government of Canada, 2013; Parks and Protected Areas: Natural Resources Canada, 2013, Altalis, 2013, Alberta Tourism, Parks and Recreation, 2012, BC FLNRO, 2008.

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Although there is no reason to believe that there are any errors associated with the data used to generate this product or in the product itself, users of these data are advised that errors in the data may be present.

MAP NUMBER		PAGE
201310_MAP_TERA_SE_00442_REV0_14		SHEET 13 OF 16
DATE: December 2013	TERA REF.: 7894	REVISION: 0
SCALE: 1:90,000	PAGE SIZE: 11x17	DISCIPLINE: ESA
DRAWN: AJS	CHECKED: HS	DESIGN: TGG

0 500 1,000 1,500 2,000 Meters

ALL LOCATIONS APPROXIMATE

TABLE 6.1-13

SUMMARY OF ENVIRONMENTAL ELEMENTS AND CONSIDERATIONS FOR THE KINGSVALE PUMP STATION

Environmental Elements	Summary of Considerations
Physical and Meteorological Environment	• The Kingsvale Pump Station and associated power line are located within the Interior Plateau Physiographic Region, which is characterized by gentle to moderately sloping rolling uplands with rounded ridges and summits, valleys deeply dissecting the plateau, terraces, fluvial plains, fans, and cones (Demarchi 2011, Holland 1976). • The Kingsvale Pump Station is predominantly underlain by igneous and metamorphic rock as well as potential sandstones and carbonates (Monger and McMillan 1989). • The surficial geology beneath the site is mapped as glacial till (BGC Engineering Inc. 2013a). • There are no areas of permafrost within the area of the Kingsvale Pump Station or associated power line (refer to Section 5.1.1). • No areas of potential terrain instability are known or anticipated to occur in the vicinity of the Kingsvale Pump Station or associated power line. • No volcanoes (NRCan 2010e) have been recorded in the vicinity of the Kingsvale Pump Station or associated power line. • The site is located in a zone of moderate seismic activity (NRCan 2010a). Peak ground acceleration with a 1:2475 annual probability of exceedance is between 0.2 and 0.3 g (NRCan 2013a). Several minor earthquakes (magnitude 3) and one moderate earthquake (magnitude 4) have been recorded near the pump station and associated power line (NRCan 2013b). • The topography in the area of Kingsvale Pump Station is sloping from east (high) to west (low) and the elevation is approximately 900 m above sea level. • The Kingsvale power line crosses predominantly forested lands of rolling terrain of gentle to moderate slopes. • Activities are planned at the Kingsvale Pump Station on forested lands within the boundaries of the existing station. Wind erosion risk for unprotected soils in the vicinity of Kingsvale Pump Station and associated power line is considered negligible and is unrated by NRCan (NRCan 2010d). • A description of the climate for the IDF BGC Zone is provided in Section 5.1.2. • Meteorological data from Environment Canada's Hope Airport Station, located approximately 75 km southwest of the Kingsvale Pump Station, are provided in Section 5.1.2. • No major tornadoes or hailstorms have been recorded in the vicinity of the Kingsvale Pump Station or associated power line (NRCan 2010b,c).
Soil and Soil Productivity	• Some forested lands will be disturbed within the existing boundary of the Kingsvale Pump Station. • Soils in the vicinity of the Kingsvale Pump Station and associated power line are dominated by Humo-Ferric Podzol soils (Valentine *et al.* 1978). Podzolic soils have B horizons in which the dominant accumulated product is amorphous material composed mainly of humified organic matter (Agriculture and Agri-Food Canada 1998). • The CLI (1976) has rated the soils in the vicinity of the Kingsvale Pump Station and associated power line as having severe limitations (Class 6) to crop production. Soils in this class are capable of only producing perennial forage crops and improvement practices are not feasible. • No contamination is anticipated at the Kingsvale Pump Station. If any contamination is encountered during construction, the Contamination Discovery Contingency Plan (Appendix B of the Facilities EPP of Volume 6C) will be implemented.
Water Quality and Quantity	• The Kingsvale Pump Station and associated power line is located in the Lower Nicola River Watershed of the Fraser River Basin. • No work at the Kingsvale Pump Station will occur within 30 m of any waterbodies and, therefore, detailed information on surface water quality and quantity for the pump station is not deemed warranted as per Table A-1 of the NEB *Filing Manual*. • The proposed power line route crosses Kanevale, Kimble, Howarth and Nisson creeks. • The terrain slopes down to the west across the site. Site drainage and groundwater flow is expected to be towards the Coldwater River located approximately 500 m west of the site. • The surficial geology beneath the site is mapped as glacial till (BGC Engineering Inc. 2013a). • No water supply wells are located on the site and approximately 10 water wells are located within the Water Quality and Quantity LSA. • Groundwater levels in the area appear variable with reported water levels from driller's records ranging from 4-60 m bgl. • The Kingsvale Pump Station and associated power line do not overlie any mapped aquifers (BC MOE 2013a).
Air Emissions	• All existing pumps are electrically driven and are not direct sources of CACs. • Fugitive VOC emissions from leaks at the Kingsvale Pump Station are estimated to be 2.2 tonnes per year. • Air quality around the area of the Kingsvale Pump Station is expected to be primarily influenced by vehicle traffic emissions along Highway 5 and a nearby compressor station.
Greenhouse Gas Emissions	• Indirect GHG emissions due to electric power consumption by the existing pumps at the Kingsvale Pump Station are the main emissions. These include emissions from fossil fuel combustion, unallocated energy from power line losses, metering differences and other losses, and emissions of SF_6 from gas handling and transferring operations, electrical equipment operation, and from equipment mechanical failures. • Small amounts of direct GHG emissions will be released due to the space heating of the existing buildings at the Kingsvale Pump Station. • Small amounts of indirect GHG emissions will be released due to electricity use for equipment other than pumps. • Small amounts of GHG emissions will be released from the motor vehicles used by field staff and contractors.

TABLE 6.1-13 Cont'd

Environmental Elements	Summary of Considerations
Acoustic Environment	• Sources of existing sound in the Acoustic Environment LSA are traffic travelling along Highway 5, surrounding arterial roadways and natural sound (*e.g.*, wind, wildlife). • Receptors were identified within the Acoustic Environment LSA. The nearest receptor is located approximately 300 m to the southwest of the fenceline of the Kingsvale Pump Station. • ASL in the absence of regulated energy facilities is approximately 35 dBA at night and 45 dBA during the day based on BC OGC *Noise Control Best Practices Guideline* (BC OGC 2009). • A measurement program to define sound emissions from the existing facility was conducted. • A noise model was generated based on existing conditions observed and measurements of the major on-site sources of sound. Specifications of equipment not operating during the site visit were used to estimate sound levels. Applicable buildings and shelters were modelled along with the appropriate insertion losses and screening effects. • The noise modelling results indicate that sound from the existing Kingsvale Pump Station complies with the BC OGC *Noise Control Best Practices Guideline* permissible sound levels for all surrounding receptors. • Contoured noise prediction results are available in the Terrestrial Noise and Vibration Technical Report of Volume 5C.
Fish and Fish Habitat	• The power line associated with the Kingsvale Pump Station is located within the Lower Nicola and Similkameen river watersheds of the Fraser River Basin. The pump station is located in the Lower Nicola River Watershed. • The power line associated with the Kingsvale Pump Station crosses 28 potential watercourses, including Kanevale, Kimble, Howarth and Nisson creeks. • Of the 26 potential watercourses assessed during the fisheries field program, two (*i.e.,* Kanevale and Howarth creeks) were determined to be fish-bearing. Ongoing studies will be conducted at two potential watercourse crossings (Section 5.5 of the Fisheries [British Columbia] Technical Report of Volume 5C). • Of the five indicator species in BC, four (bull trout/Dolly Varden, Chinook salmon, coho salmon and rainbow trout/steelhead) are found in the Lower Nicola and Similkameen river watersheds) and may be found in watercourses crossed by the proposed power line. Rainbow trout/steelhead was captured or observed during the assessment at Howarth Creek, and rainbow trout/steelhead has been previously reported at both Howarth and Kanevale creeks. Bull trout is considered a Species of Special Concern under COSEWIC (2013) and is Blue-listed in BC (BC CDC 2013). Chiselmouth is also Blue-listed in BC (BC CDC 2013). Both species may be found in the Lower Nicola and Similkameen river watersheds (Table 4.5 of the Fisheries [British Columbia] Technical Report of Volume 5C).
Wetland Loss or Alteration	• The Kingsvale Pump Station and associated power line are located within the Thompson-Okanagan Plateau Ecoregion, a component of the Montane Cordillera Ecozone of Canada (Ecological Stratification Working Group 1995). • The Kingsvale Pump Station and associated power lines are also located within the Intermountain Prairie Wetland Region. Wetlands characteristic of this region include marshes bordering fresh to saline ephemeral or semi-permanent shallow waters (Government of Canada 1986). • The Kingsvale Pump Station and associated power line are located within the IDF BGC Zone of BC. In this BGC Zone, wetlands are often found in depressions, around open water, small streams and drainage channels. Wetland types include fens, marshes as well as shrubby swamps (BC MOF 1996b, Meidinger and Pojar 1991). • Wetlands provide habitat for native plants and wildlife species, including nesting and foraging habitat for bird species as well as provide storage and natural filtering of water. • It was determined during satellite imagery interpretation that the proposed power line encounters 23 potential wetlands. Ground-based wetland surveys will be conducted along the proposed power line in summer 2014 (see Section 9.0). • No wetlands were identified within or adjacent to the Kingsvale Pump Station during the helicopter reconnaissance and satellite imagery review. As a result, a ground-based wetland survey was determined not to be required for the station. • There are no Ramsar Wetlands of International Importance (Bureau of the Convention on Wetlands 2013), IBAs (Bird Studies Canada and Nature Canada 2012), Western Hemisphere Shorebird Reserves (WHSRN 2013), Migratory Bird Sanctuaries (Environment Canada 2013b) or DUC Priority Areas (DUC 2013) located within the Wetland LSA surrounding the Kingsvale Pump Station and associated power line.

TABLE 6.1-13 Cont'd

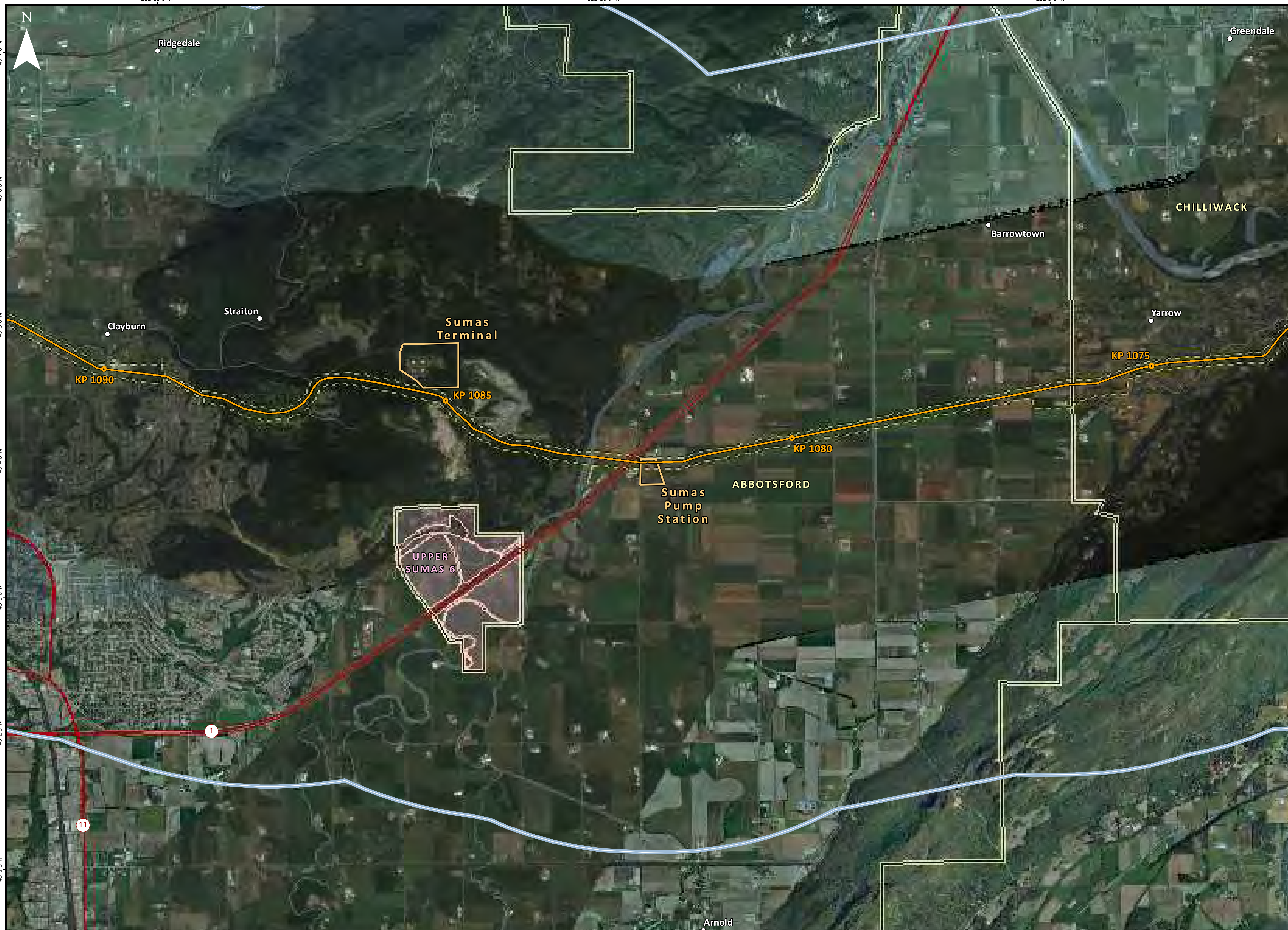
Environmental Elements	Summary of Considerations
Vegetation	• The Kingsvale Pump Station and associated power line are located within the Thompson-Okanagan Plateau Ecoregion, a component of the Montane Cordillera Ecozone of Canada. This ecoregion is characterized by Engelmann spruce, subalpine fir, lodgepole pine, ponderosa pine, white spruce, Douglas-fir and trembling aspen. Shrub and grass communities dominate open areas and forest understories (Ecological Stratification Working Group 1995). • The Kingsvale Pump Station and associated power line are located within the IDF BGC Zone of BC. The IDF BGC Zone is dominated by closed, mature forests of Douglas-fir. Mixed stands of Douglas-fir, lodgepole pine, ponderosa pine, white spruce, western redcedar and trembling aspen are also common. Grassland communities also occur in parts of the zone (Meidinger and Pojar 1991). • There are no national parks, provincial parks, provincial recreation areas, Environmentally Significant Areas or other protected areas located within the Vegetation LSA near the Kingsvale Pump Station or the associated power line. • Records of rare plant observations within 5 km of the Kingsvale Pump Station and associated power line were acquired from the BC CDC (2013) database. No provincially-listed (BC CDC) species records were found within the boundaries of the Vegetation LSA. • A ground-based vegetation survey of the Kingsvale Pump Station was conducted on July 22, 2013. Dominant communities observed during the 2013 vegetation survey at the Kingsvale Pump Station and associated power line consist of an upland conifer forest and a seeded area dominated by agronomic grasses. No rare plants or rare ecological communities were observed during the 2013 vegetation survey of the Kingsvale Pump Station. The associated power line is assumed to be on native vegetation based upon a review of satellite imagery, the professional judgement of the vegetation team and the adjacent land conditions. Mitigation contained in the Facilities EPP of Volume 6C is considered adequate for expected conditions and a supplemental vegetation survey conducted prior to construction will confirm the predictions of potential effects on the native vegetation in this area. • Consultation with local agricultural authorities was conducted to determine weed species of concern for the region. See Section 4.4 of the Vegetation Technical Report of Volume 5C for a summary of these communications. • During the 2013 vegetation survey, two Provincially Noxious weed species, Dalmatian toadflax and perennial sow-thistle, were observed. One Regionally Noxious weed species, ox-eye daisy, was observed.
Wildlife and Wildlife Habitat	• The Kingsvale Pump Station and the associated power line do not lie within an LRMP region (BC MFLNRO 2008a). • The Kingsvale Pump Station is located on industrial and forested lands. Clearing of forested lands will be required for the Kingsvale Pump Station and the associated power line. Dominant communities consist of an upland conifer forest and a seeded area dominated by agronomic grasses. • The Kingsvale Pump Station and the associated power line are not located within or adjacent to any provincial parks or protected areas (BC MFLNRO 2008b), IBAs (Bird Studies Canada and Nature Canada 2012), Migratory Bird Sanctuaries (Environment Canada 2013b), National Wildlife Areas (Environment Canada 2013b), Western Hemisphere Shorebird Reserves (WHSRN 2013), Ramsar Wetlands of International Importance (Bureau of the Convention on Wetlands 2013), World Biosphere Reserves (UNESCO 2013) or designated caribou range (BC MOE 2008). • The Kingsvale Pump Station is adjacent (north, east and south sides) to ungulate winter range (u-3-003) for mule deer (BC MOE 2005a). • The power line crosses ungulate winter range (u-3-003) for mule deer in four different locations for a total of approximately 6.2 km (BC MOE 2005a). • The power line crosses a wildlife habitat area (WHA 3-143) for Williamson's sapsucker for approximately 1 km (BC MOE 2005b). The proposed power line is also located approximately 0.1 km, 0.9 km and 1.3 km from three other Williamson's sapsucker wildlife habitat areas (WHAs 3-142, 3-095 and 3-130 respectively) (BC MOE 2005b). • The Kingsvale Pump Station and the associated power line are not located in a DUC Priority Area (DUC 2013). • The Kingsvale Pump Station is located in WMU 3-13 (BC ILMB 2006). The power line crosses WMU 3-13, WMU 8-5 and WMU 8-6 (BC ILMB 2006). • A ground-based wildlife habitat reconnaissance for the Kingsvale Pump Station and the associated power line was conducted on August 17, 2013. The habitat reconnaissance did not identify any features of concern (see the Wildlife Technical Report of Volume 5C for further details). The habitat reconnaissance was limited by land access. • A supplemental wildlife survey will be conducted for both the Kingsvale Pump Station and associated power line (see Section 9.0).

TABLE 6.1-13 Cont'd

Environmental Elements	Summary of Considerations
Species at Risk or Species of Special Status and Related Habitat	• Bull trout is considered a species of Special Concern under COSEWIC (2013) and may be found in the Lower Nicola and Similkameen river watersheds (Table 4.5 of the Fisheries [British Columbia] Technical Report of Volume 5C). • Records of rare plant observations within 5 km of the Kingsvale Pump Station and the associated power line were acquired from the BC CDC (2013) database. No federally-listed (*SARA* or COSEWIC) species records were found within these boundaries. • Based on known species range and habitat preferences, the following federally-listed (*SARA* Schedule 1 or COSEWIC) or provincially-listed (Red, Blue, or under BC's *Wildlife Act*) wildlife species were identified as having the potential to occur in the vicinity of the Kingsvale Pump Station and associated power line (BC MOE 2013b, COSEWIC 2013, Environment Canada 2012): – common nighthawk (*SARA*: Threatened, COSEWIC: Threatened, provincial: Yellow); – Williamson's sapsucker (*SARA*: Endangered, COSEWIC: Endangered, provincial: Blue); – American badger (*SARA*: Endangered, COSEWIC: Endangered, provincial: Red); – fringed myotis (provincial: Blue); – gopher snake (*deserticola* subspecies) (*SARA*: Threatened, COSEWIC: Threatened, provincial: Blue); – rubber boa (*SARA*: Special Concern, COSEWIC: Special Concern, provincial: Yellow); and – western toad (*SARA*: Special Concern, COSEWIC: Special Concern, provincial: Blue). • A search of the BC CDC database did not identify any federally-listed (*SARA* Schedule 1 or COSEWIC) or provincially-listed (Red, Blue, or under BC's *Wildlife Act*) wildlife species within 2 km of the Kingsvale Pump Station or the associated power line (BC CDC 2012, 2013). • A ground-based wildlife habitat reconnaissance for the Kingsvale Pump Station and the associated power line was conducted on August 17, 2013. The habitat reconnaissance did not identify any features of concern (see the Wildlife Technical Report of Volume 5C for further details). The habitat reconnaissance was limited by land access. • A supplemental wildlife survey will be conducted for both the Kingsvale Pump Station and associated power line (see Section 9.0). • Given that new clearing of previously undisturbed lands will be required for the Kingsvale Pump Station and the associated power line, both the Kingsvale Pump Station and the associated power line have the potential to have suitable habitat for wildlife and plant species at risk.

6.1.14 Sumas Pump Station

The existing Sumas Pump Station is located at c-073-B/092-G-01 at RK 1114.2 on lands owned by Trans Mountain in the municipal boundary of the City of Abbotsford. Current land use at this facility site is industrial. All work will be conducted within the existing disturbed fenced area. No disturbance of previously undisturbed lands is proposed at the Sumas Pump Station. One new 2,500 HP pump unit will be installed at the site serving the Puget Sound line. Access to the Sumas Pump Station is via Highway 1. Table 6.1-14 provides a summary of the environmental elements and considerations for the Sumas Pump Station pursuant to Guide A.2.4 and Table A-2 of the NEB *Filing Manual*. The location of the Sumas Pump Station is shown on Figure 6.1-14.



TRANS MOUNTAIN

FIGURE 6.1-14

SUMAS PUMP STATION

TRANS MOUNTAIN EXPANSION PROJECT

- Kilometre Post (KP)
- Hamlet / Village / Community
- Trans Mountain Pipeline (TMPL)
- Trans Mountain Expansion Project Proposed Pipeline Corridor
- Subject Property Facility Boundary
- Acoustic Environment RSA
- Highway
- Paved Road
- Railway
- City / Town
- Indian Reserve / Métis Settlement

Projection: NAD 1983 UTM Zone 10N. Routing: Baseline TMPL & Facilities: provided by KMC 2012; Proposed Pipeline Corridor V6: provided by UPI Aug. 23, 2013; Transportation: IHS Inc., 2013, Natural Resources Canada, 2011; Geopolitical Boundaries: Natural Resources Canada, 2003, Altalis, 2012, IHS Inc., 2011, ESRI, 2005; First Nation Lands: Government of Canada, 2013; Parks and Protected Areas: Natural Resources Canada, 2013, Altalis, 2013, Alberta Tourism, Parks and Recreation, 2012, BC FLNRO, 2008; Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

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Although there is no reason to believe that there are any errors associated with the data used to generate this product or in the product itself, users of these data are advised that errors in the data may be present.

MAP NUMBER		PAGE
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DATE: December 2013	TERA REF.: 7894	REVISION: 0
SCALE: 1:50,000	PAGE SIZE: 11x17	DISCIPLINE: ESA
DRAWN: AJS	CHECKED: HS	DESIGN: TGG

0 500 1,000 1,500 2,000 m

ALL LOCATIONS APPROXIMATE

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TABLE 6.1-14

SUMMARY OF ENVIRONMENTAL ELEMENTS AND CONSIDERATIONS FOR THE SUMAS PUMP STATION

Environmental Elements	Summary of Considerations
Physical and Meteorological Environment	• The Sumas Pump Station is located within the Cascade Mountains Physiographic Region, which is characterized by rugged mountain ranges, steeply incised tributary valleys, wide U-shaped main valleys, relict glacial landforms, terraces, fans, cones, steep slopes, fluvial plains and small basins (Demarchi 2011, Holland 1976). • The Sumas Pump Station may be underlain by a variety of rock types of volcanic or sedimentary origin in addition to metamorphic rocks such as gneiss and schist (BGC Engineering Inc. 2013c). • The surficial geology beneath the site is mapped as lacustrine deposits consisting of silt, clayey silt and silty clay up to 15 m thick but normally less than 3 m thick overlying sand (Armstrong 1961). • There are no areas of permafrost within the area of the Sumas Pump Station (refer to Section 5.1.1). • No areas of potential terrain instability are known to occur in the vicinity of the Sumas Pump Station. • No volcanoes (NRCan 2010e) have been recorded in the vicinity of the Sumas Pump Station. • The site is located in a zone of high seismic activity (NRCan 2010a). Peak ground acceleration with a 1:2475 annual probability of exceedance is between 0.4 and 0.5 g (NRCan 2013a). Several known and suspected post-glacial faults lie near the pump station. Major earthquakes (up to and over magnitude 7) have occurred in the Coast Mountains and Cascade Ranges around the pump station (NRCan 2013b). Refer to the Seismic Assessment Desktop Study of Volume 4A for additional information. • There is a large earthen dike surrounding the Sumas Pump Station as protection against flooding of the Fraser River. The topography within the dike is flat and the elevation is approximately 9 m above sea level. • Where activities are planned within the Sumas Pump Station, soils have been disturbed for industrial use and construction of the new infrastructure will be conducted within the boundaries of the existing station. NRCan considers unprotected soils in the vicinity of the Sumas Pump Station to have moderate wind erosion risk with low climatic sensitivity (NRCan 2010d). • A description of the climate for the Coastal Western Hemlock (CWH) BGC Zone is provided in Section 5.1.3. • Meteorological data from Environment Canada's Chilliwack Station, located approximately 20 km northeast of the Sumas Pump Station, are provided in Section 5.1.4. • No major tornadoes or hailstorms have been recorded in the vicinity of the Sumas Pump Station (NRCan 2010b,c).
Soil and Soil Productivity	• Activities at the Sumas Pump Station will be conducted within an existing fenced, industrial site lacking topsoil and, therefore, detailed soil information is not warranted as per Table A-2 of the NEB *Filing Manual*. • The CLI has not rated the soils in the vicinity of the Sumas Pump Station. • Historical spills have been recorded at the Sumas Pump Station. Soils to be disturbed will be tested prior to construction. If contamination is encountered during construction, the Contamination Discovery Contingency Plan (Appendix B of the Facilities EPP of Volume 6C) will be implemented. • Potential soil contaminants of concern include gasoline, diesel fuel, lubricants and hydraulic fuels.
Water Quality and Quantity	• The Sumas Pump Station is located in the Chilliwack River Watershed of the Fraser River Basin. • No work will occur within 30 m of any waterbodies and, therefore, detailed information on surface water quality and quantity is not warranted as per Table A-1 of the NEB *Filing Manual*. • The terrain at the Sumas Pump Station is level and considered relatively stable. A high water table is noted in the area. • The surficial geology beneath the site is mapped as lacustrine deposits consisting of silt, clayey silt and silty clay up to 15 m thick but normally less than 3 m thick overlying sand (Armstrong 1961). • One water supply well is located on the site (ID # 15012), but its current use is unknown. One other well is located within the Water Quality and Quantity LSA. • The Sumas Pump Station overlies the Sumas Prairie Aquifer, Aquifer #21, a moderately vulnerable aquifer (BC MOE 2013a).
Air Emissions	• All existing pumps are electrically driven and are not direct sources of CACs. • Fugitive VOC emissions from leaks at the Sumas Pump Station are estimated to be 7.8 tonnes per year. • Air quality around the area of the Sumas Pump Station is described as part of the Project settings for the Sumas Terminal Air Quality RSA (see Table 6.1-15).
Greenhouse Gas Emissions	• Indirect GHG emissions due to electric power consumption by the existing pumps at the Sumas Pump Station are the main emissions. These include emissions from fossil fuel combustion, unallocated energy from power line losses, metering differences and other losses, and emissions of SF_6 from gas handling and transferring operations, electrical equipment operation, and from equipment mechanical failures. • Small amounts of direct GHG emissions will be released due to the space heating of the existing buildings at the Sumas Pump Station. • Small amounts of indirect GHG emissions will be released due to electricity use for equipment other than pumps. • Small amounts of GHG emissions will be released from the motor vehicles used by field staff and contractors.

TABLE 6.1-14 Cont'd

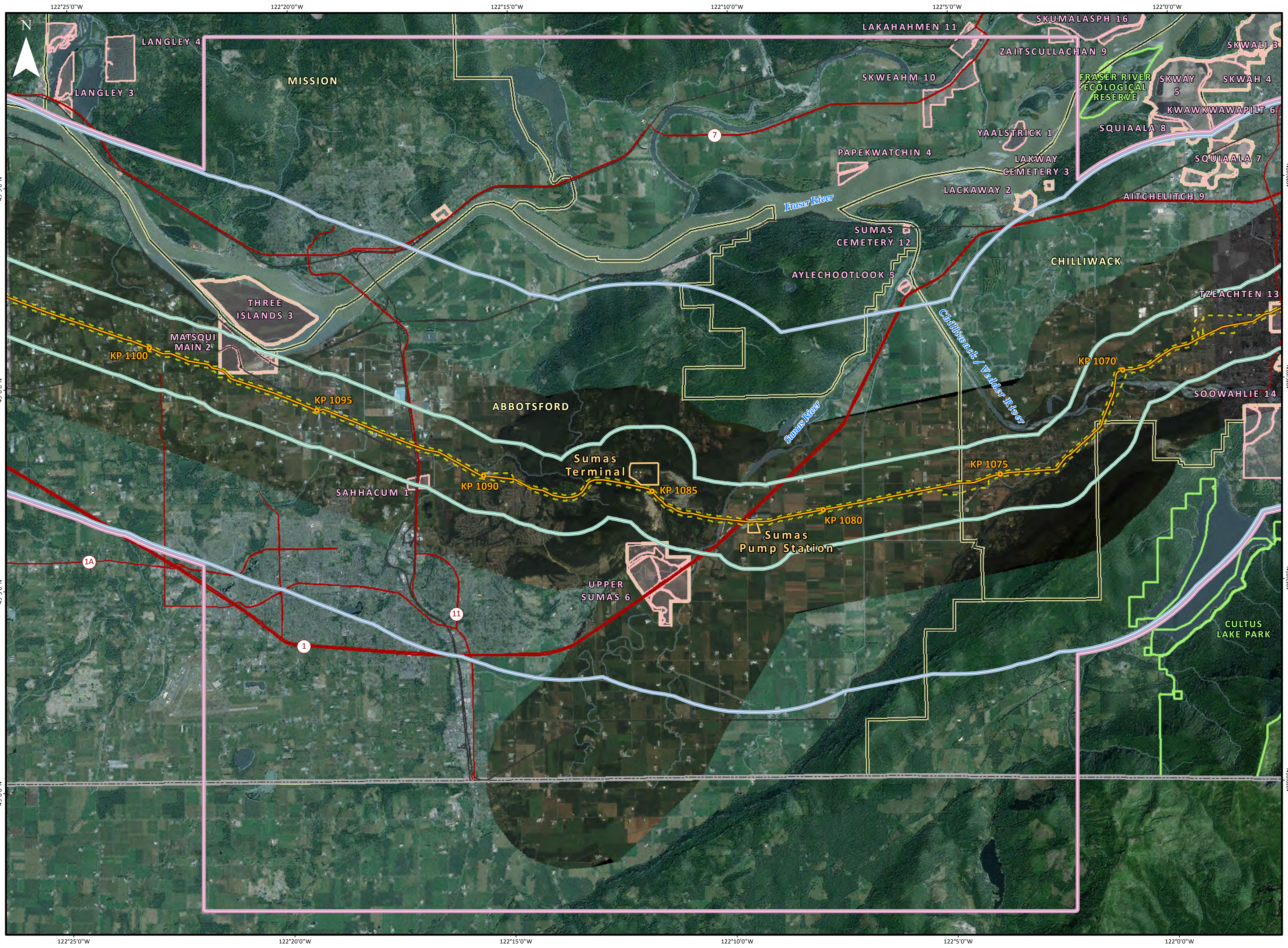
Environmental Elements	Summary of Considerations
Acoustic Environment	• Sources of existing sound in the Acoustic Environment LSA are traffic travelling along Highway 1, agricultural activities and natural sound (*e.g.*, wind, wildlife). • Receptors were identified within the Acoustic Environment LSA. The nearest receptor is located approximately 110 m to the southwest of the fenceline of the Sumas Pump Station. • ASL in the absence of regulated energy facilities ranges between 35-45 dBA at night and 45-55 dBA during the day based on BC OGC *Noise Control Best Practices Guideline* (BC OGC 2009). • A measurement program was conducted at both the facility and representative ambient sound level at receptors surrounding the facility. The results of the receptor-based program gave a range of values between 52-54 dBA during the nighttime and 54-55 dBA during daytime. • A measurement program to define sound emissions from the existing facility was conducted. • A noise model was generated based on existing conditions observed and measurements of the major on-site sources of sound. Specifications of equipment not operating during the site visit were used to estimate sound levels. Applicable buildings and shelters were modelled along with the appropriate insertion losses and screening effects. • The noise modelling results indicate that sound from the existing Sumas Pump Station complies with the BC OGC *Noise Control Best Practices Guideline* permissible sound levels for all surrounding receptors. • Contoured noise prediction results are available in the Terrestrial Noise and Vibration Technical Report of Volume 5C.
Fish and Fish Habitat	• The Sumas Pump Station is located in the Chilliwack River Watershed of the Fraser River Basin. • No work will occur within 30 m of any fish-bearing waterbodies and, therefore, detailed information on fish and fish habitat is not deemed warranted as per Table A-1 of the NEB *Filing Manual*.
Wetland Loss or Alteration	• The Sumas Pump Station is located within the Lower Mainland Ecoregion, a component of the Pacific Maritime Ecozone of Canada. Wetter areas are characterized by Douglas-fir, western hemlock and western redcedar. Coastal salt marshes are located on the Fraser River delta and along Boundary Bay (Ecological Stratification Working Group 1995). • The Sumas Pump Station is also located within the Intermountain Prairie Wetland Region. Wetlands characteristic of this region include marshes bordering fresh to saline ephemeral or semi-permanent shallow waters (Government of Canada 1986). • The Sumas Pump Station is located within the CWH BGC Zone of BC. In this BGC Zone, wetlands are often found in depressions, around open water, small streams and drainage channels. Wetlands types include fens, marshes as well as shrubby swamps (BC MOF 1999, Meidinger and Pojar 1991). • Wetlands provide habitat for native plants and wildlife species, including nesting and foraging habitat for bird species as well as provide storage and natural filtering of water. • No wetlands were identified within or adjacent to the Sumas Pump Station during the helicopter reconnaissance and satellite imagery review. As a result, a ground-based wetland survey was determined not to be required. • There are no Ramsar Wetlands of International Importance (Bureau of the Convention on Wetlands 2013), IBAs (Bird Studies Canada and Nature Canada 2012), Western Hemisphere Shorebird Reserves (WHSRN 2013) or Migratory Bird Sanctuaries (Environment Canada 2013b) located within the Wetland LSA surrounding the Sumas Pump Station. • The Sumas Pump Station is located in a DUC Level 2 Priority Area, the BC Coastal Areas and Estuaries (DUC 2013).
Vegetation	• The Sumas Pump Station is located within the Lower Mainland Ecoregion, a component of the Pacific Maritime Ecozone of Canada. This ecoregion is characterized by forests of Douglas-fir, western hemlock and western redcedar. Understories of shrubs, vines and moss are common in mature forests. Arbutus and dogwood communities are common on drier sites (Ecological Stratification Working Group 1995). • The Sumas Pump Station is located within the CWH BGC Zone of BC which is dominated by western hemlock, with western redcedar and Douglas-fir frequent throughout the zone. Amabilis fir, yellow-cedar, shore pine, grand fir, western white pine, bigleaf maple and black cottonwood are also common (Meidinger and Pojar 1991). • There are no national parks, provincial parks, provincial recreation areas, Environmentally Significant Areas or other protected areas located within the Vegetation LSA near the Sumas Pump Station. • Records of rare plant observations within 5 km of the Sumas Pump Station were acquired from the BC CDC (2013) database. No provincially-listed (BC CDC) species records were found within the boundaries of the Vegetation LSA. • It was determined with satellite imagery interpretation that no native vegetation would be directly disturbed within the site boundaries and, therefore, a ground-based vegetation survey was deemed unnecessary. • Consultation with local agricultural authorities was conducted to determine weed species of concern for the region. See Section 4.4 of the Vegetation Technical Report of Volume 5C for a summary of these communications.
Wildlife and Wildlife Habitat	• The Sumas Pump Station is not in an LRMP region (BC MFLNRO 2008a). • The Sumas Pump Station is located on industrial lands. • The Sumas Pump Station is not located within or adjacent to any parks or protected areas (BC MFLNRO 2008b), IBAs (Bird Studies Canada and Nature Canada 2012), Migratory Bird Sanctuaries (Environment Canada 2013b), National Wildlife Areas (Environment Canada 2013b), Western Hemisphere Shorebird Reserves (WHSRN 2013), Ramsar Wetlands of International Importance (Bureau of the Convention on Wetlands 2013), World Biosphere Reserves (UNESCO 2013), designated caribou range (BC MOE 2008), ungulate winter range (BC MOE 2005a), or Wildlife Habitat Areas (BC MOE 2005b). • The Sumas Pump Station is located in a DUC Level 2 Priority Area, the BC Coastal Areas and Estuaries (DUC 2013). • The Sumas Pump Station is located in WMU 2-4 (BC ILMB 2006).

TABLE 6.1-14 Cont'd

Environmental Elements	Summary of Considerations
Species at Risk or Species of Special Status and Related Habitat	• No work will occur within 30 m of any fish-bearing waterbodies and, therefore, detailed information on fish and fish species at risk is not deemed warranted as per Table A-1 of the NEB *Filing Manual*. • Records of rare plant observations within 5 km of the Sumas Pump Station were acquired from the BC CDC (2013) database. No federally-listed (*SARA* or COSEWIC) species records were found within these boundaries. • Based on known species range and habitat preferences, the following federally-listed (*SARA* Schedule 1 or COSEWIC) or provincially-listed (Red, Blue, or under BC's *Wildlife Act*) wildlife species were identified as having the potential to occur in the vicinity of the Sumas Pump Station (BC MOE 2013b, COSEWIC 2013, Environment Canada 2012): – California gull (provincial: Blue); – horned lark (*strigata* subspecies) (*SARA*: Endangered, COSEWIC: Endangered, provincial: Red); – short-eared owl (*SARA*: Special Concern, COSEWIC: Special Concern, provincial: S3B, S2N, Blue, Priority 2); – mountain beaver (*rufa* subspecies) (*SARA*: Special Concern, COSEWIC: Special Concern, provincial: Blue); and – Oregon forestsnail (*SARA*: Endangered, COSEWIC: Endangered, provincial: Red). • A search of the BC CDC database identified the following federally-listed (*SARA* Schedule 1 or COSEWIC) or provincially-listed (Red, Blue, or under BC's *Wildlife Act*) wildlife species within 2 km of the Sumas Pump Station (BC CDC 2012, 2013): – mountain beaver (*rufa* subspecies) (*SARA*: Special Concern, COSEWIC: Special Concern, provincial: Blue); and – Oregon forestsnail (*SARA*: Endangered, COSEWIC: Endangered, provincial: Red). • Given that the Sumas Pump Station is an existing facility and all work will occur within the existing fenced area on previously disturbed land, the Sumas Pump Station is not considered suitable habitat for wildlife or plant species at risk.

6.1.15 Sumas Terminal

The existing Sumas Terminal is located at a-097-B/092-G-01 at RK 1117.5 on lands owned by Trans Mountain in the municipal boundaries of the City of Abbotsford. Current land use at this facility site is industrial and undisturbed forested lands. The proposed activities are within the existing Sumas Terminal property boundary, however, the existing fenceline will be moved approximately 20 m north (0.7 ha of new disturbance). One new 27,820 m^3 (175,000 bbl) storage tank will be installed at the Sumas Terminal. Access to the Sumas Terminal is via Highway 1. Table 6.1-15 provides a summary of the environmental elements and considerations for the Sumas Terminal pursuant to Guide A.2.4 and Table A-2 of the NEB *Filing Manual*. The location of the Sumas Terminal is shown on Figure 6.1-15.



TRANS MOUNTAIN

FIGURE 6.1-15

SUMAS TERMINAL

TRANS MOUNTAIN EXPANSION PROJECT

- Kilometre Post (KP)
- Trans Mountain Pipeline (TMPL)
- Trans Mountain Expansion Project Proposed Pipeline Corridor
- Subject Property Facility Boundary
- Acoustic Environment RSA
- Vegetation RSA Boundary
- Air Quality RSA Boundary
- Highway
- Paved Road
- Railway
- City / Town
- National / Provincial Park
- Indian Reserve / Métis Settlement
- International Boundary

Projection: NAD 1983 UTM Zone 10N. Routing: Baseline TMPL & Facilities: provided by KMC 2012; Proposed Pipeline Corridor V6: provided by UPI Aug. 23, 2013; Transportation: IHS Inc., 2013, Natural Resources Canada, 2011; Geopolitical Boundaries: Natural Resources Canada, 2003, Altalis, 2012, IHS Inc., 2011, ESRI, 2005; First Nation Lands: Government of Canada, 2013; Parks and Protected Areas: Natural Resources Canada, 2013, Altalis, 2013, Alberta Tourism, Parks and Recreation, 2012, BC FLNRO, 2008; Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

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MAP NUMBER		PAGE
201310_MAP_TERA_SE_00442_REV0_16		SHEET 15 OF 16
DATE December 2013	TERA REF. 7894	REVISION 0
SCALE 1:100,000	PAGE SIZE 11x17	DISCIPLINE ESA
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0 1 2 3 4 km

ALL LOCATIONS APPROXIMATE

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TABLE 6.1-15

SUMMARY OF ENVIRONMENTAL ELEMENTS AND CONSIDERATIONS FOR THE SUMAS TERMINAL

Environmental Elements	Summary of Considerations
Physical and Meteorological Environment	• The Sumas Terminal is located within the Georgia Depression Physiographic Region, which is characterized by a flat valley floor 1-5 km wide, steep valley walls, gently rolling uplands and ridges, gently rolling to flat lowlands of terraces and plains, and deltas (Armstrong 1984, Holland 1976). • The Sumas Terminal is likely underlain by coarse-grained clastic and volcanic rock types (BGC Engineering Inc. 2013c). • The surficial geology beneath the site is mapped as bedrock within 7.6 m of surface covered by drift (likely Sumas till) (Armstrong 1961). • There are no areas of permafrost within the area of the Sumas Terminal (refer to Section 5.1.1). • No areas of potential terrain instability are known to occur in the vicinity of the Sumas Terminal. • No volcanoes (NRCan 2010e) have been recorded in the vicinity of the Sumas Terminal. • The site is located in a zone of high seismic activity (NRCan 2010a). Peak ground acceleration with a 1:2475 annual probability of exceedance is between 0.4 g and 0.5 g (NRCan 2013a). Several known and suspected post-glacial faults lie near the pump station. Major earthquakes (up to and over magnitude 7) have occurred in the Coast Mountains and Cascade Ranges around the pump station (NRCan 2013b). Refer to the Seismic Assessment Desktop Study of Volume 4A for additional information. • The topography in the area of the Sumas Terminal is sloping from north (high) to south (low) and the elevation is approximately 200 m above sea level. • Where activities are planned within the Sumas Terminal, construction of the new infrastructure will be conducted within the boundaries of the existing station, however, the existing fenceline will be moved approximately 20 m north in forested lands to accommodate a new access road and earthworks associated with the new storage tank. NRCan considers unprotected soils in the vicinity of the Sumas Terminal to have moderate wind erosion risk with low climatic sensitivity (NRCan 2010d). • A description of the climate for the CWH BGC Zone is provided in Section 5.1.3. • The following meteorological data were obtained from an Environment Canada meteorological station (1100030) at Abbotsford Airport (Environment Canada 2013a). The data were taken approximately 15 km southwest of the Sumas Terminal. – Average monthly rainfall for Abbotsford Airport is 123.6 mm and the average monthly rainfall from November to March is 174.9 mm. In November of 1971, Abbotsford Airport recorded its highest daily rainfall of 95 mm, which is well below the monthly average of 241.5 mm for the month of November. – Average monthly snowfall for Abbotsford Airport is 4.6 cm and the average monthly snowfall from November to March is 10.9 cm. In January of 1954, Abbotsford Airport recorded its highest daily snowfall of 49.8 cm, well above the 18.5 cm average for the month of January. – Average daily temperature for Abbotsford Airport is 10.4°C, with the warmest month in August averaging 18.2°C and coolest month in December, averaging 2.9°C. In July of 2009, Abbotsford Airport experienced its warmest day of 38°C and in January of 1950, its coolest day at -21.1°C. • No major tornadoes or hailstorms have been recorded in the vicinity of the Sumas Terminal (NRCan 2010b,c).
Soil and Soil Productivity	• Current land use at the Sumas Terminal is industrial and undisturbed forested lands. The proposed activities are within the existing Sumas Terminal property boundary, however, the existing fenceline will be moved approximately 20 m north. The Sumas Terminal has been previously disturbed and contains tanks, buildings and other equipment. • The CLI has not rated the soils in the vicinity of the Sumas Terminal. • Historical spills have occurred at the Sumas Terminal and soils to be disturbed will be tested prior to construction. If contamination is encountered during construction, the Contamination Discovery Contingency Plan (Appendix B of the Facilities EPP of Volume 6C) will be implemented. • Potential soil contaminants of concern include gasoline, diesel fuel, lubricants and hydraulic fuels.
Water Quality and Quantity	• The Sumas Terminal is located in the Chilliwack River Watershed of the Fraser River Basin. • No work will occur within 30 m of any watercourse, however, there is a potential shrubby swamp associated with an ephemeral drainage outside of the Sumas Terminal boundary that will be confirmed during supplemental surveys in 2013. • Hydrostatic testing is planned for the piping and new tank to be installed within the Sumas Terminal. Water may be withdrawn and released from Trans Mountain's existing fire water pond at the Sumas Terminal. Alternatively, test water may be diverted from a nearby river or creek, subject to obtaining a water withdrawal permit, or purchased from municipalities depending on availability from natural sources. Following testing, water will be tested for contaminants before being treated and either discharged back into the fire water pond, trucked away, or released to a natural waterbody or the municipal sewer system. • The terrain at the Sumas Terminal is sloped. Groundwater flow direction is inferred to be to the southeast (SNC Lavalin Inc. 2013). • The surficial geology beneath the site is mapped as bedrock within 7.6 m of the surface covered by drift (likely Sumas till) (Armstrong 1961). The site is located over a topographic divide with drainage flowing to the south-southwest on the southern half of the site and to the northeast on the northern half of the site. • Three water supply wells are located within the site boundaries (ID # 6686, #67529 and #75552), though their uses have not been confirmed. • Nine wells are located within the Water Quality and Quantity LSA.

TABLE 6.1-15 Cont'd

Environmental Elements	Summary of Considerations
Water Quality and Quantity (cont'd)	• Groundwater levels are expected to be approximately 8-15 m bgl based on local monitoring wells. Depth to groundwater ranged from 1.6-4.2 m bgl. • The Sumas Terminal does not overlie any mapped aquifers (BC MOE 2013a). • Studies conducted by SNC Lavalin Inc. (2013) following the release of 90,000 L of light crude oil from an above ground storage tank indicate that the release was contained within the bermed containment area around the above ground storage tank. Hydrocarbons were detected in three wells at less than guideline concentrations. In addition, aluminum and cadmium were detected at concentrations exceeding the aquatic life guideline in three and two wells respectively. • Groundwater samples collected from five perimeter monitoring wells by Golder Associates (2013) showed analytical results to be all less than the reporting limit suggesting no off-site migration of hydrocarbons.
Air Emissions	• Continuous VOC, H_2S and mercaptan emissions are primarily due to standing and working losses from existing product storage tanks at the Sumas Terminal. • Fugitive emissions from leaks are expected to be a small contributor relative to emissions from existing tanks. • All existing pumps are electrically driven and are not direct sources of CACs. • CAC and VOC emissions from regular testing of emergency diesel generators and fire water pumps are infrequent. • The largest sources of CAC emissions, except PM, in the Air Quality RSA are on-road motor vehicle traffic, non-road engines and aircraft. The largest sources of PM emissions in the area are road dust, and agricultural and construction activities. The largest sources of VOC emissions are solvent evaporation and natural sources. • Predicted VOC, H_2S and mercaptan concentrations in the Air Quality RSA due to existing operations at the Sumas Terminal and other existing natural and anthropogenic sources are presented in the Air Quality and Greenhouse Gas Technical Report of Volume 5C. Maximum concentrations are expected to be below BC ambient air quality objectives and published odour thresholds.
Greenhouse Gas Emissions	• Indirect GHG emissions due to electric power consumption by the existing pumps at the Sumas Terminal are the main emissions. These include emissions from fossil fuel combustion, unallocated energy from power line losses, metering differences and other losses, and emissions of SF_6 from gas handling and transferring operations, electrical equipment operation, and from equipment mechanical failures. • Products handled and stored in existing tanks contain trace levels of GHGs; small amounts might be released through fugitive or process emissions (*e.g.*, CH_4 and formation CO_2). • Small amounts of direct GHG emissions will be released due to the space heating of the existing buildings at the Sumas Terminal. • Small amounts of indirect GHG emissions will be released due to electricity use for equipment other than pumps. • Small amounts of GHG emissions will be released from the motor vehicles used by operations/maintenance staff.
Acoustic Environment	• Sources of existing sound in the Acoustic Environment LSA are aggregate facilities (borrow pits) located to the south and southeast of the site, local traffic, and natural sound (*e.g.*, wind, wildlife). • Receptors were identified within the Acoustic Environment LSA. The nearest receptor is located approximately 60 m south of the fenceline of the Sumas Terminal. • ASL in the absence of regulated energy facilities is approximately 35-38 dBA at night and 45-48 dBA during the day based on BC OGC *Noise Control Best Practices Guideline* (BC OGC 2009). • A measurement program to define sound emissions from the existing facility was conducted. • A noise model was generated based on existing conditions and measurements of the major sources of sound. Specifications of non-operating equipment during the site visit were used to estimate sound levels. Applicable buildings and shelters were modelled along with their appropriate insertion losses and screening effects. • The noise modelling results indicate that sound from the existing Sumas Terminal is expected to comply with the BC OGC *Noise Control Best Practices Guideline* for permissible sound levels for all surrounding receptors. • Contoured noise prediction results are available in the Terrestrial Noise and Vibration Technical Report of Volume 5C.
Fish and Fish Habitat	• The Sumas Terminal is located in the Chilliwack River Watershed of the Fraser River Basin. • Hydrostatic testing is planned for the piping and new tank to be installed within the Sumas Terminal. Water may be withdrawn and released from Trans Mountain's existing fire water pond at the Sumas Terminal. Alternatively, test water may be diverted from a nearby river or creek, subject to obtaining a water withdrawal permit, or purchased from municipalities depending on availability from natural sources. • All five BC indicator species (*i.e.,* bull trout/Dolly Varden, Chinook salmon, coho salmon, cutthroat trout and rainbow trout/steelhead) are found in the Chilliwack River Watershed. • White sturgeon (Endangered under *SARA*, Threatened under COSEWIC for the Lower Fraser River population [2013a] and Red-listed [BC CDC 2013]), Salish sucker (Endangered under *SARA*, and provincially Red-listed [BC CDC 2013]), bull trout (Blue-listed [BC CDC 2013] and Special Concern under COSEWIC [2013a]), coho salmon (Endangered under COSEWIC for the interior Fraser River population [COSEWIC 2013a] and sockeye salmon (Endangered under COSEWIC [2013a] for the Cultus Lake population) are known to occur in the Chilliwack River Watershed.
Wetland Loss or Alteration	• The Sumas Terminal is located within the Lower Mainland Ecoregion, a component of the Pacific Maritime Ecozone of Canada. Wetter areas are characterized by Douglas-fir, western hemlock and western redcedar. Coastal salt marshes are located on the Fraser River delta and along Boundary Bay (Ecological Stratification Working Group 1995). • The Sumas Terminal is also located within the Intermountain Prairie Wetland Region. Wetlands characteristic of this region include marshes bordering fresh to saline ephemeral or semi-permanent shallow waters (Government of Canada 1986).

TABLE 6.1-15 Cont'd

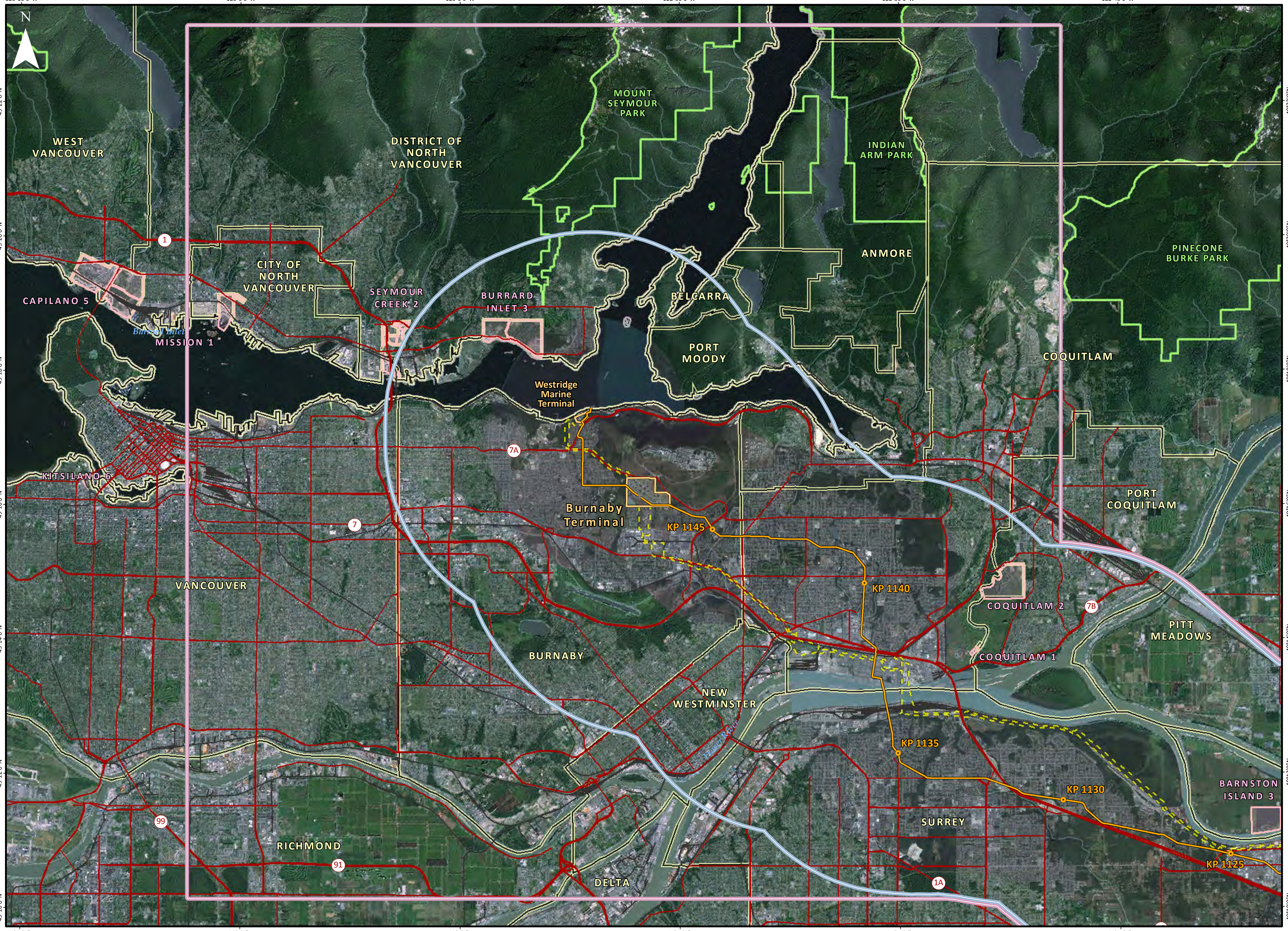
Environmental Elements	Summary of Considerations
Wetland Loss or Alteration (cont'd)	• The Sumas Terminal is located within the CWH BGC Zone of BC. In this BGC Zone, wetlands are often found in depressions, around open water, small streams and drainage channels. Wetlands types include fens, marshes as well as shrubby swamps (BC MOF 1999, Meidinger and Pojar 1991). • Wetlands provide habitat for native plants and wildlife species, including nesting and foraging habitat for bird species as well as provide storage and natural filtering of water. • No wetlands were identified within to the Sumas Terminal during the helicopter reconnaissance and satellite imagery review. However, there is a potential shrubby swamp associated with an ephemeral drainage outside of the Sumas Terminal boundary that will need to be confirmed during supplemental surveys in 2013. There are no Ramsar Wetlands of International Importance (Bureau of the Convention on Wetlands 2013), IBAs (Bird Studies Canada and Nature Canada 2012), Western Hemisphere Shorebird Reserves (WHSRN 2013) or Migratory Bird Sanctuaries (Environment Canada 2013b) located within the Wetland LSA surrounding the Sumas Terminal. • The Sumas Terminal is located within a DUC Level 2 Priority Area, the BC Coastal Areas and Estuaries (DUC 2013).
Vegetation	• The Sumas Terminal is located within the Lower Mainland Ecoregion, a component of the Pacific Maritime Ecozone of Canada. This ecoregion is characterized by forests of Douglas-fir, western hemlock and western redcedar. Understories of shrubs, vines and moss are common in mature forests. Arbutus and dogwood communities are common on drier sites (Ecological Stratification Working Group 1995). • The Sumas Terminal is located within the CWH BGC Zone of BC. The CWH BGC Zone is dominated by western hemlock, with western redcedar and Douglas-fir frequent throughout the zone. Amabilis fir, yellow-cedar, shore pine, grand fir, western white pine, bigleaf maple and black cottonwood are also common (Meidinger and Pojar 1991). • There are no national parks, provincial parks, provincial recreation areas, Environmentally Significant Areas or other protected areas located within the Vegetation LSA near the Sumas Terminal. • Records of rare plant observations within 5 km of the Sumas Terminal were acquired from the BC CDC (2013) database. No provincially-listed (BC CDC) species records were found within the boundaries of the Vegetation LSA. • The proposed expansion of the Sumas Terminal is assumed to be on native vegetation based upon a review of satellite imagery and the professional judgement of the vegetation team. Mitigation contained in the Facilities EPP of Volume 6C is considered adequate for expected conditions and a supplemental vegetation survey conducted prior to construction will confirm the predictions of potential effects on the native vegetation in this area. • Consultation with local agricultural authorities was conducted to determine weed species of concern for the region. See Section 4.4 of the Vegetation Technical Report of Volume 5C for a summary of these communications.
Wildlife and Wildlife Habitat	• The Sumas Terminal is located in the City of Abbotsford in the Fraser Valley Regional District (FVRD). • The expansion will occur onto industrial and undisturbed forested lands and clearing will be required. • The Sumas Terminal is not located within or adjacent to any provincial parks or protected areas (BC MFLNRO 2008b), IBAs (Bird Studies Canada and Nature Canada 2012), Migratory Bird Sanctuaries (Environment Canada 2013b), National Wildlife Areas (Environment Canada 2013b), Western Hemisphere Shorebird Reserves (WHSRN 2013), Ramsar Wetlands of International Importance (Bureau of the Convention on Wetlands 2013), World Biosphere Reserves (UNESCO 2013), designated caribou range (BC MOE 2008), ungulate winter range (BC MOE 2005a), or Wildlife Habitat Areas (BC MOE 2005b). • The Sumas Terminal is located in a DUC Level 2 Priority Area, the BC Coastal Areas and Estuaries (DUC 2013). • The Sumas Terminal is located in WMU 2-4 (BC ILMB 2006). • A supplemental wildlife survey will be conducted in 2014 (see Section 9.0).
Species at Risk or Species of Special Status and Related Habitat	• White sturgeon (Endangered under *SARA* and Threatened under COSEWIC for the Lower Fraser River population [2013a]), Salish sucker (Endangered under *SARA*), bull trout (Special Concern under COSEWIC [2013a]), coho salmon (Endangered under COSEWIC for the interior Fraser River population [COSEWIC 2013a] and sockeye salmon (Endangered under COSEWIC [2013a] for the Cultus Lake population) are known to occur in the Chilliwack River Watershed. • Records of rare plant observations within 5 km of the Sumas Terminal were acquired from the BC CDC (2013) database. No federally-listed (*SARA* or COSEWIC) species records were found within these boundaries. • A supplemental wildlife survey will be conducted in 2014 (see Section 9.0). • Based on known species range and habitat preferences, the following federally-listed (*SARA* Schedule 1 or COSEWIC) or provincially-listed (Red, Blue, or under BC's *Wildlife Act*) wildlife species were identified as having the potential to occur in the vicinity of the Sumas Terminal (BC MOE 2013b, COSEWIC 2013, Environment Canada 2012): – common nighthawk (*SARA*: Threatened, COSEWIC: Threatened, provincial: Yellow); – mountain beaver (*rufa* subspecies) (*SARA*: Special Concern, COSEWIC: Special Concern, provincial: Blue); – olympic shrew (provincial: Red); – Pacific water shrew (*SARA*: Endangered, COSEWIC: Endangered, provincial: Red); – southern red-backed vole (*occidentalis* subspecies) (provincial: Red); – Townsend's big-eared bat (provincial: Blue); – Trowbridge's shrew (provincial: Blue); – rubber boa (*SARA*: Special Concern, COSEWIC: Special Concern, provincial: Yellow); – coastal tailed frog (*SARA*: Special Concern, COSEWIC: Special Concern, provincial: Blue); and – Oregon forestsnail (*SARA*: Endangered, COSEWIC: Endangered, provincial: Red).

TABLE 6.1-15 Cont'd

Environmental Elements	Summary of Considerations
Species at Risk or Species of Special Status and Related Habitat (cont'd)	• A search of the BC CDC database identified the following federally-listed (*SARA* Schedule 1 or COSEWIC) or provincially-listed (Red, Blue, or under BC's *Wildlife Act*) wildlife species within 2 km of the Sumas Terminal (BC CDC 2012, 2013): – mountain beaver (*rufa* subspecies) (*SARA*: Special Concern, COSEWIC: Special Concern, provincial: Blue); and – Oregon forestsnail (*SARA*: Endangered, COSEWIC: Endangered, provincial: Red). • Given that the Sumas Terminal will require new clearing of previously undisturbed forested lands, the Sumas Terminal has the potential to be suitable habitat for wildlife and plant species at risk. A supplemental survey will be conducted in 2014 to confirm predictions relating to species at risk (see Section 9.0).

6.1.16 Burnaby Terminal

The existing Burnaby Terminal is located at a-025-D/092-G-07 at RK 1179.8 on lands owned by Trans Mountain in the municipal boundaries of the City of Burnaby. Current land use at this facility site is industrial. The proposed activities are within the existing Burnaby Terminal property boundary on previously disturbed industrial lands. Two new 39,750 m^3 (250,000 bbl) storage tanks, 10 new 45,310 m^3 (285,000 bbl) storage tanks and 2 new 53,260 m^3 (335,000 bbl) storage tanks will be installed at the Burnaby Terminal. An existing 12,720 m^3 (80,000 bbl) tank will be dismantled and replaced by one of the 45,310 m^3 (285,000 bbl) tanks. Access to the terminal is via Shellmont Street. Table 6.1-16 provides a summary of the environmental elements and considerations for the Burnaby Terminal pursuant to Guide A.2.4 and Table A-2 of the NEB *Filing Manual*. The location of the Burnaby Terminal is shown on Figure 6.1-16.



TRANS MOUNTAIN

FIGURE 6.1-16

BURNABY TERMINAL AND WESTRIDGE MARINE TERMINAL

TRANS MOUNTAIN EXPANSION PROJECT

- Kilometre Post (KP)
- Trans Mountain Pipeline (TMPL)
- Trans Mountain Expansion Project Proposed Pipeline Corridor
- Subject Property Facility Boundary
- Acoustic Environment RSA
- Air Quality RSA Boundary
- Highway
- Paved Road
- Railway
- City / Town
- National / Provincial Park
- Indian Reserve / Métis Settlement

Projection: NAD 1983 UTM Zone 10N. Routing: Baseline TMPL & Facilities: provided by KMC 2012; Proposed Pipeline Corridor V6: provided by UPI Aug. 23, 2013; Transportation: IHS Inc., 2013, Natural Resources Canada, 2011; Geopolitical Boundaries: Natural Resources Canada, 2003, Altalis, 2012, IHS Inc., 2011, ESRI, 2005; First Nation Lands: Government of Canada, 2013; Parks and Protected Areas: Natural Resources Canada, 2013, Altalis, 2013, Alberta Tourism, Parks and Recreation, 2012, BC FLNRO, 2008; Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

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MAP NUMBER		PAGE
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DATE December 2013	TERA REF. 7894	REVISION 0
SCALE 1:100,000	PAGE SIZE 11x17	DISCIPLINE ESA
DRAWN AJS	CHECKED HS	DESIGN TGG

0 1 2 3 4 km

ALL LOCATIONS APPROXIMATE

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TABLE 6.1-16

SUMMARY OF ENVIRONMENTAL ELEMENTS AND CONSIDERATIONS FOR THE BURNABY TERMINAL

Environmental Elements	Summary of Considerations
Physical and Meteorological Environment	• The Burnaby Terminal is located within the Georgia Depression Physiographic Region, which is characterized by a flat valley floor 1-5 km wide, steep valley walls, gently rolling uplands and ridges, gently rolling to flat lowlands of terraces and plains, and deltas (Armstrong 1984, Holland 1976). • The Burnaby Terminal is likely underlain by coarse-grained clastic and volcanic rock types (BGC Engineering Inc. 2013c). • The surficial geology beneath the site is mapped as Capilano sediments consisting of beach deposits of poorly-sorted sand to gravel normally less than 1 m thick (may be up to 8 m thick). The extreme northeast corner of the facility is underlain by tertiary bedrock (Armstrong and Hicock 1980). • There are no areas of permafrost within the area of the Burnaby Terminal (refer to Section 5.1.1). • Terrain instability has the potential to occur along ravine slopes located within the terminal site. Otherwise, no areas of potential terrain instability are known to occur in the vicinity of the Burnaby Terminal. • No volcanoes (NRCan 2010e) have been recorded in the vicinity of the Burnaby Terminal. • The site is located in a zone of high seismic activity (NRCan 2010a). Peak ground acceleration with a 1:2475 annual probability of exceedance is between 0.4 and 0.5 g (NRCan 2013a). Several known and suspected post-glacial faults lie near the pump station. Major earthquakes (up to and over magnitude 7) have occurred in the Coast Mountains and Cascade Ranges around the pump station (NRCan 2013b). Refer to the Seismic Assessment Desktop Study of Volume 4A for additional information. • The topography in the area of the Burnaby Terminal is sloping from northeast (high) to the southwest (low) and the elevation is approximately 160 m above sea level. • Where activities are planned within the Burnaby Terminal, soils have predominantly been disturbed for industrial use, and construction of the new infrastructure will be conducted within the boundaries of the existing station. NRCan considers unprotected soils in the vicinity of the Burnaby Terminal to have moderate wind erosion risk with low climatic sensitivity (NRCan 2010d). • A description of the climate for the CWH BGC Zone is provided in Section 5.1.3. • The following meteorological data were obtained from an Environment Canada meteorological station (1108447) at Vancouver International Airport (Environment Canada 2013a). The data were taken approximately 20 km southwest of the Burnaby Terminal. – Average monthly rainfall for Vancouver Airport is 96.1 mm and the average monthly rainfall from November to March is 140.4 mm. In September of 2004, Vancouver Airport recorded its highest daily rainfall of 91.6 mm, which is above the monthly average of 50.9 mm for the month of September. – Average monthly snowfall for Vancouver Airport is 3.2 cm and the average monthly snowfall from November to March is 7.5 cm. In December of 1996, Vancouver Airport recorded its highest daily snowfall of 41 cm, well above the 14.8 cm average for the month of December. – Average daily temperature for Vancouver Airport is 10.4°C, with the warmest month in August, averaging 18°C and coolest month in December, averaging 3.6°C. In July of 2009, Vancouver Airport experienced its warmest day of 34.4°C and in January of 1950, its coolest day at -17.8°C. • No major tornadoes or hailstorms have been recorded in the vicinity of the Burnaby Terminal (NRCan 2010b,c).
Soil and Soil Productivity	• Activities at the Burnaby Terminal will be conducted within an existing fenced, industrial site lacking topsoil and, therefore, detailed soil information is not warranted as per Table A-2 of the NEB *Filing Manual*. • Historical spills have been recorded at the Burnaby Terminal. Soils in the area of the storage yard located in the terminal will be tested prior to construction. If contamination is encountered during construction, the Contamination Discovery Contingency Plan (Appendix B of the Facilities EPP of Volume 6C) will be implemented. • Potential soil contaminants of concern include gasoline, diesel fuel, lubricants and hydraulic fuels.
Water Quality and Quantity	• The Burnaby Terminal is located in the Lower Fraser River Watershed of the Fraser River Basin. • The headwaters of Eagle Creek are within the existing property boundaries and will be within 30 m of planned work. Currently, watercourses are directed beneath the existing storage tanks via a below ground conveyance system, which will be expanded to accommodate the proposed storage tanks. Eagle Creek drains into Burnaby Lake, which flows south via Brunette River into the Fraser River. • The City of Burnaby and AECOM are collaborating to develop an Integrated Stormwater Management Plan (ISMP) for the watershed of Eagle Creek, in order to better manage land development and support environmental protection, preservation and enhancement of Eagle Creek and its tributaries. During an external stakeholder workshop for the Eagle Creek ISMP, recent studies conducted to provide an indication of the current state of water quality and quantity were summarized. Some key observations were the presence of low base flows in the late summer period, presence of iron oxide (likely naturally occurring) and downstream sedimentation, including at the Burnaby Lake inflow. The Eagle Creek ISMP will aim to address issues such as minimizing erosion and resulting problems with sedimentation in the lake, habitat enhancements, improving water quality in the stream and reducing pollution (Hill, Phang pers. comm.). The Eagle Creek ISMP is expected to be released in 2014. The potential effects of terminal construction and operation on the Eagle Creek drainage are assessed in Section 7.5.3.

TABLE 6.1-16 Cont'd

Environmental Elements	Summary of Considerations
Water Quality and Quantity (cont'd)	• Hydrostatic testing is planned for the piping and new tanks to be installed within the Burnaby Terminal. Water may be withdrawn and released from Trans Mountain's existing fire water pond at the Burnaby Terminal. Alternatively, test water may be diverted from a nearby river or creek, subject to obtaining a water withdrawal permit, or purchased from municipalities depending on availability from natural sources. Following testing, water will be tested for contaminants before being treated and either discharged back into the fire water pond, trucked away, or released to a natural water body or the municipal sewer system. • The terrain at the Burnaby Terminal is sloped and will require additional grading. The ground slopes down to the northeast across the site. Groundwater flow direction is inferred to be to the southwest. • The surficial geology beneath the site is mapped as Capilano sediments consisting of beach deposits of poorly-sorted sand to gravel normally less than 1 m thick (may be up to 8 m thick). The extreme northeast corner of the facility is underlain by Tertiary bedrock (Armstrong and Hicock 1980). • No water supply wells are mapped on the site or within the Water Quality and Quantity LSA. • Stantec Consulting Ltd. (2011) noted groundwater levels ranging from artesian (0.79 m above ground level) to 9.57 m bgl in on-site monitoring wells. • The southwestern corner of the Burnaby Terminal appears to overlie Aquifer #49, a moderately vulnerable aquifer, based on regional mapping (BC MOE 2013a).
Air Emissions	• Continuous VOC, H_2S and mercaptan emissions are primarily due to standing and working losses from existing product storage tanks at the Burnaby Terminal. • Fugitive emissions from leaks are expected to be a small contributor relative to emissions from existing tanks. • All existing pumps are electrically driven and are not direct sources of CACs. • CAC and VOC emissions from regular testing of emergency diesel generators and fire water pumps are infrequent. • The largest sources of CAC, except PM, in the Air Quality RSA are vehicle traffic, non-road engines and heating. The largest sources of PM emissions in the area are road dust and construction activities. The largest sources of VOC emissions are on-road motor vehicles and solvent evaporation. • Predicted VOC, H_2S and mercaptan concentrations in the Air Quality RSA due to existing operations at the Burnaby Terminal and other existing natural and anthropogenic sources are presented in the Air Quality and Greenhouse Gas Technical Report of Volume 5C.
Greenhouse Gas Emissions	• Indirect GHG emissions due to electric power consumption by the existing pumps at the Burnaby Terminal are the main emissions. These include emissions from fossil fuel combustion, unallocated energy from power line losses, metering differences and other losses, and emissions of SF_6 from gas handling and transferring operations, electrical equipment operation, and from equipment mechanical failures. • Products handled and stored in existing tanks contain trace levels of GHGs; small amounts might be released through fugitive or process emissions (*e.g.*, CH_4 and formation CO_2). • Small amounts of direct GHG emissions will be released due to the space heating of the existing buildings at the Burnaby Terminal. • Small amounts of indirect GHG emissions will be released due to electricity use for equipment other than pumps. • Small amounts of GHG emissions will be released from the motor vehicles used by operations/maintenance staff.
Acoustic Environment	• Sources of existing sound in the Acoustic Environment LSA are traffic travelling along local arterial roadways and natural sound (*e.g.*, wind, wildlife). • Receptors were identified within the Acoustic Environment LSA. The nearest receptor is located approximately 50 m to the south of the fenceline of the Burnaby Terminal. • ASL in the absence of regulated energy facilities is approximately 38-41 dBA at night and 48-51 dBA during the day based on BC OGC *Noise Control Best Practices Guideline* (BC OGC 2009). • A measurement program was conducted at both the facility and representative ambient sound level at receptors surrounding the facility. The results of the receptor-based program gave a range of values between 42-49 dBA during nighttime and 45-49 dBA during the daytime. • A noise model was generated based on the sound level measurements of similar equipment at other Project locations as well as calculated sound levels based on equipment specifications. Applicable buildings and shelters were modelled along with the appropriate insertion losses and screening effects. • The noise modelling results indicate that sound from the existing Burnaby Terminal complies with the BC OGC *Noise Control Best Practices Guideline* permissible sound levels for all surrounding receptors. • Contoured noise prediction results are available in the Terrestrial Noise and Vibration Technical Report of Volume 5C.

TABLE 6.1-16 Cont'd

Environmental Elements	Summary of Considerations
Fish and Fish Habitat	• The Burnaby Terminal is located in the Lower Fraser River Watershed of the Fraser River Basin. • The headwaters of Eagle Creek are within the existing property boundaries and will be within 30 m of planned work. Eagle Creek drains into Burnaby Lake, which eventually flows into the Fraser River. • All five BC indicator species (bull trout/Dolly Varden, rainbow trout/steelhead, cutthroat trout, coho salmon and Chinook salmon) are found in the Lower Fraser River Watershed. • Green sturgeon is a species of Special Concern under *SARA* (Environment Canada 2012) and is also Red-listed in BC (BC CDC 2013). Observations of green sturgeon in freshwater are rare, but there are some historical records in the Lower Fraser River (the most recent was near Fort Langley in 2005) (McPhail 2007). • Salish sucker and Nooksack dace are both Red-listed in BC (BC CDC 2013) and Endangered under *SARA* (Environment Canada 2012). Although both species are found in the Lower Fraser River Watershed, they have very limited distributions and there are no records of either species being found in Eagle Creek (COSEWIC 2002a, 2007a). However, Eagle Creek is a tributary to the Brunette River, which is known to support Nooksack dace (Fisheries [British Columbia] Technical Report of Volume 5C). • Westslope cutthroat trout is a species of Special Concern under *SARA* (Environment Canada 2012) and is also Blue-listed (BC CDC 2013). Westslope cutthroat trout is known to occur in the Lower Fraser River Watershed, however, this population is introduced and, therefore, not of conservation concern (see Table 4.4 of the Fisheries [British Columbia] Technical Report of Volume 5C). • Bull trout and mountain sucker may be found in the Lower Fraser River Watershed and are both listed as a Species of Special Concern under COSEWIC (2013) and are Blue-listed in BC (BC CDC 2013) (see Table 4.5 of the Fisheries [British Columbia] Technical Report of Volume 5C). • The Lower Fraser River population of white sturgeon is considered Threatened under COSEWIC (2013) and is Red-listed in BC (BC CDC 2013). • Chiselmouth has no federal listing (COSEWIC 2013, Environment Canada 2012) but is Blue-listed provincially (BC CDC 2013). • Eulachon is Endangered under COSEWIC (2013) and Blue-listed (BC CDC 2013) and may be found in the Lower Fraser River Watershed. • The Cultus Lake population of Sockeye salmon is Endangered under COSEWIC and is found in the Lower Fraser River Watershed, however, its range is limited to Cultus Lake, which is upstream of Project activities.
Wetland Loss or Alteration	• The Burnaby Terminal is located within the Lower Mainland ecoregion, a component of the Pacific Maritime ecozone of Canada. Wetter areas are characterized by Douglas-fir, western hemlock and western redcedar. Coastal salt marshes are located on the Fraser River delta and along Boundary Bay (Ecological Stratification Working Group 1995). • The Burnaby Terminal is also located within the Intermountain Prairie Wetland Region. Wetlands characteristic of this region include marshes bordering fresh to saline ephemeral or semi-permanent shallow waters (Government of Canada 1986). • The Burnaby Terminal is located within the CWH BGC Zone of BC. In this BGC Zone, wetlands are often found in depressions, around open water, small streams and drainage channels. Wetlands types include fens, marshes as well as shrubby swamps (BC MOF 1999, Meidinger and Pojar 1991). • Wetlands provide habitat for native plants and wildlife species, including nesting and foraging habitat for bird species as well as provide storage and natural filtering of water. • No wetlands were identified within or adjacent to the Burnaby Terminal during the helicopter reconnaissance and satellite imagery review. However, two artificial ponds are located within the vicinity of the Burnaby Terminal. As a result, a ground-based wetland survey was determined not to be required. • There are no Ramsar Wetlands of International Importance (Bureau of the Convention on Wetlands 2013), Western Hemisphere Shorebird Reserves (WHSRN 2013) or Migratory Bird Sanctuaries (Environment Canada 2013b) located within the Wetland LSA surrounding the Burnaby Terminal. • The English Bay and Burrard Inlet IBA is located approximately 1.7 km north of the Burnaby Terminal (Bird Studies Canada and Nature Canada 2012). • The Burnaby Terminal is located within a DUC Level 2 Priority Area, the BC Coastal Areas and Estuaries (DUC 2013).
Vegetation	• The Burnaby Terminal is located within the Lower Mainland Ecoregion, a component of the Pacific Maritime Ecozone of Canada. This ecoregion is characterized by forests of Douglas-fir, western hemlock and western redcedar. Understories of shrubs, vines and moss are common in mature forests. Arbutus and dogwood communities are common on drier sites (Ecological Stratification Working Group 1995). • The Burnaby Terminal is located within the CWH BGC Zone of BC. The CWH BGC Zone is dominated by western hemlock, with western redcedar and Douglas-fir frequent throughout the zone. Amabilis fir, yellow-cedar, shore pine, grand fir, western white pine, bigleaf maple and black cottonwood are also common (Meidinger and Pojar 1991). • The Burnaby Terminal is adjacent to the Burnaby Mountain Conservation Area (City of Burnaby 2013). • Records of rare plant observations within 5 km of the Burnaby Terminal were acquired from the BC CDC (2013) database. No provincially-listed (BC CDC) species records were found within the boundaries of the Vegetation LSA. • It was determined with satellite imagery interpretation that no native vegetation would be directly disturbed within the site boundaries and, therefore, a ground-based vegetation survey was deemed unnecessary. • Consultation with local agricultural authorities was conducted to determine weed species of concern for the region. See Section 4.4 of the Vegetation Technical Report of Volume 5C for a summary of these communications.

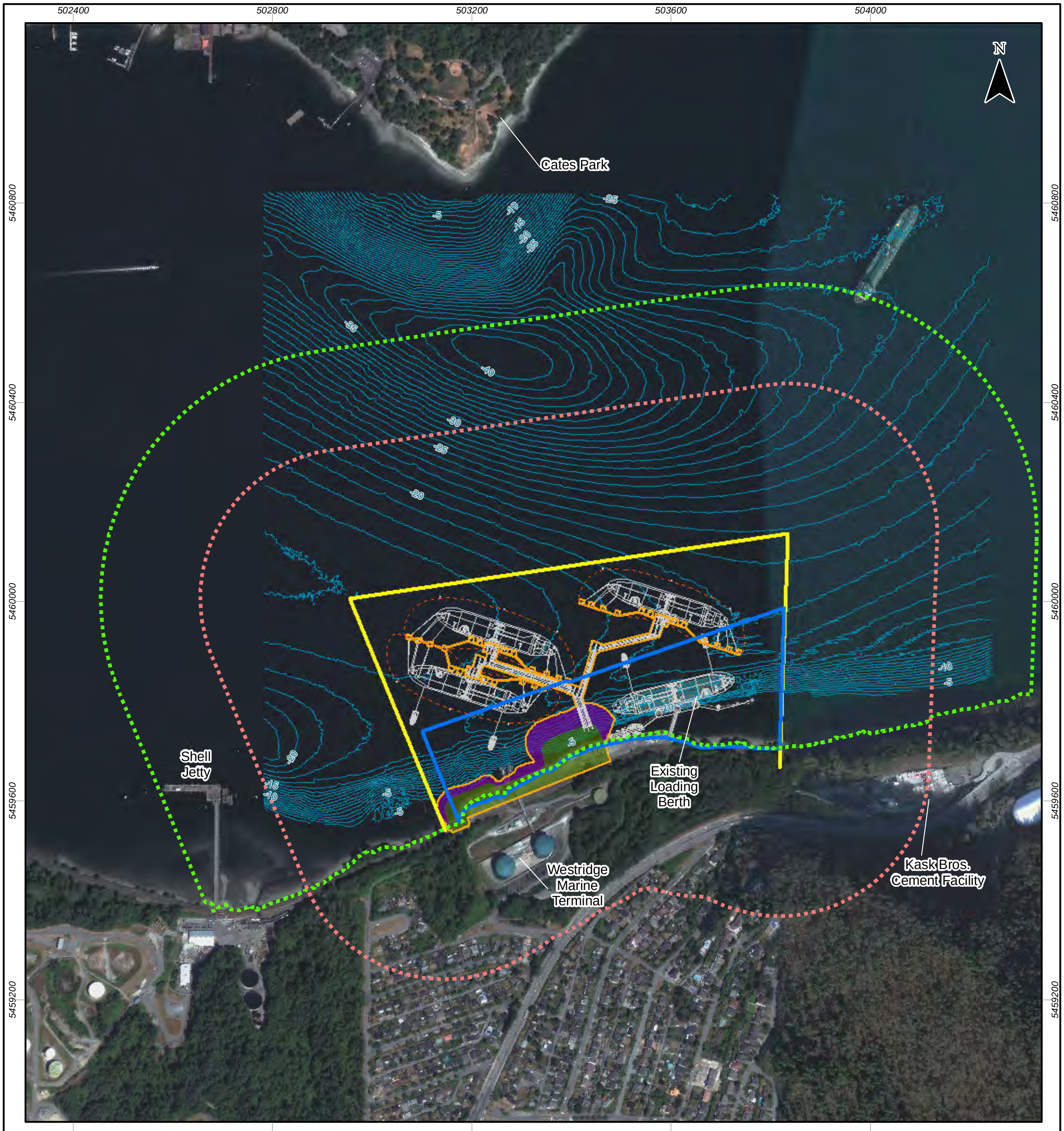
TABLE 6.1-16 Cont'd

Environmental Elements	Summary of Considerations
Wildlife and Wildlife Habitat	• The Burnaby Terminal does not lie within an LRMP region (BC MFLNRO 2008a). The Burnaby Terminal is located in the City of Burnaby, BC. • The Burnaby Terminal is located adjacent to existing tank facilities on industrial lands • The Burnaby Terminal is not located within or adjacent to any provincial parks or protected areas (BC MFLNRO 2008b), IBAs (Bird Studies Canada and Nature Canada 2012), Migratory Bird Sanctuaries (Environment Canada 2013b), National Wildlife Areas (Environment Canada 2013b), Western Hemisphere Shorebird Reserves (WHSRN 2013), Ramsar Wetlands of International Importance (Bureau of the Convention on Wetlands 2013), World Biosphere Reserves (UNESCO 2013), designated caribou range (BC MOE 2008), ungulate winter range (BC MOE 2005a), or Wildlife Habitat Areas (BC MOE 2005b). • The Burnaby Terminal is located in a DUC Level 2 Priority Area, the BC Coastal Areas and Estuaries (DUC 2013). • The English Bay and Burrard Inlet IBA is located approximately 1.7 km north of the Burnaby Terminal (Bird Studies Canada and Nature Canada 2012). • The Burnaby Terminal is adjacent to the Burnaby Mountain Conservation Area (City of Burnaby 2013). • The Burnaby Terminal is located in WMU 2-8 (BC ILMB 2006).
Species at Risk or Species of Special Status and Related Habitat	• The following federally-listed fish species are known to occur in the Lower Fraser River Watershed. See the Fish and Fish Habitat row of this table above for more details about each species (*e.g.*, distribution): – green sturgeon (*SARA*: Special Concern); – Salish sucker (*SARA*: Endangered); – Nooksack dace (*SARA*: Endangered); – bull trout (COSEWIC: Special Concern); – mountain sucker (COSEWIC: Special Concern); – white sturgeon (COSEWIC: Threatened); – eulachon (COSEWIC: Endangered); and – sockeye salmon (COSEWIC: Endangered). • Records of rare plant observations within 5 km of the Burnaby Terminal were acquired from the BC CDC (2013) database. No federally-listed (*SARA* or COSEWIC) species records were found within these boundaries. • Based on known species range and habitat preferences, the following federally-listed (*SARA* Schedule 1 or COSEWIC) or provincially-listed (Red, Blue, or under BC's *Wildlife Act*) wildlife species were identified as having the potential to occur in the vicinity of the Burnaby Terminal (BC MOE 2013b, COSEWIC 2013, Environment Canada 2012): – olympic shrew (provincial: Red); – Pacific water shrew (*SARA*: Endangered, COSEWIC: Endangered, provincial: Red); and – southern red-backed vole (*occidentalis* subspecies) (provincial: Red). • A search of the BC CDC database did not identify any federally-listed (*SARA* Schedule 1 or COSEWIC) or provincially-listed (Red, Blue, or under BC's *Wildlife Act*) wildlife species within 2 km of the Burnaby Terminal (BC CDC 2012, 2013). • Given that the Burnaby Terminal is an existing facility and all work will occur within the existing fenced area on previously disturbed land, the Burnaby Terminal is not considered suitable habitat for wildlife or plant species at risk.

6.2 Westridge Marine Terminal

The existing Westridge Marine Terminal is located at d-047-D/092-G-07 at RK 3.6 on reclaimed foreshore lands. The Westridge Marine Terminal is located in the municipal boundary of the City of Burnaby. It is located on approximately 6.2 ha of land owned by Trans Mountain, with the exception of a small portion of land located between the railway and the shoreline, which is leased from Canadian Pacific Railway (CPR). The facility also extends into Burrard Inlet. The expansion of the existing Westridge Marine Terminal will include the construction of one dock with three operational berths, as well as a utility dock. The existing water lease will need to be expanded to accommodate the new docks. Existing access to the Westridge Marine Terminal via Barnet Highway will be used. Table 6.2-1 provides a summary of the environmental elements and considerations for the Westridge Marine Terminal pursuant to Guide A.2.4 and Table A-2 of the NEB *Filing Manual*. The location of the Westridge Marine Terminal is shown on Figure 6.1-16.

An LSA of 500 m extending from the proposed water lease expansion applies to marine sediment and water quality, marine fish and fish habitat, and marine mammals. The Marine Birds LSA extends 300 m from the proposed water lease expansion. The Marine RSA applies to all marine elements and includes the area of Burrard Inlet east of the First Narrows, including Indian Arm and Port Moody Arm. Study area boundaries for the marine elements at Westridge Marine Terminal are shown on Figures 6.2-1 to 6.2-2.



Stantec

SCALE: 1:11,000

0 100 200 300 400 m

ALL LOCATIONS APPROXIMATE

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MAP NUMBER		PAGE
10494_EA_TERMINAL_06_02_02		SHEET 1 OF 1
DATE: Nov 2013	REF.: 7894	REVISION: 0
SCALE: 1:11,000	PAGE SIZE: 8.5 x11	DISCIPLINE: SD
DRAWN: SS	CHECKED: SD	DESIGN: SD

- Bathymetry
- Proposed Westridge Water Lease Expansion
- Existing Westridge Water Lease
- Footprint (Marine)
- Containment Boom
- Fill Slope of Land Reclamation
- Land Reclamation
- LSA for Marine Sediment and Water Quality, Marine Fish and Fish Habitat, and Marine Mammals
- LSA for Marine Birds

Projection: UTM Zone 10N; Satellite Imagery: I-cubed, 2010; Bathymetry: Canadian Hydrographic Service, 2011; Existing Pipeline: Kinder Morgan Canada, 2012; Trans Mountain Expansion Proposed Pipeline Corridor: Universal Pegasus International, 2013; Fill Slope of Land Reclamation: CH2M Hill, 2013; Footprint (Marine): Moffatt & Nichol, 2013; Land Reclamation: CH2M Hill, 2013.

Although there is no reason to believe that there are any errors associated with the data used to generate this product or in the product itself, users of these data are advised that errors in the data may be present.

TRANS MOUNTAIN

FIGURE:6.2-1

LSA FOR MARINE SEDIMENT AND WATER QUALITY, MARINE FISH AND FISH HABITAT, MARINE MAMMALS AND MARINE BIRDS

TRANS MOUNTAIN EXPANSION PROJECT

Stantec

SCALE: 1:150,000

0 2,000 4,000 6,000 m

ALL LOCATIONS APPROXIMATE

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MAP NUMBER		PAGE
10494_EA_TERMINAL_06_02_03		SHEET 1 OF 1
DATE: Nov 2013	REF.: 7894	REVISION: 0
SCALE: 1:150,000	PAGE SIZE: 8.5 x11	DISCIPLINE: SD
DRAWN: SS	CHECKED: SD	DESIGN: SD

Legend:
- Westridge Marine Terminal
- Highway
- Paved Road
- Bathymetry
- Watercourse
- Existing Trans Mountain Pipeline
- Trans Mountain Expansion Proposed Pipeline Corridor
- Existing Facility
- Waterbody
- Provincial Park
- Indian Reserve
- Land of British Columbia
- Marine RSA

Projection: UTM Zone 10N; Highway and Paved Road: National Road Network (BC), 2007; Bathymetry: Canadian Hydrographic Service, 2011; Watercourse: National Hydro Network, 2007; Existing Pipeline: Kinder Morgan Canada, 2012; Trans Mountain Expansion Proposed Pipeline Corridor: Universal Pegasus International, 2013; Facilities: KMC, 2012; Provincial Park: BC MFLNRO, 2008; Indian Reserve: Geographic Data Discovery Service, 2005; Land of British Columbia: National Topographic Data Base, 2007.

Although there is no reason to believe that there are any errors associated with the data used to generate this product or in the product itself, users of these data are advised that errors in the data may be present.

TRANS MOUNTAIN

FIGURE: 6.2-2

MARINE RSA

TRANS MOUNTAIN EXPANSION PROJECT

TABLE 6.2-1

SUMMARY OF ENVIRONMENTAL ELEMENTS AND CONSIDERATIONS FOR THE WESTRIDGE MARINE TERMINAL

Environmental and Socio-Economic Elements	Summary of Considerations
Physical Environment	• The Westridge Marine Terminal is located within the Georgia Depression Physiographic Region, which is characterized by a flat valley floor 1-5 km wide, steep valley walls, gently rolling uplands and ridges, gently rolling to flat lowlands of terraces and plains, and deltas (Armstrong 1984, Holland 1976). • The Westridge Marine Terminal is likely underlain by coarse-grained clastics and volcanic rock types (BGC Engineering Inc. 2013c). • The surficial geology beneath the site is mapped as glaciofluvial (BGC Engineering Inc. 2013a). • There are no areas of permafrost within the area of the Westridge Marine Terminal (refer to Section 5.1.1). • No areas of potential terrain instability are known to occur in the vicinity of the Westridge Marine Terminal. • No volcanoes (NRCan 2010e) have been recorded in the vicinity of the Westridge Marine Terminal. • The site is located in a zone of high seismic activity (NRCan 2010a). Peak ground acceleration with a 1:2475 annual probability of exceedance is between 0.4 and 0.5 g (NRCan 2013a). Several known and suspected post-glacial faults lie near the pump station. Major earthquakes (up to and over magnitude 7) have occurred in the Coast Mountains and Cascade Ranges around the pump station (NRCan 2013b). Refer to the Seismic Assessment Desktop Study of Volume 4A for additional information. • The topography in the area of the Westridge Marine Terminal is sloping from south (high) to the north (low) toward Burrard Inlet and the elevation ranges from approximately 30-0 m above sea level. • Where activities are planned within the Westridge Marine Terminal, soils have been disturbed for industrial use and construction of the new infrastructure will be conducted within the boundaries of the existing terminal. • A description of the climate for the CWH BGC Zone is provided in Section 5.1.3. • Meteorological data were obtained from an Environment Canada meteorological station (1108447) at Vancouver International Airport (Environment Canada 2013a). The data were taken approximately 20 km southwest of the Westridge Marine Terminal and are provided in Table 6.1-16. • No major tornadoes or hailstorms have been recorded in the vicinity of the Westridge Marine Terminal (NRCan 2010b,c).
Soil and Soil Productivity	• Activities at the Westridge Marine Terminal will be conducted within an existing fenced, industrial site. Some topsoil/root zone material will be disturbed during construction activities. • Historical spills have been recorded at the Westridge Marine Terminal. No further assessment is required. If contamination is encountered during construction, the Contamination Discovery Contingency Plan (Appendix B of the Westridge Marine Terminal EPP of Volume 6D) will be implemented. • Potential soil contaminants of concern include gasoline, diesel fuel, lubricants and hydraulic fuels.
Water Quality and Quantity	• No work will occur within 30 m of any waterbodies and, therefore, detailed information on surface water and groundwater quality and quantity is not warranted as per Table A-1 of the NEB *Filing Manual*. • Marine sediment and water quality is discussed below in this table.
Air Emission	• Continuous VOC, H_2S and mercaptan emissions are primarily due to standing and working losses from existing product storage tanks and fugitive losses from marine vessel loading/unloading activities at the Westridge Marine Terminal. • Fugitive emissions from leaks are expected to be a small contributor relative to emissions from existing tanks and marine vessel loading/unloading activities. • Continuous CAC emissions are associated with marine vessels at berth and combustion of propane assist gas in the Vapour Combustion Unit used to destroy fugitive VOC losses from marine vessel loading/unloading activities. • All existing pumps are electrically driven and are not direct sources of CACs. • CAC and VOC emissions from regular testing of emergency diesel generators and fire water pumps are infrequent. • The largest sources of CAC, except PM, in the Air Quality RSA are vehicle and marine traffic, non-road engines and heating. The largest sources of PM emissions in the area are road dust and construction activities. The largest sources of VOC emissions are on-road motor vehicles, marine vessels and solvent evaporation. • Predicted VOC, H_2S and mercaptan concentrations in the Air Quality RSA due to existing operations at the Westridge Marine Terminal and other existing natural and anthropogenic sources are presented in the Air Quality and Greenhouse Gas Technical Report of Volume 5C.
Greenhouse Gas Emissions	• Indirect GHG emissions due to electric power consumption by the existing pumps at the Westridge Marine Terminal are the main emissions. These include emissions from fossil fuel combustion, unallocated energy from power line losses, metering differences and other losses, and emissions of SF_6 from gas handling and transferring operations, electrical equipment operation, and from equipment mechanical failures. • Products handled and stored in existing tanks contain trace levels of GHGs; small amounts might be released through fugitive or process emissions (*e.g.*, CH_4 and formation CO_2). • Products filled into and stored in ship hulls contain trace levels of GHGs; small amounts might be released through fugitive or process emissions (*e.g.*, CH_4 and formation CO_2). • Small amounts of direct GHG emissions will be released due to the space heating of the existing buildings at the Westridge Marine Terminal. • Small amounts of indirect GHG emissions will be released due to electricity use for equipment other than pumps. • Small amounts of GHG emissions will be released from the motor vehicles used by operations/maintenance staff.

TABLE 6.2-1 Cont'd

Environmental and Socio-Economic Elements	Summary of Considerations
Acoustic Environment	• Sources of existing sound in the Acoustic Environment LSA are vehicle traffic travelling along local arterial roadways, vessel traffic in Burrard inlet, energy facility and natural sound (*e.g.*, wind, wildlife, water). • Receptors were identified within the Acoustic Environment LSA. The nearest receptor is a private residence located approximately 75 m to the south of the fenceline of the Westridge Marine Terminal. • The BC OGC *Noise Control Best Practices Guideline* (BC OGC 2009) defined ASL in the absence of regulated energy facilities ranges between 46-51 dBA at night and 56-61 dBA during the day for urban settings. • A measurement program was conducted at both the facility and representative ambient sound level at receptors surrounding the facility. The results of the receptor-based program indicate existing sound levels in residential areas near the terminal range between 38-46 dBA during the nighttime and 44-51 dBA during the daytime. The levels reflect the amount of industrial sound from Westridge, neighbouring facilities and traffic already experienced by residents. • A noise model was generated based on the sound level measurements of similar equipment as well as calculated sound levels based on equipment specifications. Applicable buildings and shelters were modelled along with the appropriate insertion losses and screening effects. • The noise modelling results indicate that sound from the existing Westridge Marine Terminal complies with the BC OGC *Noise Control Best Practices Guideline* permissible sound levels for all surrounding receptors. • Contoured noise prediction results are available in the Terrestrial Noise and Vibration Technical Report of Volume 5C.
Wetland Loss or Alteration	• No wetlands were identified within or adjacent to the Westridge Marine Terminal and, therefore, detailed information on wetlands is not deemed warranted as per Table A-1 of the NEB *Filing Manual*.
Vegetation	• No native vegetation is anticipated to be disturbed by the Project and, therefore, detailed information on vegetation is not deemed warranted as per Table A-1 of the NEB *Filing Manual*.
Fish and Fish Habitat	• No work will occur within 30 m of any freshwater fish-bearing waterbodies and, therefore, detailed information on freshwater fish and fish habitat is not deemed warranted as per Table A-1 of the NEB *Filing Manual*. • Marine fish and fish habitat is discussed below in this table.
Marine Sediment and Water Quality	• The Marine RSA is affected by a variety of historical and current human activities that have introduced contaminants that affect marine sediment and water quality. In some areas, contaminants are present at levels higher than applicable guidelines to protect marine life, but generally, sediment and water quality meet the guidelines. • Activities in the Marine RSA include vessel traffic, recreational boating, port facilities (petroleum products, bulk cargo, metal concentrates, coal, sulphur, sugar, wheat), Lions Gate Wastewater Treatment Plant effluent and urban runoff. There are 173 municipal storm water outfalls, 13 combined sanitary and storm water outfalls, several emergency sanitary system outfalls (for sanitary sewer overflows and lift station overflows), 31 BC MOE-permitted effluent outfalls for industries, and a number of oil interceptors. Numerous streams draining residential, commercial and industrial areas also enter Burrard Inlet and may convey contaminants. • Shoreline areas, mainly near the Westridge Marine Terminal east of the Second Narrows, were affected by the release of crude oil from the accidental rupture of the Trans Mountain pipeline in 2007, when oil entered Burrard Inlet through several storm drain outfalls; oil was removed during the immediate spill response and remediation efforts in 2007 and 2008 (Stantec Consulting Ltd. 2010, 2012). • Marine sediment and marine water quality were selected as indicators for the assessment of Project-related effects associated with construction and operations of the Westridge Marine Terminal. • Contaminants of potential concern associated with the Westridge Marine Terminal are related to hydrocarbons (shipment of oil, ambient sources) and also metals and historical contaminants such as PCBs (from ambient sources not related to construction or operation of the Westridge Marine Terminal, but which could be disturbed during dredging for construction). • Total polycyclic aromatic hydrocarbon (PAH) levels are compared to draft sediment quality objectives for Burrard Inlet (1.68 µg/g) (Swain 2009) and screening criterion for disposal at sea (2.5 µg/g) (Environment Canada 2013c), and some areas have PAH levels higher than these objectives and criteria. • Total PAH levels in subtidal sediment of the Marine RSA (nearshore samples from eight sites in 2002) ranged from 1.0-3.3 µg/g, with three samples (Loch Katrine, Clark Drive, and Vancouver Wharves, between the First Narrows and Second Narrows) higher than the 2.5 µg/g criterion (BC Ministry of Water, Land and Air Protection [MWLAP] 2004). Total PAH levels were also monitored from 2007 through 2011 at three subtidal sites after the 2007 oil release (Barnet Marine Park, Westridge and Berry Point); levels were higher than the screening criterion at all three sites (maximum of 3.97 µg/g) in 2007 and at Westridge and Barnet Marine Park in subsequent years (range of 1.6-11.4 µg/g), assumed to reflect ambient conditions, as PAH composition reflected a variety of hydrocarbon sources. • Subtidal sediment in the Marine Sediment and Water Quality LSA at the existing Westridge Marine Terminal historically contained elevated levels of PAHs (0.01-9 µg/g, with two isolated samples up to 130 µg/g in 2005); contaminated sediment was removed in 2006 during maintenance dredging at the Westridge Marine Terminal (BGC Engineering Inc. 2006). Field surveys conducted in 2013 in the Marine Sediment and Water Quality LSA indicated total PAH levels of < 0.2-3.66 µg/g, with 1 of 39 samples higher than the screening criterion.

TABLE 6.2-1 Cont'd

Environmental and Socio-Economic Elements	Summary of Considerations
Marine Sediment and Water Quality (cont'd)	• Total PAH in intertidal sediment around the Westridge Marine Terminal was affected by the 2007 accidental release of oil, which entered the Inlet through storm sewer outfalls; levels were elevated (up to 30.3 µg/g in July 2007), and were reduced following clean-up in 2007 and remediation in 2008. Most of the samples from Westridge and other areas of Burrard Inlet met the sediment quality objective in 2008 and later years, although higher levels were noted consistently for Maplewood Flats (unrelated to the spill, likely originating from historical industrial activities). • Total polychlorinated biphenyls (PCBs) in subtidal sediment were measured at three locations in the Marine RSA between 1985 and 2004 (BC MWLAP 2004, BGC Engineering Inc. 2006, Jacques Whitford AXYS 2008) and in 2005 at the Westridge Marine Terminal (BGC Engineering Inc. 2006). Most of the samples had concentrations lower than the *Disposal at Sea Regulations* screening criterion of 0.1 µg/g and CCME ISQG of 0.0215 µg/g, although 1 of 38 samples collected at the Westridge Marine Terminal in 2005 had a concentration of 4.5 µg/g (later removed during dredging) and 1 of 8 samples collected throughout Burrard Inlet in 2002 had a concentration of 0.2 µg/g. Field surveys conducted in 2013 in the Westridge Marine Terminal area indicated total PCB levels of < 0.02-0.276 µg/g, with 1 of 39 samples higher than the screening criterion. • Metal levels in subtidal sediment near the Westridge Marine Terminal were measured in 2005 (BGC Engineering Inc. 2006) and 2013 (see the Marine Sediment and Water Quality – Westridge Marine Terminal Technical Report of Volume 5C) and in the Marine RSA in 2002 (BC MWLAP 2004). Levels of several metals were higher than the Canadian Council of Ministers of the Environment (CCME) Interim Sediment Quality Guideline (ISQG) and disposal at sea screening criteria, reflecting natural conditions (arsenic, copper) and human activities (cadmium, copper, lead, mercury, zinc). In areas east of the Second Narrows, including the Project Footprint and the Marine Sediment and Water Quality LSA, the reported levels were well below the CCME Probable Effects Levels (PEL). However, in localized areas west of the Second Narrows, copper and zinc levels were higher than the PEL at Vancouver Wharves (which handles mineral concentrates) and copper was above the PEL at Clark Drive (near a combined storm water and sanitary outfall), reflecting the strong influence of particular human activities. • Water quality was assessed at four locations during fall 2002 for the Burrard Inlet Objectives Attainment program (BC MWLAP 2004), with samples collected for general parameters, metals and total suspended solids (TSS). Copper, iron, lead and manganese levels were below BC guidelines in all samples. Zinc levels were just above the BC maximum water quality guideline in one sample (Pacific Coast Terminal, November 2002). • In May 2013, water samples were collected during the field survey for the Project, at one location near the Westridge Marine Terminal (at 1 m depth and at 1 m above the sediment) and analyzed for general chemistry, metals, nutrients, TSS and hydrocarbons. Samples collected on incoming (flood) and outgoing (ebb) tides had metal levels lower than water quality guidelines for the protection of marine life (BC MOE 2013c, CCME 2013), with the exception of zinc in shallow ebb tide water (slightly above BC MOE guidelines). All organic parameters associated with hydrocarbons were below detection limits. • More detailed information on marine sediment and water quality in the Marine Sediment and Water Quality LSA and the Marine RSA is provided in the Marine Sediment and Water Quality – Westridge Marine Terminal Technical Report of Volume 5C.
Marine Fish and Fish Habitat	• Burrard Inlet is approximately 50 km in length and ranges from 0.5–3 km in width. It includes over 11,000 ha of water and seabed, 190 km of shoreline, and a drainage basin of 98,000 ha (Stantec Consulting Ltd. 2009). • Maximum water depth in Burrard Inlet is approximately 220 m, which is found in the deep basin of Indian Arm. English Bay and the Harbour are shallower, with typical water depths of 25-35 m and a maximum depth of approximately 65 m. The mean tidal range in the Inlet is 3.3 m. Currents vary according to location, with the highest velocities occurring at locations where the Inlet narrows, constricting water movement. Maximum currents at the First Narrows are on the order of 5.5 knots. • At least 75 species of fish are known to use Burrard Inlet including a number of species targeted in commercial, recreational, and Aboriginal fisheries such as all five species of Pacific salmon, Pacific herring, anchovy, lingcod, copper rockfish, quillback rockfish, and kelp greenling (Hanrahan 1994 in Haggarty 2001, Renyard 1988). • Three marine fish habitats and three marine fish species were selected as indicators for the assessment of Project-related effects associated with construction and operations of the Westridge Marine Terminal. These are: marine riparian habitat; intertidal habitat; subtidal habitat; Dungeness crab; inshore rockfish; and Pacific salmon. • Marine riparian, intertidal, and subtidal habitats are used by marine fish and invertebrates for spawning, rearing, migration, and foraging (Healey 1980, Lemieux *et al.* 2004, Levings and Jamieson 2001, Levings and Thom 1994). • The total length of shoreline in the Marine Fish and Fish Habitat LSA is 2.3 km. 'Man-made' is the most common shore type in the Marine Fish and Fish Habitat LSA covering 1.04 km and 44.5% of the total shoreline (BC ILMB 2005). The total length of shoreline in the Marine RSA is 157.5 km. 'Man-made' is also the most common shore type in the Marine RSA covering 53.5 km and 33.9% of the total shoreline (BC ILMB 2005). Subtidal habitats of Burrard Inlet are dominated by soft, muddy substrates (BC Marine Conservation Analysis 2009, Burd 1990, Burd *et al.* 2008). Adult Pacific salmon have been observed to return to at least 17 streams in Burrard Inlet, 12 of which are located in the Marine RSA (BC MOE 2013d, Haggarty 2001). Four populations of Pacific salmon have been designated as species of conservation concern by COSEWIC, however, none of these populations spawn in streams entering Burrard Inlet (COSEWIC 2002b, 2003a,b, 2006). Burrard Inlet has been identified as a Fisheries and Oceans Canada (DFO) Important Area for Pacific salmon which overlaps with the Marine RSA (Jamieson and Levesque 2012a,b). • Quillback rockfish and copper rockfish are the most likely rockfish species to occur in Burrard Inlet (Renyard 1988). The quillback rockfish has been designated as Threatened by COSEWIC but is not currently listed under *SARA* (COSEWIC 2009). The copper rockfish has not been identified as a species of conservation concern.

TABLE 6.2-1 Cont'd

Environmental and Socio-Economic Elements	Summary of Considerations
Marine Fish and Fish Habitat (cont'd)	• Three Rockfish Conservation Areas (RCAs) overlap with the Marine RSA including Indian Arm – Crocker Island RCA, Indian Arm – Twin Islands RCA, and Eastern Burrard Inlet RCA. The Marine Fish and Fish Habitat LSA overlaps with the Eastern Burrard Inlet RCA. • Dungeness crabs are common in Burrard Inlet and are expected to occur within the Marine Fish and Fish Habitat LSA and Marine RSA throughout the year (DFO 2012, Jamieson and Levesque 2012a,b). Several areas in eastern Burrard Inlet have been identified as DFO Important Areas for Dungeness crab, one of which overlaps with the Marine Fish and Fish Habitat LSA (Jamieson and Levesque 2012a,b). • A survey of marine riparian habitat in the Marine Fish and Fish Habitat LSA was conducted on September 26, 2012. Riparian habitats have been extensively modified by historical development activities, including the original construction of the Westridge Marine Terminal in 1954. Riparian vegetation at the Westridge Marine Terminal is limited to a narrow fringe of small shrubs and low growing vegetation. Second-growth deciduous trees are found to the north and south of the Westridge Marine Terminal, along the shoreline adjacent to the Canadian National (CN) rail line. A total of 38 vascular plant species were identified during the survey. • A survey of intertidal habitat in the Marine Fish and Fish Habitat LSA was conducted from August 18 to 19, 2012. The intertidal zone is dominated by coarse substrate types, particularly boulder and cobble riprap. Two shore types were identified in the intertidal zone including man-made rock ramps and rock cliffs. A total of 17 marine invertebrate species and 8 marine algae species were identified. The most common sessile invertebrate species were common acorn barnacles and blue mussels, and the most common motile invertebrate species were periwinkles and limpets. The most common algae species were rockweed, Turkish washcloth and green ribbon. • A camera-mounted remotely-operated vehicle (ROV) was used to survey subtidal habitat in the Marine Fish and Fish Habitat LSA from September 17 to 20, 2012. The substrate observed consisted almost entirely of soft bottom (silt, mud, sand) with traces of broken shells and wood debris. A small section of steeply-sloping rip-rap was identified inshore of the existing berth. A total of 32 species of fish and invertebrates were observed. Brown bladed algae were the dominant algal species in the survey area. Dungeness crabs were very abundant and red rock crabs were moderately abundant. Demersal fish of the family *Stichaeidae* and various flatfish were very abundant on soft bottom habitat. Shiner perch, pile perch and kelp perch were moderately abundant in the shallow rip-rap and around pilings. • More detailed information on marine riparian habitat, intertidal habitat, subtidal habitat, Pacific salmon, rockfish and Dungeness crab in the Marine Fish and Fish Habitat LSA and Marine RSA is provided in the Marine Resources – Westridge Marine Terminal Technical Report of Volume 5C.
Wildlife and Wildlife Habitat	• The Westridge Marine Terminal is located in the City of Burnaby in the Greater Vancouver Regional District (GVRD). • The Westridge Marine Terminal is partially located on reclaimed foreshore lands. All terrestrial work will be conducted within the existing fenced area. • The Westridge Marine Terminal is not located within or adjacent to any provincial parks or protected areas (BC MFLNRO 2008b), Migratory Bird Sanctuaries (Environment Canada 2013b), National Wildlife Areas (Environment Canada 2013b), Western Hemisphere Shorebird Reserves (WHSRN 2013), Ramsar Wetlands of International Importance (Bureau of the Convention on Wetlands 2013), World Biosphere Reserves (UNESCO 2013), designated caribou range (BC MOE 2008), ungulate winter range (BC MOE 2005a), or Wildlife Habitat Areas (BC MOE 2005b). • The Westridge Marine Terminal is located at the edge of the English Bay and Burrard Inlet IBA (Bird Studies Canada and Nature Canada 2012). • The Burnaby Mountain Conservation Area is approximately 240 m from the Westridge Marine Terminal and Barnet Marine Park is adjacent to the eastern boundary of the terminal. • The Westridge Marine Terminal is located in a DUC Level 2 Priority Area, the BC Coastal Areas and Estuaries (DUC 2013). • The Westridge Marine Terminal is located in WMU 2-8 (BC ILMB 2006).
Marine Mammals	• Marine mammal diversity and abundance in Burrard Inlet is generally considered low. • The most abundant and commonly observed species by far is the Pacific harbour seal, which is resident within the Inlet and throughout the coastal waters of BC (DFO 2010, Hanrahan 1994 in Haggarty 2001). Harbour seals were selected as the representative marine mammal indicator for the assessment of Project-related effects associated with construction and operations of the Westridge Marine Terminal. • Over the years, there have been occasional but rare sightings in Burrard Inlet of other marine mammal species such as Steller and California sea lions, northern fur seal and harbour porpoise (Marine Mammal Research Unit 2012). Killer whale, Pacific white-sided dolphin, false killer whale, grey whale, humpback whale, and minke whale have also made the occasional appearance in Burrard Inlet or nearby waters (BC Cetacean Sightings Network 2013), though their use of this habitat is limited and sightings are relatively uncommon. • No marine mammal field work was conducted for the Project, as available information suggests that aside from harbour seals, marine mammal diversity and abundance in Burrard Inlet is low. • Harbour seals use both aquatic and terrestrial environments and do not migrate but instead reside in BC's coastal waters and inlets year-round (Baird 2001, Bigg 1981, DFO 2010). They are likely the most commonly-sighted marine mammal in BC and prefer nearshore habitats including sounds, inlets, straits, marinas and harbours; they have also been known to occur in river estuaries (Baird 2001). Terrestrial haul out sites are used for resting, mating and pupping, and include isolated rocks or islets, sandbars, log booms, and recreational floats (Baird 2001).

TABLE 6.2-1 Cont'd

Environmental and Socio-Economic Elements	Summary of Considerations
Marine Mammals (cont'd)	• No DFO Important Areas for marine mammals have been identified in the Marine RSA (Jamieson and Levesque 2012a,b). • More detailed information on harbour seals in the Marine Mammal LSA and Marine RSA is provided in the Marine Resources – Westridge Marine Terminal Technical Report of Volume 5C.
Marine Birds	• Information on marine bird and habitat use within the Marine RSA was primarily derived from a review of relevant literature and databases from peer-reviewed journals, agency publications, technical reports (*e.g.,* COSEWIC status reports), and local and regional data (*e.g.,* Bird Studies Canada, BC Coastal Waterbird Survey, BC Breeding Bird Atlas, BC Marine Bird Atlas, Project Feederwatch, Great Backyard Bird Count, eBird). Data from 45 years of North American Breeding Bird Survey data and 14 years of overwintering BC Coastal Waterbirds Survey data was used to characterize the marine bird use of the Marine RSA. Key sources include Birds of Burrard Inlet (Breault and Watts 1996, Burrard Inlet Environmental Action Program [BIEAP] 2002) and the IBAs program coordinated by BirdLife International (2013). • Indicator species selected to represent potential effects from Project activities at the Westridge Marine Terminal are: bald eagle; great blue heron; pelagic cormorant; Barrow's goldeneye; glaucous-winged gull; and spotted sandpiper. Each of these six species represents a foraging guild within an overall diverse group of marine birds, using a range of niches within the marine and coastal habitats present within the Marine RSA boundaries. More detailed information on these marine bird indicators' use of habitats in the Marine Bird LSA and Marine RSA is provided in the Marine Birds – Westridge Marine Terminal Technical Report of Volume 5C. • Bald eagles are relatively abundant and nest in large mature trees at approximately 15 locations, with an average of 3.45 km between nests, along the shores of Burrard Inlet, Indian Arm and Port Moody Arm. They have large home ranges and high nest site fidelity. It is suggested that they are a primary reason for the decline of some marine bird breeding colonies in the Marine RSA (Cook 2008) and despite increasing human disturbance, their numbers are increasing. • A great blue heron breeding colony has been active for many years in Stanley Park (187 breeding individuals recorded in 2007). A smaller colony is also located on Heron Creek several kilometres upstream of the Westridge Marine Terminal near Cliff Avenue, Burnaby. • Within Burrard Inlet, breeding colonies of pelagic cormorants have been identified at Second Narrows, Prospect Point, and occasionally the Burrard dry dock facility (Chatwin *et al*. 2002, Campbell *et al.* 1990, Hobson and Wilson 1985, Vermeer and Rankin 1984). • Glaucous-winged gulls nest on the roofs of buildings and the supports of the Ironworkers Memorial Second Narrows Crossing (Hobson and Wilson 1985, Vermeer *et al.* 1988). In the Marine RSA, they are abundant and widespread in all seasons, breeding at 5 or more seasonal colonies in the RSA with up to 250 pairs at each site. The closest known colony to the Project footprint is to the east approximately 1 km from the Westridge Marine Terminal and located on the south shoreline at the entrance to Port Moody Arm. • Long-term data sets of marine bird distribution and abundance in the Marine RSA indicate a total of 121 different waterbird species are present seasonally. Field studies were completed in the Marine Bird LSA on October 17, 2012, and on January 16, April 9 and July 15, 2013. These surveys were intended to validate and/or update existing information on marine bird seasonal distribution and abundance in the Marine Bird LSA. Field studies included a structured shore-based survey at stationary points and were supplemented with incidental observations. • A total of 405 individuals of 25 species were recorded during both 2012 and 2013 surveys. Species of concern observed were the Red-listed pelagic cormorant, and the following Blue-listed species: double-crested cormorant; surf scoter; California gull; and great blue heron (also listed in Schedule 1 of *SARA* as of Special Concern). • Burrard Inlet is part of the English Bay and Burrard Inlet IBA (IBA020) (Bird Studies Canada and Nature Canada 2013, BirdLife International 2013). The IBA is globally important for western grebes, Barrow's goldeneye and surf scoter, and is nationally important for great blue heron (BIEAP 2002, BirdLife International 2013). • Tens of thousands of migratory birds stop in Burrard Inlet along the Pacific Flyway. Parks that border the Inlet include Indian Arm Provincial Park, Belcarra Regional Park and Stanley Park. There are extensive tidal flats, remnant mudflats and saltwater marshes at Maplewood Conservation Area and Port Moody Inlet. Maplewood Flats, located west across Burrard Inlet from the Westridge Marine Terminal approximately 4 km, is regionally known for its importance as a conservation area for greater than 200 species of aquatic and terrestrial birds including the rare passerine, purple martin, which nests in nestboxes installed on pilings offshore in the Inlet. Maplewood Flats has the largest area of tidal mudflats on the Lower Mainland North Shore. • Bird abundance in Burrard Inlet has been recorded at more than 24,000 birds during the peak of spring migration (Breault and Watts 1996, BIEAP 2002). The marine areas of the Central Harbour typically have the greatest abundance of waterbirds within the Inlet. The highest diversity of species has been recorded at Port Moody, First Narrows and Second Narrows (Breault and Watts 1996).

TABLE 6.2-1 Cont'd

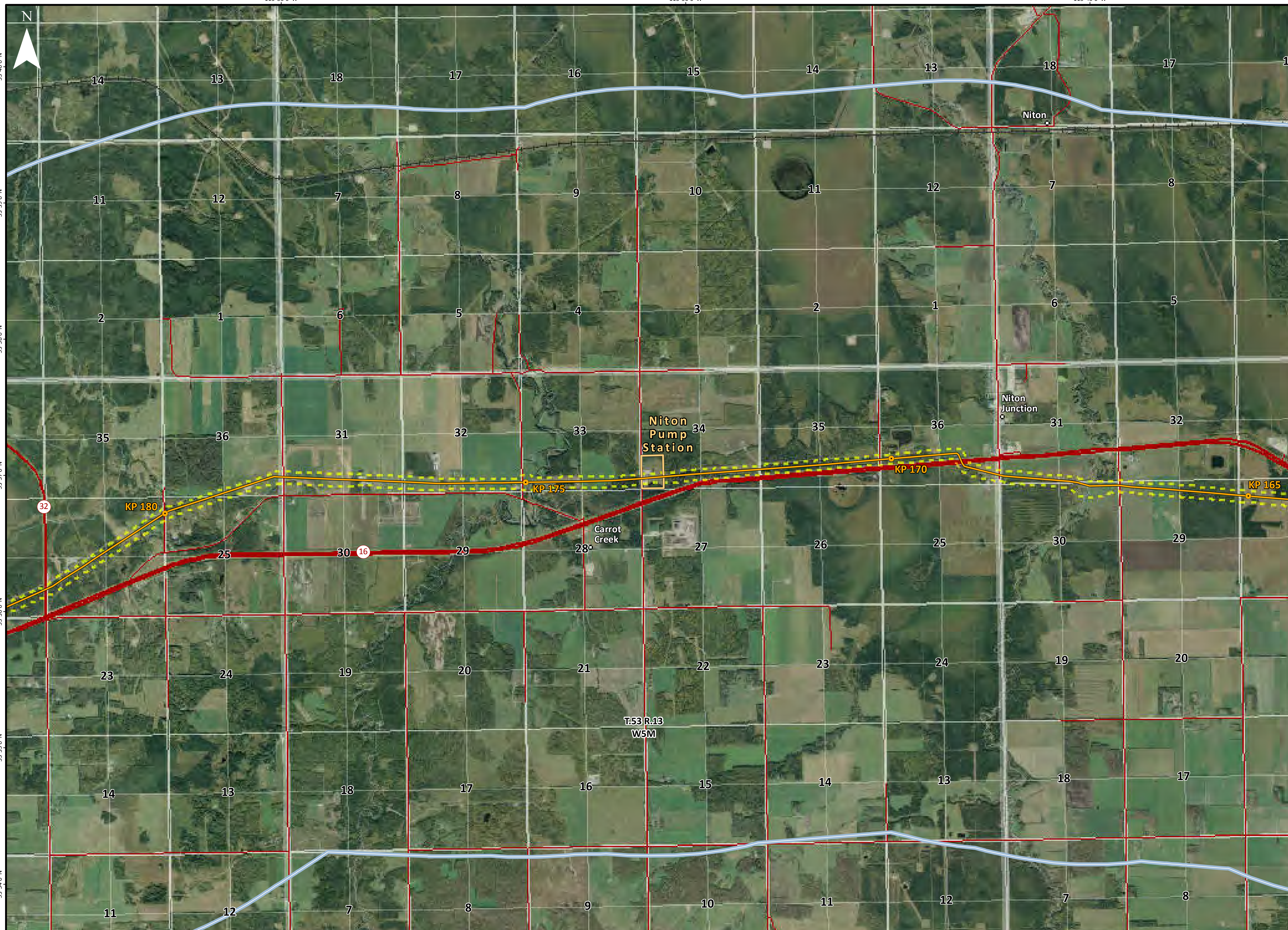
Environmental and Socio-Economic Elements	Summary of Considerations
Marine and Terrestrial Species at Risk or Species of Special Status and Related Habitat	<u>Onshore and Freshwater Species</u> • No work will occur within 30 m of any freshwater fish-bearing waterbodies and, therefore, detailed information on freshwater fish and fish species at risk is not deemed warranted as per Table A-1 of the NEB *Filing Manual*. • No federally-listed (*SARA* or COSEWIC) plant species records were found within the Westridge Marine Terminal. • Based on known species range and habitat preferences, the following federally-listed (*SARA* Schedule 1 or COSEWIC) or provincially-listed (Red, Blue, or under BC's *Wildlife Act*) wildlife species were identified as having the potential to occur in the vicinity of the Westridge Marine Terminal (BC MOE 2013b, COSEWIC 2013, Environment Canada 2012): – great blue heron (*fannini* subspecies) (*SARA*: Special Concern, COSEWIC: Special Concern, provincial: Blue); and – Pacific water shrew (*SARA*: Endangered, COSEWIC: Endangered, provincial: Red). • A search of the BC CDC database identified the following federally-listed (*SARA* Schedule 1 or COSEWIC) or provincially-listed (Red, Blue, or under BC's *Wildlife Act*) wildlife species within 2 km of the Westridge Marine Terminal (BC CDC 2012, 2013): – great blue heron (*fannini* subspecies) (*SARA*: Special Concern, COSEWIC: Special Concern, provincial: Blue); and – Pacific water shrew (*SARA*: Endangered, COSEWIC: Endangered, provincial: Red). • Given that the Westridge Marine Terminal is an existing facility and all terrestrial work will occur within the existing fenced area, the Westridge Marine Terminal is not considered suitable habitat for wildlife or plant species at risk (excluding marine wildlife). <u>Marine Species</u> • There are two marine fish species of conservation concern that are likely to be found in the Marine RSA: quillback rockfish (Threatened, COSEWIC 2009); and spiny dogfish (Special Concern, COSEWIC 2011a). Yelloweye rockfish (Special Concern, COSEWIC 2008) may also occur within the Marine RSA at very low abundance. • Other fish species that are considered unlikely to occur in the Marine RSA but which have inferred ranges that overlap Burrard Inlet are: bluntnose sixgill shark (Special Concern, COSEWIC 2007b; Special Concern under *SARA*, Environment Canada 2012), Bocaccio (Threatened, COSEWIC 2002c), green sturgeon (Special Concern, COSEWIC 2004), eulachon – Fraser River population (Endangered, COSEWIC 2011b), coho salmon – Interior Fraser population (Endangered, COSEWIC 2002b); and sockeye salmon – Cultus population (Endangered, COSEWIC 2003a). • The following *SARA*-listed marine mammal species may occasionally be observed in the Marine RSA: Steller sea lion (Special Concern), harbour porpoise (Special Concern), southern resident killer whale (Endangered), Bigg's (previously transient) killer whale (Threatened), grey whale (Special Concern) and humpback whale (Threatened) (BC Cetacean Sightings Network 2013, Environment Canada 2012, Marine Mammal Research Unit 2012). Additionally, the northern fur seal is listed as Threatened by COSEWIC (Environment Canada 2012). None of these species are considered particularly common or abundant in the Marine RSA. • Based on a review of COSEWIC (2013), the federal *SARA* public registry list (Schedule 1) (Environment Canada 2012) and the BC CDC (2013) Red and Blue-lists, 21 marine bird species of conservation concern could occur seasonally within the Marine RSA due to range overlap (including migration) (Section 3.21, Table 3.1 of the Marine Birds - Westridge Marine Terminal Technical Report of Volume 5C). Under the BC *Wildlife Act*, 17 of these species are designated as Blue-listed (Special Concern) and 4 are designated as Red-listed (Endangered or Threatened). Under *SARA*, four of these species are considered Threatened and four are of Special Concern. Of the six indicators selected to represent marine birds, the pelagic cormorant is provincially Red-listed and the great blue heron is both provincially Blue-listed and designated under COSEWIC and Schedule 1 of *SARA* as a species of Special Concern.

6.3 Reactivated Pump Stations

As an outcome of the pipeline expansion, the Niton Pump Station will be reactivated (currently deactivated) to serve the existing pipeline. Reactivation activities will be conducted within the current fenced areas and no new disturbance will be required.

6.3.1 Niton Pump Station

The existing Niton Pump Station is located at SW 34-53-13 W5M at RK 191.4 on lands owned by Trans Mountain in Yellowhead County. Current land use at and around this facility site is industrial. Access to the Niton Pump Station is via Highway 16. Table 6.3-1 provides a summary of the environmental elements and considerations for the Niton Pump Station pursuant to Guide A.2.4 and Table A-2 of the NEB *Filing Manual*. The location of the Niton Pump Station is shown on Figure 6.3-1.



TRANS MOUNTAIN

FIGURE 6.3-1

NITON PUMP STATION

TRANS MOUNTAIN EXPANSION PROJECT

- Kilometre Post (KP)
- Hamlet / Village / Community
- Trans Mountain Pipeline (TMPL)
- Trans Mountain Expansion Project Proposed Pipeline Corridor
- Subject Property Facility Boundary
- Acoustic Environment RSA
- Highway
- Paved Road
- Railway

Projection: NAD 1983 UTM Zone 11N. Routing: Baseline TMPL & Facilities: provided by KMC 2012; Proposed Pipeline Corridor V6: provided by UPI Aug. 23, 2013; Transportation: IHS Inc., 2013, Natural Resources Canada, 2011; Geopolitical Boundaries: Natural Resources Canada, 2003, Altalis, 2012, IHS Inc., 2011, ESRI, 2005; First Nation Lands: Government of Canada, 2013; Parks and Protected Areas: Natural Resources Canada, 2013, Altalis, 2013, Alberta Tourism, Parks and Recreation, 2012, BC FLNRO, 2008; Service Layer Credits: Source: Esri, i-cubed, USDA, USGS, AEX, GeoEye, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community

tera ENVIRONMENTAL CONSULTANTS

Although there is no reason to believe that there are any errors associated with the data used to generate this product or in the product itself, users of these data are advised that errors in the data may be present.

MAP NUMBER 201310_MAP_TERA_SE_00442_REV0_03		PAGE SHEET 1 OF 1
DATE December 2013	TERA REF. 7894	REVISION 0
SCALE 1:50,000	PAGE SIZE 11x17	DISCIPLINE ESA
DRAWN AJS	CHECKED HS	DESIGN TGG

0 500 1,000 1,500 2,000 m

ALL LOCATIONS APPROXIMATE

201310_MAP_TERA_SE_00442_Rev0_03.mxd

TABLE 6.3-1

SUMMARY OF ENVIRONMENTAL ELEMENTS AND CONSIDERATIONS FOR THE NITON PUMP STATION

Environmental Elements	Summary of Considerations
Physical and Meteorological Environment	• The Niton Pump Station is located within the Western Alberta Plains Physiographic Region, characterized by undulating plains, less abundant hummocky terrain and incised river valleys (Natural Regions Committee 2006a, Pettapiece 1986). • The Niton Pump Station is underlain by the Paskapoo Formation, which is characterized by a thick sequence of Paleocene sand and siltstones, consisting of buff medium-grained sandstone overlain by interbedded light grey soft sandy siltstone and mudstones (Dawson *et al*. 1994, Hamblin 2004). • Surficial deposits at the Niton Pump Station are till and glaciolacustrine sediments with lesser active fluvial, glaciofluvial, deltaic, eolian and ice-thrust moraine deposits (Natural Regions Committee 2006a, Roed 1975, Shetsen 1990). • There are no areas of permafrost within the area of the Niton Pump Station (refer to Section 5.1.1). • No areas of potential terrain instability are known to occur in the vicinity of the Niton Pump Station. • The site is located in a zone of low seismic activity (NRCan 2010a). Peak ground acceleration with a 1:2475 annual probability of exceedance is less than 0.1 g (NRCan 2013a). No earthquakes have been recorded in the area (NRCan 2013b). • The topography in the area of the Niton Pump Station is generally flat and elevation is approximately 860 m above sea level. • Where reactivation activities are planned within the Niton Pump Station, soils have been disturbed for industrial use and any reactivation activities will be conducted within the boundaries of the existing station. • The Niton Pump Station is located in an agricultural area considered to have low soil erosion risk (AARD 2005a). Wind erosion risk, which assesses the risk of soil degradation by wind on bare, unprotected mineral soil, is considered low at the pump station (AARD 2005b). Water erosion risk, which assesses the risk of soil degradation by water on bare, unprotected mineral soil, is considered severe in the vicinity of the site (AARD 2005c). • A description of the climate for the Lower Foothills Natural Subregion is provided in Section 5.1.1. • Meteorological data from Environment Canada's Edson Station, located approximately 45 km west of the Niton Pump Station, are provided in Section 5.1.1. • No major tornadoes or hailstorms have been recorded in the vicinity of the Niton Pump Station (NRCan 2010b,c).
Soil and Soil Productivity	• Activities at the Niton Pump Station will be conducted within an existing fenced, industrial site lacking topsoil and, therefore, detailed soil information is not warranted as per Table A-2 of the NEB *Filing Manual*. • No contamination is anticipated at the Niton Pump Station. If any contamination is encountered during construction, the Contamination Discovery Contingency Plan (Appendix B of the Facilities EPP of Volume 6C) will be implemented. Potential soil contaminants of concern include gasoline, diesel fuel, lubricants and hydraulic fuels.
Water Quality and Quantity	• The Niton Pump Station is located in the Pembina River Watershed of the Athabasca River Basin. • No work will occur within 30 m of any waterbodies and, therefore, detailed information on surface water quality and quantity is not warranted as per Table A-1 of the NEB *Filing Manual*.
Air Emissions	• This pump station is currently not active. Therefore, no fugitive air emissions are expected to occur unless the station is reactivated. • Air quality in the area surrounding the Niton Pump Station is expected to be primarily influenced by vehicle traffic emissions along Highway 5, the Community of Carrot Creek, and several oil and gas facilities.
Greenhouse Gas Emissions	• This pump station is currently not active. Therefore, no GHG emissions are expected to occur unless the station is reactivated.
Acoustic Environment	• Niton Pump Station will have no new noise sources added. • Sound from the reactivated station will be the same as sound experienced historically when the station was previously in operation. • A detailed analysis was not completed since no change from historical levels is expected.
Fish and Fish Habitat	• The Niton Pump Station is located in the Pembina River Watershed of the Athabasca River Basin. • No work will occur within 30 m of any fish-bearing waterbodies and, therefore, detailed information on fish and fish habitat is not deemed warranted as per Table A-1 of the NEB *Filing Manual*.
Wetland Loss or Alteration	• The Niton Pump Station is situated within the boundaries of the Boreal Transition Ecoregion of the Boreal Plains Ecozone. Small lakes, ponds and marshes occupy shallow depressions within this ecoregion (Ecological Stratification Working Group 1995). • The Niton Pump Station is also located in the Continental Mid-boreal Wetland Region. Wetlands characteristic of this region include flat and basin bogs often associated with horizontal and ribbed fens. Plateau bogs occur occasionally in large fens. Marshes can be found along gently sloping lakeshores (Government of Canada 1986). • The Niton Pump Station is located within the Lower Foothills Natural Subregion of the Foothills Natural Region. Wetlands are predominantly treed fens, bogs and open fens (Natural Regions Committee 2006b). • No wetlands were identified within or adjacent to the Niton Pump Station during the helicopter reconnaissance and satellite imagery review. As a result, a ground-based wetland survey was determined not to be required. • There are no Ramsar Wetlands of International Importance (Bureau of the Convention on Wetlands 2013), IBAs (Bird Studies Canada and Nature Canada 2012), Western Hemisphere Shorebird Reserves (WHSRN 2013) or Migratory Bird Sanctuaries (Environment Canada 2013b) located within the Wetland LSA surrounding the Niton Pump Station. • The Niton Pump Station is located within the DUC Level 1 Priority Area, the Prairie Pothole Region and Western Boreal Forest (DUC 2013).

TABLE 6.3-1 Cont'd

Environmental Elements	Summary of Considerations
Vegetation	• The Niton Pump Station is located within the boundaries of the Boreal Transition Ecoregion of the Boreal Plains Ecozone. In its native state, this ecoregion is characterized by trembling aspen, balsam poplar, white spruce, balsam fir and a thick understory of tall shrubs and herbs. Poorly-drained areas support communities of willow species and sedges, with black spruce and tamarack occurring occasionally (Ecological Stratification Working Group 1995). • The Niton Pump Station is located in the Lower Foothills Natural Subregion of the Foothills Natural Region. The Lower Foothills Natural Subregion is dominated by mixed stands of trembling aspen, lodgepole pine, white spruce and balsam poplar. Understory communities are dominated by shrubs and herbs (Natural Regions Committee 2006a). • There are no national parks, provincial parks, provincial recreation areas, Environmentally Significant Areas or other protected areas located within the Vegetation LSA near the Niton Pump Station. • Records of rare plant observations within 5 km of the Niton Pump Station were acquired from the ACIMS (2013) database. No provincially-listed (ACIMS) species records were found within the boundaries of the Vegetation LSA. • It was determined with satellite imagery interpretation that no native vegetation would be directly disturbed within the site boundaries and, therefore, a ground-based vegetation survey was deemed unnecessary. • Consultation with local agricultural authorities was conducted to determine weed species of concern for the region. See Section 4.4 of the Vegetation Technical Report of Volume 5C for a summary of these communications.
Wildlife and Wildlife Habitat	• The Niton Pump Station is not located within or adjacent to any Environmentally Significant Areas (ATPR 2009), provincial parks or protected areas (ATPR 2012), IBAs (Bird Studies Canada and Nature Canada 2012), Migratory Bird Sanctuaries (Environment Canada 2013b), National Wildlife Areas (Environment Canada 2013b), Western Hemisphere Shorebird Reserves (WHSRN 2013), Ramsar Wetlands of International Importance (Bureau of the Convention on Wetlands 2013), World Biosphere Reserves (UNESCO 2013), or provincially identified wildlife areas (AESRD 2013b).
Species at Risk or Species of Special Status and Related Habitat	• No work will occur within 30 m of any fish-bearing waterbodies and, therefore, detailed information on fish and fish species at risk is not deemed warranted as per Table A-1 of the NEB *Filing Manual*. • Records of rare plant observations within 5 km of the Niton Pump Station were acquired from the ACIMS (2013) database. No federally-listed (*SARA* or COSEWIC) species records were found within these boundaries. • A search of the AESRD FWMIS database did not identify any federally-listed (*SARA* Schedule 1 or COSEWIC) and/or provincially-listed (At Risk, May be at Risk, or under Alberta's *Wildlife Act* and *Wildlife Regulation*) wildlife species within 2 km of the Niton Pump Station (AESRD 2013c). • Given that the Niton Pump Station is an existing facility and all work will occur within the existing fenced area on previously disturbed land, the Niton Pump Station is not considered suitable habitat for wildlife or plant species at risk.

6.4 Temporary Facilities

The locations of potential temporary facilities (*e.g.*, staging and stockpile sites, equipment storage sites, construction work camps) will be determined as far in advance of construction as practical to allow adequate time to choose and evaluate any alternate sites. Wherever practical, the temporary facilities will be located on previously disturbed areas to minimize overall Project disturbance. All temporary facility sites will be reviewed from an environmental perspective prior to their use.

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TERA wishes to acknowledge those people identified in the Personal Communications for their assistance in supplying information and comments incorporated into this report.

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7.0 ENVIRONMENTAL EFFECTS ASSESSMENT

The description of the environmental setting (current state of the environment) within the Project area (Sections 5.0 and 6.0), is compared against the project description (Section 2.0) to assess potential environmental effects that might be caused by the Project. The environmental effects assessment uses the information provided in the environmental setting and Project description to:

- evaluate the environmental elements of importance in the Project area;
- identify and evaluate potential Project effects associated with each environmental element of importance; and
- develop appropriate technically and economically feasible site-specific mitigation.

In addition, the environmental effects assessment determines the significance of potential residual effects resulting from construction and operations activities after taking into consideration proposed mitigation measures. Trans Mountain has informed TERA that it will adopt the recommendations herein.

7.1 Methodology

The assessment evaluates the environmental effects of the construction (including reactivation/modification), operations, decommissioning and abandonment phases of each component of the Project. The assessment method includes the following steps.

1. Describe the environmental setting.
2. Identify key environmental elements that could be affected.
3. Define the indicators and measurement endpoints to be used to assess each element.
4. Determine spatial and temporal boundaries for each element.
5. Identify potential environmental effects for each indicator.
6. Develop appropriate technically and economically feasible site-specific mitigation and, where warranted, restitution measures that are technically and economically feasible.
7. Predict anticipated residual effects.
8. Determine the significance of residual effects.

Steps 2 to 8 are described below in the applicable Methodology subsection. This environmental effects assessment methodology is based on:

- *The Responsible Authority's Guide to the Canadian Environmental Assessment Act: Part II The Practitioner's Guide* (Federal Environmental Assessment Review Office [FEARO] 1994a);
- FEARO's *A Reference Guide for the Canadian Environmental Assessment Act: Addressing Cumulative Environmental Effects* (FEARO 1994b);
- FEARO's *A Reference Guide for the Canadian Environmental Assessment Act: Determining Whether a Project is Likely to Cause Significant Environmental Effects* (FEARO 1994c);
- the Canadian Environmental Assessment (CEA) Agency *Cumulative Effects Assessment Practitioners Guide* (Hegmann *et al.* 1999);
- CEA Agency's *Incorporating Climate Change Considerations in Environmental Assessment* (CEA Agency 2003);
- CEA Agency's *Addressing Cumulative Environmental Effects under the Canadian Environmental Assessment Act, 2012* (CEA Agency 2013);
- the *CEA Act, 2012*; and

- the NEB *Filing Manual* (NEB 2013a).

Subsequent steps of an effects assessment include a cumulative effects assessment (Section 8.0), inspection and monitoring during construction and post-construction (Volume 6A) and follow-up monitoring (Section 10.0).

An ESA Approach Summary document was released to stakeholders, Aboriginal communities and potentially interested regulatory authorities in March 2013 by Trans Mountain. The intent of the document was to provide an overview of Trans Mountain's understanding of the environmental and socio-economic context of the Project at that time. The methods, indicators and spatial boundaries for the environmental elements were reviewed based on feedback received on the ESA Approach Summary document from participants of the ESA Workshops, consultation with regulatory authorities and engagement with Aboriginal communities.

The environmental effects assessment of the Project is a collaborative effort of several qualified professionals with element-specific expertise, under the guidance of representatives of TERA. Table 7.1-1 acknowledges the contribution of these experts and professionals by environmental element.

TABLE 7.1-1

ENVIRONMENTAL EFFECTS ASSESSMENT TEAM

Environmental Element	Assessor
Physical and Meteorological Environment	TERA and BGC
Soil and Soil Productivity	TERA and Mentiga
Water Quality and Quantity	Waterline and TERA
Air Emissions	RWDI
GHG Emissions	RWDI
Acoustic Environment	RWDI
Fish and Fish Habitat	GeoMarine and TERA
Wetland Loss or Alteration	TERA
Vegetation	TERA
Marine Sediment and Water Quality	Stantec
Marine Fish and Fish Habitat	Stantec
Wildlife and Wildlife Habitat	TERA
Marine Mammals	Stantec
Marine Birds	Stantec
Species at Risk	TERA and Stantec
Accidents and Malfunctions	TERA
Changes to the Project Caused by the Environment	TERA

7.1.1 Environmental Elements

The potential environmental (*i.e.*, biophysical) elements interacting with the Project have been identified through: consultation and engagement with Aboriginal communities, landowners, regulatory authorities, stakeholders and the general public; experience gained during previous pipeline projects with similar conditions/potential issues (*e.g.,* TMX Anchor Loop Project, Trans Mountain Pump Station Expansion Project, Blue River Pump Station Project); scientific studies; and the professional judgment of the assessment team. Issues noted during consultation/engagement with Aboriginal communities, landowners, federal, provincial and municipal regulatory authorities, stakeholders and the general public were essential in the determination of element interactions with the Project (Section 3.0).

Environmental elements potentially interacting with the Project include:

- physical elements such as the physical and meteorological environment, soil and soil productivity, water quality and quantity, air emissions, GHG emissions and the acoustic environment;

- biological elements such as fish and fish habitat, wetland loss or alteration, vegetation, wildlife and wildlife habitat, and species at risk; and

- marine elements such as marine sediment and water quality, marine fish and fish habitat, marine mammals, marine birds and marine species at risk.

Effects arising from potential accidents and malfunctions, and changes to the Project caused by the environment are also considered. The assessment of onshore facility hypothetical spill scenarios, including a spill at the Westridge Marine Terminal, on the environment is provided in Volume 7.

Those environmental elements which are not considered to interact with the Project are identified and discussed in Sections 7.2 to 7.7. In accordance with Guide A.2.6 of the NEB *Filing Manual*, no further analysis is necessary for those elements where interactions between the Project component and an environmental element are not predicted.

7.1.2 Assessment Indicators and Measurement Endpoints

Beanlands and Duinker (1983) suggest that it is impossible for an impact assessment to address all potential environmental effects of a project. Therefore, it is necessary that the environmental attributes considered to be important in project decisions be identified. Environmental impact assessments should be required to identify at the beginning of the assessment an initial set of indicators (sometimes called Valued Ecosystem Components [VECs] or Valued Social Components [VSCs]) to provide a focus for subsequent study and evaluation (Beanlands and Duinker 1983).

For this assessment, an indicator is defined as a biophysical, social or economic property or variable that society considers to be important and is assessed to predict Project-related changes and focus the impact assessment on key issues. One or more indicators are selected to describe the present and predicted future condition of an element. Societal views are understood by the assessment team through published information such as management plans and engagement with regulators, the public, Aboriginal communities and other interested groups.

The indicators for each element have been identified based on: the NEB *Filing Manual* and other regulatory guidelines; experience gained during previous projects with similar conditions/potential issues; feedback from Aboriginal communities, landowners, regulatory authorities, stakeholders and the general public; public issues raised through media; available research literature; and professional judgment of the assessment team.

One or more 'measurement endpoints' (measurable parameters) are identified for each indicator to allow quantitative or qualitative measurement of potential Project effects. The endpoints have been selected based on: the NEB *Filing Manual*; experience gained through during previous projects with similar conditions/potential issues; feedback from regulatory authorities and stakeholders; available research literature; and professional judgment of the assessment team. The degree of change in these measurable parameters is used to characterize and evaluate the magnitude of Project-related effects. A selection of measurement endpoints may also be the focus of monitoring and follow-up programs, where applicable.

7.1.3 Spatial and Temporal Boundaries

The environmental effects assessment considers the potential effects of the Project on the environment in the context of defined spatial and temporal boundaries. These boundaries vary with the issues and environmental elements or interactions to be considered, and reflect:

- the construction, operations, and decommissioning and abandonment phases of the proposed physical works and physical activities;

- the natural variation of a population or environmental indicator;

- the timing of sensitive life cycle phases of various biotic elements in relation to the scheduling of the proposed physical works and physical activities;

- the time required for an effect to become evident;

- the time required for a population or environmental indicator to recover from an effect and return to a natural condition;
- the area directly affected by proposed physical works and physical activities; and
- the area in which a population or environmental indicator functions and within which a Project effect may be experienced.

Temporal Boundaries

The time frames of the assessment of the Project include the planning, construction (including reactivation/modification), operations, and decommissioning and abandonment phases. The planning phase includes all environmental studies, engineering surveys and land surveys conducted in support of the Project application and prior to construction. The construction phase for the TMEP includes surveying, clearing, soil handling, grading, pipeline trenching and testing, construction at the Westridge Marine Terminal, facility assembly or expansion, additional tankage at Edmonton, Sumas and Burnaby Terminals, pipeline reactivation, pump station reactivation and reclamation.

Pending regulatory approval of the Project, construction of the pipeline and facilities is scheduled over an approximately 24 month period to achieve the planned in-service date of late 2017. The installation of automated valves would occur intermittently from Q2 2016 to Q1 2017, while the reactivation of existing pipeline segments would occur from Q3 2016 to Q4 2017. Construction and equipment installation at pump stations and tank terminals is expected to begin in Q1 2016 and take approximately 8 to 10 months for each pump station and between 14 and 23 months at the terminals, depending on, among other variables, scope, land use and construction techniques for each facility. The construction period at the Westridge Marine Terminal is expected to commence in Q4 2015 with the first berth expected to be in-service by Q3 2017. The second and third new berths are expected to be in-service by late 2017. Demolition of the existing berth is planned to commence in late 2017 after the new berths are commissioned. The operations phase commences following completion of construction in Q4 2017 and is anticipated to extend for 50 years or more. The decommissioning and abandonment phase would occur at the end of the useful life of the pipeline (50 to 70 years). A detailed construction schedule for the Project is provided in Section 2.0.

Spatial Boundaries

The assessment of the Project was undertaken in the context of one or more of the following spatial boundaries: the Footprint; Local Study Area (LSA); Regional Study Area (RSA); Provincial Area; National Area; and International Area. LSAs and RSAs were developed on an element-specific basis and, therefore, may vary between environmental elements. The Footprint of the Project assumes certain quantitative values for the area that will be directly disturbed by Project facilities and activities within the proposed pipeline corridor, including: a 45 m pipeline construction right-of-way (assumed conservative average value including permanent easement and temporary workspace); permanent access road at Black Pines Pump Station (assumed 5 m wide x 25 m long); temporary access roads (assumed to use existing access, where practical); camp and stockpile sites (assumed 7 ha averaging one every 80 km on existing disturbance); valves (assumed to be within the disturbed right-of-way); and power lines (assumed 50 m wide).

The definitions for each spatial boundary are provided in Table 7.1-2. Detailed discussions regarding the element-specific LSAs, RSAs and associated rationale are provided in Sections 7.2 to 7.7.

Individually established ecological boundaries are described within the discussions in Sections 7.2 to 7.7 for each applicable biological element. Spatial ecological boundaries were determined by the distribution, movement patterns and potential zones of interaction between an element and the Project. The ecological boundary may be limited to the Footprint (*e.g.,* proposed pipeline construction right-of-way) or extend beyond the physical boundaries of the area of the Project component since the distribution or movement of an element can be local, regional or provincial, national or international in extent.

7.1.4 *Potential Environmental Effects*

The potential environmental effects resulting from the Project are identified through engagement with Aboriginal communities, landowners, regulatory authorities, stakeholders and the general public; through experience gained during previous pipeline projects with similar conditions/potential issues; through scientific studies; and the professional judgment of the assessment team. The potential environmental effects arising from the construction and operations of the pipeline, temporary facilities, pump stations, tanks and the expansion of the Westridge Marine Terminal, as well as the reactivation of existing pipeline segments and the installation of automated valves, are identified in Sections 7.2 to 7.7. Section 7.8 discusses potential effects of decommissioning and abandonment.

This assessment is based on preliminary engineering and designs. In general, conservative assumptions have been used. In order to confirm the predictions on environmental effects, further technical development will be carried out in the engineering and detailed design phase.

TABLE 7.1-2

EVALUATION OF THE SIGNIFICANCE OF RESIDUAL EFFECTS - ENVIRONMENTAL ASSESSMENT CRITERIA[1]

Assessment Criteria		Definition
IMPACT BALANCE – of the Residual Effect		
Positive		Residual effect is considered to have a net benefit to the environmental indicator.
Neutral		Residual effect is considered to have no net benefit or loss to the environmental indicator.
Negative		Residual effect is considered to be a net loss or a detriment to the environmental indicator.
SPATIAL BOUNDARY – Location of Residual Effect		
Footprint		The area directly disturbed by surveying, construction and clean-up of the pipeline and associated physical works and activities (including, where appropriate, the permanent right-of-way, pump stations, tanks, Westridge Marine Terminal, temporary construction workspace, temporary stockpile sites, temporary staging sites, construction camps, access roads, power lines).
LSA		The zone of influence (ZOI) or area where the element and associated indicators are most likely to be affected by Project construction and operations. This generally represents a buffer from the centre of the proposed pipeline corridor or edge of a facility site.
RSA		The area extending beyond the LSA boundary where the direct and indirect influence of other activities could overlap with Project-specific effects and cause cumulative effects on the environmental indicator. This varies for each element.
Provincial		The area extending beyond regional or administrative boundaries but confined to AB and BC (*e.g.,* provincial permitting boundaries).
National		The area extending beyond AB and BC but confined to Canada.
International		The area extending beyond Canada.
TEMPORAL CONTEXT		
Duration – (period of the event causing the effect)	Immediate	Event is limited to less than or equal to two days during either the construction phase or operations phase.
	Short-term	Event occurs during the construction phase or is completed within any 1 year during the operations phase.
	Long-term	Ongoing event that is initiated during the construction phase and extends beyond the first year of the operations phase or is initiated during the operations phase and extends for the life of the Project.
Frequency[2] - (how often would the event that caused the effect occur)	Accidental	Event occurs rarely over assessment period.
	Isolated	Event is confined to a specified phase of the assessment period.
	Occasional	Event occurs intermittently and sporadically over the assessment period.
	Periodic	Event occurs intermittently but repeatedly over the assessment period.
	Continuous	Event occurs continually over the assessment period.
Reversibility (period of time over which the residual effect extends)	Immediate	Residual effect is alleviated in less than or equal to two days.
	Short-term	Greater than two days and less than or equal to 1 year to reverse residual effect.
	Medium-term	Greater than 1 year and less than or equal to 10 years to reverse residual effect.
	Long-term	Greater than 10 years to reverse residual effects.
	Permanent	Residual effects are irreversible.
MAGNITUDE[3] – of the Residual Environmental Effect		
Negligible		Residual effects are not detectable from existing (baseline) conditions.
Low		Residual effects are detectable, but well within environmental and/or regulatory standards.
Medium		Residual effects are detectable and may approach, but are still within the environmental and/or regulatory standards.
High		Residual effects are beyond environmental and/or regulatory standards.
PROBABILITY OF OCCURRENCE – Likelihood of Residual Effect		
High		Likely

TABLE 7.1-2 Cont'd

Assessment Criteria	Definition
Low	Unlikely
LEVEL OF CONFIDENCE[4] – Degree of Certainty Related to Significance Evaluation	
Low	Determination of significance based on incomplete understanding of cause-effect relationships and incomplete data pertinent to the Project area.
Moderate	Determination of significance based on good understanding of cause-effect relationships using data from outside the Project area or incompletely understood cause-effect relationships using data pertinent to the Project area.
High	Determination of significance based on good understanding of cause-effect relationships and data pertinent to the Project area.

Notes: 1 Significant Residual Environmental Effect: A high probability of occurrence of a permanent or long-term residual effect of high magnitude that cannot be technically or economically mitigated.

2 The assessment period for the effects assessment includes planning, construction, operations, and decommissioning and abandonment phases for the Project while the assessment period for the cumulative effects assessment includes the above interval as well as the development, construction and operations phases of activities or projects that have previously occurred and those that are planned (publicly disclosed).

3 In consideration of magnitude, there is no environmental standard, threshold, guideline or objective for many of the construction/operations issues under evaluation. Therefore, the determination of magnitude of the adverse residual effect often entailed a historical consideration of the assessment of magnitude made by regulators, land authorities, lessees, other stakeholders and the assessment team to adverse effects. The assessment team was also aware of the increasingly stringent societal norms related to environmental effects.

4 Level of confidence was affected by availability of data, precedence and degree of scientific uncertainty or other factors beyond the control of the assessment team.

7.1.5 Mitigation Measures

Mitigation measures, as defined under the *CEA Act, 2012*, means measures for the elimination, reduction or control of a project's adverse environmental effects, including restitution for any damage to the environment caused by such effects through replacement, restoration, compensation or any other means.

To ensure that the potential adverse environmental effects are reduced, general and site-specific mitigation measures are recommended in this ESA based upon current industry-accepted standards, consultation with regulatory authorities, interested groups and individuals, engagement with Aboriginal communities, and the professional judgment of the assessment team. Mitigation measures, suggested by regulatory authorities or other stakeholders have been incorporated into this assessment.

Many of the mitigation measures presented in this ESA have been discussed with Aboriginal communities that have been involved in specific supporting environmental studies. A comprehensive review of all the issues that have been raised by each community and the recommended mitigation measures was conducted with each community during the field surveys and during follow-up results review (Section 3.0).

Mitigation measures are outlined in the Project effects assessment, as well as in the Project-specific Environmental Protection Plans (EPPs) (Volumes 6B through 6D). Mitigation measures in element-specific technical reports are incorporated into the assessment. In addition, various federal and provincial regulatory authorities, and industry-accepted standards and guidelines are considered in the ESA, and are referenced for each element.

Accompanying this ESA are Environmental Alignment Sheets (Volume 6E) which identify where some site-specific mitigation measures are to be implemented. Inspector(s) will be retained by Trans Mountain to help ensure that the mitigation measures within this ESA are understood and properly implemented during construction. Environmental inspection is further described in Volume 6A.

7.1.6 Residual Effects

As defined in the NEB *Filing Manual* (NEB 2013a), residual effects are the environmental effects that are present after mitigation measures are applied. In many situations, the mitigation measures are predicted to eliminate the potential adverse effects while in other situations, the mitigation measures are predicted to lessen the effects, but do not entirely eliminate them. Elements for which no residual effects are predicted require no further analysis (*i.e.*, significance evaluation).

7.1.7 Significance Evaluation of Potential Residual Effects

The determination of the significance of potential residual effects generally followed the guidelines and principles provided by the NEB, CEA Agency and FEARO documents listed in Section 7.1. The agencies identify several possible methods for determining whether residual environmental effects are significant. These include:

- the use of regulatory environmental standards, guidelines or objectives in relation to potential residual effects;
- quantitative assessment of residual effects; and
- qualitative assessment of residual effects.

The NEB *Filing Manual* indicates that the quantitative method should be used where possible; otherwise, the qualitative method can be used. Some elements can be assessed quantitatively using regulatory standards and guidelines. Where there are no standards, guidelines, objectives or other established and accepted thresholds to define quantitative rating criteria or where quantitative thresholds are not appropriate, the qualitative method that is based on available literature is considered to be the appropriate method for determining the significance of most of the potential residual effects. Consequently, the significance is evaluated by developing a set of qualitative criteria based on those identified by Hegmann *et al.* (1999). These criteria are identified below and their definitions are presented in Table 7.1-2.

- Spatial boundary (*i.e.*, the geographic extent in the Footprint, LSA, RSA, Provincial, National, International).
- Temporal context (*i.e.*, duration and frequency of the event causing the residual effect, reversibility of the residual effect).
- Magnitude (*i.e.*, severity of the residual effect in relation to environmental and/or regulatory standards).
- Probability or likelihood of occurrence of the residual effect.
- Level of confidence or uncertainty (*i.e.*, availability of data to substantiate the assessment conclusion, previous success of mitigation measures).

The ecological context (*e.g.,* levels of existing disturbance; resilience of the receiving environment) is not included in Table 7.1-2. However, the ecological context is provided in Section 7.2 for each applicable element.

For environmental elements, a significant residual effect has a high probability of occurrence, is permanent or reversible in the long-term, is of high magnitude and cannot be technically or economically mitigated.

The impact balance or direction (*i.e.*, determination as to whether the effect is positive, neutral or negative) was also established for each predicted environmental residual effect. A positive impact balance is considered to have a net benefit to the environmental indicator. A neutral impact balance is defined as having no net benefit or loss to the environmental indicator. A negative balance is considered to be a net loss or detriment to the environmental indicator.

All significance assessment criteria (*e.g.,* temporal context, magnitude) are considered by the assessment team for each residual environmental effect. Where appropriate, the key or most influential assessment criteria used to determine the significance of each residual effect are noted. It should be noted that the determination of a “not significant residual effect” is based on a pre-defined approach that incorporates magnitude, probability and reversibility, but a “not significant residual effect” determination does not mean that the potential residual effect is not important to one or more Aboriginal communities, landowners, regulatory authorities or stakeholders.

For the Project effects assessment, an evaluation of combined residual effects is conducted for those indicators where more than one identified potential adverse residual effect may occur. The evaluation of the combined effects considers only those residual effects that are likely to occur (*i.e.*, of high probability). A discussion of combined effects is included in the significance evaluation in Section 7.11 to clarify the overall effect of the Project on the environmental indicator in question and the overall effect of the Project on the element. In addition, the overall effects of the Project on the element are evaluated in consideration of the objectives or goals of applicable land and resource use management plans, municipal development plans (MDPs) and government policies.

The extent to which the professional judgment of the assessment team is used to evaluate the significance of potential environmental residual effects is provided within the relevant section of the assessment for each element. For this Project, the assessment team consisted of discipline experts, the TERA Project Manager, experienced assessment practitioners and senior reviewers. For some elements, the evaluation of significance benefited from a review of select publically available post-construction environmental monitoring reports from previous Trans Mountain projects and other projects that encountered environmental settings and associated issues similar to those of the Project.

A summary of the significance evaluation for predicted residual environmental effects arising from the construction and operations of the proposed pipeline, temporary facilities, pump stations (including reactivation of a station), tanks, the expansion of the Westridge Marine Terminal and reactivation of existing pipeline segments is provided in Sections 7.2 to 7.7. A discussion of effects for decommissioning and abandonment is provided in Section 7.8. A summary of the significance evaluation for residual effects arising from accidents and malfunctions is provided in Section 7.9.

7.2 Effects Assessment - Pipeline Construction and Operations

Using the assessment methodology described in Section 7.1, the potential environmental effects associated with the construction and operations of the pipeline component of the Project as well as the proposed mitigation measures and resulting residual effects on the environmental indicators were evaluated for each element and are described in the following subsections. In addition, the evaluation of significance of potential residual effects using the criteria presented in Table 7.1-2 is also provided. A discussion of the potential effects associated with decommissioning and abandonment of the pipeline is provided in Section 7.8.

Environmental elements potentially interacting with construction and operations of the proposed pipeline segments are identified in Table 7.2-1.

TABLE 7.2-1

ELEMENT INTERACTION WITH THE PROPOSED PIPELINE COMPONENT

Element	Interaction with Pipeline Component	
	Construction	Operations[1]
Physical and Meteorological Environment	Yes	Yes
Soil and Soil Productivity	Yes	Yes
Water Quality and Quantity	Yes	Yes
Air Emissions	Yes	Yes
GHG Emissions	Yes	Yes
Acoustic Environment	Yes	Yes
Fish and Fish Habitat	Yes	Yes
Wetland Loss or Alteration	Yes	Yes
Vegetation	Yes	Yes
Wildlife and Wildlife Habitat	Yes	Yes
Species at Risk	Yes	Yes

Note: 1 Activities during operations include aerial and ground patrols, vegetation management and integrity digs.

7.2.1 Physical and Meteorological Environment

This subsection describes the potential Project effects on physical environment. Further information pertaining to the physical environment along the proposed pipeline corridor is provided in the following reports prepared by BGC Engineering Inc.: Route Physiography and Hydrology, Terrain Mapping and Geohazard Inventory, and Seismic Assessment Desktop Study of Volume 4A; and the Acid Rock Drainage and Metal Leaching Potential Technical Report of Volume 5C. Section 7.10 provides an assessment of changes to the Project caused by the environment.

7.2.1.1 Assessment Indicators and Measurement Endpoints

Assessment indicators identified for the physical environment element are: terrain instability; topography; and acid generating and metal leaching rock. Assessment indicators and measurement endpoints for physical environment are listed in Table 7.2.1-1. Potential effects related to the meteorological environment are considered under Section 7.10 Changes to the Project Caused by the Environment.

The selection of indicators for physical and meteorological environment included: consideration of the filing requirements in the NEB *Filing Manual*; experience gained during previous projects with similar conditions/potential issues; feedback from Aboriginal communities, regulatory authorities and stakeholders; available research literature; public issues raised through the media; and the professional judgment of the assessment team. A list of the proposed physical environment indicators was discussed during the ESA Workshops. An additional physical environment indicator suggested by participants was karst topography in the Lower Mainland. A response to this stakeholder recommendation is provided in Section 7.2.1.4. Participants of the workshops did not indicate that the proposed physical environment indicators were inappropriate for evaluating the effects of the Project on physical and meteorological environment.

Qualitative measurement endpoints are applied to assess potential Project effects on physical environment indicators (Table 7.2.1-1).

TABLE 7.2.1-1

ASSESSMENT INDICATORS AND MEASUREMENT ENDPOINTS FOR PHYSICAL ENVIRONMENT

Physical Environment Indicators	Measurement Endpoints	Rationale for Indicator Selection
Terrain instability	• Areas of steep slopes • Areas susceptible to slumping at watercourses • Areas of sidehills	The selection of indicators and measurement endpoints considered NEB *Filing Manual* requirements for the physical and meteorological environment element in Table A-2, addressed concerns raised through stakeholder engagement and were informed by regulatory authorities (*i.e.*, AESRD and BC MFLNRO).
Topography	• Areas of steep slopes • Areas of sidehills • Areas susceptible to blasting	
Acid generating and metal leaching rock	• Areas susceptible to acid generating rock and/or metal leaching	

7.2.1.2 Spatial Boundaries

The spatial boundaries used in the effects assessment of physical environment considered one or more of the following areas:

- a Footprint Study Area (as defined in Section 7.1.3); and
- a Physical Environment LSA.

A Physical Environment LSA was established to reflect the area in which Project construction and operations activities would be most likely affect the physical environment. The Physical Environment LSA is defined as the ZOI likely to be affected by terrain instability during construction and operations of the proposed pipeline, consisting of a 1 km wide band generally extending from the centre of the proposed pipeline corridor and facilities (*i.e.*, 500 m on both sides of the proposed pipeline corridor centre) to incorporate effects that may extend off the Footprint (*e.g.,* blasting, water erosion on slopes, slumping, acid rock drainage [ARD]). Potential effects are not anticipated to extend beyond the Physical Environment LSA and, therefore, a Physical Environment RSA has not been established.

The Physical Environment LSA was discussed during the ESA Workshops held in March 2013. There was general agreement that the Physical Environment LSA boundary was appropriate and no alternative boundaries were suggested for consideration by the assessment team.

The study area boundaries for the Physical Environment LSA have been used to define the spatial boundary for the Soil LSA based on the extent of the effects of both of these environmental elements. Further details regarding the Soil LSA are provided in Section 7.2.2.2.

7.2.1.3 Physical Environment Context

The proposed pipeline corridor along the Edmonton to Hinton Segment crosses the following physiographic regions: Eastern Alberta Plains; Western Alberta Plains; Southern Alberta Uplands; and Rocky Mountains physiographic regions (Pettapiece 1986). The proposed pipeline corridor in BC crosses the following physiographic regions: Rocky Mountains, Rocky Mountain Trench, Columbia Mountains and Interior Plateau physiographic regions along the Hargreaves to Darfield Segment; Interior Plateau and Cascade Mountains physiographic regions along the Black Pines to Hope Segment; and the Cascade Mountains and Georgia Depression physiographic regions along the Hope to Burnaby and Burnaby to Westridge Segments (Holland 1976). No permafrost is expected to be encountered along the proposed pipeline corridor (refer to Section 5.1.1 for additional information) and no active volcanoes are located in vicinity to the proposed pipeline corridor.

BGC Engineering Inc. investigated and characterized the potential for acid rock drainage (ARD) and metal leaching along the proposed pipeline corridor (refer to the Acid Rock Drainage and Metal Leaching Potential Technical Report of Volume 5C). Of the sites investigated during the field program, nine were considered to contain potentially acid generating (PAG) material. Of these nine sites, three were classified as PAG along the proposed pipeline corridor in the Physical Environment LSA:

- Site 004 is located along the Edmonton to Hinton Segment at RK 14. The ARD potential at this site is considered to be high due to the modest sulphide-S content associated with the coal fragments within the till. There is very little neutralization potential available within the till to neutralize any acid that may be generated from the coal seams.

- Site 019 is located along the Hargreaves to Darfield Segment at RK 669.5. The ARD potential at this site is considered to be high due to the high sulphide-S content. Given the low neutralization potential of the surrounding material, it is uncertain if the non-PAG rock will have the potential to neutralize all the acid generated from the PAG material.

- Site 042 is located along the Black Pines to Hope Segment at RK 987.8. This site had the highest total-sulphur content of all the samples, but measured sulphide content was low, as was the leachable sulphate content. Consequently, ARD potential at this site is considered to be moderate since total sulphur is dominated by non-extractable sulphur and not a likely a concern (*i.e.*, the risk of ARD is minimal).

No traditional ecological knowledge (TEK) was collected for any physical environment indicators and participants did not share any specific information or concerns with respect to terrain instability, topography, or acid generating and metal leaching rock.

7.2.1.4 Potential Effects and Mitigation Measures

<u>Effects Considerations</u>

The topic of naturally occurring radioactive materials (NORMs) was raised during public consultation activities and whether there are any potential effects associated with the Project. NORMs are long-lived radioactive elements of the Earth's crust normally found in low concentrations, although higher concentrations can result from human activities (Health Canada 2000). In the oil and gas industry, NORMs may be encountered in liquids and gases from hydrocarbon-bearing geological formations, contaminated soils, liberated shale deposits and accumulations of slurry debris (Health Canada 2000, Jaremko 2006). Trans Mountain considers exposure to NORMs as a very low risk for the current Project and, consequently, any potential effects associated with the presence of NORMs were not carried through the assessment.

During the Surrey ESA Workshop, a participant noted the possible presence of karst in the area of the proposed pipeline corridor and questioned whether there would be any potential effects associated with constructing on karst lands. However, the only area where karst lands have been documented in the Lower Mainland is in the mountains southeast of the City of Chilliwack, well outside of the Physical Environment LSA (Pike *et al.* 2010). Consequently, any potential effects associated with karst lands were not carried through the assessment.

Identified Potential Effects

Potential effects associated with the construction and operations of the proposed pipeline on physical environment indicators are listed in Table 7.2.1-2. These interactions are based on the results of the literature review, desktop analysis, field work, engagement with Aboriginal communities, landowners, regulatory authorities, stakeholders and the general public (Section 3.0), and the professional experience of the assessment team.

A summary of mitigation measures provided in Table 7.2.1-2 was principally developed in accordance with Trans Mountain standards and industry and provincial regulatory guidelines including Alberta Environment (AENV) (1994a,b, 1995), BC Oil and Gas Commission (OGC) (2013), BC Ministry of Energy and Mines (Price and Errington 1998) and Government of Alberta (2001, 2013a).

TABLE 7.2.1-2

POTENTIAL EFFECTS, MITIGATION MEASURES AND RESIDUAL EFFECTS OF PIPELINE CONSTRUCTION AND OPERATIONS ON PHYSICAL ENVIRONMENT

Potential Effect	Pipeline Segment(s)	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
1. Physical Environment Indicator – Terrain Instability				
1.1 General Measures	All	LSA	• Blast bedrock encountered within trench depth only if ripping or typical trenching methods are not feasible [Section 8.3]. See additional blasting measures in Section 8.3 of the Pipeline EPP. • Assess the need for special trench compaction measures or equipment prior to commencement of backfilling [Section 8.4]. See additional backfilling measures in Section 8.4 of the Pipeline EPP. • Install subsoil cross ditches and berms on steep and moderate slopes on tame pasture, and treed lands in order to prevent runoff along the construction right-of-way and subsequent erosion [Section 8.6]. • Recontour the construction right-of-way, including the removal of temporary subsoil berms on agricultural land and re-establish the pre-construction grades and drainage channels if frozen soil conditions prevented completion of this task during backfilling [Section 8.6]. • Confirm, prior to seeding/planting, that surface texturing is present on steep slopes. If warranted, establish mounds to create microsites on steep, wind exposed slopes where woody vegetation establishment is desirable to retain moisture and enhance vegetation establishment success by creating mounds on steep slopes or, where grass vegetation establishment is desirable, implement track cleat imprinting by aligning the final pass of bulldozers parallel to the slope during the final pass [Section 8.6]. • Revegetate as soon as feasible to reduce or avoid soil erosion and establish long-term cover. Seed immediately following topsoil/root zone material replacement [Section 8.6]. See additional erosion control and revegetation measures in Section 8.6 of the Pipeline EPP.	• Areas of terrain instability may occur as a result of construction activities.

TABLE 7.2.1-2 Cont'd

Potential Effect	Pipeline Segments	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
1.2 Terrain instability due to slumping at watercourse crossings	Edmonton to Hinton Hargreaves to Darfield Black Pines to Hope Hope to Burnaby	LSA	• Install the pipeline at each watercourse using the technique as identified in environmental resource-specific mitigation table for aquatic resources in Appendix I of Volume 6B and as shown on the Environmental Alignment Sheets in Volume 6E. Ensure that the technique is implemented as per the reports/notifications/applications provided to applicable regulators [Section 8.7]. • Bore the irrigation canal crossings during the irrigation season or where a trenched crossing will result in potentially long-term bank instability [Section 8.3]. • Take extra care to compact the trench at banks of watercourse crossings that have been trenched [Section 8.4]. Stabilize and revegetate areas disturbed during installation and removal of a bridge; install erosion control measures, where warranted, to control surface erosion until vegetation is established [Section 8.7]. • Return the bed and banks of each watercourse crossing as close as feasible to their pre-construction contours (slope and height). Take appropriate measures to reduce the risk of sloughing of the streambanks following construction [Section 8.7]. • Install riprap bank armouring [see Streambank Protection – Cobble or Riprap Armouring Drawing in Appendix R] along unstable banks with high erosion potential locations [Section 8.7]. • Install permanent erosion control measures, as outlined in the Reclamation Management Plan [Appendix C] unless otherwise approved by Trans Mountain to adjust for site conditions and suitability [Section 8.6]. • Seed riparian areas with an approved annual or perennial grass cover crop or native grass mix as soon as feasible after construction [Section 8.6]. See additional erosion control and revegetation measures in Section 8.6 of the Pipeline EPP.	• Areas of slope instability may occur if trenched crossing methods are required at large watercourse crossings.
1.3 Terrain instability due to sidehill terrain	All	LSA	• Replace grade material to a stable contour that will approximate the pre-construction contour, except where it is not practical or safe to do so [Section 8.4].	• Areas of terrain instability may occur as a result of construction activities.
2. Physical Environment Indicator – Topography				
2.1 Alteration of topography along steep slopes	All	LSA	• Minimize grading on steep slopes, unless safety concerns are identified [Section 8.2]. • Install subsoil cross ditches and berms on steep and moderate slopes on tame pasture, and treed lands in order to prevent runoff along the construction right-of-way and subsequent erosion [Section 8.6]. • Recontour the construction right-of-way, including the removal of temporary subsoil berms on agricultural land and re-establish the pre-construction grades and drainage channels if frozen soil conditions prevented completion of this task during backfilling [Section 8.6]. • Regrade areas with vehicle ruts, erosion gullies or where the trench has settled [Section 8.6]. • Rollback slash and small diameter, salvageable timber on steep slopes [Section 8.6]. • Apply hydromulch/hydroseed at a rate recommended by the supplier on steep recontoured slopes [Section 8.6]. • Confirm, prior to seeding/planting, that surface texturing is present on steep slopes. If warranted, establish mounds to create microsites on steep, wind exposed slopes where woody vegetation establishment is desirable to retain moisture and enhance vegetation establishment success by creating mounds on steep slopes or, where grass vegetation establishment is desirable, implement track cleat imprinting by aligning the final pass of bulldozers parallel to the slope during the final pass [Section 8.6].	• Topography may be altered at locations where cut slopes are too steep to be replaced to the pre-construction profile without creating areas of instability.

TABLE 7.2.1-2 Cont'd

Potential Effect	Pipeline Segments	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
2.2 Alteration of topography along slopes of watercourse crossings	Edmonton to Hinton Hargreaves to Darfield Black Pines to Hope Hope to Burnaby	LSA	• Restrict root grubbing to the area located outside of the vegetated riparian buffer adjacent to watercourses [Section 8.1]. See additional root grubbing measures in Section 8.1 of the Pipeline EPP. • Fell trees away from watercourses and away from limits of the construction right-of-way to reduce damage to streambanks, beds and adjacent trees [Section 8.1]. • Reduce grading along the construction right-of-way and associated facilities, especially within watercourse and wetland vegetated buffers and on hay land and tame pasture lands with a competent vegetation mat/sod layer [Section 8.2]. • Confine the use of fords to watercourses or segments of watercourses with low, stable banks and a stable substrate composed of materials such as gravel or bedrock. Trans Mountain will not grade the banks to create a ford. Install matting, where warranted, to protect the bed and banks of a watercourse to be forded [Section 8.7]. • Re-establish streambanks and approaches immediately following construction of water crossings as outlined in the Reclamation Management Plan [Appendix C] [Section 8.6]. • Recontour the construction right-of-way and stabilize approach slopes at watercourse crossings. Where reclamation of the pre-construction grade is not feasible due to risk of failure of fill on slopes or maintenance of an access trail, recontour to grades as directed by the Geotechnical Engineer [Section 8.6].	• Topography may be altered at locations where cut slopes are too steep to be replaced to the pre-construction profile without creating areas of instability.
2.3 Alteration of topography due to sidehill terrain	All	LSA	• Replace grade material to a stable contour that will approximate the pre-construction contour, except where it is not practical or safe to do so [Section 8.4].	• Topography may be altered at locations where cut slopes are too steep to be replaced to the pre-construction profile without creating areas of instability.
2.4 Alteration of topography at areas of blasting	Edmonton to Hinton Hargreaves to Darfield Black Pines to Hope Hope to Burnaby	LSA	• Blast bedrock encountered within trench depth only if ripping or typical trenching methods are not feasible [Section 8.3]. • Dispose of excess blast rock and excavated rock at approved locations [Section 8.3]. • Dispose of excess rock displaced from the trench or from blasting on non-agricultural lands in discrete piles, windrows or scattered along the construction right-of-way, or as directed by the landowner or appropriate regulatory authority [Section 8.6].	• Topography may be altered at locations where blasting occurs.
3. Physical Environment Indicator – Acid Generating and Metal Leaching Rock				
3.1 Acid generation or metal leaching rock	Edmonton to Hinton Hargreaves to Darfield Black Pines to Hope	LSA	• Adhere to recommendations of the Soil/Geotechnical Resource Specialist and/or the Lead Environmental Inspector and Inspector(s) at locations where ARD may be present and trench dewatering is necessary. Record locations and estimated volumes of trench water discharged [Section 8.3]. • Adhere to recommendations in the Acid Rock Drainage and Metal Leaching Potential Technical Report (Volume 5C).	• Acidification/ contamination of the terrestrial and/or aquatic environment from ARD or metal leaching.

Notes: 1 LSA = Physical Environment LSA.

2 Detailed mitigation measures are outlined in the Pipeline EPP (Volume 6B).

7.2.1.5 Potential Residual Effects

The potential residual environmental effects on physical environment indicators associated with the construction and operations of the pipeline (Table 7.2.1-2) are:

- areas of terrain instability may occur as a result of construction activities;
- areas of slope instability may occur if trenched crossing methods are required at large watercourse crossings;
- topography may be altered at locations where cut slopes are too steep to be replaced to the pre-construction profile without creating areas of instability;
- topography may be altered at locations where blasting occurs; and
- acidification/contamination of the terrestrial and/or aquatic environment from ARD or metal leaching.

7.2.1.6 Significance Evaluation of Potential Residual Effects

Where there are no standards, guidelines, objectives or other established and accepted ecological thresholds to define quantitative rating criteria or where quantitative thresholds are not appropriate, the qualitative method is considered to be the appropriate method for determining the significance of the anticipated residual environmental effects. Consequently, a qualitative assessment of physical environment was determined to be the most appropriate method with the evaluation of significance of each of the potential residual effects relying on the professional judgment of the assessment team.

Table 7.2.1-3 provides a summary of the significance evaluation of the potential residual environmental effects of the construction and operations of the proposed pipeline on the physical environment. The rationale used to evaluate the significance of each of the residual environmental effects is provided below.

TABLE 7.2.1-3

SIGNIFICANCE EVALUATION OF POTENTIAL RESIDUAL EFFECTS OF PIPELINE CONSTRUCTION AND OPERATIONS ON PHYSICAL ENVIRONMENT

	Potential Residual Effects	Impact Balance	Spatial Boundary[1]	Temporal Context			Magnitude	Probability	Confidence	Significance[2]
				Duration	Frequency	Reversibility				
1.	Physical Environment Indicator – Terrain Instability									
1(a)	Areas of terrain instability may occur as a result of construction activities.	Negative	LSA	Short-term	Isolated	Short to medium-term	Low	High	High	Not significant
1(b)	Areas of slope instability may occur if trenched crossing methods are required at large watercourse crossings.	Negative	LSA	Short-term	Isolated	Short to medium-term	Low	Low	High	Not significant
2.	Physical Environment Indicator – Topography									
2(a)	Topography may be altered at locations where cut slopes are too steep to be replaced to the pre-construction profile without creating areas of instability.	Negative	LSA	Short-term	Isolated	Permanent	Low to medium	High	High	Not significant
2(b)	Topography may be altered at locations where blasting occurs.	Negative	LSA	Short-term	Isolated	Permanent	Low	High	High	Not significant
2(c)	Combined effects on the topography indicator (2[a] and 2[b]).	Negative	LSA	Short-term	Isolated	Permanent	Low to medium	High	High	Not significant
3.	Physical Environment Indicator – Acid Generating and Metal Leaching Rock									
3(a)	Acidification/contamination of the terrestrial and/or aquatic environment from ARD or metal leaching.	Negative	LSA	Short-term	Isolated	Short to medium-term	Low	Low	High	Not significant

Notes: 1 LSA = Physical Environment LSA.

2 Significant Residual Environmental Effect: A high probability of occurrence of a permanent or long-term residual effect of high magnitude that cannot be technically or economically mitigated.

Physical Environment Indicator – Terrain Instability

The following provides the evaluation of significance of potential residual effects on the terrain instability indicator.

Terrain Instability

Terrain instability resulting from construction of the Project was a concern identified during several of the stakeholder engagement events for the Project (*e.g.,* Hope, Abbotsford, Coquitlam and Burnaby Community Workshops). Minor areas of terrain instability may occur along areas of the proposed pipeline corridor as a result of the proposed construction activities (*e.g.,* grading, trenching, blasting and backfilling). The impact balance of this residual effect is considered negative since terrain instability could affect the safety of the pipe and result in surface erosion. Terrain along most of the proposed pipeline corridor is considered to be stable, based on observations and operating experience of the existing TMPL system to date, as well as the results of the Terrain Mapping and Geohazard Inventory (Volume 4A). The proposed pipeline corridor does, however, cross several mountain ranges and encounters adverse topography and angled bedrock with the potential to cause slope failure and rock slide events during construction activities. Some notably steep areas along the proposed pipeline corridor are located in the North Thompson River valley, near the District of Hope, in the Coquihalla River valley and at Sumas Mountain.

During construction of the TMX Anchor Loop Project, minor rock slides occasionally resulted during blasting activities at three locations, which were readily cleaned up, and a debris (rock and soil) slide occurred along a steep slope north of the trench line. Although material from the debris slide was cleaned up, it resulted in a scar extending approximately 10 m beyond the right-of-way boundaries. No other issues related to terrain instability were encountered during construction (TERA 2009a).

Selection of the proposed pipeline corridor for the new segments considered reducing exposure to known locations of slope instability, potential for rock falls and debris flows, and reducing potential of construction and long-term operations of the pipeline to effect stability of the surrounding terrain. These terrain stability considerations along with their standard mitigation measures are summarized in Section 4.1 of Volume 4A. The entire proposed pipeline corridor has been evaluated for terrain stability by qualified engineering consultants and the results are provided in the Terrain Mapping and Geohazard Inventory (Volume 4A). The KMC Natural Hazards Management Program database for the existing TMPL system was also used as a source to identify specific areas of concern.

During construction of the pipeline, removal of vegetation and root mass, grading, blasting, cut and fills and runoff controls could lead to localized areas of potential instability. Monitoring during construction will ensure any observed instability issues will be resolved early before potentially severe instability problems arise. Grade material will be replaced to a stable contour that will approximate the pre-construction contour, except where it is not practical or safe from a pipe integrity perspective or for public safety. When replacing sidehills or other graded areas is not practical due to the risk of slope failure, the Inspector(s), Construction Manager and a geotechnical engineer will discuss to determine an appropriate grade.

During pipeline construction, there is potential for Project construction to trigger large slide or rock fall events (*e.g.,* steep terrain in the Coquihalla River valley). Risks associated with specific areas of potential instability will be characterized during the geotechnical risk assessment for the Project; planned to commence as part of detailed engineering design. Specific mitigation or contingency measures, including minor reroutes, if warranted, will be implemented if deemed necessary to avoid high risk areas. Furthermore, during grading of the new right-of-way, the potential for localized instability and rock fall concerns will be identified. In these instances, qualified geotechnical engineers will review the locations of concern and, where warranted, prepare site-specific mitigation designs.

During operations, prior to establishment of a vegetative cover, exposed slopes and cut and fills prone to instability have the potential to become unstable as a result of increased pore pressure (from water saturated soil) and erosion (*e.g.,* sloughing from gullying and scouring). During post-construction environmental monitoring for the TMX Anchor Loop Project in 2010, erosion gullies were observed at several locations along the pipeline right-of-way. Site-specific sediment and erosion control measures were implemented the same year to provide effective long-term stability (TERA 2011a). During post-construction environmental monitoring in 2012, only one erosion gully was observed, and repaired, along the right-of-way (TERA 2013a). Sink holes also have the potential to occur from subsurface erosion along the pipeline trench during operations. During post-construction environmental monitoring for the TMX Anchor Loop Project in 2009, sinkholes were observed at six locations along the right-of-way (TERA 2009b). Remedial measures were conducted during the summer of 2009 and during subsequent years, no new sink holes were identified and the reclaimed sink holes were observed to be stable. Other than a small, localized slumping event, no other issues related to terrain instability were observed during post-construction environmental monitoring for the TMX Anchor Loop Project (TERA 2009b, 2011a, 2013a).

Regular aerial and ground patrols will be conducted to examine vegetation establishment and confirm mitigation measures are functioning as intended, as well as identify any new areas of potential instability. At any areas where a mass wasting event is observed, appropriate measures will be implement to clean-up and stabilize the site. Monitoring of the reclaimed sites will continue until the site is determined to be in a stable condition.

Effective route refinement prior to construction will help to reduce the overall effect of the Project along areas of steep and potentially unstable topography. Furthermore, the construction of the pipeline will comply with industry accepted practices and measures outlined in the Pipeline EPP (Volume 6B) as well as engineering and design considerations in Volume 4A and, therefore, the pipeline is not expected to cause rock slides, slumping or other mass wasting events. The mitigation measures in Table 7.2.1-2 have been found to be effective during construction and reclamation of the TMX Anchor Loop Project. Similar mitigation measures are planned for the construction of the proposed pipeline. Areas of potential terrain instability will be regularly monitored during aerial patrols over the life of the pipeline and promptly remediated, where necessary, to protect pipeline integrity and reduce effects on the environment. The residual effect of terrain instability occurring as a result of planned construction activity is reversible in the short to medium-term and of low magnitude (Table 7.2.1-3, point 1[a]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Physical Environment LSA - terrain instability as a result of construction activities may extend beyond the construction workspace.
- Duration: short-term – the event causing potential terrain instability is construction of the pipeline (*e.g.,* grading, and rough clean-up).
- Frequency: isolated – the event causing potential terrain instability (*i.e.*, construction of the pipeline) is confined to a specific period.
- Reversibility: short to medium-term – most areas of terrain instability will be remediated within a year, however, some areas may require a second or third year of remedial effort to fully stabilize.
- Magnitude: low – the implementation of the proposed mitigation measures in addition to detailed engineering design is expected to effectively reduce the severity and extent of potential effects on terrain instability.
- Probability: high – terrain instability is likely to result from pipeline construction at localized areas.
- Confidence: high – based on data pertinent to the Project area and the experience of the assessment team.

Slope Instability at Watercourses

Areas of slope instability may occur where a trenched crossing method is used at watercourse crossings. The impact balance of this residual effect is considered negative since slope instability could affect the safety of the pipe and water quality of the watercourses. Terrain along the proposed pipeline corridor ranges from level to undulating to mountainous, with steep slopes present at many of the larger and intermediate watercourses. The placement of trenchless crossing entry and exit locations well back from the potentially unstable areas and the depth of the drill path are expected to avoid the effect of terrain instability issues on the pipeline. However, where a trenchless crossing is unsuccessful or not feasible and a trenched (*i.e.*, isolated if water present/open cut if dry or frozen to the bottom) installation is necessary, Trans Mountain will engage a geotechnical engineer regarding additional mitigation measures to prevent and control terrain instability, as needed, during construction. The installation of erosion protection measures will reduce the potential for slumping occurrence. Specific mitigation measures will be embedded in detailed crossing drawings that will be developed during detailed engineering design to address site-specific slope stability issues at watercourses. The residual effect of slope instability during trenched watercourse crossings is of low magnitude and is reversible in the short to medium-term depending on the length of time required to restabilize the affected area (Table 7.2.1-3, point 1[b]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Physical Environment LSA – slope instability as a result of trenching at watercourses may extend beyond the construction workspace.
- Duration: short-term – the event causing potential slope instability is construction of the pipeline (*e.g.,* grading, trenching and backfilling during trenched crossing).
- Frequency: isolated – the event causing potential slope instability (*i.e.*, construction of the pipeline) is confined to a specific period.
- Reversibility: short to medium-term – depending upon the length of time required to restabilize the affected area.
- Magnitude: low – the implementation of the proposed mitigation measures is expected to effectively reduce the potential effects on slope instability.
- Probability: low – slope instability will likely be avoided by the installation of erosion protection measures and proper trenched crossing procedures.
- Confidence: high – based on the professional experience of the assessment team on previous pipeline projects with similar conditions.

Combined Effects on Terrain Instability

An evaluation of the combined effects considers those residual effects that may interact with each other and are likely to occur. Since terrain instability occurring during construction and operations activities is the only likely potential residual effect identified, an evaluation of combined effects of the pipeline on the terrain instability indicator is not warranted.

Physical Environment Indicator – Topography

The following provides the evaluation of significance of potential residual effects on the topography indicator.

Alteration of Topography at Cut Slopes

As a result of construction, topography along the proposed pipeline corridor may be altered at locations where cut slopes are too steep to be returned to the pre-construction profile. Alteration of topography was raised as concern at Kamloops and Merritt Community Workshops, specifically along grassland areas between the proposed Black Pines Pump Station and the existing Kingsvale Pump Station.

Grading of the construction right-of-way must be sufficient to accommodate pipe stringing, welding, field bending, lowering-in and safe movement of pipe, equipment and personnel along the construction right-of-way. Grading along the construction right-of-way will vary from only topsoil/root zone material salvaging in some areas to extensive cuts and fills in other areas. The grade and trench rock along the construction right-of-way will be ripped mechanically using bulldozers and excavators, where practical. Otherwise, controlled blasting techniques in will be used (refer to Alteration of Topography from Blasting below). Following construction, the construction right-of-way, including approach slopes at watercourse crossings, will be recontoured to pre-construction profiles and stabilized, except where it is not practical or safe to do so.

Alteration of topography will be reduced by installing the pipeline adjacent to the existing TMPL right-of-way and other linear infrastructure (*e.g.,* Telus fibre optic line right-of-way, Spectra gas pipeline right-of-way). In grassland areas around the cities of Kamloops and Merritt, the proposed pipeline corridor will parallel the existing TMPL right-of-way for most of its length. The impact balance of this residual effect is considered negative since local topographic alteration is considered a detriment to the environment. Although this unavoidable consequence will be permanent in localized areas and of high probability, the magnitude is considered to be low to medium depending on the extent of topographic alteration, type of vegetative cover (*e.g.*, treed vs. grassland) and sensitivity of nearby receptors (Table 7.2.1-3, point 2[a]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Physical Environment LSA – alteration of topography may extend beyond the construction workspace.
- Duration: short-term – the event causing the potential alteration of topography is construction of the pipeline.
- Frequency: isolated – the event causing the potential alteration of topography (*i.e.*, construction of the pipeline) is confined to a specific period.
- Reversibility: permanent – alteration of topography resulting from slopes that are too steep to be restored to the pre-construction profile cannot be reversed.
- Magnitude: low to medium – the implementation of the proposed mitigation measures is expected to effectively reduce the potential effect of alteration of local topography, however, grassland areas where bedrock is likely to be encountered between the proposed Black Pines Pump Station and the existing Kingsvale Pump Station are particularly susceptible to visible alterations in topography.
- Probability: high – the proposed pipeline corridor encounters areas of steep terrain where it is likely that cut slopes may not be returned to pre-construction profiles.
- Confidence: high – based on data pertinent to the Project area and the professional experience of the assessment team.

Alteration of Topography from Blasting

Blasting of the trench and grade rock is expected to be required only after all reasonable means of excavation by mechanical equipment (*e.g.,* bulldozers, excavators) have been used and are unsuccessful in achieving the required results, and where deemed absolutely necessary by construction and blasting experts after detailed site examination. The impact balance of this residual effect is considered negative since local topographic alteration is considered a detriment to the environment. This unavoidable consequence will be permanent and of high probability. However, efforts will be made to reduce the area of permanent disturbance by ensuring blasting will only be conducted by licensed blasters and implementing controlled blasting techniques in accordance with Trans Mountain's Blasting Specification for grade and trench rock excavation. The Blasting Specification will be developed during detailed engineering design for the Project.

Detonation methods and procedures will be dependent on, among other factors, associated rock type and geological structure (solid, layered, or fractured). On occasion, control over the volume and extent of material removed may be limited due to difficulties in predicting extent and accuracy of blast parameters and indeterminate geologic structures and nearby terrain instabilities. Test blasting will be conducted at locations where blasting is required to evaluate ground damage and vibration and establish site-specific blasting parameters and procedures to reduce unintentional disturbances and potential instabilities.

On occasion, unintended alterations in topography may occur resulting from mass wasting events triggered during blasting. For example, during construction of the TMX Anchor Loop Project, a debris (rock and soil) slide occurred along a steep slope north of the trench line resulting in a scar extending approximately 10 m beyond the right-of-way boundaries (TERA 2009a). Otherwise, no issues related to shallow bedrock or blasting were encountered during construction (TERA 2009a). To limit any unintended alterations in topography, a Blasting Management Plan will be prepared prior to construction to ensure blasting is performed in a manner that safeguards the public and environment, and alterations of terrain are controlled and limited to the required site dimensions for safe construction and pipeline installation. Given the anticipated limited extent of blasting along the construction right-of-way (*i.e.*, only in areas where excavation by mechanical equipment is unsuccessful), implementation of mitigation measures, and since most blasting will be conducted in remote areas well away from receptors and/or adjacent to terrain previously altered from existing linear infrastructure, magnitude is considered to be low (Table 7.2.1-3, point [2b]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Physical Environment LSA – alteration of topography from blasting may extend beyond the construction workspace.
- Duration: short-term – the event causing the potential alteration of topography from blasting is construction of the pipeline.
- Frequency: isolated – the event causing the potential alteration of topography from blasting (*i.e.*, construction of the pipeline) is confined to a specific period.
- Reversibility: permanent – topography altered from blasting activities is unlikely to be restored to the pre-construction profile and cannot be reversed.
- Magnitude: low – the implementation of the proposed mitigation measures is expected to effectively reduce the potential effect of alteration of topography from blasting.
- Probability: high – there are localized areas along the proposed pipeline corridor where blasting activities will likely be necessary.
- Confidence: high - based on data pertinent to the Project area and the professional experience of the assessment team.

Combined Effects on Topography

An evaluation of the combined effects considers those likely residual effects which contribute to overall effects on topography. Therefore, both residual effects evaluated in Table 7.1.3-3 (points 2[a] and 2[b]) could act in combination on the topography indicator.

The adverse effects identified have the potential to contribute to combined effects on topography along the proposed pipeline corridor. This residual effect is considered permanent and the probability of these residual effects acting in combination to alter topography at any specific location along the proposed pipeline corridor is high. The magnitude of the combined effects on the topography indicator is considered to be low to medium since the combined effect is likely to be reduced by implementation of mitigation strategies for each of the residual effects and since most of proposed pipeline corridor parallels the existing TMPL right-of-way and/or other linear infrastructure (Table 7.2.1-3, point 2[c]). A summary of the rationale for all of the significance criteria of combined effects on the topography indicator is provided below.

- Spatial Boundary: Physical Environment LSA – combined effects on the topography indicator may extend beyond the construction workspace.
- Duration: short-term – the event causing the combined effects on the topography indicator is construction of the pipeline.
- Frequency: isolated – the event causing the combined effects on the topography indicator (*i.e.*, construction of the pipeline) is confined to a specific period.
- Reversibility: permanent – combined effects on the topography indicator may result in alterations of topography which cannot be restored to pre-construction conditions.
- Magnitude: low to medium – combined effects on the topography indicator are anticipated to be largely mitigated during construction.
- Probability: high – it is likely that topography will be altered at cut slopes where pre-construction contours cannot be replaced and at areas where blasting occurs.

- Confidence: high – based on data pertinent to the Project area and the professional experience of the assessment team.

Physical Environment Indicator – Acid Generating and Metal Leaching Rock

The following provides the evaluation of significance of potential residual effects on the acid generating and metal leaching rock indicator.

Acid Rock Drainage and Metal Leaching

Although no specific concerns were identified during stakeholder engagement events, participants in the Clearwater and Kamloops Community Workshops were unfamiliar with ARD and questioned how it will be mitigated.

Exposing, excavating or reusing rock during construction can increase the likelihood of ARD from sulphide-bearing rocks due to increased interaction with water and oxygen and larger surface areas relative to undisturbed rock. Processes that could disturb bedrock during pipeline construction include grading by cutting or filling, and trenching, which will expose bedrock in the walls of the trench. Weathering conditions, such as those related to the oxidation of metal sulphides (*e.g.,* pyrite) will largely determine if ARD will be generated by the exposed outcrops identified as potentially containing acid generating (PAG) materials. Geochemical conditions (*e.g.,* pH, alkalinity) created by weathering play a major role in determining trace element solubility and, therefore, the potential for offsite dissolved metal transport. An important factor controlling the rates and timing of metal release and leaching is whether or not ARD will occur and, if so, the timing of the onset of ARD. The impact balance of this residual effect is considered negative since ARD and metal leaching is considered a detriment to the environment.

Effectively managing ARD along the pipeline construction right-of-way will reduce the environmental effects and the need for remediation. Site conditions that need to be taken into consideration in order to properly mitigate PAG and metal leaching areas include location, topography, climate, geology, hydrology and hydrogeology, availability of neutralizing materials, and vegetation. Climate variations along the proposed pipeline corridor are considerable; therefore, physical weathering processes such as expansion and contraction of the rock due to freeze/thaw events should be taken into consideration. Furthermore, chemical weathering processes continue at temperatures below 0ºC. The ionic strength (*e.g.,* salinity) of the pore water may depress the freezing point of water which could result in unfrozen water present in waste materials at temperatures well below freezing.

Exposure of PAG material to oxygen and water will be kept to a minimum during pipeline construction. As recommended in the Acid Rock Drainage and Metal Leaching Potential Technical Report (Volume 5C), this will be achieved by reducing the time of exposure, reducing excess PAG material generated by grading and trenching, and by covering freshly exposed PAG material with a compacted cover of till or clay material in a way that promotes water shedding while limiting potential erosion. Any PAG material will be stored at sites that are elevated and dry to avoid exposure to any surface or groundwater flow. In the event long-term storage of PAG material is required, a thick vegetation mat (*e.g.,* grass) should be maintained on the cover. Any excess rock that will not be returned to the construction right-of-way and reclaimed will be removed from the site as per recommendations of the Soil/Geotechnical Resource Specialist and/or the Lead Environmental Inspector and Inspector(s).

Given the mitigation measures, the likelihood of acidification/contamination of the terrestrial and/or aquatic environment from ARD or metal leaching rock during or after construction of the pipeline is considered to be low. The magnitude of this residual effect is considered to be low as well based on the material composition of identified PAG sites and the limited volume of materials being disturbed and exposed from construction (Table 7.2.1-3, point 3[a]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Physical Environment LSA – any ARD or metal leaching may extend beyond the construction workspace.

- Duration: short-term – short-term ARD or metal leaching may result from exposure of fresh rock-cut surfaces during construction until mitigation measures are implemented (*e.g.*, covering fresh surfaces, proper storage) or material is removed from site and properly disposed of.

- Frequency: isolated – ARD or metal leaching may be confined to exposed construction materials until covered or removed from site.
- Reversibility: short to medium-term – acidification/contamination of the terrestrial and/or aquatic environment from ARD or metal leaching may result in localized changes to the surrounding environment, which may take longer than 1 year to fully remediate.
- Magnitude: low – given implementation of the proposed mitigation measures to effectively reduce the potential effect and based on the material composition of identified PAG sites and the limited volume of materials being disturbed and exposed from construction.
- Probability: low – given implementation of the proposed mitigation measures to effectively reduce the potential effect and given the limited volume of materials being disturbed and exposed from construction.
- Confidence: high – based on data pertinent to the Project area and the professional experience of the assessment team.

7.2.1.7 Summary

As identified in Table 7.2.1-3, there are no situations where there is a high probability of occurrence of a permanent or long-term residual environmental effect on the physical environment indicators of high magnitude that cannot be technically or economically mitigated. Consequently, it is concluded that the residual environmental effects of pipeline construction and operations on the physical environment will be not significant.

7.2.2 Soil and Soil Productivity

This subsection describes the potential Project effects on soil and soil productivity. The Soils Technical Report of Volume 5C provides further information pertaining to existing soil conditions along the proposed pipeline corridor.

7.2.2.1 Assessment Indicators and Measurement Endpoints

Assessment indicators identified for the soil and soil productivity element are: soil productivity; soil degradation; bedrock and stone disposal; and soil contamination. Assessment indicators and measurement endpoints for soil and soil productivity are listed in Table 7.2.2-1.

The selection of indicators for soil and soil productivity included: consideration of the filing requirements in the NEB *Filing Manual*; experience gained during previous projects with similar conditions/potential issues; feedback from Aboriginal communities and stakeholders; feedback from participants in ESA Workshops; available research literature; public issues raised through the media; and the professional judgment of the assessment team. A list of the proposed indicators for soil and soil productivity were discussed during the Edmonton, Kamloops and Surrey ESA Workshops held in March 2013. The proposed indicators were also discussed with participants of an agricultural-focused ESA Workshop in Abbotsford in May 2013. Participants of the workshops did not indicate that the proposed soil indicators were inappropriate for evaluating the effects of the Project on soil and soil productivity.

Food production was suggested as an additional indicator by a participant of the Surrey ESA Workshop. Upon consideration by the assessment team, food production was not adopted as a soil indicator since this topic is discussed as part of the indicator of agricultural use in Section 7.2.4 Human Occupancy and Resource Use of Volume 5B. Food production is also discussed in the Agricultural Assessment Technical Report of Volume 5D.

Qualitative measurement endpoints are applied to assess potential Project effects on soil and soil productivity indicators. Table 7.2.2-1 provides a summary of the indicators and measurement endpoints used in the assessment of potential effects on soil and soil productivity.

TABLE 7.2.2-1

ASSESSMENT INDICATORS AND MEASUREMENT ENDPOINTS FOR SOIL AND SOIL PRODUCTIVITY

Soil Indicators	Measurement Endpoints	Rationale for Indicator Selection
Soil productivity	• Areas susceptible to topsoil/root zone material and subsoil mixing • Areas susceptible to saline lower subsoil mixing with upper horizons • Changes in evaporation and transpiration rates • Areas of shallow bedrock • Hydrostatic test water discharge locations • Areas susceptible to trench subsidence • Areas susceptible to clubroot infestation	The selection of indicators and measurement endpoints considered NEB *Filing Manual* requirements for soil and soil productivity element in Table A-2 and addressed concerns raised through Aboriginal engagement and stakeholder consultation.
Soil degradation	• Areas susceptible to compaction and rutting • Areas susceptible to wind erosion • Areas susceptible to water erosion • Areas susceptible to surface water erosion on slopes • Areas susceptible to pulverization of soil and sod • Hydrostatic test water discharge locations	
Bedrock and stone disposal	• Areas of shallow bedrock or stony soils	
Soil contamination	• Identification of historic contaminated sites • Hydrostatic test water discharge locations • Possible future contamination	

7.2.2.2 Spatial Boundaries

The spatial boundaries used in the effects assessment of soil and soil productivity considered one or more of the following areas:

- a Footprint Study Area (as defined in Section 7.1.3); and
- a Soil LSA.

A Soil LSA was established to reflect the area in which Project construction and operations activities would be most likely to affect soil and soil productivity. The ZOI likely to be affected by direct disturbance is defined as a 1 km wide band generally extending from the centre of the proposed pipeline corridor and facilities (*i.e.*, 500 m on both sides of the proposed pipeline corridor centre) to incorporate effects that may extend off the Footprint (*e.g.,* wind/water erosion). Potential effects are not anticipated to extend beyond the Soil LSA and, therefore, an RSA for soil and soil productivity was not established.

The Soil LSA was discussed during the ESA Workshops held in March 2013 and during the agricultural-focused ESA Workshop held in Abbotsford in May 2013 (Section 3.0). There was general agreement that the Soil LSA boundary was appropriate, although a suggestion was made to go beyond 1 km for select agricultural areas in the Lower Mainland. Upon consideration, the assessment team felt that for the types of potential effects on soil and soil productivity likely to result from the construction and operations of the pipeline, a 1 km LSA was deemed appropriate.

7.2.2.3 Soil Context

The Edmonton to Hinton Segment is located primarily in an agricultural area and encounters mainly previously disturbed soils. Chernozems and Luvisols are the dominant soil orders encountered along this segment of the proposed pipeline corridor (Natural Regions Committee 2006). The proposed pipeline corridor in BC encounters mountainous, rural, urban and agricultural areas. Luvisols and Podzols are the dominant soil orders encountered along the segments of the proposed pipeline corridor in BC (Valentine *et al.* 1978).

A soil survey was conducted on lands with agricultural capability for new pipeline segments along the proposed pipeline corridor approximately every 250 m on ALR lands or wherever there was a change in the crop being grown or topography encountered (see Soils Technical Report of Volume 5C). A variety of surficial deposits occur along the proposed pipeline corridor. Topography along the proposed pipeline corridor is varied. Steeper slopes are generally confined to larger watercourse crossings and mountainous areas. In total, 186 soil units were described and mapped along the proposed pipeline corridor. Bedrock within trench depth may be encountered in certain soil units; however, it is anticipated that most bedrock can be easily excavated using normal trenching procedures. Locations of soil types encountered along the proposed pipeline corridor are identified on the Environmental Alignment Sheets (Volume 6E).

Known occurrences of clubroot have been identified in Alberta and BC. Generally, the risk of clubroot disease is higher along the eastern portion of the proposed pipeline corridor (*e.g.,* Parkland County and Yellowhead County) and in the Lower Mainland (*e.g.,* FVRD).

Historical spills have occurred along the existing TMPL right-of-way. To address the releases, various remedial methods were employed to the standards of the time. The locations of historical spills will be monitored during construction for signs of contamination. If contamination is suspected, the Contamination Discovery Contingency Plan (Appendix B of the Pipeline EPP of Volume 6B) will be implemented.

A cursory inventory of potential third-party contaminated sites was conducted by reviewing aerial photography to identify potential sites which could be sources of contamination that have the potential to affect the proposed pipeline corridor. Areas of interest were identified within the proposed pipeline corridor and will be monitored during construction.

No Crown dispositions related to soil conservation were identified as being crossed by the proposed pipeline corridor in Alberta or BC (Alberta Energy 2013, BC ILMB 2013).

7.2.2.4 Potential Effects and Mitigation Measures

Effects Considerations

Participants at the Abbotsford and Surrey ESA Workshops expressed concern over heat generated from the pipeline affecting soils. Previous studies of the effects of pipeline temperature on soil and crop growth have been conducted for the TransCanada Pipeline, LP (TransCanada) Keystone XL Pipeline Project and the Alliance Pipeline Project. These studies suggest that effects on surficial soil temperature attributable to an operating pipeline are negligible, and that the heating of rooting zone soil by the pipeline did not have a statistically significant effect on plant available soil water (Dunn *et al.* 2004, TransCanada 2009). Further discussion on soil temperature near the pipe and limited potential to affect crop growth are provided in the Agricultural Assessment Technical Report of Volume 5D and under the agricultural use indicator of Section 7.2.4 Human Occupancy and Resource Use of Volume 5B.

Participants at the Abbotsford and Chilliwack Community Workshops expressed concern that there is naturally occurring asbestos in the soil in the areas around Abbotsford (particularly the former Sumas Lake bed) and Chilliwack. Asbestos-containing sediment is found in the Sumas River originating from a landslide in the 1930s on the Swift Creek tributary in Washington State. The landslide is composed of serpentine rock which is rich in asbestos and heavy metals. The portion of the Sumas River flowing through the Abbotsford area has been contained within its channel by a diking system built in the 1920s and there has been no overbanking in any areas near the existing TMPL right-of-way. The risk of disturbing asbestos rich soils in the Abbotsford area is extremely low since no sediment from the Sumas River has been deposited on farmland since the time of the landslide (McTavish pers. comm.). Consequently, asbestos in the soil was not carried through the assessment. The Sumas River was dredged in the early 1980s and sediments containing asbestos are stored on the river bank and capped to prevent any exposure. Any sediment from recent dredging has been deposited in a secure landfill, eliminating any risk of exposure to asbestos (McTavish pers. comm.). Trans Mountain is aware of the location of the stored dredged sediments on the banks of the Sumas River.

Identified Potential Effects

Potential effects associated with the construction and operations of the proposed pipeline on soil and soil productivity indicators are listed in Table 7.2.2-2. These interactions are based on the results of the literature review, desktop analysis, field work, Aboriginal engagement, consultation with landowners, regulatory authorities, stakeholders and the general public (Section 3.0), and the professional experience of the assessment team.

A summary of mitigation measures provided in Table 7.2.2-2 was principally developed in accordance with Trans Mountain standards as well as industry and provincial regulatory guidelines including AENV (1988, 1994a,b, 1995, 1998), Alberta Pipeline Environmental Steering Committee (1996), BC OGC (2010a) and Canadian Association of Petroleum Producers (CAPP) (1996, 1999, 2008).

TABLE 7.2.2-2

POTENTIAL EFFECTS, MITIGATION MEASURES AND RESIDUAL EFFECTS OF PIPELINE CONSTRUCTION AND OPERATIONS ON SOIL AND SOIL PRODUCTIVITY

Potential Effect	Pipeline Segment(s)	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
1. Soil Indicator – Soil Productivity				
1.1 Decreased topsoil/root zone material productivity during topsoil/root zone material salvaging	All	Footprint	<u>Topsoil/Root Zone Material Depth</u> • Salvage all available topsoil (min. 10 cm and max. 40 cm) and root zone material (min. 15-20 cm or 50% organic material and 50% mineral soil) using the Environmental Alignment Sheets as a guide [Section 8.2]. • Utilize three-lift soils handling where indicated on the Environmental Alignment Sheets (see Drawings [Topsoil or Root Zone Material Salvage – Three-Lift Soils Handling on Well-Sodded Land] and [Topsoil or Root Zone Material Salvage – Three-Lift Soils Handling on Cultivated Land] provided in Appendix R) [Section 8.2]. • Overstrip topsoils to a total depth indicated on the Environmental Alignment Sheets at select locations with saline or sodic lower subsoils, or sands and gravels at depth which occurs on native grassland, irrigated lands and/or areas of high wind erosion (see Environmental Alignment Sheets) [Section 8.2]. • Salvage surface material in unsaturated wetlands, giving extra attention to maintaining dormant root stocks for replacement, where feasible. Salvage a maximum of 40 cm of surface soil if the peat is deeper than 40 cm or to the depth of colour change where there is less than 40 cm of surface material. Ensure a minimum of 15 cm of surface and subsoil is stripped if peat is less than 15 cm [Section 8.2]. • Salvage very shallow surface soils (*i.e.*, organic and mineral soils) to at least a 15 cm depth, unless the material is unsuitable (*e.g.,* bedrock, gravel, rock) [Section 8.2]. • See additional measures in Section 8.2 of the Pipeline EPP. <u>Topsoil/Root Zone Material Salvage (General)</u> • Implement the Wet/Thawed Soils Contingency Plan (see Appendix B) during wet/thawed soil conditions in the event wet or thawed soils are encountered during construction [Section 8.2]. • Accommodate landowner/Crown land authority topsoil/root zone material salvage requests, if feasible. Record any locations where a landowner/land authority has requested topsoils handling which differs from the planned method [Section 8.2]. • Maintain a separation distance between the topsoil and the upper subsoil piles as well as between upper and lower subsoil piles, where three-lift soils handling is conducted [Section 8.3].	• Mixing of topsoil/root zone material and subsoil.

TABLE 7.2.2-2 Cont'd

Potential Effect	Pipeline Segment(s)	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
1.1 Decreased topsoil/root zone material productivity during topsoil/root zone material salvaging (cont'd)	All	Footprint	• Salvage topsoil/root zone material from areas to be graded and windrow to the closest edge of the construction right-of-way. Avoid overstripping. The area salvaged is to correspond to the area to be graded [Section 8.2]. See additional grading measures in Section 8.2 of the Pipeline EPP. • Store topsoil/root zone material prior to grading along the nearest pipeline construction right-of-way boundary taking into consideration space requirements for grade and trench spoil, existing nearby hotlines, local topography and drainage [Section 8.2]. • Keep trench spoil pile separate from topsoil/root zone material pile. Maintain a minimum separation distance of 1 m between topsoil and trench spoil piles (on agricultural lands (see Drawing [Conventional Right-of-Way Configuration] provided in Appendix R) [Section 8.3]. Topsoil/Root Zone Material Salvage (Non-frozen) • Salvage topsoil/root zone material from the entire construction right-of-way (see Drawing [Topsoil or Root Zone Material Salvage in Forest – Full Right-of-Way] provided in Appendix R) where grading is necessary and at locations indicated on the Environmental Alignment Sheets [Section 8.2]. • Salvage topsoil from the entire construction right-of-way at locations indicated on the Environmental Alignment Sheets (as outlined in the Line List) where localized weed infestations are encountered or at organic farm locations (see Drawing [Topsoil Salvage in Agricultural Lands – Full Right-of-Way] provided in Appendix R) [Section 8.2]. • Salvage topsoil from the trench and spoil pile area (see Drawing [Topsoil or Root Zone Material Salvage – Trench and Spoil Area] provided in Appendix R) at the locations indicated on the Environmental Alignment Sheets [Section 8.2]. • Salvage a blade width of topsoil/root zone material centered over the trench (see Drawing [Topsoil or Root Zone Material Salvage – Blade Width/Frozen] provided in Appendix R) at locations indicated on the Environmental Alignment Sheets. Disc well-sodded lands prior to topsoil/root zone material salvage in order to facilitate topsoil salvage operations [Section 8.2]. • Salvage topsoil from twice the width of the trench centred over the trench at locations indicated on the Environmental Alignment Sheets [Section 8.2]. • See additional topsoil/root zone material salvage measures in Section 8.2 of the Pipeline EPP. Topsoil/Root Zone Material Salvage (Frozen) • Pre-salvage topsoil/root zone material prior to freeze-up if feasible. Attempt to have all topsoil/root zone material salvage completed prior to October 31 where feasible for areas to be constructed that winter in Alberta and Interior BC [Section 8.2]. • Salvage topsoil/root zone material from an area approximately 1 m wider than the trench and centred over the trench (see Drawing [Topsoil or Root Zone Material Salvage – Trench Width] provided in Appendix R) a t all locations during frozen soil conditions unless otherwise indicated on the Environmental Alignment Sheets [Section 8.2]. See additional measures in Section 8.2 of the Pipeline EPP.	• See above.

TABLE 7.2.2-2 Cont'd

Potential Effect	Pipeline Segment(s)	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
1.1 Decreased topsoil/root zone material productivity during topsoil/root zone material salvaging (cont'd)	All	Footprint	• During winter construction, avoid mixing snow with spoil material during backfill. Have trench spoil backfilled by the end of the working day to minimize hazards to livestock and wildlife, as well as reduce frost penetration. Ensure that all segments trenched during frozen soil conditions are backfilled prior to spring breakup [Section 8.4]. • Postpone compaction of frozen trench spoil until final clean-up in mid to late spring [Section 8.4]. <u>Topsoil/Root Zone Material Replacement</u> • Follow mitigation measures for backfilling as outlined in Section 8.4 of the Pipeline EPP. • Postpone replacement during wet conditions or high winds to prevent damage to soil structure or erosion of topsoil/root zone material [Section 8.6]. • Replace topsoil/root zone material evenly over all portions of the construction right-of-way that have been stripped. Salvage a wider area of topsoil, if warranted, on cultivated, hay or tame pasture lands where topsoil salvage was conducted during the winter to allow excess trench spoil to be feathered-out over the stripped area (see Drawing [Conventional Right-of-Way Configuration] provided in Appendix R) [Section 8.6]. • Revegetate as soon as feasible to reduce or avoid soil erosion and establish long-term cover. Seed immediately following topsoil/root zone material replacement [Section 8.6]. • See additional topsoil/root zone material replacement mitigation measures in Section 8.6 of the Pipeline EPP.	• See above.
1.2 Decreased topsoil/root zone material productivity through trench instability during trenching	Edmonton to Hinton (Alberta) Elk Point, Peace Hills, Primula, Rochester, peaty Rochester, shallow Rochester, Sundance BC Pipeline Segments 46 soil units (see Soils Technical Report of Volume 5C)	Footprint	• Suspend trenching and salvage a wider area of topsoil/root zone material if the trench walls slough into the trench and the potential for topsoil/root zone material/subsoil mixing exists. Backslope the trench walls until stable. Equip backhoe with a swamp bucket, if practical, to avoid or reduce trench sloughing [Section 8.3]. • Weld up pipe prior to trenching at locations with soils prone to sloughing in order to reduce the time the trench is left open [Section 8.3]. • Limit the length of open trench and the time the trench will be left open to reduce the amount of trench sloughing, frost penetration and interference with wildlife, landowners and livestock [Section 8.3]. • Store salvaged topsoil or root zone material at a sufficient distance from the trench so that topsoil or root zone material is not lost in the trench, if trench instability is anticipated [Section 8.3]. • Delay trenching until immediately prior to lowering-in at locations with a high water table or where there is a risk of sloughing [Section 8.3].	• Mixing of topsoil/root zone material and subsoil due to trench instability.
1.3 Decreased topsoil/root zone material productivity through mixing due to shallow topsoil/root zone material	Edmonton to Hinton (Alberta) gleyed Alluvium, shallow Bremay, stony Cooking Lake, Devon 1, Devon 2, Hoadley, shallow Hubalta, Modeste, MacKay, peaty Onoway, peaty Rochester, Sundance, Wildwood, peaty Wildwood BC Pipeline Segments 77 soil units (see Soils Technical Report of Volume 5C)	Footprint	• Overstrip topsoils to a total depth indicated on the Environmental Alignment Sheets at select locations with saline or sodic lower subsoils, or sands and gravels at depth which occurs on native grassland, irrigated lands and/or areas of high wind erosion (see Environmental Alignment Sheets) [Section 8.2].	• Mixing of topsoil/root zone material and subsoil due to shallow topsoil/root zone material depths.

TABLE 7.2.2-2 Cont'd

Potential Effect	Pipeline Segment(s)	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
1.4 Decreased topsoil productivity through mixing due to poor colour change	Edmonton to Hinton (Alberta) Bremay, Cooking Lake, Evansburg, Hubalta, shallow Hubalta, Modeste, MacKay, peaty MacKay, Maywood, Primula, Rosevear, Sundance BC Pipeline Segments Chasm, Flat Creek, gleyed Nicholson, Glossey 1, Glossey 2, Isar, Lundbom, Lonzo Creek, Minnie, Scat, shallow Flat Creek, saline Flat Creek, shallow Courtney, Ryder, shallow Tranquille, Tranquille, Whatcom	Footprint	• Where soils are not readily distinguishable by colour, the Inspector(s) will provide direction based on an evaluation of soil texture and structure as well as the recommended depths noted on the Environmental Alignment Sheets [Section 8.2]. • Clearly identify the topsoil piles and grade spoil piles with signs or staking where the topsoil/subsoil colour change is not obvious [Section 8.2].	• Mixing of topsoil/root zone material and subsoil due to poor colour change between topsoil/root zone material and subsoil.
1.5 Decreased soil productivity through mixing with gravely lower subsoils	BC Pipeline Segments Carvolth 1, Dixon, Fairfield 1, Hopedale, Struthers 2 overlying gravel, Struthers 3, Sim	Footprint	• Utilize three-lift soils handling where indicated on the Environmental Alignment Sheets (see Drawings [Topsoil or Root Zone Material Salvage – Three-Lift Soils Handling on Well-Sodded Land] and [Topsoil or Root Zone Material Salvage – Three-Lift Soils Handling on Cultivated Land] provided in Appendix R). Salvage topsoil from the trench and spoil area on lands requiring three-lift soils handling. Depths of material to be removed during the upper subsoil lift will be outlined on the Environmental Alignment Sheets unless otherwise directed by the Inspector(s) [Section 8.2]. • Maintain a separation distance between the topsoil and the upper subsoil piles as well as between upper and lower subsoil piles, where three-lift soils handling is conducted [Section 8.3]. • Ensure that the lower lift of subsoil is backfilled before the upper lift of subsoil where three-lift soils handling has been conducted [Section 8.4].	• Undesirable lower subsoils may be unexpectedly encountered and admixed with upper subsoil horizons.
1.6 Decreased soil productivity resulting from changes in evaporation and transpiration rates	All	Footprint	• Implement mitigation measures provided in point 2.1 of this table to reduce compaction and rutting of soils along the construction right-of-way. • Implement mitigation measures provided in points 2.2 and 2.3 of this table to reduce loss of topsoil/root zone material through wind erosion and water erosion, respectively. • Use only Certified Canada No. 1 or the best available agronomic seed. For native seed, the highest seed grade available will be obtained [Section 8.6]. • Follow seeding and revegetation measures outlined in Section 8.6 of the Pipeline EPP.	• Reduction in soil productivity on agricultural areas resulting from changes in evaporation and transpiration rates.
1.7 Decreased soil productivity from use of sand as bedding material	All	Footprint	• Avoid depositing bedding or padding material on non-salvaged topsoil/root zone material prior to placement in the trench unless a snow layer is present or is otherwise approved by the Inspector(s) [Section 8.4].	• No residual effect identified.
1.8 Decreased soil productivity from flooding of soil as a result of release of hydrostatic test water on land	All	LSA	• Implement mitigation measures provided in potential effect 2.6 of this table to prevent/reduce erosion of soil as a result of release of hydrostatic test water on land. • Implement mitigation measures provided in potential effect 4.2 of this table to prevent/reduce contamination of soil as a result of release of hydrostatic test water on land.	• No residual effect identified.

TABLE 7.2.2-2 Cont'd

Potential Effect	Pipeline Segment(s)	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
1.9 Decreased soil productivity from disturbance (*e.g.,* maintenance dig activities) during operations	All	Footprint	• Implement the recommended soil handling procedures outlined in the Pipeline EPP to reduce the potential for a reduction in soil productivity when construction activities involving soil disturbance are necessary during operations of the pipeline. • Monitor areas along the construction right-of-way that are disturbed during operations and maintenance activities. Implement remedial measures, where warranted.	• Mixing of topsoil/root zone material and subsoil.
1.10 Decreased soil productivity from trench subsidence	All	Footprint	• Compact the backfill, if feasible, to reduce trench settlement by running a grader wheel over the backfill when the trench has been backfilled to the level of the surrounding ground. Take extra care to compact the trench at banks of watercourse crossings and wetlands that have been trenched [Section 8.4]. • Crown the trench with remaining spoil to allow for settlement. A larger crown will be needed to compensate for settlement after thawing allows the portion of the route constructed during frozen soil conditions [Section 8.4]. • Postpone feathering-out of excess spoil along segments of the route constructed during frozen soil conditions until after the spring breakup and the trench has settled [Section 8.4]. • Feather-out excess trench spoil over the salvaged portion of the construction right-of-way on a non-peat land use during non-frozen soil conditions to avoid the creation of a permanent trench crown. Excess spoil will not be feathered-out over the salvaged area to an extent that may cause excessive subsidence of the trench [Section 8.4]. • Leave a trench crown during clean-up of peatlands and non-peat wetlands to allow for settlement of backfilled material within the trench [Section 8.6]. • See additional measures in Section 8.4 of the Pipeline EPP.	• Excessive trench subsidence or a remnant crown.
1.11 Decreased soil productivity from soil diseases (*i.e.,* clubroot disease and potato cyst nematodes)	All	LSA	• All equipment will be fine cleaned and disinfected prior to mobilization to the construction right-of-way [Section 2.1 of Appendix C]. • Follow phased sanitation approach as presented in the *Alberta Clubroot Management Plan*, CAPP *Best Management Practices for Clubroot Disease*, and the Canadian Food Inspection Agency *Best Management Practices for Preventing Potato Cyst Nematode Contamination* [Section 2.1 of Appendix C]. • When travelling on foot, remove excess topsoil from footwear and any equipment (*e.g.,* shovels) before moving between cultivated quarter-sections. When working in high risk areas or when requested by the landowner, this may include wearing disposable booties [Section 2.1 of Appendix C]. • Work and traffic on topsoil will be minimized between quarter-sections and during wet conditions, to the extent feasible. Extra caution will be taken regarding topsoil transfer on slightly wet soil and working in very wet soil conditions will be avoided, where possible [Section 2.1 of Appendix C]. • During construction activities, equipment involved in clearing/brushing and topsoil handling will be cleaned at designated cleaning stations, either with compressed air or with a power wash plus disinfectant misting. Cleaning station locations and type will be identified prior to construction [Section 2.1 of Appendix C].	• Clubroot disease introduction and spread. Potato cyst nematode introduction and spread.

TABLE 7.2.2-2 Cont'd

Potential Effect	Pipeline Segment(s)	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
1.11 Decreased soil productivity from soil diseases (*i.e.,* clubroot disease and potato cyst nematodes) (cont'd)	All	LSA	• If work is conducted in a high risk clubroot area/county and then equipment is mobilized to start work in a different area/county, a thorough cleaning will be performed prior to starting again on the new location [Section 2.1 of Appendix C]. • Rough cleaning using shovel and sweep cleaning to remove obvious clumps of soil is recommended between cultivated fields and quarter-sections (*e.g.,* at changes in land use and/or at road crossings) as a minimum measure in high risk locations such as Parkland County, Alberta to prevent movement of topsoil from one landowner to the next [Section 2.1 of Appendix C]. • The contractor will develop a documentation process to track compliance with the cleaning protocols in terms of what equipment/vehicles were cleaned, how and where [Section 2.1 of Appendix C]. • Refer to the Agricultural Management Plan for additional measures [Section 2.0 of Appendix C].	• Clubroot disease introduction and spread. Potato cyst nematode introduction and spread.
2. Soil Indicator – Soil Degradation				
2.1 Degradation of soil structure due to compaction and rutting	Edmonton to Hinton (Alberta) 26 soil units (see Soils Technical Report of Volume 5C) BC Pipeline Segments 36 soil units (see Soils Technical Report of Volume 5C)	Footprint	• Work during frozen soil conditions along the portions of the construction right-of-way where frozen soils are encountered during winter to ensure that there is sufficient frost or during periods of low soil moisture where frozen soil conditions are not encountered during winter (Lower Mainland Region of BC) to allow construction without causing excessive rutting or soil compaction [Section 8.3]. • Implement the Wet/Thawed Soils Contingency Plan (see Appendix B) during wet/thawed soil conditions in the event wet or thawed soils are encountered during construction [Section 8.2]. • Determine locations where subsoil compaction has occurred by comparing compaction levels on and off the construction right-of-way. Sites compared will be in close proximity and have similar drainage, soil moisture, aspect and land use, if feasible [Section 8.6]. • Rip compacted subsoils on the construction right-of-way adjacent to the ditchline and along shoo-flies with a multi-shank ripper or breaking disc to a depth of 30 cm or the depth of compaction, whichever is deeper. If soils are moist, postpone ripping of subsoils until soils dry to ensure that the soils fracture when ripped [Section 8.6]. • Employ a subsoiler plow (*e.g.,* Paratiller) along segments of the construction right-of-way adjacent to the ditchline where topsoil salvage did not occur and subsoil compaction is severe. Do not use a subsoiler plow on native grasslands [Section 8.6]. • Disc or chisel plow and harrow ripped subsoils to smooth the surface. Limit discing to that necessary to break up clods in order to prevent further compaction of the subsoils or to increase the potential for soil erosion by wind [Section 8.6]. • See additional measures to reduce compaction and rutting in Section 8.6 of the Pipeline EPP.	• Degradation of soil structure and impairment of rooting zone due to compaction and rutting.

TABLE 7.2.2-2 Cont'd

Potential Effect	Pipeline Segment(s)	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
2.2 Loss of topsoil/root zone material through wind erosion	**Edmonton to Hinton (Alberta)** Carvel, Elk Point, gleyed Gabriel, Hoadley, Peace Hills, Primula, Rochester, peaty Rochester, shallow Rochester, Sundance, Winterburn **BC Pipeline Segments** 60 soil units (see Soils Technical Report of Volume 5C)	Footprint	<u>General</u> • Tackify or apply water/snow or pack the topsoil/root zone material windrow with a sheep foot packer or other approved equipment, if the assessment by the Inspector(s) indicates that soils are likely to be prone to erosion by wind (see Soil Erosion and Sediment Control Contingency Plan in Appendix B) [Section 8.2]. • Assess the wind erosion hazard, competency of the sod and potential for soil pulverization due to droughty soils. Implement measures applicable to droughty, wind erodible soils to reduce the impact of soil pulverization and wind erosion (see Soil/Sod Pulverization Contingency Plan in Appendix B) [Section 8.2]. • Apply water or approved tackifier to exposed soil piles if wind erosion occurs [Section 8.2]. • Monitor soils windrows during the growing season for wind and water erosion, and weed growth until the soils are replaced. Implement additional mitigation measures to control erosion (see Soil Erosion and Sediment Control Contingency Plan in Appendix B) and weed growth when warranted (see Weed and Vegetation Management Plan in Appendix C) [Section 8.2]. • Avoid removing excess small diameter slash in wooded areas with erodible soils [Section 8.6]. • Apply hydromulch/hydroseed at a rate recommended by the supplier on steep recontoured slopes and/or where soil wind erosion may be problematic (see Environmental Alignment Sheets) [Section 8.6]. • Seed disturbed erodible soils on non-cultivated land with a mixture of approved agronomic or native seed and cover crop seed such as fall rye if seeding in late summer or annual oats if seeding in the winter, spring or early summer [Section 8.6]. • See additional measures in the Soil Erosion and Sediment Control Contingency Plan and Soil/Sod Pulverization Contingency Plan in Appendix B of the Pipeline EPP. <u>Highly Erodible Soils</u> • Install erosion control blanket, coir/straw logs or rollback on exposed moderately to highly erodible soils where there is potential for water or wind erosion prior to re-establishment of vegetation (see Drawings [Rollback] and [Erosion Control – Rollback in Riparian Areas] and [Coir/Straw Log Installation] and [Erosion Control Matting/Blanket] provided in Appendix R) [Section 8.6]. • Conduct straw crimping on disturbed agricultural or native grassland soils where wind erosion may be problematic [Section 8.6]. See additional straw crimping measures in Section 8.6 of the Pipeline EPP. • Drill (during non-frozen soil conditions) or broadcast seed highly erodible cultivated lands with a cover crop of barley (var. Local Certified) or annual oats (var. Local Certified) at 45 kg/ha immediately following topsoil replacement [Section 8.6]. • Install temporary fences, if warranted, to restrict grazing and trampling of the seeded construction right-of-way until vegetation becomes established or less palatable [Section 8.6].	• Surface erosion of topsoil/root zone material can be expected until a vegetative cover is established.

TABLE 7.2.2-2 Cont'd

Potential Effect	Pipeline Segment(s)	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
2.3 Loss of topsoil/root zone material through water erosion	All	Footprint	• Postpone root grubbing until immediately prior to grading along segments of the construction right-of-way where pre-clearing occurred and where there is a potential for soil erosion to occur, due to sloping terrain and erodible soils [Section 8.1]. See additional grubbing measures in Section 8.1 of the Pipeline EPP. • Leave breaks in the trench crown at obvious drainages and wherever seepage occurs to reduce or avoid interference with natural drainage. Leave breaks in the crown at frequent intervals where sidehill is encountered. Compact backfill where breaks have been left [Section 8.4]. • Install temporary sediment fences, where warranted, to control sedimentation prior to final clean-up and the establishment of permanent erosion and sediment control measures (see Drawing [Sediment Fence] provided in Appendix R) [Section 8.6.2]. • Implement the Soil Erosion and Sediment Control Contingency Plan [Section 8.0 of Appendix B]. • Replace grade material to a stable contour that will approximate the pre-construction contour, except where it is not practical or safe to do so. When replacing sidehill or other graded areas is not practical due to the risk of slope failure, the Lead Activity Inspector, the Lead Environmental Inspector, the Inspector(s), the Construction Manager and a Geotechnical Engineer will discuss to determine an appropriate grade [Section 8.4]. • Recontour the construction right-of-way, including the removal of temporary subsoil berms on agricultural land and re-establish the pre-construction grades and drainage channels if frozen soil conditions prevented completion of this task during backfilling [Section 8.6]. • Regrade areas with vehicle ruts, erosion gullies or where the trench has settled [Section 8.6]. • See additional measures to reduce water erosion at watercourses and wetlands in Sections 8.6 and 8.7 of the Pipeline EPP.	• Surface erosion of topsoil/root zone material can be expected until a vegetative cover is established.
2.4 Loss of topsoil/root zone material through surface water erosion on moderately steep slopes	Edmonton to Hinton (Alberta) Angus Ridge, Cooking Lake, Carvel, Hubalta, Modeste, Malmo, Primula, Winterburn BC Pipeline Segments 63 soil units (see Soils Technical Report of Volume 5C)	Footprint	• Install temporary berms on approach slopes to watercourses and erect sediment fence(s) near the base of approach slopes to watercourse(s) following grading (see Drawings [Cross Ditches and Diversion Berms] and [Sediment Fence] provided in Appendix R) where indicated on the Environmental Alignment Sheets. Inspect the temporary sediment control structures on a daily basis and repair, if warranted, before the end of each working day [Section 8.2]. • Install trench breakers (sack, foam or bentonite), where warranted, on moderate and steep slopes with high soil water erosion potential on non-agricultural lands to control subsurface flow (see Drawing [Trench Breakers/Ditch Plugs] provided in Appendix R) [Section 8.4]. • Install subdrains in association with trench breakers as directed by the Hydrogeological Resource Specialist where there is evidence of seepage or a flowing spring on a slope once the trench is excavated (see Drawing [Subdrains] provided in Appendix R) [Section 8.4]. • Install stub berms when directed by Trans Mountain, on sloping peatland terrain to prevent surface water flows along the trench line and erosion of trench backfill (see Drawing [Peatland Wetland – Stub Berms] provided in Appendix R) [Section 8.4].	• Surface erosion of topsoil/root zone material can be expected until a vegetative cover is established.

TABLE 7.2.2-2 Cont'd

Potential Effect	Pipeline Segment(s)	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
2.4 Loss of topsoil/root zone material through surface water erosion on moderately steep slopes (cont'd)	Same as above	Footprint	• Install subsoil cross ditches and berms on steep and moderate slopes on tame pasture, and treed lands in order to prevent runoff along the construction right-of-way and subsequent erosion (see Drawing [Cross Ditches and Diversion Berms] provided in Appendix R) [Section 8.6]. • Recontour the construction right-of-way and stabilize approach slopes at watercourse crossings. Where reclamation of the pre-construction grade is not feasible due to risk of failure of fill on slopes or maintenance of an access trail, recontour to grades as directed by the Geotechnical Engineer [Section 8.6]. • Seed riparian areas with an approved annual or perennial grass cover crop or native grass mix as soon as feasible after construction. See additional measures outlined in the Reclamation Management Plan [see Appendix C]. • Install temporary erosion control measures such as temporary berms, sediment fences or cross ditches within 24 hours of backfilling banks and approach slopes of water crossings at any location where runoff from the construction right-of-way may flow into a watercourse. See additional measures outlined in the Reclamation Management Plan (see Appendix C) and aquatic resources (see Appendix J) [Section 8.6]. • Rollback slash and small diameter, salvageable timber on steep slopes and approach slopes to watercourses. Do not bury rollback when walking down with bulldozer. Leave gaps in rollback at all obvious wildlife trails [Section 8.6].	• Surface erosion of topsoil/root zone material can be expected until a vegetative cover is established.
2.5. Degradation of soil structure due to pulverization of soil and sod	All	Footprint	• Retain sod and the vegetation mat on all lands if a competent sod layer exists. In these areas, grade only where safety considerations dictate in order to reduce disturbance to sod and the vegetation mat. Grading of well-sodded lands will not be permitted on level terrain [Section 8.2]. • Assess the wind erosion hazard, competency of the sod and potential for soil pulverization due to droughty soils. Implement measures applicable to droughty, wind erodible soils to reduce the impact of soil pulverization and wind erosion (see Soil/Sod Pulverization Contingency Plan in Appendix B) [Section 8.2]. • Apply water or approved tackifier to disturbed areas if traffic and wind conditions result in pulverized soils and dust problems [Section 8.2]. • Cultivate or rip the full width of the construction right-of-way on cultivated fields and hay, tame pasture, bush or woodlands where poor sod development exists to a depth adequate to alleviate surface compaction and in a manner acceptable to the landowner. Do not cultivate into the subsoil [Section 8.6]. • Limit cultivation in areas of fine textured soils to prevent pulverization of the soil (see Soil/Sod Pulverization Contingency Plan in Appendix B) [Section 8.6]. • Disc and harrow only if the site is to be seeded immediately; otherwise, leave the ripped topsoil in a rough condition to reduce wind erosion potential [Section 8.6]. • Disc or rip disturbed soils on hay and tame pasture lands where the sod layer has been broken or where topsoils are compacted and reseeding is warranted [Section 8.6].	• Pulverization resulting in fugitive dust and loss of soil structure can be expected during dry conditions.

TABLE 7.2.2-2 Cont'd

Potential Effect	Pipeline Segment(s)	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
2.6. Erosion of soil as a result of release of hydrostatic test water on land	All	LSA	• Include resource-specific measures in water withdrawal plans (see Sections 7.0 and 8.0) to stabilize both the substrate of the water source and approaches to water sources to ensure that accelerated erosion will not occur during equipment installation, use or removal [Section 8.5]. • Monitor fill and discharge lines for leaks. Repair or control leaks to prevent erosion [Section 8.5]. • Collect pre-test pigging debris and water. Discharge the water at an acceptable location on-site in a manner that does not cause erosion or allow unfiltered or silted water to directly re-enter a waterbody/wetland/lake. Dispose of the remaining material with other construction waste, in accordance with appropriate federal and provincial guidelines [Section 8.5]. • Monitor discharge locations to ensure that no erosion, flooding or icing occurs. If conditions become saturated to the extent that adequate natural filtration is no longer occurring, suspend dewatering and move the discharge to another approved location (confirm that appropriate approvals and, if warranted, soil testing have been completed) or construct a holding pond for the water and release the water when natural filtration is feasible [Section 8.5].	• No residual effect identified.
2.7. Loss of topsoil/root zone material from disturbance (*e.g.,* maintenance dig activities) during operations	All	Footprint	• Implement the recommended soil handling procedures outlined in the Pipeline EPP to reduce the potential for soil degradation when maintenance activities involving soil disturbance are necessary during operations of the pipeline. • Monitor areas along the right-of-way that are disturbed during operations and maintenance activities. Implement remedial measures, where warranted.	• Surface erosion of topsoil/root zone material can be expected until a vegetative cover is established.
3. Soil Indicator – Bedrock and Stone Disposal				
3.1 Increased stoniness in surface horizons	Edmonton to Hinton (Alberta) stony Cooking Lake, shallow Rochester, shallow Rosevear BC Pipeline Segments bouldery Cheam 1, bouldery Kwikoit 1, bouldery Minnie, bouldery Roserim, bouldery Struthers 1, bouldery Stukemapten, Cheam 1, Harrison, Harrison 1, stony Glossey 1, stony Lucerne, stony Minnie, stony McQueen, stony Roserim, stony Timber, stony Woodley	Footprint	• Attempt to use conventional equipment to salvage topsoil/root zone material. Employ a backhoe if the conventional equipment is ineffective [Section 8.2]. • Surface stoniness on right-of-way will match that off right-of-way (stone size and density) on agricultural land and native grasslands. • Haul excavated trench spoil that is not suitable for use as backfill (*e.g.,* excess bedrock) and dispose of at locations approved by the Lead Environmental Inspector and the Inspector(s) [Section 8.3].	• Stone picking may result in disposal issues.

TABLE 7.2.2-2 Cont'd

Potential Effect	Pipeline Segment(s)	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
3.2. Bedrock or large rocks within trench depth	Edmonton to Hinton (Alberta) shallow Bremay, shallow Dekalta, shallow Hubalta, Modeste BC Pipeline Segments bouldery Cheam 1, Modeste, shallow Bremay, shallow Dekalta, shallow Hubalta, shallow bouldery Stukemapten, shallow Allie, shallow bouldery Stukemapten, shallow Cheam, shallow Cheam 1, shallow Chasm, shallow Courtney, shallow Lucerne, shallow Minnie, shallow Roserim, shallow Snookwa, shallow Timber, shallow Tunkwa, shallow Tullee, shallow Tranquille, shallow Trapp Lake	LSA	• Rip bedrock in trench, if encountered and if feasible. Ripping is preferred over blasting [Section 8.3]. • Blast bedrock encountered within trench depth only if ripping or typical trenching methods are not feasible [Section 8.3]. See additional measures for blasting in Section 8.3 of the Pipeline EPP. • Haul excavated trench spoil that is not suitable for use as backfill (*e.g.,* excess bedrock) and dispose of at locations approved by the Lead Environmental Inspector and the Inspector(s) [Section 8.3]. • Ensure that bedrock excavated from the trench is not backfilled into the upper 50 cm of the trench if the potential exists for a reduction in agricultural capability. Dispose of excess bedrock at locations approved by the landowner/Crown land authority, where warranted, and the Lead Environmental Inspector and the Inspector(s). Known locations with shallow bedrock will be identified on the Environmental Alignment Sheets [Section 8.4]. See additional measures for bedrock in Section 8.4 of the Pipeline EPP.	• Removal of bedrock or large rocks from trench depth may result in disposal issues.
4. Soil Indicator – Soil Contamination				
4.1. Disturbance of previously contaminated soil	All	Footprint	• Avoid known areas of contaminated sediments. Implement the Contamination Discovery Contingency Plan (see Appendix B) in the event that contaminated sediments are discovered during construction. Adhere to applicable measures provided in the Waste Management Standard (see Appendix C) for handling of contaminated material [Section 7.0]. • Any sites contaminated by a spill will be assessed, remediation will be designed, and disposal sites will be identified in accordance with the *NEB Remediation Process Guide*. This document will be provided to the Construction Manager or designate, and the Lead Environmental Inspector(s) and Inspector(s) as part of the Environmental Education Program [Section 11.0 of Appendix B].	• No residual effect identified.
4.2 Contamination of soil as a result of release of hydrostatic test water on land	All	LSA	• Ensure that the appropriate testing and treatment measures are implemented in accordance with Sections 7(2) and 7(3) of the *BC Oil and Gas Waste Regulation* when dewatering in BC [Section 8.5]. • Ensure that the appropriate testing and treatment measures are implemented in accordance with provincial legislation, including Schedule 1, Requirements for Release to Land of the AESRD *Code of Practice for the Release of Hydrostatic Test Water from Hydrostatic Testing of Petroleum Liquid and Gas Pipelines* when dewatering in Alberta [Section 8.5]. • Conduct testing of the test water and soils at the discharge site, when required, and in accordance with applicable federal/provincial requirements [Section 8.5]. • Ensure that enough workers and equipment are available on-site to repair any rupture, leak or erosion problems that arise during testing [Section 8.5].	• No residual effect identified.

TABLE 7.2.2-2 Cont'd

Potential Effect	Pipeline Segment(s)	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
4.2 Contamination of soil as a result of release of hydrostatic test water on land (cont'd)	All	LSA	• Dewater onto approved areas where water will be filtered through vegetation and soils before returning to a watercourse/wetland/lake. Provide scour protection (*e.g.,* use of rock aprons, plastic sheeting, plywood, straw bales) or an energy diffuser (*e.g.,* cone with baffles, frog's foot) at the discharge site as directed by Trans Mountain. The rate of discharge will be reduced if these measures are ineffective [Section 8.5]. • Dewater into a bar ditch, if feasible, or onto non-arable land. Do not dewater onto cultivated lands or directly back into a watercourse or watercourse/wetland/lake unless otherwise allowed by water discharge approvals and the Inspector(s) [Section 8.5]. • Collect samples of source water, hydrostatic test water and soil of the receiving environment and analyze according to the parameters listed in Water Withdrawal and Discharge Procedures Management Plan (see Appendix C) [Section 8.5].	• No residual effect identified.
4.3. Soil contamination due to spot spills during construction	All	Footprint	• Ensure that during construction no fuel, lubricating fluids, hydraulic fluids, methanol, antifreeze, herbicides, biocides, or other chemicals are dumped on the ground or into watercourses/wetlands/lakes. In the event of a spill, implement the Spill Contingency Plan (see Appendix B) [Section 7.0]. • Place tarps or other impermeable material on the ground to catch drippings from coating application at weld joints and areas where repairs to the coating are made. Dispose of spilled coating at approved locations [Section 8.3]. • Isolate test pumps, generators and fuel storage tanks with an impermeable lined dike or depression to capture and retain any spills of fuels or lubricants [Section 8.5].	• No residual effect identified.

Notes: 1 LSA = Soil LSA.
2 Detailed mitigation measures are outlined in the Pipeline EPP (Volume 6B).

7.2.2.5 Potential Residual Effects

The potential residual environmental effects on soil and soil productivity indicators associated with the construction and operations of the pipeline (Table 7.2.2-2) are:

- mixing of topsoil/root zone material and subsoil during topsoil/root zone material salvage, storage and replacement activities during both construction and maintenance activities including the effects associated with trench instability, shallow topsoil/root zone material depth and poor colour change;
- undesirable lower subsoils may be unexpectedly encountered and admixed with upper subsoil horizons;
- reduction in soil productivity on agricultural areas resulting from changes in evaporation and transpiration rates;
- excessive trench subsidence or a remnant crown;
- clubroot disease and potato cyst nematode introduction and spread;
- degradation of soil structure and impairment of rooting zone due to compaction and rutting;
- surface erosion of topsoil/root zone material can be expected until a vegetative cover is established;

- pulverization resulting in fugitive dust and loss of soil structure can be expected during dry conditions; and
- stone picking and bedrock or large rock removal may result in disposal issues.

Some of the potential effects on soil and soil productivity associated with the construction and operations of the pipeline are predicted to be eliminated through the implementation of mitigation measures (Table 7.2.2-2). The potential effects determined not to have a residual effect are:

- decreased soil productivity from use of sand as bedding material;
- disturbance of previously contaminated soil;
- soil contamination due to spot spills during construction; and
- flooding, erosion or contamination of soil as a result of a release of hydrostatic test water.

7.2.2.6 Significance Evaluation of Potential Residual Effects

Where there are no standards, guidelines, objectives or other established and accepted ecological thresholds to define quantitative rating criteria or where quantitative thresholds are not appropriate, the qualitative method is considered to be the appropriate method for determining the significance of the anticipated residual environmental effects. Consequently, a qualitative assessment of soil and soil productivity was determined to be the most appropriate method with the evaluation of significance of each of the potential residual effects relying on the professional judgment of the assessment team.

Table 7.2.2-3 provides a summary of the significance evaluation of the potential residual environmental effects of the construction and operations of the proposed pipeline on soil and soil productivity. The rationale used to evaluate the significance of each of the residual environmental effects is provided below.

TABLE 7.2.2-3

SIGNIFICANCE EVALUATION OF POTENTIAL RESIDUAL EFFECTS OF PIPELINE CONSTRUCTION AND OPERATIONS ON SOIL AND SOIL PRODUCTIVITY

	Potential Residual Effects	Impact Balance	Spatial Boundary[1]	Temporal Context			Magnitude	Probability	Confidence	Significance[2]
				Duration	Frequency	Reversibility				
1.	Soil Indicator – Soil Productivity									
1(a)	Mixing of topsoil/root zone material and subsoil.	Negative	Footprint	Short-term	Periodic	Medium-term	Low	High	High	Not significant
1(b)	Undesirable lower subsoils may be unexpectedly encountered and admixed with upper subsoil horizons.	Negative	Footprint	Short-term	Periodic	Medium to long-term	Low	High	High	Not significant
1(c)	Reduction in soil productivity on agricultural areas from changes in evaporation and transpiration rates.	Negative	Footprint	Short-term	Periodic	Short to medium-term	Low	High	Moderate	Not significant
1(d)	Excessive trench subsidence or a remnant crown.	Negative	Footprint	Short-term	Isolated	Short to medium-term	Low	High	High	Not significant
1(e)	Clubroot disease and potato cyst nematode introduction and spread.	Negative	LSA	Short-term	Accidental	Long-term	High	Low	Moderate	Not significant
1(f)	Combined effects on the soil productivity indicator (1[a] to 1[d]).	Negative	Footprint	Short-term	Periodic	Short to long-term	Low	High	High	Not significant
2.	Soil Indicator – Soil Degradation									
2(a)	Degradation of soil structure and impairment of rooting zone due to compaction and rutting.	Negative	Footprint	Short-term	Periodic	Short to medium-term	Low	High	High	Not significant

TABLE 7.2.2-3 Cont'd

Potential Residual Effects	Impact Balance	Spatial Boundary[1]	Temporal Context: Duration	Temporal Context: Frequency	Temporal Context: Reversibility	Magnitude	Probability	Confidence	Significance[2]
2(b) Surface erosion of topsoil/root zone material can be expected until a vegetation cover is established.	Negative	Footprint	Short-term	Periodic	Medium-term	Low	High	High	Not significant
2(c) Pulverization resulting in fugitive dust and loss of soil structure can be expected during dry conditions.	Negative	Footprint	Short-term	Isolated	Short to medium-term	Low	Low to high	High	Not significant
2(d) Combined effects on the soil degradation indicator (2[a] to 2[c]).	Negative	Footprint	Short-term	Periodic	Short to medium-term	Low	High	High	Not significant
3. Soil Indicator – Bedrock and Stone Disposal									
3(a) Stone picking and bedrock or large rock removal may result in disposal issues.	Negative	LSA	Short-term	Isolated	Short to medium-term	Low	High	High	Not significant
4. Soil Indicator – Soil Contamination									
No residual effects identified.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Notes: 1 LSA = Soil LSA.

2 Significant Residual Environmental Effect: A high probability of occurrence of a permanent or long-term residual effect of high magnitude that cannot be technically or economically mitigated.

Soil Indicator – Soil Productivity

The following provides the evaluation of significance of potential residual effects on the soil productivity indicator, including mixing of topsoil/root zone material and subsoil, mixing of undesirable lower subsoils with upper subsoil horizons, reduction in soil productivity due to changes in evaporation and transpiration, excessive trench subsidence or remnant crown, and clubroot disease/potato cyst nematode introduction and spread.

Topsoil/Root Zone Material and Subsoil Mixing

During the construction of the pipeline and, to a lesser extent, during maintenance activities, it is likely that a minor amount of topsoil/root zone material and subsoil mixing will occur along the proposed construction right-of-way. The impact balance of this residual effect is considered negative since admixing could decrease soil productivity. Participants of several of the community workshops (*e.g.,* Edmonton, Clearwater, Kamloops and Langley) noted the importance of proper management of topsoil, including handling and separation procedures, and emphasized that the rooting depth of soil is important for soil productivity on agricultural lands.

Since admixing can be alleviated over time through tilling, the addition of soil amendments (*e.g.,* green feed or manure), importation of topsoil or natural processes, the residual effect is reversible in the medium-term. Based on the results of a recent post-construction environmental monitoring program for a large pipeline project on agricultural lands, issues related to topsoil/subsoil mixing have been found to be resolved within 2 to 3 years (*i.e.*, in the medium-term) (TERA 2009a, 2011a, 2012a, 2013a). The results of the post-construction environmental monitoring program for the TMX Anchor Loop Project also demonstrated that topsoil/root zone material and subsoil mixing issues were resolved within 2 to 3 years in a forested setting (TERA 2009b, 2011b,c, 2013b). Similar mitigation measures are planned for the construction of the proposed pipeline.

Where topsoil/root zone material and subsoil admixing occurred along the TMX Anchor Loop Project route, results of the post-construction environmental monitoring reports indicated that admixing was minor/moderate and few locations required the addition of soil amendments to alleviate this effect (TERA 2009b, 2011b,c, 2013b). No areas with severe admixing were encountered during post-construction environmental monitoring for the TMX Anchor Loop Project (TERA 2009b, 2011b,c, 2013b). The results of another recent post-construction environmental monitoring program for a large pipeline project on agricultural lands also demonstrated that topsoil and subsoil mixing is generally minor in severity and is limited in extent (TERA 2009a, 2011a, 2012a, 2013a). Given the proven effectiveness of the mitigation measures to reduce admixing along the construction right-of-way, it is anticipated that the extent and severity of admixing will be minor. As a result, admixing is considered to be of low magnitude (Table 7.2.2-3, point 1[a]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Footprint – admixing is confined to the area of disturbance along the construction right-of-way.
- Duration: short-term – the events causing potential admixing are construction of the pipeline and maintenance-related activities, the latter of which are limited to any 1 year during the operations phase.
- Frequency: periodic – the events causing potential admixing (*i.e.*, construction and maintenance-related activities) occur intermittently but repeatedly over the assessment period.
- Reversibility: medium-term – loss of soil productivity due to minor topsoil/root zone material and subsoil mixing is expected to be reversed within 10 years given the implementation of mitigation measures during construction and, if necessary, the application of soil amendments post-construction. The results of recent post-construction environmental monitoring programs in agricultural, forested and mountainous areas demonstrate that topsoil/root zone material mixing with subsoil is alleviated within a few years post-construction.
- Magnitude: low – given the implementation of industry-standard and provincial regulatory mitigation measures outlined in Table 7.2.2-2 and, if necessary, soil amendments applied post-construction. The results of recent post-construction environmental monitoring programs in agricultural, forested and mountainous areas demonstrate that topsoil/root zone material mixing with subsoil is generally minor in severity and limited in extent.
- Probability: high – admixing is a common residual effect of pipeline construction and may also occur during maintenance activities.
- Confidence: high – there is a good understanding by the assessment team of cause-effect relationships between pipeline construction and soil productivity.

Undesirable Lower Subsoil/Upper Subsoil Mixing

Lower subsoils with a high gravel content may be unexpectedly encountered within a localized area during construction activities and admixed with upper subsoil horizons exhibiting less gravel content. The impact balance of this residual effect is considered negative since admixing could decrease soil productivity. The detailed soil survey (see Soils Technical Report of Volume 5C) and Environmental Alignment Sheets (Volume 6E) identify where the three-lift soil handling technique will be implemented (*i.e.*, Carvolth, Dixon, Fairfield 1, Hopedale, Struthers 2 overlying gravel and Sim soil series) to reduce the risk of mixing undesirable lower subsoils with upper subsoil, thereby maintaining the agricultural productivity of the soil. Three-lift soils handling was conducted on a recent large pipeline project on agricultural lands due to saline/sodic lower subsoils or lower subsoils with soil texture concerns (TERA 2009a). Based on the results of the Environmental As-built Report for that project, the three-lift soils handling technique was effective and localized issues related to poor crop growth due to problem lower subsoils (saline/sodic conditions or soil texture concerns) were resolved within 2 years post-construction (TERA 2009a, 2012a). Nevertheless, should some admixing of problem lower subsoils occur, the reversibility of mixing problem lower subsoils with upper subsoils could extend beyond 10 years. Similar mitigation measures as those outlined in Table 7.2.2-2 were effective in reducing the impairment of surface soils on past projects. Any admixing of undesirable lower subsoil with upper subsoil is expected to be limited in extent and, as a result, is considered to be of low magnitude (Table 7.2.2-3, point 1[b]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Footprint – admixing is confined to the area of disturbance along the construction right-of-way.

- Duration: short-term – the events causing potential admixing of problem subsoils are construction of the pipeline and maintenance-related activities, the latter of which are limited to any 1 year during the operations phase.
- Frequency: periodic – the events causing potential admixing of problem lower subsoils with upper subsoils (*i.e.*, construction and maintenance-related activities) occur intermittently but repeatedly over the assessment period.
- Reversibility: medium to long-term – depending upon the amount of admixing and the textural composition of the subsoils.
- Magnitude: low – any admixing of undesirable lower subsoil with upper subsoil will be limited in extent and reduced by the industry-standard and provincial regulatory mitigation measures outlined in Table 7.2.2-2.
- Probability: high – the precision of soil mapping units to 250 m intervals on ALR lands (less dense on non-ALR lands) may result in short, localized segments of undesirable lower subsoils admixing with upper soil horizons.
- Confidence: high – a detailed soil survey along the pipeline corridor was conducted that identified areas of problem lower subsoils.

Evaporation and Transpiration

Loss of vegetation and soil disturbance will result in changes to evaporation and transpiration rates on agricultural areas following construction potentially reducing soil productivity. The potential effects on soil productivity will be reduced by scheduling construction activities in agricultural areas during late summer/fall in some areas when vegetation will be either desiccated or harvested and soil will likely be dry.

Segments of the construction right-of-way located on cultivated land will be returned to agricultural use following final clean-up. Following tilling and seeding activities, evaporation and transpiration rates on the construction right-of-way will not differ from off the construction right-of-way unless compaction or lower nutrient levels from admixing reduce vegetation yield. Mitigation measures outlined in Table 7.2.2-2 and the Pipeline EPP (Volume 6B) will reduce the potential for changes of soil structure and available environmental nutrients. Furthermore, any notable decrease in soil productivity will be identified during post-construction environmental monitoring and appropriate procedures will be implemented (*e.g.,* soil compaction alleviation, fertilization, landowner consultation).

The loss of vegetation on agricultural land will not result in any considerable alteration of wind patterns and resultant changes in evaporation rates of adjacent vegetation, nor are increased surface temperatures of bare soil resulting from losses in evaporative cooling expected to affect adjacent vegetation. In general, post-construction environmental monitoring reports for the TMX Anchor Loop Project and for a recent large pipeline project on agricultural lands demonstrate that soil productivity on right-of-way and off right-of-way are comparable with proper revegetation (TERA 2009a,b, 2011a,b,c, 2012a, 2013a,b). Locations along the construction right-of-way where seeding or natural revegetation have not been as successful will be recorded and appropriate measures will be implemented (*e.g.,* fencing to prevent grazing, reseeding, soil decompaction, fertilization).

Through appropriate scheduling and implementation of soil conservation and vegetation management measures in Table 7.2.2-2 and the Pipeline EPP (Volume 6B), the magnitude of changes in evaporation and transpiration resulting from pipeline construction is considered to be low. A reduction in soil productivity resulting from changes in evaporation and transpiration rates is considered reversible in the short to medium-term depending on land use, vegetation type and the success of soil handling and revegetation efforts (Table 7.2.2-3, point 1[c]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Footprint – reduction in soil productivity on agricultural areas resulting from changes in evaporation and transpiration rates are confined to the area of disturbance along the construction right-of-way.

- Duration: short-term – the events causing potential evaporation and transpiration rates are construction of the pipeline and maintenance-related activities, the latter of which are limited to any 1 year during the operations phase.

- Frequency: periodic – the events causing reduction in soil productivity on agricultural areas resulting from changes in evaporation and transpiration rates (*i.e.*, construction and maintenance-related activities) occur intermittently but repeatedly over the assessment period.

- Reversibility: short to medium-term – depending on vegetation type and success of soil handling and revegetation efforts, potential reduction in soil productivity resulting from changes in evaporation and transpiration rates may take up to or more than 1 year but less than 10 years to alleviate.

- Magnitude: low – given the implementation of industry-standard and provincial regulatory mitigation measures outlined in Table 7.2.2-2 and, if necessary, soil amendments applied post-construction. The results of recent post-construction environmental monitoring programs in agricultural, forested and mountainous areas demonstrate that changes in evaporation and transpiration rates are generally minor in severity and limited in extent.

- Probability: high – changes in evaporation and transpiration rates are common residual effects of pipeline construction and may also occur during maintenance activities.

- Confidence: moderate – there is a good understanding by the assessment team of cause-effect relationships between pipeline construction and changes in evaporation and transpiration rates from data outside of the Project area.

Trench Subsidence or Remnant Crown

Construction activities may result in localized areas of excessive trench subsidence and/or a remnant crown over the trench. The impact balance of this residual effect is considered negative since excessive trench subsidence or a remnant crown may reduce soil productivity through erosion and drainage issues. Trench subsidence and a remnant crown do not always occur during the year following construction and reclamation, and will be greatly influenced by the amount of precipitation. The reversibility of trench subsidence and/or a remnant crown is considered to be short to medium-term since remedial work associated with trench subsidence and/or a remnant crown typically occurs within a year of construction; however, localized trench subsidence may arise 2 to 3 years following construction (TERA 2009a,b, 2011a,b,c, 2012a, 2013a,b). Issues related to a remnant crown over the trench were not noted in the post-construction environmental monitoring reports for the TMX Anchor Loop Project or for a recent large pipeline project on agricultural lands (TERA 2009a,b, 2011a,b,c, 2012a, 2013a,b). With effective compaction of the backfilled trench and feathering out any remaining material over the trench, the magnitude of the effect of trench subsidence on soil and soil productivity is considered to be low (Table 7.2.2-3, point 1[d]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Footprint – trench subsidence or a remnant crown is confined to the trench line within the construction right-of-way.

- Duration: short-term – the event causing potential trench subsidence or a remnant crown is construction of the pipeline which is limited to the construction phase.

- Frequency: isolated – the event causing potential trench subsidence or a remnant crown (*i.e.*, construction activities) is confined to a specified phase of the assessment period.

- Reversibility: short to medium-term – remedial work associated with a remnant crown and trench subsidence typically is conducted within a year of construction, however, localized trench subsidence may also arise 2 to 3 years after construction.

- Magnitude: low – given the implementation of industry-standard and provincial regulatory mitigation measures outlined in Table 7.2.2-2 and, if necessary, soil amendments applied post-construction. The results of recent post-construction environmental monitoring programs in agricultural, forested and mountainous areas demonstrate that trench subsidence or a remnant crown is generally minor in severity and limited in extent.

- Probability: high – trench subsidence or a remnant crown is a common residual effect of pipeline construction.
- Confidence: high – there is a good understanding by the assessment team of cause-effect relationships between pipeline construction and trench subsidence/remnant crowns.

Clubroot Disease and Potato Cyst Nematode Introduction and Spread

Clubroot is a soil-borne disease that affects canola and other crops in the mustard family. It is considered a pest under the *Agricultural Pests Act* and was first detected in Alberta in a canola field near Edmonton in 2003. Clubroot disease is spread through resting spores in the soil which can survive for up to 20 years. Table C.1-1 in Appendix C of the Pipeline EPP (Volume 6B) summarizes known occurrences of clubroot in Alberta and BC. In Alberta, clubroot disease has been identified at 149 locations in Parkland County (Leskiw pers. comm.) and 3 locations in Yellowhead County (Pichette pers. comm.). In BC, clubroot disease has been found in cole crops in Fraser Valley (Joshi pers. comm.) and was noted as an issue in the Lower Mainland by participants of the Abbotsford ESA Workshop. Generally, the risk of clubroot disease is higher along the eastern portion of the proposed pipeline corridor (*i.e.*, Parkland County), where there are many confirmed cases of clubroot and lower western BC (*i.e.*, FVRD).

Potato cyst nematode is considered a pest under Alberta's *Agricultural Pests Act* and is regulated by the Canadian Food Inspection Agency (CFIA) under the *Plant Protection Act*. If potato cyst nematodes are confirmed at a given location, the CFIA may put the field under regulation. Potato cyst nematode regulated fields are monitored for access and equipment/vehicle sanitation. Furthermore, any equipment moving off a CFIA regulated field needs a CFIA Movement Certificate. Through landowner consultation, Trans Mountain has identified one cultivated field near Spruce Grove, Alberta that may be potentially contaminated with potato cyst nematode (Worobec pers. comm.).

Participants of the Abbotsford ESA Workshop expressed concern that a plan is needed for movement of personnel and equipment to ensure no cross-contamination of clubroot between fields. Mitigation measures outlined in Table 7.2.2-2 and the Pipeline EPP (Volume 6B) are consistent with recommended industry standard measures to reduce the introduction and spread of clubroot disease (Alberta Agriculture and Rural Development 2010, CAPP 2008) and potato cyst nematodes (CFIA 2012). The mitigation measures from Table 7.2.2-2 will be implemented during both construction and maintenance activities. Similar measures for clubroot were implemented for a large pipeline project on agricultural lands in Alberta, and post-construction environmental monitoring reports for that project indicate that no clubroot issues have been reported (TERA 2013b). This residual effect is reversible in the long-term and of high magnitude, however, progressive equipment cleaning measures to be implemented during construction of the Project ensure that the potential effect is unlikely to occur (Table 7.2.2-3, point 1[e]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Soil LSA – clubroot disease and potato cyst nematodes could spread beyond the construction right-of-way.
- Duration: short-term – the events causing potential soil disease introduction and spread (construction of the pipeline and maintenance activities) occur during the construction phase or are completed within any 1 year during the operations phase.
- Frequency: accidental – introduction or spread of clubroot disease/potato cyst nematodes is rare when the mitigation measures in Table 7.2.2-2 are implemented.
- Reversibility: long-term – once introduced or spread, the effects of clubroot disease/potato cyst nematodes may take longer than 10 years to be reversed.
- Magnitude: high – the residual effect of introduction or spread of clubroot disease/potato cyst nematodes is considered to be beyond environmental standards.

- Probability: low – all required mitigation measures will be implemented during construction to prevent the introduction and spread of clubroot disease and potato cyst nematodes.
- Confidence: moderate – there is a good understanding by the assessment team of cause-effect relationships between pipeline construction and potential soil disease introduction and spread.

Combined Effects on Soil Productivity

The following assesses the combined effects on the soil productivity indicator that could potentially occur. Only those residual effects that are likely to occur have been considered in the overall effects on the soil productivity indicator. The potential exists for the following potential residual effects to occur and contribute to overall effects on the soil productivity indicator:

- mixing of topsoil/root zone material and subsoil;
- undesirable lower subsoils may be unexpectedly encountered and admixed with upper subsoils;
- reduction in soil productivity on agricultural areas from changes in evaporation and transpiration rates; and
- excessive trench subsidence or a remnant crown.

The combined effects on the soil productivity indicator of these potential residual effects would be not significant due to the overall low magnitude of the potential effects which is based in part on the limited areal extent where the effects would occur (*i.e.*, localized areas on the Footprint) (Table 7.2.2-3, point 1[f]). In addition, effects on soil will be monitored as part of the post-construction environmental monitoring program (Volume 6A). A summary of the rationale for all of the significance criteria on the combined effects on the soil productivity indicator is provided below.

- Spatial Boundary: Footprint – combined effects on the soil productivity indicator are confined to the area of disturbance along the construction right-of-way.
- Duration: short-term – the events causing combined effects on the soil productivity indicator are construction of the pipeline, and maintenance-related activities which are limited to any 1 year during the operations phase.
- Frequency: periodic – the events causing combined effects on the soil productivity indicator (*i.e.*, construction and maintenance-related activities) occur intermittently but repeatedly over the assessment period.
- Reversibility: short to long-term – combined effects on the soil productivity indicator are anticipated to take less than 10 years to reverse but could take more than 10 years to reverse where there is admixing of undesirable lower subsoils with upper subsoils.
- Magnitude: low – the implementation of the proposed mitigation measures is expected to effectively reduce the combined effects on soil productivity.
- Probability: high – the individual effects on the soil productivity indicator are likely to occur in combination.
- Confidence: high – based on a good understanding by the assessment team of cause-effect relationships between pipeline construction and soil productivity.

Soil Indicator – Soil Degradation

The following provides the evaluation of significance of potential residual effects on the soil degradation indicator, including degradation of soil structure from compaction and rutting, surface erosion and soil/sod pulverization.

Degradation of Soil Structure from Compaction and Rutting

Soil compaction, as a result of construction activities, can result in the reduction of soil pore space and an increase of soil bulk density or mass. Plant roots have greater difficulty penetrating compacted soil which can reduce the productivity of plant communities. Rutting can occur by vehicle traffic during wet conditions. The impact balance of this residual effect is considered negative since compaction and rutting could decrease the structure of the soil and, therefore, reduce soil productivity. Based on the results of a recent post-construction environmental monitoring program for a large pipeline project on agricultural lands, issues related to compaction and rutting have been found to be resolved within 1 to 2 years (*i.e.*, in the short to medium-term) (TERA 2009a, 2011a, 2012a, 2013a). The results of the post-construction environmental monitoring program for the TMX Anchor Loop Project also demonstrated that rutting issues were typically resolved within 2 years in a forested setting (TERA 2009b, 2011b,c, 2013b). Similar mitigation measures are planned for the construction of the proposed pipeline.

Given the proven effectiveness of the mitigation measures to reduce admixing along the construction right-of-way, it is anticipated that the extent and severity of compaction and rutting will be minor. As a result, this residual effect is considered to be of low magnitude (Table 7.2.2-2, point 2[a]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Footprint – degradation of soil structure from compaction and rutting is confined to the area of disturbance along the construction right-of-way.
- Duration: short-term – the events causing potential degradation of soil structure from compaction and rutting are construction of the pipeline and maintenance-related activities, the latter of which are limited to any 1 year during the operations phase.
- Frequency: periodic – the events causing potential degradation of soil structure from compaction and rutting (*i.e.*, construction and maintenance-related activities) occur intermittently but repeatedly over the assessment period.
- Reversibility: short to medium-term – degradation of soil structure from compaction and rutting is expected to be reversed within a few years given the implementation of mitigation measures during construction and, if necessary, the application of soil amendments post-construction.
- Magnitude: low – given the implementation of industry-standard and provincial regulatory mitigation measures outlined in Table 7.2.2-2 and, if necessary, soil amendments applied post-construction.
- Probability: high – degradation of soil structure from compaction and rutting is a common residual effect of pipeline construction and may also occur during maintenance activities.
- Confidence: high – there is a good understanding by the assessment team of cause-effect relationships between pipeline construction and soil degradation.

Surface Erosion of Topsoil/Root Zone Material

Construction and maintenance activities which disturb the soil will likely result in some surface erosion of topsoil/root zone material until a stable vegetative cover can be established, particularly on slopes which are more susceptible to water erosion. The impact balance of this residual effect is considered negative since erosion could decrease soil productivity. Soil erosion was noted as a concern by stakeholders, including participants of the Wabamun, Hinton, Valemount and Kamloops Community Workshops. It is expected that a vegetative cover can be established on non-cultivated disturbed slopes within a year with the seeding of a rapidly establishing cover crop in addition to the appropriate seed mix for the location. Based on the results of post-construction monitoring programs for pipeline projects in agricultural and forested settings, issues related to erosion can generally be resolved within 2 to 3 years following final clean-up (TERA 2009a,b, 2011a,b,c, 2012a, 2013a,b). Similar measures are planned for the construction of the proposed pipeline. Consequently, minor surface erosion of topsoil/root zone material is considered to be reversible in the medium-term.

A participant of the Hinton Community Workshop noted that eolian soils are present under the vegetation mat in the Hinton area and may be difficult to reclaim. Eolian and sandy textured soils were also noted as an erosion concern along the TMX Anchor Loop Project pipeline route. However, results of the post-construction environmental monitoring program for this project did not reveal any extraordinary issues related to wind erodible soils and, as stated above, issues related to erosion were generally resolved within 2 to 3 years following final clean-up (TERA 2009b, 2011b,c, 2013b). The erosion control measures outlined in Table 7.2.2-2 to address soil erosion are the industry-accepted standards and, consequently, are expected to reduce loss of surface soils resulting from erosion to minor levels. Given the proven effectiveness of the mitigation measures to reduce erosion outlined in Table 7.2.2-2, this residual effect is considered to be of low magnitude (Table 7.2.2-3, point 2[b]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Footprint – surface erosion is confined to the area of disturbance along the construction right-of-way.
- Duration: short-term – the events causing surface erosion are construction of the pipeline and maintenance-related activities, the latter of which are limited to any 1 year during the operations phase.
- Frequency: periodic – the events causing surface erosion (*i.e.*, construction and maintenance-related activities) occur intermittently but repeatedly over the assessment period.
- Reversibility: medium-term – surface erosion is generally expected to be reversed within 2 to 3 years given the implementation of mitigation measures during construction and, if necessary, the application of soil amendments post-construction.
- Magnitude: low – given the implementation of industry-standard and provincial regulatory mitigation measures outlined in Table 7.2.2-2 and, if necessary, soil amendments applied post-construction.
- Probability: high – surface erosion is a common residual effect of pipeline construction which can be addressed during post-construction environmental monitoring and may also occur during maintenance activities.
- Confidence: high – there is a good understanding by the assessment team of cause-effect relationships between pipeline construction and soil degradation.

Degradation of Soil Structure from Pulverization

Construction activities during dry conditions may result in pulverization of soil and sod along the proposed pipeline corridor. The impact balance of this residual effect is negative since pulverization of soil and sod could lead to increased fugitive dust and loss of soil structure. Given the mitigation measures in Table 7.2.2-2 to reduce soil/sod pulverization, including the Soil/Sod Pulverization Contingency Plan, degradation of soil structure from pulverization is considered to be reversible in the short to medium-term (Table 7.2.2-3, point 2[c]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Footprint – degradation of soil structure from pulverization is confined to the area of disturbance along the construction right-of-way.
- Duration: short-term – the event causing degradation of soil structure from pulverization is construction of the pipeline.
- Frequency: isolated – the event causing degradation of soil structure from pulverization (*i.e.*, construction of the pipeline) is confined to a specified phase of the assessment period.
- Reversibility: short to medium-term – effects related to dust are reversible in less than 1 year (short-term); while the effects related to loss of soil structure is expected to take more than 1 year but less than 10 years to reverse the effect (medium-term).
- Magnitude: low – given the implementation of mitigation measures outlined in Table 7.2.2-2 and, if necessary, soil amendments applied post-construction.

- Probability: low to high – degradation of soil structure from pulverization is a common residual effect of pipeline construction but only in dry conditions so the likelihood varies by location along the construction right-of-way and weather conditions.
- Confidence: high – based on data pertinent to the Project area and the professional experience of the assessment team.

Combined Effects on Soil Degradation

The following assesses the residual effects that could potentially contribute to overall effects on the soil degradation indicator. Only those residual effects that are likely to occur have been considered in combination, including:

- degradation of soil structure and impairment of rooting zone due to compaction and rutting;
- surface erosion of topsoil/root zone material can be expected until a vegetative cover is established; and
- pulverization resulting in fugitive dust and loss of soil structure can be expected during dry conditions.

The combined effects on the soil degradation indicator of these potential residual effects would be not significant due to the overall low magnitude of the potential effects which is based in part on the limited areal extent where the effects would occur (*i.e.*, localized areas on the Footprint) (Table 7.2.2-3, point 2[d]). In addition, effects on soil will be monitored as part of the post-construction environmental monitoring program (Volume 6A). A summary of the rationale for all of the significance criteria of combined effects on the soil degradation indicator is provided below.

- Spatial Boundary: Footprint – combined effects on the soil degradation indicator are confined to the area of disturbance along the construction right-of-way.
- Duration: short-term – the events causing combined effects on the soil degradation indicator are construction of the pipeline and maintenance-related activities, the latter of which are limited to any 1 year during the operations phase.
- Frequency: periodic – the events causing combined effects on the soil degradation indicator (*i.e.*, construction and maintenance-related activities) occur intermittently but repeatedly over the assessment period.
- Reversibility: short to medium-term – combined effects on the soil degradation indicator are expected to be reversed within 1 year, or in more than 1 year but less than 10 years given the implementation of mitigation measures during construction and, if necessary, the application of soil amendments post-construction.
- Magnitude: low – combined effects on the soil degradation indicator are anticipated to be reduced through the implementation of industry standard and provincial regulatory mitigation measures and, if necessary, soil amendments applied post-construction.
- Probability: high – the individual effects on the soil productivity indicator are likely to occur in combination.
- Confidence: high – based on a good understanding by the assessment team of cause-effect relationships between pipeline construction and soil degradation.

Soil Indicator – Bedrock and Stone Disposal

The following provides the evaluation of significance of potential residual effects on the bedrock and stone disposal indicator.

Disposal Issues Resulting from Stone Picking and Removal of Bedrock from the Trench

Stones picked from the top of the backfilled subsoil and from the topsoil/root zone material as well as bedrock or large rock removed from the trench by ripping or blasting may result in disposal issues depending on the volume accumulated. Stones/large rocks may be disposed of off right-of-way, including areas within the Soil LSA, depending on landowner or Crown land authority preferences. Spoil removal in urban areas was also mentioned by a participant at the Surrey ESA Workshop. Similar to disposal of stones/large rocks, excess spoil in urban areas may also need to be disposed of off right-of-way and hauled away to an approved location.

Stone picking was conducted during clean-up activities for a large pipeline project on agricultural lands in 2009 (TERA 2009c). Following the 2011 post-construction environmental monitoring program for the pipeline, all sites previously identified as requiring additional stone picking were resolved (TERA 2012a). Although there is potential to encounter bedrock within trench depth along the proposed pipeline corridor, these areas are very minor in extent and conventional trenching methods are anticipated to be successful for most locations. However, localized blasting is anticipated along the Edmonton to Hinton, Hargreaves to Darfield, Black Pines to Hope and Hope to Burnaby segments. The impact balance of this effect is considered to be negative since excess stones can impact the management of soils on agricultural lands. The magnitude of this residual effect is considered to be low (Table 7.2.2-3, point 3[a]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Soil LSA – excess stones or bedrock originating from disturbed portions of the construction right-of-way (*i.e.,* Footprint), may result in disposal off right-of-way, including areas within the Soil LSA, depending on landowner or government land authority preferences.
- Duration: short-term – the event causing disposal issues resulting from stone picking and removal of bedrock from the trench is construction of the pipeline.
- Frequency: isolated – the event causing disposal issues resulting from stone picking and removal of bedrock from the trench (*i.e.*, construction activities) is confined to a specified phase of the assessment period.
- Reversibility: short to medium-term – excess bedrock is typically disposed of within a year of construction while excess stones at the surface can occur beyond the first year of post-construction but are typically resolved within 1 to 2 years.
- Magnitude: low – given the implementation of mitigation measures outlined in Table 7.2.2-2 and through post-construction environmental monitoring which will address any issues of surface stoniness after construction.
- Probability: high – based on similar projects, disposal issues resulting from stone picking and removal of bedrock from the trench are a common residual effect of pipeline construction.
- Confidence: high – there is a good understanding by the assessment team of cause-effect relationships between pipeline construction and bedrock and stone disposal.

Soil Indicator – Soil Contamination

No residual effects of the construction and operations of the proposed pipeline were identified for the soil contamination indicator (Table 7.2.2-3). Consequently, no further assessment is warranted.

7.2.2.7 Summary

As identified in Table 7.2.2-3, there are no situations where there is a high probability of occurrence of a permanent or long-term residual environmental effect on soil and soil productivity indicators of high magnitude that cannot be technically or economically mitigated. Consequently, it is concluded that the residual environmental effects of pipeline construction and operations on soil and soil productivity will be not significant.

7.2.3 Water Quality and Quantity

This subsection describes the potential Project effects on surface water quality and quantity and groundwater quality. The Fisheries (Alberta) Technical Report and Fisheries (British Columbia) Technical Report of Volume 5C provide further information pertaining surface water quality and quantity along the proposed pipeline corridor, while the Groundwater Technical Report of Volume 5C provides further information pertaining to existing groundwater conditions along the proposed pipeline corridor.

7.2.3.1 Assessment Indicators and Measurement Endpoints

Assessment indicators identified for the water quality and quantity element are: surface water quality; surface water quantity; groundwater quality; and groundwater quantity. Assessment indicators and measurement endpoints for water quality and quantity are listed in Table 7.2.3-1. Surface water quality and quantity indicator selection considered: filing requirements in the NEB *Filing Manual*; experience gained during previous projects with similar conditions/potential issues, such as the TMX Anchor Loop Project; feedback from Aboriginal communities, regulatory authorities, stakeholders; available research literature; feedback from participants in ESA Workshops; public issues raised through the media; and the professional judgment of the assessment team. A list of the proposed surface water quality and quantity indicators was discussed during the ESA Workshops. Participants in the Edmonton, Kamloops and Surrey ESA Workshops questioned how surface water quality would be adequately assessed, and suggested that existing benthic invertebrate and sediment conditions be used as a water quality indicator. A response to these stakeholder recommendations is provided in Section 7.2.3.4. Otherwise, there was general consensus among workshop participants that the proposed surface water indicators were appropriate for evaluating Project effects on surface water quality and quantity.

The selection of indicators for groundwater quality and quantity was based on the NEB *Filing Manual* requirements, experience gained during previous projects with similar conditions/potential issues, feedback from stakeholders, available research literature including various maps, drilling records, water wells, groundwater information, field inspection and the professional judgment of the assessment team. The proposed groundwater quality and quantity indicators were discussed during the Edmonton, Kamloops and Surrey ESA Workshops. The workshop participants generally agreed that the proposed groundwater indicators were appropriate for evaluating the effects of the Project on groundwater quality and quantity. Upon consideration by the assessment team, contaminated groundwater migration was considered to be already covered by the other indicators. Input was also sought from Environment Canada, AESRD, BC MOE and BC MFLNRO and these agencies were in agreement that the proposed groundwater indicators were appropriate and suggested no additional indicators for consideration.

Qualitative measurement endpoints are applied to assess potential Project effects on water quality and quantity indicators (Table 7.2.3-1).

TABLE 7.2.3-1

ASSESSMENT INDICATORS AND MEASUREMENT ENDPOINTS FOR WATER QUALITY AND QUANTITY

Water Quality and Quantity Indicators	Measurement Endpoints	Rationale for Indicator Selection
Surface water quality	• Areas with high water table susceptible to trench instability • Suspended sediment in water column • Approach slopes susceptible to erosion • Drilling mud release • Hydrostatic test water withdrawal and release locations • Surface water contamination	The selection of indicators and measurement endpoints considered NEB *Filing Manual* requirements for the water quality and quantity element under Table A-2 and addressed concerns raised through Aboriginal engagement and stakeholder consultation.
Surface water quantity	• Surface drainage patterns • Disruption of streamflow • Hydrostatic test water withdrawal and release locations	

TABLE 7.2.3-1 Cont'd

Water Quality and Quantity Indicators	Measurement Endpoints	Rationale for Indicator Selection
Groundwater quality	• Shallow groundwater with potential existing contamination • Areas susceptible to drilling mud release during HDD construction • Areas in the aquifer susceptible to sedimentation • Areas of shallow groundwater susceptible to blasting effects • Areas with potential artesian conditions • Aquifers or wells vulnerable to possible future contamination from an accident or malfunction	The selection of indicators and measurement endpoints considered the NEB *Filing Manual* requirements for the water quality and quantity element under Table A-2 and addressed concerns raised by participants of the ESA Workshops and was informed by regulatory authorities (*i.e.,* Environment Canada, AESRD, BC MOE and BC MFLNRO). Groundwater will not be used for hydrostatic testing, therefore, groundwater withdrawal or discharge for this purpose has not been considered. Groundwater use requirements at Trans Mountain facilities will not increase with the proposed expansion activities.
Groundwater quantity	• Areas susceptible to changes in groundwater flow patterns • Areas where dewatering may be required during pipeline construction activities • Areas with potential artesian conditions • Areas shallow groundwater susceptible to blasting effects	

7.2.3.2 Spatial Boundaries

The following spatial boundaries are used in the water quality and quantity effects assessment:

- a Footprint Study Area (as defined in Section 7.1.3);
- a Water Quality and Quantity LSA; and
- an Aquatics RSA.

The Water Quality and Quantity LSA reflects the area where Project construction and operations activities would most likely affect water quality and quantity. The direct disturbance ZOI is defined as the area extending 100 m upstream of the centre of the proposed pipeline corridor to a minimum of 300 m downstream of the centre of the proposed pipeline corridor. For groundwater, the area within 300 m of the proposed pipeline corridor, facility or HDD entrance in potentially vulnerable aquifer areas in hydraulic connection with the Footprint constituted the Water Quality and Quantity LSA. The downstream Water Quality and Quantity LSA boundary of each watercourse crossed by the proposed pipeline corridor was determined by the ZOI, the reach where 90% of the sediment load caused by construction activities is expected to fall out of suspension (Government of Alberta 2013b,c). The ZOI was determined in the field based on the professional experience and judgment of the Qualified Aquatic Environmental Specialist (QAES) in Alberta or the Qualified Environmental Professional (QEP) in BC who considered relevant site-specific factors (*e.g.,* stream gradient, channel width, channel depth, substrate composition, channel morphology, flow velocity and discharge and instream cover). Due to variable drainage patterns along the proposed pipeline corridor, it is not feasible to accurately map the Water Quality and Quantity LSA using the above-mentioned definition. Consequently, for illustrative purposes, Figures 7.2.7-1 and 7.2.7-2 of Section 7.2.7 provide examples of the Water Quality and Quantity LSA at watercourses of varying size. The Water Quality and Quantity LSA boundaries for each watercourse can be found in the Summary Crossing Table (Appendix A of the Fisheries [Alberta] Technical Report and the Fisheries [British Columbia] Technical Report of Volume 5C).

The Aquatics RSA includes all watersheds affected by the Project (as defined in Section 5.7 of the Fisheries [Alberta] Technical Report and the Fisheries [British Columbia] Technical Report of Volume 5C). These watersheds include the area where the direct and indirect influence of other land uses and activities could overlap with proposed Project-specific effects and cause cumulative effects on the water quality and quantity indicators for surface water. The Aquatics RSA does not apply to groundwater indicators since potential effects on groundwater quality and quantity are not anticipated beyond the Water Quality and Quantity LSA. The Aquatics RSA is shown on Figures 5.3-1 and 5.3-2.

The Water Quality and Quantity LSA and Aquatics RSA were discussed during the ESA Workshops and with Environment Canada, AESRD, BC MOE and BC MFLNRO (Section 3.0). There was general agreement that the spatial boundaries for water quality and quantity were appropriate and no alternative boundaries were suggested for consideration by the assessment team.

7.2.3.3 Water Quality and Quantity Context

The proposed pipeline corridor lies within four drainage basins, including the North Saskatchewan and Athabasca river basins in Alberta and the Fraser and Columbia river basins in BC. Twenty-one Project watersheds are crossed by the proposed pipeline corridor as described in Section 5.7 of the Fisheries (Alberta) and Fisheries (British Columbia) Technical Reports of Volume 5C and as shown on Figures 5.3-1.

Potential watercourses along the proposed pipeline corridor were originally identified during helicopter overflights and from desktop analysis. The 2012 and 2013 fisheries field program investigated 928 potential watercourses crossed by the proposed pipeline corridor (including 10 watercourses that were assessed based on historical information). Ongoing fisheries field studies are discussed in Section 9.0. It was determined that 88 defined watercourses are crossed by the proposed pipeline corridor in Alberta and 386 in BC. Named rivers crossed by the proposed pipeline corridor in Alberta include the North Saskatchewan, Pembina and McLeod rivers. The proposed pipeline corridor crosses 14 named rivers in BC, including the Fraser, North Thompson, Thompson, Coldwater and Coquihalla rivers.

A variety of surficial deposits and bedrock formations occur along the proposed pipeline corridor. Through most of Alberta, south of Kamloops and through the Burnaby area, fine-grained clay till deposits are predominant. However, where the proposed pipeline corridor either parallels in close proximity or crosses a large watercourse, fluvial or glaciofluvial deposits are more common (*e.g.,* Chilliwack area). Coarser grained surficial materials such as sand and gravel, components of fluvial and glaciofluvial deposits, are generally more permeable, facilitating groundwater flow and potential contaminant transport.

Section 5.3 and the Groundwater Technical Report of Volume 5C provide additional setting information related to water quality and quantity along the proposed pipeline corridor.

7.2.3.4 Potential Effects and Mitigation Measures

<u>Effects Considerations</u>

In a letter to Trans Mountain dated June 19, 2012, Enoch Cree Nation expressed concern over potential effects to water quality from herbicide use during post-construction weed management activities. Measures provided in the Weed and Vegetation Management Plan of the Pipeline EPP (Volume 6B), such as prohibiting the use of herbicides within 30 m of a watercourse or waterbody, will be implemented to avoid any potential effects to water quality and, therefore, this potential effect was not carried through the assessment.

A participant at the Wabamun Community Workshop noted that soils in the Wabamun Lake area have a high phosphorous content which, if exposed as a result of pipeline construction, could affect water quality of Wabamun Lake. Standard sediment erosion control measures provided in the Pipeline EPP (Volume 6B) will be implemented to reduce or limit the extent of site runoff. Consequently, given that the proposed pipeline corridor is located approximately 350 m north of the lake at its nearest point (RK 113), any runoff of phosphorus-laden sediment is not expected to reach Wabamun Lake and, therefore, this potential effect was not carried through the assessment.

Naturally occurring deposits of asbestos are known to occur within the Sumas River and Sumas Lake Canal, which is crossed by the proposed pipeline corridor at RK 1114.6 and RK 1110.7, respectively. In order to negate any potential effects to water quality as a result of sediment disturbance, these watercourses will be crossed using a trenchless method and, therefore, this potential effect was not carried through the assessment.

As previously mentioned, participants at the ESA Workshops suggested sediment sampling and benthic invertebrate studies as measurement endpoints for the surface water quality indicator. For reasons provided in the following subheadings, conventional pipeline assessment and monitoring methods will be implemented for the Project that do not include sediment sampling and benthic invertebrate studies.

Sediment and Water Quality Testing

Through water quality monitoring over the years (*e.g.,* TERA 2009a), there is good confidence in concluding that effects of pipeline associated watercourse crossings are limited to increased sediment input and deposition, and this influences the type of data collection and monitoring program design. Due to the inherent variability in water quality, baseline water quality data for parameters such as heavy metals, nutrient loads and bacteria, and sediment quality, are no longer routinely collected since the construction and operations of the pipeline itself will not involve any additional contribution of effluents and chemicals that would increase current contaminant levels. Emphasis is now placed on monitoring water quality during construction and post-construction. In addition to previous experience and results of peer-reviewed research on the effects of pipeline crossings and increased sedimentation, potential effects on surface water quality were identified based on regulatory guidance materials including the Pipeline Associated Watercourse Crossings: 3rd Addition (CAPP *et al.* 2005), Standards and Best Practices for Instream Works (BC Ministry of Water, Land and Air Protection [MWLAP] 2004a) and Guide to the Code of Practice for Watercourse Crossings (Government of Alberta 2013b).

Watercourses along the proposed pipeline corridor were examined to document site-specific features. Field data consisting of both qualitative observations (*e.g.,* habitat quality, turbidity, bed and bank characteristics, riparian health) and quantitative data collection (*e.g.,* pH, dissolved oxygen, conductivity, temperature, fish sampling) to identify existing water quality conditions and the likely ZOI for sediment effects. Available water quality information was also obtained from provincial and federal water quality monitoring programs (Section 5.3).

Sediment testing is only considered necessary for pipeline crossings where existing contaminants (from historic contamination) bound within the streambed sediments have the potential to become entrained in the water column as a result of instream construction activities. Otherwise, potential effects resulting from re-suspension of uncontaminated materials are not unlike those resulting from seasonal fluctuations in turbidity and total suspended solids (TSS) from natural processes. If contamination was suspected at any watercourse, sediment samples would be collected to determine potential effects. For example, sediment quality was sampled at the Westridge Marine Terminal in Burrard Inlet for this reason (refer to Section 7.6.7). In the event areas of contaminated sediments are encountered during construction, the Contaminated Sites Discovery Contingency Plan in Appendix B of the Pipeline EPP (Volume 6B) will be implemented and procedures outlined in the *NEB Remediation Process Guide* (NEB 2011) will be followed.

Site-specific sediment and/or water quality testing may, however, be warranted for several other Project activities, including:

- hydrostatic test water discharge areas, which are considered as measurement endpoints of the water quality indicator (Table 7.2.3-1);
- contamination resulting from large spills, which are considered in Volume 7;
- potential acid rock drainage near waterbodies (Section 7.2.1);
- stormwater discharge locations at pump stations (Section 7.4.3) and terminals (Section 7.5.3); and
- waste water discharge locations from work camps (Section 7.3.3).

Benthic Invertebrates

Pollution in sediments influences the development of benthic invertebrates, the base of the food chain, and can lead to modification of the whole ecological structure (Beasley and Kneale 2002). Benthic invertebrates are a useful indicator of water quality for effluent discharge, but may not be the most practical indicator to use for short-term disturbances such as those from pipeline watercourse crossings. However, that does not suggest potential effects to benthic invertebrates from increased suspended solids at pipeline watercourse crossings should be overlooked. Benthic invertebrates are an important food source for many aquatic organisms, including fish and, consequently, are considered under the fish and fish habitat element (Section 7.2.7).

Newcombe's work on sediment dose-response relationships (Newcombe 1994) identified that impacts to benthic invertebrates are directly related to concentration and duration of TSS in a watercourse. Previous studies on pipeline watercourse crossings (*e.g.,* Reid and Anderson 1999, Reid *et al.* 2002a, Tsui and McCart 1981, Wood and Armitage 1997, Young and Mackie 1991) showed that benthic invertebrate populations are normally able to withstand short-term increases in suspended sediment and recover quickly following open cut (trenched) crossings. Consequently, in recent years, the focus has shifted from pre-disturbance testing and monitoring to sediment and habitat monitoring during and following instream construction activities.

In accordance with CCME guidelines for particulate matter, pipeline crossings are monitored during construction to ensure sediment concentrations do not exceed 25 mg/L from background levels in a 24 hour period and turbidity does not exceed 8 NTU from background levels in a 24 hour period in accordance with CCME guidelines for total particulate matter (CCME 2002). With this standard industry guidance, effects from instream pipeline crossings on benthic invertebrates are expected to be within an acceptable range. Consequently, benthic invertebrates as a measure of surface water quality were not carried through the assessment.

Identified Potential Effects

Potential effects of pipeline construction and operations on water quality and quantity indicators are listed in Table 7.2.3-2. These interactions are based on results of the literature review, desktop analysis, field work, TEK, engagement with Aboriginal communities landowners, regulatory authorities, stakeholders and the general public (Section 3.0), and the professional experience of the assessment team.

Issues and concerns related to surface water quality and quantity identified by participating Aboriginal communities through the biophysical field studies for the Project are described in the Fisheries (Alberta) and Fisheries (British Columbia) Technical Reports of Volume 5C. A comprehensive review of the issues raised by participating Aboriginal communities was conducted with each community during the field surveys and during follow-up results review meetings (see the Fisheries [Alberta] Technical Report and the Fisheries [British Columbia] Technical Report of Volume 5C).

Standard pipeline construction activities are designed to avoid diversion and/or unnatural retention of water along the construction right-of-way by following recommendations from various industry and provincial guidelines (AENV 1988, 1994a; BC OGC 2013; CAPP 1999; CAPP *et al*. 2005). In addition, applicable measures from several industry and provincial and federal regulatory guidelines have been incorporated into Table 7.2.3-2 to reduce the potential effects of pipeline construction and operations on water quality and quantity including Alberta Energy Regulator (AER) (2001), AEP (1999), BC MWLAP (2004a), Canadian Pipeline Environment Committee (2009), CAPP (1996, 2004), DFO (1995, 1999, 2007a,b) and Government of Alberta (2001, 2013a,b,c), as well as groundwater legislation under the *Oil and Gas Activities Act* (*Environmental Protection and Management Regulation*) and the *BC Environmental Assessment Act.*

In Table 7.2.3-2, RK values in the Pipeline Segments column refer to locations where potential effects may be encountered and are shown on the Environmental Alignment Sheets (Volume 6E).

TABLE 7.2.3-2

POTENTIAL EFFECTS, MITIGATION MEASURES AND RESIDUAL EFFECTS OF PIPELINE CONSTRUCTION AND OPERATIONS ON WATER QUALITY AND QUANTITY

Potential Effect	Pipeline Segment(s)	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
1. Water Quality and Quantity Indicator – Surface Water Quality				
1.1 Instability of trench at locations with high water table	Edmonton to Hinton Hargreaves to Darfield Black Pines to Hope Hope to Burnaby	LSA	• Dewater the trench, if warranted, when laying pipe in areas with high water tables. Place pumps on polyethylene sheeting above the ordinary high water mark of the watercourse. Pump water onto stable and well vegetated areas, tarpaulins or sheeting at least 50 m from the nearest waterbody in a manner that does not cause erosion or any unfiltered or silted water to re-enter a watercourse [Section 8.3]. See additional dewatering measures in Section 8.3 of the Pipeline EPP. • Monitor the water discharge site to ensure that erosion, saturation of the discharge site, flooding, icing or flow off of the property does not occur. Suspend dewatering and either apply erosion control measures, reduce the flow or move the discharge site if it appears that the above effects could occur [Section 8.3]. • See recommended mitigation measures outlined in Table 7.2.8-2 Wetland Loss or Alteration.	• No residual effect identified.
1.2 Suspended sediment concentrations in the water column during instream activities	All	LSA	Pipeline Crossings • Appropriate watercourse crossing methods have been selected in consideration of the size, environmental sensitivities of the watercourses and period of construction (Appendix A of the Fisheries [Alberta] and Fisheries [British Columbia] Technical Reports of Volume 5C). • Install the pipeline at each watercourse using the technique as identified in environmental resource-specific mitigation table for aquatic resources in Appendix I of the Pipeline EPP and as shown on the Environmental Alignment Sheets (Volume 6E). Ensure that the technique is implemented as per the reports/notifications/applications provided to applicable regulatory authorities [Section 8.7]. General • Confirm with the Inspector(s) that all notifications and approvals and/or letters of advice are in place prior to commencing instream construction at each water/canal crossing [Section 8.7]. • Grade away from watercourses to reduce the risk of introduction of soil and organic debris. Do not place windrowed or fill material in watercourses during grading [Section 8.2]. • Install a temporary sediment barrier (*e.g.,* sediment fences), where warranted, to eliminate the flow of sediment from spoil piles and disturbed areas into nearby waterbodies [Section 8.7]. • Inspect temporary sediment control structures (*e.g.,* sediment fences, subsoil berms) installed on approach slopes, on a daily basis throughout crossing construction. Repair the structures, if warranted, before the end of the working day [Section 8.7]. • Develop water quality monitoring plans, where required, to monitor for sediment events during select isolated trenched crossings of watercourses with high sensitivity fish habitat, or open-cut crossing construction activities where flow is present. If monitoring reveals that sediment values are approaching threshold values, the water quality monitors will notify the Lead Environmental Inspector and Inspector(s) who, with the Construction Manager and contractor, will develop corrective actions [Section 8.7].	• Reduction in surface water quality due to suspended sediment during instream activities at trenched crossings during construction and site-specific maintenance activities.

TABLE 7.2.3-2 Cont'd

Potential Effect	Pipeline Segment(s)	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
1.2 Suspended sediment concentrations in the water column during instream activities (cont'd)	All	LSA	Open Cut Crossing Technique • Conduct an open cut crossing of seasonally dry or frozen to the bottom watercourses in Alberta in accordance with the Alberta *Operational Statement for Isolated or Dry Open-cut Stream Crossings* (see Watercourse Crossing – Open Cut Method for Dry/Frozen Watercourses Drawing in Appendix R of the Pipeline EPP) [Section 8.7]. Isolation Crossing Technique • Construct the crossing in accordance with the COP (Alberta only) requirements and in accordance with the conditions of the DFO's Operational Statement for *Isolated or Dry Open-cut Stream Crossings*, letter of advice or other DFO conditions. In BC, isolated pipeline crossings are not included under the Pacific Region DFO's *Operational Statement for Isolated or Dry Open-cut Crossings* [Section 8.7]. • Dewater the segment of the watercourse between the dams, if feasible and safe to do so. Pump any silt-laden water out between the dams to well-vegetated lands, away from the watercourse or to settling ponds [Section 8.7]. • Remove any accumulations of sediment within the isolation areas that resulted from crossing construction. Spread all sediment and unused trench spoil removed from the watercourse at a location above the high water mark where the materials will not directly re-enter the watercourse [Section 8.7]. • Install sack trench breakers back from the edge of watercourses where the banks consist of organic material to prevent sloughing of backfill into the channel (see Trench Breaker – Watercourse / Wetland Drawing in Appendix R of the Pipeline EPP) [Section 8.7]. • Ensure that water from flumes, dam and pumps, diversion or other methods does not cause erosion or introduce sediment into the channel. If warranted, place rock rip rap, tarpaulins, plywood sheeting or other materials to control erosion at the outlet of pump hoses and flumes. Supplement the erosion control materials, if warranted, to control any erosion [Section 8.7]. Vehicle Crossings General • Use the vehicle crossings at watercourses crossed by access roads identified in Section 9.0 of the Pipeline EPP and within the aquatic resources tables [Appendix I] and on the Environmental Alignment Sheets [Section 8.7]. • Ensure that upgraded or new construction vehicle crossing structures are appropriate for the watercourse approaches, channel width and configuration, anticipated streamflows during the period of use, planned vehicle loads, and overall period/duration of use [Section 8.7]. Temporary Bridges • Install temporary bridges at locations identified in the environmental resource-specific mitigation tables for aquatic resources provided in Appendix I of the Pipeline EPP. Ensure bridges are clean prior to installation and dispose of soil at an appropriate location (see Vehicle Crossing – Typical Ramp and Culvert Drawing in Appendix R of the Pipeline EPP) [Section 8.7]. • Implement erosion control measures as soon as disturbance of the vegetation mat occurs [Section 8.7]. • Ensure stormwater from the bridge deck, side slopes and bridge approaches is directed away from the watercourse onto a well vegetated area [Section 8.7].	• See above.

TABLE 7.2.3-2 Cont'd

Potential Effect	Pipeline Segment(s)	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
1.2 Suspended sediment concentrations in the water column during instream activities (cont'd)	All	LSA	• Stabilize and revegetate areas disturbed during installation and removal of a bridge; install erosion control measures, where warranted, to control surface erosion until vegetation is established [Section 8.7]. Temporary Fords • Ensure the use of a ford is a one-time crossing (over and back) or limit ford to a seasonally dry streambed [Section 8.7]. • Confine the use of fords to watercourses or segments of watercourses with low, stable banks and a stable substrate composed of materials such as gravel and bedrock. Trans Mountain will not grade the banks to create a ford [Section 8.7]. • Install matting, where warranted, to protect the bed and banks of a watercourse to be forded [Section 8.7]. Ice Bridges/Snow Fills • Install clean snowfills during frozen conditions at locations identified in the environmental resource-specific mitigation tables for aquatic resources provided in Appendix I of the Pipeline EPP and at all minor and intermittent watercourses [Section 8.7]. • Install ice bridges at locations identified in the aquatic resources tables during frozen soil conditions (see Appendix I of the Pipeline EPP) [Section 8.7]. • Design, construct and abandon ice bridge and snow fill vehicle crossings at watercourses in accordance with the DFO *Operational Statement for Ice Bridges and Snow Fills* [Section 8.7]. • See recommended mitigation measures outlined in Table 7.2.7-2 Fish and Fish Habitat and Section 8.7 of the Pipeline EPP for additional measures. Operations • Implement measures similar to construction under direction of Trans Mountain's Environmental, Health and Safety Management System to reduce suspended sediment released during integrity digs conducted instream.	• See above.
1.3 Erosion from approach slopes	All	LSA	Pipeline Crossings • Prohibit clearing of extra temporary workspace within the riparian buffer, only the trench and temporary workspace areas will be cleared. Ensure staging areas for watercourse crossing construction and spoil storage areas are located a minimum of 10 m from the banks of watercourse boundaries. This distance may be reduced by the Lead Environmental Inspector and the Inspector(s) where appropriate controls are in place and where no riparian area is present (*e.g.,* cultivated or disturbed lands that abut the watercourse banks) [Section 8.1]. • Restrict root grubbing to the area outside of the vegetated riparian buffer adjacent to watercourses [Section 8.1]. See additional root grubbing measures in Section 8.1 of the Pipeline EPP. • Install erosion control measures, where warranted, prior to commencing grading in the vicinity of water crossings [Section 8.2]. • Grade away from watercourses to reduce the risk of introduction of soil and organic debris. Do not place windrowed or fill material in watercourses during grading [Section 8.2].	• Reduction in surface water quality due to erosion from banks and approach slopes.

TABLE 7.2.3-2 Cont'd

Potential Effect	Pipeline Segment(s)	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
1.3 Erosion from approach slopes (cont'd)	All	LSA	• Install temporary berms on approach slopes to watercourses and erect sediment fence(s) near the base of approach slopes to watercourse(s) following grading (see Cross Ditches and Diversion Berms and Sediment Fence Drawings provided in Appendix R of the Pipeline EPP) where indicated in the Environmental Alignment Sheets (Volume 6E). Inspect the temporary sediment control structures on a daily basis and repair, if warranted, before the end of each working day [Section 8.2]. • Install sack trench breakers back from the edge of watercourses where the banks consist of organic material to prevent sloughing of backfill into the channel (see Trench Breaker – Watercourse / Wetland Drawing in Appendix R of the Pipeline EPP) [Section 8.4]. • Install temporary erosion and sediment control structures (*e.g.,* sediment fences, coir logs) immediately following the completion of backfilling lands adjacent to watercourse crossings where the potential for sedimentation of the watercourse exists (see Sediment Fence and Coir/Straw Log Installation Drawings provided in Appendix R of the Pipeline EPP) [Section 8.4]. • See Appendix R of the Pipeline EPP for additional measures related to riprap armouring, vegetated soil wraps or cribwalls, and coir or other biodegradable erosion control fabric. • Seed riparian areas with an approved annual or perennial grass cover crop or native grass mix as soon as is feasible after construction. See additional measures outlined in the Reclamation Management Plan [Appendix C and Section 8.6]. • Transplant dormant shrubs, or install dormant willow stakes or commercially grown rooted stock plants (plugs), where warranted, during reclamation of streambanks where riparian vegetation is present prior to construction. See additional measures outlined in the Reclamation Management Plan [Appendix C] and aquatic resources tables [Appendix I and Section 8.6]. • Install permanent erosion control measures, as outlined in the Reclamation Management Plan [Appendix C] unless otherwise approved by Trans Mountain to adjust for site conditions and suitability [Section 8.6]. • Install temporary fencing, if warranted, to allow the revegetation treatments to become established and avoid damage to the banks and riparian area by wildlife/livestock [Section 8.7]. • Monitor watercourse after construction as outlined in Section 9.0 of Volume 6A to assess the success of construction and reclamation mitigation measures following the temporary disturbance. Implement remedial measures, where warranted. <u>Vehicle Crossings</u> • Ensure that equipment used during construction of the vehicle crossings is used in a manner that reduces disturbance of the bed and banks and ensure bridge installation does not alter the stream bed or banks or require infilling of the channel [Section 8.7]. • Seed disturbed areas on the banks and approaches as soon as practical with an approved grass cover crop species or native grass seed mix and implement sediment control measures to stabilize watercourse banks and prevent sedimentation of the watercourse, respectively. Follow measures provided in the Reclamation Management Plan [Appendix C and Section 8.7].	• See above.

TABLE 7.2.3-2 Cont'd

Potential Effect	Pipeline Segment(s)	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
1.3 Erosion from approach slopes (cont'd)	See above	See above	<u>Operations</u> • Implement measures similar to construction under direction of Trans Mountain's Environmental, Health and Safety Management System for controlling erosion from banks and approach slopes during integrity digs conducted instream or in vicinity to watercourses.	• See above.
1.4 Inadvertent instream drilling mud release	Edmonton to Hinton Hargreaves to Darfield Black Pines to Hope Hope to Burnaby	LSA	• Plan for and use the procedures for a HDD or other trenchless crossing in accordance with those provided in the Horizontal Directional Drilling/Trenchless Planning and Procedures Management Plan [Appendix C and Section 8.7]. • Cease trenchless crossing work immediately and refer to the Drilling Mud Release Contingency Plan [Appendix B] in the event that an inadvertent release of drilling mud has occurred and the material is or may enter the watercourse or affect other sensitive environmental or land use features [Section 8.7]. • Assign Inspector(s), QAES or QEP with expertise in the containment of inadvertent release of drilling mud and clean up to HDDs under a watercourse (see Drilling Mud Release Contingency Plan in Appendix B of the Pipeline EPP) [Section 8.7]. • Follow the drilling mud frac-out monitoring and other measures outlined in the Drilling Mud Release Contingency Plan [Appendix B] during horizontal directional drilling [Section 8.7]. • Monitor to assess the immediate effects of crossing construction, if warranted. Also monitor sediment release (*i.e.*, turbidity and TSS) throughout the crossing construction period, if required [Section 8.7].	Reduction in surface water quality due to an inadvertent drilling mud release during HDD crossings.
1.5 Alteration or contamination of aquatic environment as a result of withdrawal and release of hydrostatic test water	Edmonton to Hinton North Saskatchewan River Pembina River McLeod River Hargreaves to Darfield Fraser River Canoe River North Thompson River Black Pines to Hope Thompson River Coldwater River Coquihalla River Hope to Burnaby Coquihalla River Sumas River Fraser River Burnaby to Westridge Fraser River	LSA	• Conduct hydrostatic testing activities in accordance with the *NEB OPR*, provincial legislation, Transport Canada's *Minor Works for Water Intakes* as well as the latest version of Canadian Standards Association (CSA) Z662 and the *Oil and Gas Waste Regulation* Section 7(2)(e), BC Reg. 254/2005 [Section 8.5]. • Follow the mitigation measures related to water withdrawal and dewatering provided in the Water Withdrawal and Discharge Procedures Management Plan [Appendix C] during hydrostatic testing [Sections 8.5]. • Collect samples of source water, hydrostatic test water and soil of the receiving environment and analyze according to the parameters listed in Water Withdrawal and Discharge Procedures Management Plan [Appendix C] [Section 8.5]. • Employ sediment reduction methods (*e.g.,* sediment mat, sediment fence, sand bag, coffer dam), where warranted, to prevent increased sedimentation or reduced water quality [Section 8.5]. • Isolate test pumps, generators and fuel storage tanks with an impermeable lined dike or depression to capture and retain any spills of fuels or lubricants [Section 8.5]. • See additional measures related to hydrostatic testing, including the use of chemical additives and erosion control, in Section 8.5 of the Pipeline EPP. • See Section 7.2.2 Soil and Soil Productivity for discussion on the release of hydrostatic test water on land. • See Section 7.2.4 Human Occupancy and Resource Use of Volume 5B for discussion on potential effect of withdrawal of hydrostatic test water on downstream water users.	• Alteration or contamination of aquatic environment as a result of withdrawal and release of hydrostatic test water.

TABLE 7.2.3-2 Cont'd

Potential Effect	Pipeline Segment(s)	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
1.6 Reduction of surface water quality due to small spill during construction or site-specific maintenance activities	All	LSA	• Ensure the following separation distances are maintained between a watercourse when planning and constructing the pipeline, unless otherwise approved: • fuel or hazardous material storage site - 300 m; • burning site - 100 m; and • oil change area - 100 m [Section 7.0]. • See Section 7.0 of the Pipeline EPP for additional measures for hazardous materials storage, servicing vehicles and spill equipment needs as well as cleaning of equipment. • Ensure that during construction no fuel, lubricating fluids, hydraulic fluids, methanol, antifreeze, herbicides, biocides, or other chemicals are dumped on the ground or into waterbodies. In the event of a spill, implement the Spill Contingency Plan [Appendix B] [Section 7.0]. • Conduct refuelling a minimum of 100 m from any watercourse unless otherwise approved by the appropriate regulatory authority [Section 7.0]. See additional measures for refuelling near waterbodies in Section 7.0 of the Pipeline EPP.	• Contamination of surface water due to a small spill during construction or site-specific maintenance activities.
2. Water Quality and Quantity Indicator – Surface Water Quantity				
2.1 Alteration of natural surface drainage patterns	All	LSA	• Maintain drainage across the construction right-of-way during all phases of construction [Section 7.0]. • Ensure the potential for soil erosion by water is reduced during construction activities by avoiding ponding of water or the unintentional channelization of surface water flow [Section 7.0]. • Provide surface drainage of adequate capacity across the construction right-of-way [Section 7.0]. • Locate gaps in pipe, snow, topsoil/root zone material and spoil at watercourse crossings [Section 8.2]. • Reduce grading along the construction right-of-way and associated facilities, especially within watercourse/wetland/lake vegetated buffers [Section 8.2]. • Leave hard plugs or install soft plugs at locations where the open trench could dewater a wetland or flood other areas [Section 8.3]. • Leave breaks in the trench crown at obvious drainages and wherever seepage occurs to reduce or avoid interference with natural drainage [Section 8.4]. • Recontour the construction right-of-way and stabilize approach slopes at watercourse crossings. Where reclamation of the pre-construction grade is not feasible due to risk of failure of fill on slopes or maintenance of an access trail, recontour to grades as directed by the Geotechnical Engineer [Section 8.6]. • Regrade areas with vehicle ruts, erosion gullies or where the trench has settled [Section 8.6]. • Implement similar mitigation measures during site-specific maintenance activities during operations. • See recommended mitigation measures outlined in Table 7.2.8-2 Wetland Loss or Alteration.	• Localized alteration of natural surface drainage patterns until trench settlement is complete.

TABLE 7.2.3-2 Cont'd

Potential Effect	Pipeline Segment(s)	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
2.2 Instability of trench at locations with high water table	All	LSA	• Limit the length of open trench and the time the trench will be left open to reduce the amount of trench sloughing [Section 8.3]. • Suspend trenching and salvage a wider area of topsoil/root zone material if the trench walls slough into the trench and the potential for topsoil/root zone material/subsoil mixing exists. Back slope the trench walls until stable. Equip backhoe with a swamp bucket, if practical, to avoid or reduce trench sloughing [Section 8.3]. • Delay trenching until immediately prior to lowering-in at locations with a high water table or where there is a risk of sloughing [Section 8.3]. • Assess the need for well points or other dewatering methods, prior to commencing trenching, to intercept groundwater at site-specific locations before it enters the trench [Section 8.3]. • See potential effect 1.1 of this table for mitigation related to dewatering trench. • See recommended mitigation measures outlined in Table 7.2.8-2 Wetland Loss or Alteration.	• No residual effect identified.
2.3 Disruption or alteration of streamflow	All	LSA	• Adhere to clearing guidelines for protection of streams and wetlands provided in AESRD's guidelines and the Forest Practices Code, Riparian Management Area Guidebook in BC, where riparian management zones (widths) are identified based on stream or wetland class [Section 8.1]. • Fell trees away from watercourses and away from limits of the construction right-of-way to reduce damage to streambanks, beds and adjacent trees. Hand clear the area, if necessary, to reduce disturbance. Any trees, debris and soil inadvertently deposited within the ordinary high watermark will be promptly removed in a manner that avoids or reduces disturbance of the bed and banks. Trees will not be stood or hauled across watercourses [Section 8.1]. • Do not place windrowed or fill material in watercourses during grading [Section 8.2]. • Remove bar ditch ramps to prevent blockage of spring runoff in road ditches unless culverts were installed during surface preparation activities [Section 8.6]. • Re-establish streambanks and approaches immediately following construction of water crossings as outlined in the Reclamation Management Plan [Appendix C] [Section 8.6]. • Ensure that upgraded or new construction vehicle crossing structures are appropriate for the watercourse approaches, channel width and configuration, anticipated streamflows during the period of use, planned vehicle loads, and overall period/duration of use [Section 8.7]. • Ensure streamflow, if present, is maintained under ice bridge and snow fill vehicle crossings [Section 8.7]. • Ensure streamflow, if present, is maintained at all times when trenching through a watercourse [Section 8.7]. • Disruption of streamflow due to the withdrawal of hydrostatic test water is addressed in potential effect 1.5 of this table. • Disruption of streamflow and the potential effect on navigability of waterbodies are addressed in Section 7.2.6 Navigation and Navigation Safety of Volume 5B.	• Disruption and alteration of natural streamflow from instream activities.

TABLE 7.2.3-2 Cont'd

Potential Effect	Pipeline Segment(s)	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
2.4 Alteration of streamflow volumes as a result of withdrawal and release of hydrostatic test water	**Edmonton to Hinton** North Saskatchewan River Pembina River McLeod River **Hargreaves to Darfield** Fraser River Canoe River North Thompson River **Black Pines to Hope** Thompson River Coldwater River Coquihalla River **Hope to Burnaby** Coquihalla River Sumas River Fraser River **Burnaby to Westridge** Fraser River	LSA	• Determine which applicable regulatory authority approvals are necessary for water withdrawal and discharge to allow for hydrostatic testing of the pipeline and to ensure conditions of approvals are satisfied during water withdrawal for hydrostatic testing [Section 8.5]. • Conduct hydrostatic testing activities in accordance with the *NEB OPR*, provincial legislation, Transport Canada's *Minor Works for Water Intakes* as well as the latest version of CSA Z662 and the *Oil and Gas Waste Regulation* Section 7(2)(e), BC Reg. 254/2005 [Section 8.5]. • The withdrawal rate and volume will not exceed 10% of the flow rate of the watercourse or of the volume of the body of water unless otherwise approved by the appropriate authority when withdrawing water in Alberta [Section 8.5]. • Ensure the water level in a lake does not fall more than 10 cm once water withdrawal has started if the *Water Act* approval requires this. Retain a copy of the water withdrawal approval/permit onsite and ensure the Inspector(s) has reviewed the water withdrawal approval/permit prior to the commencement of withdrawal activities [Section 8.5]. • Terminate or reduce the rate of water withdrawal if the approved minimum flow or depth of water in the source waterbody is reached during a water withdrawal, unless otherwise approved by the appropriate regulatory authority. Resume or increase the rate of water withdrawal only when flows or water levels exceed approved minimum values [Section 8.5]. • Discharge locations will be preferentially selected to dewater onto stable terrain areas rather than directly into a watercourse/wetland/lake where the water will be filtered through vegetation and soils prior to returning to a watercourse/wetland/lake [Section 8.5].	• No residual effect identified.
3. Water Quality and Quantity Indicator – Groundwater Quality				
3.1 Shallow groundwater with existing contamination encountered during trench construction	All, but predominantly urban areas **Black Pines to Hope** RK 844.8 to RK 845.8	LSA	• Ensure an environmental monitor with experience in contaminated sites is present to check for indications of potential groundwater contamination (*i.e.*, sheen, odour, adjacent soil staining) during pipeline trench excavation in areas where there is higher potential for encountering contamination (*e.g.*, urban areas). Where groundwater contamination is suspected the groundwater should be sampled and analyzed by an accredited laboratory [Section 8.3]. • Ensure contaminated soil and water are not transported off-site or disposed until analytical results have been received as per federal and provincial legislation. The Construction Manager and Inspector(s) will provide notification as to when excavations can be backfilled [Section 8.3]. • Notify and adhere to the advice of the Trans Mountain Environment, Health and Safety Department or Trans Mountain's Lead Environmental Inspector and Inspector(s) at locations where water potentially contaminated with hydrocarbons or other materials is to be discharged from the trench. Measures may include the use of tank trucks to haul discharged water to an appropriate disposal facility/site, ensuring the intake is submerged below the surface sheen, lab testing and use of sorbent booms to hold the sheen away from the pump intake [Section 8.3].	• No residual effect identified.

TABLE 7.2.3-2 Cont'd

Potential Effect	Pipeline Segment(s)	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
3.2 Areas susceptible to drilling mud release during trenchless crossing construction	All	LSA	• Conduct investigations prior to the commencement of drilling activities to assess groundwater conditions and risks (water supply wells within LSA) in highly vulnerable aquifers. Modify the drill path of the horizontal directional drill, if feasible, to reduce the potential effects on groundwater quality and, if warranted, monitor water supply wells in the immediate area before, during and after the horizontal directional drill. Have plans in place for the supply of alternate water in the event that water quality in the wells is affected [Section 8.7]. • Plan for and use the procedures for a HDD or other trenchless crossing in accordance with those provided in the Horizontal Directional Drilling/Trenchless Planning and Procedures Management Plan (see Appendix C) [Section 8.7]. • Ensure that drilling mud composition is limited to bentonite mud drilling systems, fresh water and, if warranted, other inert additives [Appendix B]. • Cease trenchless crossing work immediately and refer to the Drilling Mud Release Contingency Plan (see Appendix B) in the event that an inadvertent release of drilling mud has occurred and the material is entering or may enter the watercourse or affect other sensitive environmental or land use features [Section 8.7]. • Follow the drilling mud frac-out monitoring and other measures outlined in the Drilling Mud Release Contingency Plan (see Appendix B) during horizontal directional drilling [Section 8.7].	• Elevated turbidity in groundwater as a result of accidental drilling mud release.
3.3 Areas susceptible to sedimentation in the aquifer	All	LSA	• Assess the grain size; if it is poorly graded and coarse material, the installation of filter fabric at the base of the trench to prevent migration of fine sediment into the aquifer during trenching over highly vulnerable aquifers.	• Elevated turbidity in groundwater as a result of sedimentation.
3.4 Areas susceptible to blasting effects	All	LSA	• Notify landowners with water supply wells within the Water Quality and Quantity LSA before blasting is carried out and conduct investigations, where warranted, to assess groundwater conditions and risks [Section 6.0]. • Initiate pre-construction monitoring, where warranted, prior to the commencement of a specific activity during construction (*e.g.*, blasting). Monitoring may be necessary prior to, during and following construction or a specific construction activity in the vicinity of water wells or springs [Section 6.0]. • During Project field studies, the Hydrogeological Engineer in consultation with landowners and the appropriate regulatory authorities will determine if springs and wells used for domestic purposes located in the immediate vicinity of the construction right-of-way will be sampled for water quality and flow rate prior to the start of construction. Locate and flag or fence registered or known water wells in the immediate vicinity of the construction right-of-way [Section 6.0]. • Monitor all registered or known potable water wells located within 200 m of any blasting prior to and following blasting. Monitoring will include measurement of well yields, static and pumping water levels as well as water sampling in accordance with Canadian Guidelines for Drinking Water Quality (Health Canada 2012) [Section 8.3]. • Re-establish or replace a potable water supply as required should a registered or known water well located within 30 m of the construction right-of-way be damaged (*i.e.*, diminishment in quantity and/or quality) during pipeline installation [Section 7.0].	• Elevated turbidity in groundwater as a result of silt release during blasting.

TABLE 7.2.3-2 Cont'd

Potential Effect	Pipeline Segment(s)	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
3.5 Areas with potential artesian conditions	All	LSA	• Ensure that surficial materials are hydraulically isolated before drilling to deeper depths. • Use current drilling technology to ensure mud or casing seal is effective. • Depressurize the aquifer in the vicinity of the HDD area during the subsurface crossing and casing installation operations. • Seal/cement annular space around pipeline [Section 8.3]. • Abandon boreholes upon completion of the HDD.	• Groundwater from different aquifers may be mixed.
3.6 Aquifers (including unconfined aquifers) or wells vulnerable to possible future contamination from a spill during construction	All segments for wells Unconfined aquifers: Hope to Burnaby RK 1042.2 to RK 1043.3 RK 1047.6 RK 1049.3 to RK 1051.6 RK 1054.6 to RK 1062.8 RK 1062.8 to RK 1065.1 RK 1077.3 to RK 1089.9 RK 1080.1 to RK 1083.1 RK 1089.9 to RK 1094.2 RK 1094.2 to RK 1094.9 RK 1094.9 to RK 1097.9 RK 1097.9 to RK 1101.1 RK 1101.2 to RK 1104.7 RK 1104.7 to RK 1107.5	LSA	• Utilize Best Management Practices for spill prevention outlined in the Pipeline EPP including in areas where higher vulnerability wells and aquifers are identified. • Ensure that during construction no fuel, lubricating fluids, hydraulic fluids, methanol, antifreeze, herbicides, biocides, or other chemicals are dumped on the ground or into waterbodies. In the event of a spill, implement the Spill Contingency Plan (see Appendix B) [Section 7.0]. • Re-establish or replace a potable water supply as required should a registered or known water well located within 30 m of the construction right-of-way be damaged (*i.e.*, diminishment in quantity and/or quality) during pipeline installation [Section 7.0].	• Contamination of aquifer as a result of a spill during construction.
4. Water Quality and Quantity Indicator – Groundwater Quantity				
4.1 Areas susceptible to changes in groundwater flow patterns	All	LSA	• Monitor water encountered in the trench during trenching to determine if groundwater flow is being intercepted. If spring flow has been disrupted, seek and follow the advice of the Hydrogeological or Geotechnical Resource Specialist to maintain cross drainage within the trench (*e.g.*, installation of subdrains, trench breakers) [Section 8.3]. • Assess the need for well points or other dewatering methods, prior to commencing trenching, to intercept groundwater at site-specific locations before it enters the trench [Section 8.3]. • Prevent the pipeline trench and bedding from becoming a conduit for increased groundwater flow. • Install trench breakers to force groundwater seepage along the pipeline trench to the surface, if springs are encountered along the route. Install subdrains, if warranted, to divert shallow groundwater flow from the right-of-way [Section 8.4]. • Install trench breakers, where warranted, at the edge of perched wetlands to prevent the pipeline trench from acting as a drain (see Trench Breaker – Watercourse/Wetland Drawing in Appendix R) [Section 8.4].	• Natural groundwater pathways may be bisected and create a sink (drain) for shallow groundwater. • Flooding on the up-gradient side of the pipeline may result in creation of wet zones on ground surface. • Reduction of baseflow to local streams.

TABLE 7.2.3-2 Cont'd

Potential Effect	Pipeline Segment(s)	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
4.1 Areas susceptible to changes in groundwater flow patterns (cont'd)	All	LSA	• Install subdrains in association with trench breakers as directed by Trans Mountain's Engineer where there is evidence of seepage or a flowing spring on a slope once the trench is excavated (see Subdrains Drawing in Appendix R) [Section 8.4]. • Backfill clay/mineral soil first, if salvaged separately from organic material in shallow peatland areas, to ensure that cross drainage is maintained [Section 8.4]. • Ensure that the lower lift of subsoil is backfilled before the upper lift of subsoil where three lift soil handling has been conducted [Section 8.4].	• See above.
4.2 Disruption of shallow groundwater in high permeable materials in proximity to rivers or watercourse crossings with fluvial materials or colluvium in the substrate	Edmonton to Hinton RK 24.1 to RK 24.4 RK 28 to RK 28.2 RK 34.4 to RK 34.6 RK 36.8 to RK 37.1 RK 134.9 to RK 135.6 RK 185.3 RK 220.6 RK 223.7 to RK 224.1 RK 224.7 to RK 225 RK 309.1 to RK 311.1 RK 319.8 to RK 320.1 RK 327.5 to RK 327.7 RK 337.2 to RK 337.5 Hargreaves to Darfield RK 559 RK 559 RK 592.9 to RK 593 RK 619.9 RK 621 to RK 622.9 RK 622.9 to RK 625.4 RK 625.4 to RK 626.9 RK 642 to RK 643.5 RK 645.3 to RK 645.8 RK 646.8 to RK 648.2 RK 649 RK 651.3 to RK 651.8 RK 659.8 to RK 660.7 RK 668.4 to RK 668.9 RK 669 to RK 671.2 RK 682.8 to RK 684.2 RK 515.9 RK 715.6 RK 734.9 to RK 735.1 RK 740.7 to RK 740.8 RK 581.1 RK 600.2 to RK 600.3 RK 613.8 Black Pines to Hope RK 927.8 to RK 928 RK 970.2 to RK 970.3 RK 980 to RK 980.1 RK 1021.8 RK 1026.5	LSA	• See recommended mitigation measures outlined in potential effect 4.1 of this table.	• Natural groundwater pathways may be bisected and create a sink (drain) for shallow groundwater. • Reduction of baseflow to local streams.

TABLE 7.2.3-2 Cont'd

Potential Effect	Pipeline Segment(s)	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
4.3 Disruption of groundwater flow where springs are encountered	Edmonton to Hinton RK 327.5 to RK 327.7	LSA	• Monitor water encountered in the trench during trenching to determine if groundwater flow is being intercepted. If spring flow has been disrupted, seek and follow the advice of the Hydrogeological or Geotechnical Resource Specialist to maintain cross drainage within the trench (*e.g.*, installation of subdrains, trench breakers) [Section 8.3]. • Assess the need for well points or other dewatering methods, prior to commencing trenching, to intercept groundwater at site-specific locations before it enters the trench [Section 8.3]. • Install trench breakers to force groundwater seepage along the pipeline trench to the surface, if springs are encountered along the route. Install subdrains if warranted, to divert shallow groundwater flow from the right-of-way [Section 8.4].	• Natural groundwater pathways may be bisected and create a sink (drain) for shallow groundwater.
4.4 Areas where dewatering may be necessary during pipeline construction activities	All	LSA	• Dewater the trench, if warranted, when laying pipe in areas with high water tables. Place pumps on a tray or within an excavated sump lined with polyethylene sheeting above the ordinary high water level of the watercourse/wetland/lake. Pump water onto stable and well vegetated areas, tarpaulins or sheeting at least 50 m from the nearest waterbody in a manner that does not cause erosion or any unfiltered or silted water to re enter a watercourse [Section 8.3]. See additional dewatering measures in Section 8.3 of the Pipeline EPP. • Use floating suction hose and elevated intake, or other measures approved by Trans Mountain's Inspector(s), to prevent sediment from being sucked from the bottom of the trench. Secure the pump intake a minimum of 30 cm above the bottom of the trench [Section 8.3].	• Change in natural groundwater levels and stream recharge due to the discharge of groundwater to surface water systems if not practical to discharge trench water to ground.
4.5 Disruption of groundwater flow where shallow groundwater is encountered	Hargreaves to Darfield RK 522.6 RK 531.2 RK 533 RK 545.8 to RK 545.9 RK 613.7 RK 638.7 Black Pines to Hope RK 846.5 to RK 847.5 RK 858.3 to RK 858.5 RK 869.7 to RK 870.1 RK 881.7 RK 957.8 to RK 957.9 RK 963.1 to RK 963.6 RK 1021.8 RK 1022.9 RK 1028.6 to RK 1028.7 RK 1032.6	LSA	• See recommended mitigation measures outlined in potential effects 4.1 and 4.4 of this table.	• Natural groundwater pathways may be bisected and create a sink (drain) for shallow groundwater. • Change in natural groundwater levels and stream recharge due to the discharge of groundwater to surface water systems if not practical to discharge trench water to ground.
4.6 Areas with potential artesian conditions, including deeply incised creek crossings	All	LSA	• Depressurize the construction area or subsurface crossing area prior to excavation/directional drilling through, for example, drilling wells and then extracting water in order to reduce locally, the pressure in the aquifer. • Re-create the confining layers if disturbed during construction (*e.g.*, place seal/cement in annular space around pipeline).	• Flooding from artesian flow may occur during trenchless crossing installation.

TABLE 7.2.3-2 Cont'd

Potential Effect	Pipeline Segment(s)	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
4.6 Areas with potential artesian conditions, including deeply incised creek crossings (cont'd)	Deeply incised creek crossings include: Hargreaves to Darfield RK 514.4 RK 515.9 RK 517.8 RK 523.6 RK 534.4 RK 573.5 RK 576.3 RK 590.3 RK 611.7 to RK 611.8 RK 626.6 RK 663.2 to RK 663.5 RK 910.1 RK 561.2 RK 563.4 to RK 563.5 RK 565.9 RK 567.6 RK 571.9 RK 580.3 RK 634	LSA	• Understand hydrogeological and geotechnical conditions, and assess the risks before commencing a trenchless crossing. Complete a trenchless crossing alignment site reconnaissance, supported, where warranted, by a drilling and testing program designed to confirm hydrogeological and geotechnical conditions. Design the trenchless crossing and pipeline installation to prevent damage caused by artesian flow.	• See above.
4.7 Areas of shallow groundwater susceptible to blasting effects	All	LSA	• See recommended mitigation measures for blasting outlined in potential effect 3.4 of this table.	• Reduction of water quantity if blasting damages the well or the surrounding formation. • Enhancement of water quantity if blasting opens or unclogs fractures supplying existing water well.
4.8 Impacts to shallow wells	Edmonton to Hinton RK 39.6 RK 41.6 RK 50.9 RK 56.9 RK 89.2 RK 90.2 RK 171.4 to RK 171.5 RK 329.5 RK 17.9 Hargreaves to Darfield RK 706 RK 711.5 RK 713.4 RK 717.5 RK 725.6 to RK 725.7 RK 728.8 to RK 729.5 RK 731 to RK 731.6 Black Pines to Hope RK 956.2 RK 1040.1 RK 1040.6 Hope to Burnaby RK 1057.6 RK 1147.4 RK 1159	LSA	• Initiate pre construction monitoring, where warranted, prior to the commencement of a specific activity during construction (*e.g.,* blasting). Monitoring may be necessary prior to, during and following construction or a specific construction activity in the vicinity of water wells or springs [Section 6.0]. During Project field studies, the Hydrogeological Engineer in consultation with landowners and the appropriate regulatory authorities will determine if springs and wells used for domestic purposes located within the immediate vicinity of the construction right-of-way will be sampled for water quality and flow rate prior to the start of construction. Locate and flag or fence registered or known water wells in the immediate vicinity of the construction right-of-way [Section 6.0]. • During construction, avoid blasting in proximity to wells. • Monitor all registered or known potable water wells located within 200 m of any blasting prior to and following blasting. Monitoring will include measurement of well yields, static and pumping water levels as well as water sampling in accordance with Canadian Guidelines for Drinking Water Quality [Section 8.3]. • Re-establish or replace a potable water supply as required should a registered or known water well located within 30 m of the construction right-of-way be damaged (*i.e.*, diminishment in quantity and/or quality) during pipeline installation [Section 7.0].	• No residual effects identified for shallow wells outside of blasting areas. • Shallow wells within blasting areas: - Reduction of water quantity if blasting damages the well or the surrounding formation. - Enhancement of water quantity if blasting opens or unclogs fractures supplying existing water well.

Notes: 1 LSA = Water Quality and Quantity LSA.
2 Detailed mitigation measures are outlined in the Pipeline EPP (Volume 6B).

7.2.3.5 Potential Residual Effects

The potential residual environmental effects on water quality and quantity indicators associated with the construction and operations of the pipeline (Table 7.2.3-2) are:

- reduction in surface water quality due to suspended sediments during instream activities at trenched crossings, erosion from banks and approach slopes, an inadvertent drilling mud release during HDD crossings or contamination from small spills during construction or site-specific maintenance activities;
- alteration or contamination of aquatic environment as a result of withdrawal and release of hydrostatic test water;
- localized alteration of natural surface drainage patterns until trench settlement is complete;
- disruption and alteration of natural streamflow from instream activities;
- elevated turbidity in groundwater as a result of accidental drilling mud release, sedimentation or sediment release during blasting;
- groundwater from different aquifers may be mixed;
- contamination of aquifer as a result of a spill during construction;
- natural groundwater pathways may be bisected and create a sink (drain) for shallow groundwater;
- flooding on the up-gradient side of the pipeline may result in creation of wet zones on ground surface;
- reduction of base flow to local streams;
- change in natural groundwater levels and stream recharge due to the discharge of groundwater to surface water systems if not practical to discharge trench water to ground;
- flooding from artesian flow may occur during trenchless crossing installation;
- reduction of water quantity if blasting damages the well or the surrounding formation; and
- enhancement of water quantity if blasting opens or unclogs fractures supplying existing water well.

Some of the potential effects on water quality and quantity indicators associated with the construction and operations of the pipeline either do not apply or are predicted to be eliminated through the implementation of mitigation measures (Table 7.2.3-2). The potential effects determined not to have a residual effect are:

- instability of trench at locations with high water table;
- alteration of streamflow volumes as a result of withdrawal and release of hydrostatic test water; and
- shallow groundwater with existing contamination encountered during trench construction.

7.2.3.6 Significance Evaluation of Potential Residual Effects

Where there are no standards, guidelines, objectives or other established and accepted ecological thresholds to define quantitative rating criteria or where quantitative thresholds are not appropriate, the qualitative method is considered to be the appropriate method for determining the significance of the anticipated residual environmental effects. Consequently, a qualitative assessment of water quality and quantity was determined to be the most appropriate method with the evaluation of significance of each of the potential residual effects relying on the professional judgment of the assessment team in consideration of CCME guidelines and provincial guidelines, where applicable.

Table 7.2.3-3 provides a summary of the significance evaluation for potential residual environmental effects of the construction and operations of the proposed pipeline on water quality and quantity. The rationale used to evaluate the significance of each of the residual environmental effects is provided below.

TABLE 7.2.3-3

SIGNIFICANCE EVALUATION OF POTENTIAL RESIDUAL EFFECTS OF PIPELINE CONSTRUCTION AND OPERATIONS ON WATER QUALITY AND QUANTITY

	Potential Residual Effects	Impact Balance	Spatial Boundary[1]	Temporal Context			Magnitude	Probability	Confidence	Significance[2]
				Duration	Frequency	Reversibility				
1.	Water Quality and Quantity Indicator – Surface Water Quality									
1(a)	Reduction in surface water quality due to suspended sediment during instream activities at trenched crossings during construction or site-specific maintenance activities.	Negative	LSA	Immediate to short-term	Isolated to occasional	Immediate to short-term	Low	High	High	Not significant
1(b)	Reduction in surface water quality due to erosion from banks and approach slopes.	Negative	LSA	Immediate to short-term	Isolated to occasional	Short to medium-term	Low to medium	High	High	Not significant
1(c)	Reduction in surface water quality due to an inadvertent drilling mud release during HDD crossings.	Negative	LSA	Immediate to short-term	Accidental	Immediate to short-term	Low to medium	Low	Moderate	Not significant
1(d)	Alteration or contamination of aquatic environment as a result of withdrawal and release of hydrostatic test water.	Negative	LSA	Short-term	Isolated	Immediate to short-term	Low	Low	High	Not significant
1(e)	Contamination of surface water due to a small spill during construction or site-specific maintenance activities.	Negative	LSA	Immediate	Accidental	Short to medium-term	Low to high	Low	Moderate	Not significant
1(f)	Combined effects on the surface water quality indicator (1[a] and 1[b]).	Negative	LSA	Short-term	Isolated to occasional	Immediate to medium-term	Low to medium	High	High	Not significant
2.	Water Quality and Quantity Indicator – Surface Water Quantity									
2(a)	Localized alteration of natural surface drainage patterns until trench settlement is complete.	Negative	LSA	Short-term	Isolated to occasional	Short to medium-term	Low to medium	High	High	Not significant
2(b)	Disruption and alteration of natural streamflow from instream activities.	Negative	LSA	Immediate to short-term	Isolated to occasional	Short to medium-term	Low to medium	High	High	Not significant
2(c)	Combined effects on the surface water quantity indicator (2[a] and 2[b]).	Negative	LSA	Short-term	Isolated to occasional	Short to medium-term	Low to medium	High	High	Not significant
3.	Water Quality and Quantity Indicator – Groundwater Quality									
3(a)	Elevated turbidity in groundwater as a result of accidental drilling mud release, siltation or silt release during blasting.	Negative	LSA	Short-term	Accidental	Short-term	Medium	Low	Moderate	Not significant
3(b)	Groundwater from different aquifers may be mixed.	Negative	LSA	Short-term	Accidental	Medium-term	Low to high	Low	Moderate	Not significant
3(c)	Contamination of aquifer as a result of a spill.	Negative	LSA	Immediate	Accidental	Short to medium-term	Low to high	Low	Moderate	Not significant
4.	Water Quality and Quantity Indicator – Groundwater Quantity									
4(a)	Natural groundwater pathways may be bisected and create a sink (drain) for shallow groundwater.	Negative	LSA	Short-term	Periodic	Short - term	Low	Low	Moderate	Not significant
4(b)	Flooding on the up-gradient side of the pipeline may result in the creation of wet zones on ground surface.	Negative	LSA	Short-term	Periodic	Short-term	Low	Low	Moderate	Not significant
4(c)	Reduction of base flow to local streams.	Negative	LSA	Short-term	Periodic	Short-term	Low	Low	Moderate	Not significant

TABLE 7.2.3-3 Cont'd

Potential Residual Effects		Impact Balance	Spatial Boundary[1]	Temporal Context			Magnitude	Probability	Confidence	Significance[2]
				Duration	Frequency	Reversibility				
4(d)	Change in natural groundwater levels and stream recharge due to the discharge of groundwater to surface water systems if not practical to discharge trench water to ground.	Negative	LSA	Short-term	Isolated	Short-term	Low	Low	Moderate	Not significant
4(e)	Flooding from artesian flow may occur and potentially impact trenchless crossing installation.	Negative	LSA	Immediate to short-term	Isolated	Short-term	Low to medium	Low	Moderate	Not significant
4(f)	Reduction of water quantity if blasting damages the well or the surrounding formation.	Negative	LSA	Immediate	Accidental	Short-term	Low to medium	Low	Moderate	Not significant
4(g)	Enhancement of water quantity if blasting opens or unclogs fractures supplying existing water well.	Negative	LSA	Immediate	Accidental	Short-term	Negligible	Low	Moderate	Not significant

Notes: 1 LSA = Water Quality and Quantity LSA.

2 Significant Residual Environmental Effect: A high probability of occurrence of a permanent or long-term residual effect of high magnitude that cannot be technically or economically mitigated.

Water Quality and Quantity Indicator – Surface Water Quality

The following provides the evaluation of significance of potential residual effects on the surface water quality indicator.

Instream Construction at Trenched Crossings

Sediment runoff and increased turbidity/TSS from pipeline construction was a concern during many of the stakeholder engagement events for the Project (*e.g.,* Edmonton ESA Workshop, Clearwater Community Workshop, Hope Community Workshop and Burnaby Community Workshop). In addition, TEK participants voiced concerns over water quality impacts at many of the watercourses crossed by the proposed pipeline corridor, which would predominately result from temporary increases in sediment runoff and increased turbidity/TSS (as opposed to low probability contamination from spills during construction [refer to Contamination of Surface Water Due to Small Spills below] or operations [Volume 7]). The selection of appropriate watercourse crossing techniques designed to meet federal and provincial regulatory requirements, as well as implementation of erosion controls on the approaches to watercourse crossings and riparian revegetation, are likely to substantially reduce the potential for adverse effects on surface water quality at watercourses encountered along the proposed pipeline corridor. During construction of trenched crossings, or where an instream vehicle crossing is necessary, a minor and short-term sediment release is expected during installation and removal of the vehicle or pipeline crossing structures. Trenched crossings are considered to have a negative impact balance since sediment input can temporarily decrease surface water quality.

Turbidity/TSS guidelines have been established for instream activities. At the federal level, DFO (2000) discusses ‘levels of risk’ associated with increases in TSS concentration in watercourses and indicates increases of <100 mg/L above background present low risk to fish and their habitat, while an increase of 100-200 mg/L presents a moderate risk. An excess of 400 mg/L was an unacceptable risk, but duration of exposure also needs to be taken into account (also see Birtwell 1999). The CCME guideline value for protection of aquatic life from short-term (24 hour) exposure is no more than 25 mg/L above existing levels (CCME 2007). Aquatic resources are protected by ensuring that concentration of TSS does not exceed CCME (2007) guidelines. BC guidelines specify that induced turbidity may not exceed background by more than 8 NTU during any 24 hour period or by more than 2 nephelometric turbidity units (NTU) when the duration of sediment input is between 24 hours and 30 days. Where flow is naturally turbid, induced turbidity may not exceed background by more than 8 NTU at any time when background is between 8 and 80 NTU, or by 10% at any time when background is greater than 80 NTU (BC MWLAP 2004a). Alberta's guideline of no more than 10 mg/L TSS is based on chronic, or long-term, exposure to elevated suspended solids.

The results of post-construction environmental monitoring for the TMX Anchor Loop Project demonstrate that the water crossing methods and mitigation measures implemented were effective in avoiding or reducing sediment input during construction. A total of 49 watercourses were monitored for water quality throughout construction (including open cut crossings of the Athabasca, Fraser, Miette and Snaring rivers and a number of isolated crossings). For all but one monitored watercourse, turbidity events were short in duration, with levels returning to normal within 24 hours, and compliance with the project-specific EPP and DFO Authorization or Letters of Advice was maintained. A sediment plume was observed seeping from the east bank of a smaller watercourse (Rockingham Creek) three days after the crossing was completed. Water quality monitors were dispatched to the site and remedial measures were taken to effectively stop the sedimentation. DFO was notified of mitigation measures applied and that CCME guidelines had been exceeded for a period greater than 24 hours (TERA 2009a). No ramifications to water quality were observed during post-construction environmental monitoring as a result of the sediment plume.

Open cut crossings are typically only utilized when a watercourse is dry or frozen to the bottom at the time of construction. Under these conditions, sediment release is not expected to occur, however, where an HDD or isolated crossing technique is not feasible, an open cut or partial isolation technique may be required on flowing watercourses. Monitoring will be conducted at all flowing open cut crossings to document downstream turbidity and any exceedances of the relevant guidelines will be reported to the appropriate regulatory authorities.

When compared to the open cut technique, isolated crossing techniques reduce the amount of sediment introduced to flowing watercourses. During a completely isolated crossing by dam and pump or flume, a minor sediment release is expected during installation of the dams prior to the isolation and during removal of the downstream dam at the conclusion of the isolation. Recent evidence demonstrates that smaller watercourses that lack substantial subsurface flow can be readily isolated with minimal sediment introduction when proper design, construction and mitigation measures are applied (CAPP *et al*. 2005, Reid *et al.* 2002a). Consequently, it is anticipated that average TSS levels during instream construction at these sites will be below turbidity/TSS guidelines.

Partial isolation techniques by coffer dams or partial bypass may release more sediment than a completely isolated crossing, but are more effective than unrestricted open cut crossings in reducing instream sediment loads. For example, at one watercourse crossing during construction of the TMX Anchor Loop Project, upstream pumps were used to redirect a portion of the clean flows around the crossing site, thereby reducing the amount of sediment introduced into the watercourse (TERA 2009a).

Measures in Table 7.2.3-2 and the Pipeline EPP (Volume 6B), including continual monitoring of sediment release (*i.e.*, turbidity and TSS), will be implemented at all isolated and partially isolated watercourses during crossing design and construction to reduce the magnitude and duration of the sediment pulse.

Minor releases of sediment may be associated with use of the temporary vehicle crossings at trenched crossing locations. Although elevated suspended sediment concentrations may result from instream construction and vehicle crossing use, pulses of suspended solids are generally expected to settle out of the water column within the ZOI in a timeframe measuring from minutes to a few hours (*i.e.*, less than CCME's short-term guideline of 24 hours). Water quality monitoring will be used when activities occur that have the potential to cause events that may exceed the guidelines. Any exceedances of the relevant guidelines will be reported to the appropriate regulatory authorities.

Given that suspended sediments are expected to settle out of the water column within the ZOI in a timeframe measuring from minutes to a few hours (*i.e.*, less than CCME's short-term guideline of 24 hours), residual effects on the surface water quality indicator during trenched and temporary vehicle crossings are reversible in the immediate to short-term and of low magnitude (Table 7.2.3-3, point 1[a]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Water Quality and Quantity LSA – suspended sediments released during construction activities will be carried downstream until they disperse and/or naturally settle out within the predicted ZOI.

- Duration: immediate to short-term – the events causing the release of suspended sediments into surface water are instream construction or maintenance activities (*e.g.,* integrity digs), the latter of which are limited to any 1 year during the operations phase.

- Frequency: isolated to occasional – the events causing the release of suspended sediments into a surface waterbody (*i.e.*, pipeline construction and maintenance activities) occur during construction and, for operations activities, intermittently and sporadically over the assessment period.

- Reversibility: immediate to short-term – an increase in suspended sediments is confined to a specific period not exceeding 24 hours after construction in flowing watercourses (*i.e.*, immediate) or the event when open cut crossings first become inundated with water (*i.e.*, short-term).

- Magnitude: low – an increase in suspended sediments is anticipated for a short timeframe and anticipated to be within CCME guidelines given the implementation of mitigation measures to reduce sedimentation.

- Probability: high – the proposed pipeline corridor crosses numerous watercourses for which a trenched crossing method is recommended during potentially flowing conditions at the time of construction.

- Confidence: high – based on available research literature, data pertinent to previous crossings along the existing TMPL right-of-way and the professional experience of the assessment team.

Erosion from Approach Slopes and Banks

Following grading, it is possible for some erosion to occur on approach slopes and banks and cause sedimentation of surface water. The impact balance of this potential residual effect is considered negative since sediment input could decrease surface water quality.

The results of the post-construction environmental monitoring program for the TMX Anchor Loop Project demonstrate that the water crossing methods and mitigation measures implemented were effective in avoiding or reducing erosion on the banks and approach slopes to watercourses (TERA 2009b, 2011a,b, 2013a). Most watercourse banks and slopes were stabilized and well-vegetated within 1 year of construction. During the first post-construction environmental monitoring year in 2009, bank erosion was observed at 3 of the 132 watercourses crossed by the pipeline. Remedial work was conducted and during post-construction environmental monitoring in 2010, two of the three watercourses required further remedial action (including seeding and replanting of riparian vegetation) (TERA 2011a). During post-construction environmental monitoring in 2012, no new erosion was observed and the two channels appeared stable and the current configuration appeared well-suited to the conveyance of seasonal flows (TERA 2013a). During the 2012 post-construction environmental monitoring program, however, erosion of watercourse banks was observed at three new watercourses, attributed to above average snow pack and spring freshet causing flooding of susceptible areas (TERA 2013a). At one of the watercourses, the effects on the restored right-of-way were consistent with the natural dynamics displayed by the channel. Nevertheless, restoration and restabilization of all three watercourses is planned and monitoring will continue until all erosion issues have been resolved (TERA 2013a). Mitigation measures used to control erosion and restabilize banks at trenched watercourse crossings for the TMX Anchor Loop Project are planned for trenched watercourse crossings along the pipeline segments associated with the Project.

During the Merritt Community Workshop, riparian restoration was noted as an important strategy for bank stabilization, particularly at smaller creeks vulnerable to seasonal high flows. Furthermore, at the same workshop, participants indicated the Nicola River in vicinity to the proposed pipeline crossing location is very sinuous and prone to changing course as a result of natural bank instability and riparian areas damaged by agricultural activities. Any further disturbance to the Nicola River will be avoided by implementing a trenchless (HDD) crossing technique. In the event an HDD is unsuccessful, an isolated open cut method will be used. Mitigation measures will be identified on a site-specific basis and may include, for example: installation of temporary erosion control structures (*e.g.,* sediment fences); restoration to stabilise the banks (*e.g.,* soil wraps, brush layers, willow plantings and matting); seeding the disturbed banks and approaches with the appropriate cover crop species and native grass mix; installation of coir or other biodegradable erosion control fabric on the banks of the watercourse;

installation of live dormant willow stakes or salvaged willow/shrub transplants or commercially grown rooted stock plugs in the banks of watercourses; and monitoring to assess the success of construction and reclamation mitigation measures and implementation remedial measures, where warranted (see the Pipeline EPP of Volume 6B).

Proposed mitigation measures are expected to reduce the magnitude of erosion from approach slopes and banks on the surface water quality indicator to low to medium levels. This residual effect is reversible in the short to medium-term (Table 7.2.3-3, point 1[b]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Water Quality and Quantity LSA – any sedimentation caused by erosion will be carried downstream until it disperses and/or naturally settles out within the predicted ZOI.
- Duration: immediate to short-term – the events causing the erosion and sedimentation of surface water are instream construction or maintenance activities (*e.g.,* integrity digs), the latter of which are limited any 1 year during the operations phase.
- Frequency: isolated to occasional – the events resulting in sedimentation caused by erosion of approach slopes and banks (*i.e.*, pipeline construction and operations activities [*e.g.*, integrity digs]) occur intermittently and sporadically at unstable crossings until mitigated.
- Reversibility: short to medium-term – depending on the watercourse. For watercourses with gentle banks and approach slopes, vegetation may be re-established on the approach slopes and banks within 1 year of construction while revegetation of steeper approach slopes and banks may take longer than one growing season.
- Magnitude: low to medium – depending upon the amount of erosion that occurs.
- Probability: high – although there are proven and effective industry standard mitigation measures used to control erosion on slopes and banks, erosion at some sites is likely to occur.
- Confidence: high – based on data pertinent in the Project area and the professional experience of the assessment team.

Inadvertent Drilling Mud Release

Although unlikely, it is possible for a drilling mud release to occur during HDD crossings that could introduce sediment to surface water. The impact balance of this potential residual effect is considered negative since the release could decrease surface water quality.

The HDD method of trenchless pipeline installation is one of the lowest impact watercourse construction techniques (CAPP 2004). Successful implementation of the HDD method is, however, dependent upon many factors. Trans Mountain will endeavour to reduce risks of drilling mud release through accurate geotechnical evaluations, proper planning, suitable and well-maintained equipment, experienced personnel and adequate contingency planning.

In 2003, Trans Mountain replaced a segment of its existing Trans Mountain Pipeline system across the Fraser River to minimize exposure of the pipeline to seismically triggered lateral spreading. The 2.3 km crossing was conducted by horizontal directional drilling. Despite the engineering and geotechnical complexities of such a long HDD, the crossing was considered a success and no drilling mud was released into the watercourse. Although no HDD crossings were technically feasible for TMX Anchor Loop Project, other recent pipeline projects have conducted successful HDD crossings of major watercourses, for example, an HDD method was successfully implemented at the South Saskatchewan River (TERA 2011d) as well as at the Pouce Coupe and the Kiskatinaw rivers (TERA 2013c).

Trans Mountain plans to implement the HDD crossing technique at many of the larger and more sensitive watercourses, including the North Saskatchewan, McLeod, Pembina, North Thompson, Blue, Raft, Clearwater, Thompson, Nicola, Coldwater, Coquihalla (at RK 1043.2), Chilliwack/Vedder and lower Fraser rivers. To avoid or reduce effects of a drilling mud release on surface water quality, Trans Mountain will continually monitor for sediment release (*i.e.*, turbidity and TSS) throughout the crossing construction period. In the event of a release into a watercourse, Trans Mountain will immediately suspend drilling activities and implement measures outlined in the Drilling Mud Release Contingency Plan to reduce effects of drilling mud release into the watercourse. Any releases would be reported to DFO and AESRD or BC MOE and clean up and monitoring will be carried out until water quality is returned to existing (background) conditions.

The mud used for HDD crossings will be suitable for use in waterbodies. Appropriate drill paths will be established and drilling mud pressures and returns monitored to reduce the risk of inadvertent releases of drilling mud during an HDD. Although sediment input could occur, the proposed mitigation measures are expected to reduce the magnitude of a drilling mud release on the surface water quality indicator to low to medium levels. This residual effect is reversible in the immediate to short-term (Table 7.2.3-3, point 1[c]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Water Quality and Quantity LSA – any drilling mud released during construction activities will be carried downstream until it disperses and/or naturally settles out.
- Duration: immediate to short-term – the event causing a decrease in surface water quality is the release of drilling mud, the period of which may be less than or equal to two days for small releases or could extend for longer, but less than 1 year.
- Frequency: accidental – the release of drilling mud into surface water occurs rarely over the assessment period.
- Reversibility: immediate to short-term – suspended sediments resulting from a drilling mud release would settle out of suspension within 24 hours after the release, however, any sediments that result in deposition on the substrate of a watercourse are expected to be flushed from the system during the first annual natural flushing event following construction.
- Magnitude: low to medium – depending upon the volume of the drilling mud release and the sensitivity of the receiving watercourse.
- Probability: low – it is unlikely that an accidental release of drilling mud would occur; however, in the event of an accidental release of instream drilling mud during an HDD crossing, the probability of a temporary reduction in surface water quality is high.
- Confidence: moderate – based on Trans Mountain's previous experience crossing the lower Fraser River in 2003, success of HDD crossings from similar projects and the professional experience of the assessment team.

Alteration or Contamination as a Result of Withdrawal and Release of Hydrostatic Test Water

Surface water quality could be compromised from increased suspended solids at the intake area during withdrawal of test water and, although unlikely, contamination during release of hydrostatic test water containing residual chemicals or other substances from inside the pipe. The impact balance of this potential residual effect is considered negative since the withdrawal or release of hydrostatic test water could decrease surface water quality.

The Environmental As-Built Report for the TMX Anchor Loop Project states that the East Spread (in Alberta) of the pipeline was hydrostatically tested in the spring of 2008, while the West Spread (in BC) was tested in the fall of 2008. Water was withdrawn from the Athabasca, Snaring, Miette, Moose and Fraser rivers. No additives were used during testing and water was returned to the source basin after testing. To reduce water hauling, water usage and the number of dewatering points, test water was shunted ahead from test section to test section. At all seven of the dewatering locations, water quality was tested prior to release and found to be within provincial and federal water quality parameters (TERA 2009a).

Hydrostatic test water for the proposed Edmonton to Hinton Segment is expected to be withdrawn from the North Saskatchewan, Pembina and McLeod rivers. Hydrostatic test water for the proposed pipeline segments in BC is expected to be withdrawn from the Fraser, Canoe, North Thompson, Thompson, Coldwater, Coquihalla and Sumas rivers. An estimated 81,000 m^3 of water will be needed to conduct hydrostatic testing for the Edmonton to Hinton Segment, while approximately 311,000 m^3 is estimated to be required for the remaining pipeline segments. Hydrostatic test water will be shunted from test section to test section, where feasible, allowing for less water to be used. All hydrostatic testing activities will be performed in accordance with the *NEB Onshore Pipeline Regulations (NEB OPR)*, provincial legislation, codes of practice and guidelines as well as the latest version of CSA Z662.

After hydrostatic testing the pipeline, the test water will be returned to its source basin. The inside of the pipe will be uncoated and is expected to have some rust particles. Otherwise, the pipe and tanks are not expected to contain petroleum products or other contaminants. The water ready for release will be aerated (*e.g.,* by spraying) to restore free oxygen displaced during pressuring, filtered as needed to remove rust particles (expected mainly at the beginning and end of each batch), and released. During initial release, the water will be visually inspected for evidence of foreign particles or contaminants exhibiting a surface sheen, and in the absence of such, the release will continue. Periodic visual inspections will then be made throughout the release period. The release water will be sampled near the beginning, during the middle and near the end of the release and analyzed according to parameters listed in the Water Withdrawal and Discharge Procedures Management Plan (Pipeline EPP [Volume 6B]). Water will typically be released onto a non-erodible surface (*e.g.,* rock aprons, plastic sheeting, plywood), and directed to flow through established vegetation before returning to a watercourse.

Similar measures implemented for water withdrawal and discharge for hydrostatic testing during testing activities associated with construction of the pipeline for the TMX Anchor Loop Project will be implemented for the construction of the proposed pipeline. With the implementation of the mitigation measures, the residual effect of hydrostatic water release and withdrawal is considered to be of low magnitude and reversible immediately or in the short-term since suspended sediments resulting from test water release will likely settle out of suspension within 24 hours after the release or, if the water chemistry is not suitable, water will be disposed of at a licensed facility (Table 7.2.3-3, point 1[d]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Water Quality and Quantity LSA – any sedimentation or contaminants caused by withdrawal or discharge of hydrostatic test water could be carried downstream of the withdrawal and release locations.
- Duration: short-term – the event causing the alteration or contamination of the aquatic environment (*i.e.*, hydrostatic testing of the pipeline) is limited to a period of several weeks.
- Frequency: isolated – alteration or contamination of the aquatic environment caused by hydrostatic testing is confined to the construction phase.
- Reversibility: immediate to short-term – any suspended sediments resulting from test water release will likely settle out of suspension within 24 hours after release.
- Magnitude: low – based on the mitigation strategies including limiting withdrawal volumes and testing water prior to release and avoiding erosion during the release of test water.
- Probability: low – with implementation of mitigation strategies, it is unlikely that hydrostatic testing will cause an effect on the surface water quality indicator.
- Confidence: high – based on the professional experience of the assessment team and outcomes of the testing program for the TMX Anchor Loop Project, and since no release directly into a watercourse is planned.

Contamination of Surface Water Due to Small Spills

A spill during construction or site-specific maintenance activities could cause contamination of the surface water and would be considered to have a negative impact balance; however, with proper implementation of industry and government recommended mitigation measures, the effects can be limited. For example, during the construction of the TMX Anchor Loop Project, all fuel trucks, service trucks and pick-ups with box-mounted fuel tanks were required to carry spill prevention, containment and clean up materials. Furthermore, all hazardous material storage and oil changes, refuelling, and lubrication of industrial equipment were required to occur more than 100 m from a waterbody or watercourse except where secondary containment was provided. Spills or accidental release of potentially harmful materials (*i.e.*, oil or diesel fuel) were recorded. The Spill Contingency Plan was implemented on each spot spill and all spills were cleaned up as soon as they were discovered. During the TMX Anchor Loop Project, all spills were terrestrial, and no spills or leaks occurred in, or reached, a waterbody or watercourse (TERA 2009a).

Similar spill prevention mitigation is planned for the Project and spill prevention measures outlined in Table 7.2.3-2 and the Pipeline EPP (Volume 6B) will be followed. Fuel storage and handling practices will be monitored throughout construction of the Project to reduce spill risk. Should a leak be spotted or detected during construction of the pipeline, Trans Mountain will implement the Spill Contingency Plan (Volume 6B). Depending on the nature, volume and location (*e.g.,* sensitivity of receiving waterbody) of a spill, the magnitude of change to water quality could vary from low to high. This residual effect is reversible in the short to medium-term and is of low probability (Table 7.2.3-3, point 1[e]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Water Quality and Quantity LSA – a spill during construction or site-specific maintenance activities may extend beyond the proposed pipeline corridor and evidence suggests that effect of most minor spills is localized (effects of a low probability large spill into a watercourse are considered in Volume 7).
- Duration: immediate – the event causing a potential reduction in surface water quality is a spill, the period of which is less than or equal to two days.
- Frequency: accidental – a spill into surface water occurs rarely over the assessment period.
- Reversibility: short to medium-term – the effects of a spill are not expected to last beyond 1 year, but may last longer depending on seasonal conditions and the extent and source of the spill.
- Magnitude: low to high – depending upon the volume, location and contaminant released.
- Probability: low – due to mitigation measures in place to reduce the potential for spills reaching water bodies and affecting surface water quality.
- Confidence: moderate – spill location and effects of accidental spills cannot be accurately predicted.

Combined Effects on Surface Water Quality

An evaluation of the combined effects considers those residual effects that are likely to occur. Therefore, residual effects 1(c) through 1(e) in Table 7.2.3-3 are not considered in the evaluation of combined effects on the surface water quality indicator since the probability of these effects occurring is low. Consequently, the combined effects evaluation considers the individual potential residual effects evaluated in Section 7.2.3.6 (points 1[a] and 1[b] of Table 7.2.3-3) that are likely to occur, and could act in combination on the surface water quality indicator.

The following potential residual effects are likely to act in combination to result in overall effects on the surface water quality indicator:

- reduction in surface water quality from suspended sediments during instream construction at trenched and temporary vehicle crossings; and
- reduction of surface water quality due to erosion from banks or approach slopes.

The adverse effects identified have the potential to act in combination on waterbodies and watercourses encountered along the proposed pipeline corridor. The reversibility of this residual effect is considered immediate to medium-term depending on the waterbody or watercourse encountered and the probability of these residual effects acting in combination at any specific location along the proposed pipeline corridor. However, the magnitude of the combined effects on the surface water quality indicator is considered to be low to medium since the combined effect is likely to be reduced by implementation of mitigation strategies for each of the residual effects (Table 7.2.3-3, point 1[f]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Water Quality and Quantity LSA – combined effects on the surface water quality indicator may extend beyond the pipeline right-of-way to the predicted ZOI.
- Duration: short-term – the event causing the potential combined effects on the surface water quality indicator is construction of the pipeline.
- Frequency: isolated to occasional – the events causing the potential combined effects on the surface water quality indicator (*i.e.,* pipeline construction and maintenance activities) occur during construction and, for operations activities, intermittently and sporadically over the assessment period.
- Reversibility: immediate to medium-term – combined effects on the surface water quality indicator may be reversible immediately or may several years to return to existing conditions depending on the types of effects.
- Magnitude: low to medium – combined effects on the surface water quality indicator are anticipated to be largely mitigated during construction.
- Probability: high – the proposed pipeline corridor crosses a number of watercourses for which the above effects can act in combination to reduce surface water quality.
- Confidence: high – based on available research literature, data pertinent to previous crossings along the existing TMPL right-of-way and the professional experience of the assessment team.

<u>Water Quality and Quantity Indicator – Surface Water Quantity</u>

The following provides the evaluation of significance of potential residual effects on the surface water quantity indicator.

Alteration of Natural Drainage Patterns

With proper implementation of the industry-accepted standard mitigation practices that are proposed, disruption of surface flow patterns following construction or maintenance activities is expected to be minor along the proposed pipeline corridor. However, construction activities may contribute to some localized alteration of natural surface drainage patterns until trench settlement is complete. The impact balance of this potential residual effect is considered negative since it could alter or disrupt natural above ground hydrologic conditions.

In the event that construction or maintenance activities result in changes in surface water regimes, corrective action, in consultation with the appropriate regulatory authorities, will be implemented to resolve the issue. The post-construction environmental monitoring program will identify any locations with altered drainage patterns (*e.g.,* ponded water) and remedial work will be conducted, where warranted. Consequently, the residual effect is reversible in the short to medium-term. Some minor incidents (*e.g.*, ponding, minor flooding, erosion) are expected following construction and are considered to be within environmental standards, and therefore, of low to medium magnitude (Table 7.2.3-3, point 2[a]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Water Quality and Quantity LSA – although alteration of natural drainage patterns is generally confined to the disturbed portion of the construction right-of-way, potential changes in hydrology may extend beyond the pipeline right-of-way.
- Duration: short-term – the events causing alteration of natural drainage are pipeline construction or maintenance activities (*e.g.,* integrity digs), the latter of which are limited to any 1 year of the operations phase.
- Frequency: isolated to occasional – the events causing alteration of natural drainage (*i.e.*, pipeline construction and maintenance activities) occur during construction and, for operations activities, intermittently and sporadically over the assessment period.
- Reversibility: short to medium-term – it may take more than 1 year plus adequate precipitation levels in order for the trench crown to settle and natural drainage patterns to be restored.

- Magnitude: low to medium – the potential for flooding or erosion exists until the natural drainage patterns are restored.
- Probability: high – excessive trench settlement or a remnant crown are likely to occur as a result of pipeline construction or site-specific maintenance activities and, consequently, are likely to affect natural drainage patterns in localized areas.
- Confidence: high – based on data pertinent to the Project area and the professional experience of the assessment team.

Alteration of Streamflow

Open cut and isolated pipeline crossing methods have the potential to result in alterations of natural streamflow, a concern that was specifically raised at the Langley Community Workshop and during general public consultation. Specific public concern was raised about the potential for increased disturbance to the bed and banks of the Coquihalla River, which was crossed approximately 16 times by the existing TMPL right-of-way. Reducing the number of sensitive watercourse crossings is an important environmental consideration in the routing process. By reducing the number of crossings along the proposed pipeline corridor to five, the extent of potential effects to the bed and bank complex of the Coquihalla River are greatly reduced. Furthermore, since an HDD trenchless crossing method is planned for all Coquihalla River crossings, potential effects to bed and banks may be avoided entirely. However, in the event the HDD method is not feasible at any crossing location, an open cut crossing technique will be used.

During the first year of post-construction environmental monitoring for the TMX Anchor Loop Project in 2009, all watercourse crossings were observed to be properly restored following pipeline installation (TERA 2009b). However, in August 2010, during the second year of post-construction environmental monitoring, intermittent flow at a watercourse at KL 409.1 was again identified, after previously being identified immediately following construction and restoration of the restored channel (October 2008). To improve channel flow, channel enhancement was conducted in 2010 within certain sections of the right-of-way where the channel contour was observed as flat, without a defined channel thalweg. This activity, along with additional enhancement work carried out in late September 2010, appeared to improve flow (TERA 2011a). Channel enhancements were determined to be functioning as intended during post-construction environmental monitoring in 2011 and the alteration of surface flow pattern was resolved (TERA 2011a).

With proper implementation of the industry-accepted standard mitigation practices that are proposed, alteration of natural streamflow resulting from open cut and isolated pipeline crossings is expected to be minor along the proposed pipeline corridor. However, crossing activities may contribute to some localized alteration of watercourse bed and banks until complete and stable restoration is achieved following construction. The impact balance of this potential residual effect is considered negative since it could alter or disrupt hydrologic conditions of watercourses. However, with proper implementation of the mitigation measures proposed, alteration of natural streamflow following construction is likely to be minor at all watercourse crossings where open cut and isolated pipeline crossing methods are used.

In the event that construction or maintenance activities result in alterations to watercourse hydrology, corrective action, in consultation with the appropriate regulatory authorities, will be conducted to resolve the issue. The post-construction environmental monitoring program will identify locations of altered streamflow (*e.g.,* damaged bed and banks) and remedial work will be conducted. Consequently, the residual effect is reversible in the short to medium-term. Generally, the residual effect of altered bed and banks is considered to be within environmental standards for pipeline construction and, therefore, is of low to medium magnitude (Table 7.2.3-3, point 2[b]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Water Quality and Quantity LSA – although alteration of natural streamflow is generally confined to the disturbed portion of watercourse bed and banks, potential changes in watercourse hydrology may extend beyond the pipeline right-of-way.

- Duration: immediate to short-term – the events causing alteration of natural streamflow are pipeline construction or maintenance activities (*e.g.,* integrity digs), the latter of which are limited to any 1 year of the operations phase.

- Frequency: isolated to occasional – the events causing alteration of natural streamflow (*i.e.*, pipeline construction and maintenance activities) occur during construction and, for operations activities, intermittently and sporadically over the assessment period.

- Reversibility: short to medium-term – it may take more than 1 year to fully restore and stabilize watercourse channel and associated flow conditions.

- Magnitude: low to medium – the potential for changes to streamflow exists but experience with past projects demonstrates that proper design and remedial work will reduce effect magnitude.

- Probability: high – alteration of bed and banks from open cut and isolated watercourse crossings will result from pipeline construction or site-specific maintenance activities and, consequently, alteration of natural streamflow is likely occur.

- Confidence: high – based on data pertinent to the Project area and the professional experience of the assessment team.

Combined Effects on Surface Water Quantity

The combined effects evaluation considers the individual potential residual effects evaluated in Section 7.2.3.6 (points 2[a] and 2[b] of Table 7.2.3-3) that are likely to occur, and could act in combination on the surface water quantity indicator.

The following potential residual effects are likely to act in combination to result in overall effects on the surface water quantity indicator:

- localized alteration of natural surface drainage patterns until trench settlement is complete; and

- disruption and alteration of natural streamflow from instream activities.

The adverse effects identified have the potential to act in combination on waterbodies and watercourses encountered along the proposed pipeline corridor. The reversibility of this residual effect is considered short to medium-term depending on the waterbody or watercourse encountered. However, the magnitude of the combined effects on the surface water quantity indicator is considered to be low to medium with the implementation of mitigation strategies (Table 7.2.3-3, point 2[c]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Water Quality and Quantity LSA – combined effects on the surface water quantity indicator may extend beyond the pipeline right-of-way.

- Duration: short-term – the events causing the combined effects on the surface water quantity indicator are pipeline construction or maintenance activities (*e.g.,* integrity digs), the latter of which are limited to any 1 year of the operations phase.

- Frequency: isolated to occasional – the events causing the combined effects on the surface water quantity indicator (*i.e.*, pipeline construction and maintenance activities) occur during construction and, for operations activities, intermittently and sporadically over the assessment period.

- Reversibility: short to medium-term – it may take more than 1 year to fully restore and stabilize watercourse channel and associated flow conditions.

- Magnitude: low to medium – combined effects on the surface water quantity indicator are anticipated to be largely mitigated during construction.

- Probability: high – the proposed pipeline corridor crosses a number of watercourses and drainages for which the above effects can act in combination to reduce surface water quantity.

- Confidence: high – based on data pertinent to previous crossings along the existing TMPL right-of-way and the professional experience of the assessment team.

Water Quality and Quantity Indicator – Groundwater Quality

The following provides the evaluation of significance of potential residual effects on the groundwater quality indicator.

Elevated Turbidity in Groundwater

Increased turbidity in groundwater may be the result of the effects from accidental drilling mud release, sedimentation or sediment release during blasting. In the case of an accidental drilling mud release, the turbidity originates with the drilling mud. In the other two cases, the turbidity results from a release of sediment particles in the formation. The turbidity in all three cases will decrease as the groundwater flows through the formation. Interconnected pores through which the groundwater flows are generally smaller than silt size particles causing the silt particles to be retained in the formation close to their source (*i.e.*, the location of the potential drilling mud release). This residual effect is considered to have a negative impact balance since elevated turbidity can affect groundwater quality. The residual effect of an elevated turbidity on groundwater quality is considered to be reversible in the short-term based on previous experience; particles either settle out or cannot pass through the pore space of the sediment (Table 7.2.3-3, point 3[a]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Water Quality and Quantity LSA – particles in the groundwater naturally settle out within the LSA.
- Duration: short-term – the event causing the potential increase in turbidity of groundwater is construction activities.
- Frequency: accidental – the event causing the potential increase in turbidity occurs rarely over the assessment period.
- Reversibility: short-term – turbidity of groundwater is expected to decrease in the vicinity of the accidental drilling mud release or blasting.
- Magnitude: medium – depending upon the volume of accidental drilling mud released or sediment / silt introduced during blasting and the permeability of the formation.
- Probability: low – it is unlikely that an accidental release of drilling mud would occur or that blasting will release sediment or silt.
- Confidence: moderate – based on previous experience of the assessment team.

Groundwater from Different Aquifers may be Mixed

Drilling a borehole through multiple aquifers at different depths can result in cross-formational flow between two or more water bearing units resulting in mixing of those waters. This would be the case if drilling were to proceed through unconsolidated water-bearing surficial materials into deeper unconsolidated or bedrock aquifers. The proposed pipeline trench depth will typically be 2.1 m and, consequently, no residual effects resulting in aquifer mixing are anticipated during trenching activities and the potential effect is limited to drilling activities. In addition to horizontal directional drilling, drilling may also occur as part of the investigation prior to trenchless crossing activities.

In general, this effect would apply to shallow bedrock aquifers underlying unconsolidated water-bearing surficial materials. Drilling practice in this case would be to isolate the surficial materials before drilling proceeded to deeper depths. Proper abandonment of boreholes is necessary to prevent this effect from occurring. The impact balance of this residual effect is considered negative since this could adversely affect groundwater quality in an aquifer.

This residual effect on the natural groundwater and surface water systems in terms of water quality is considered to be reversible in the medium-term. Drilling activities that advance through more than one aquifer within the Water Quality and Quantity LSA are expected to be limited over the construction phase of the Project (Table 7.2.3-3, point 3[b]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Water Quality and Quantity LSA – depending upon the site-specific conditions, potential affects could extend beyond the Footprint and into the LSA.
- Duration: short-term – the event causing the potential mixing of groundwater from different aquifers is construction of the pipeline.
- Frequency: accidental – this effect is expected to occur rarely over the assessment period and only during the construction phase.
- Reversibility: medium-term – with the implementation of mitigation measures in Table 7.2.3-2 and the Pipeline EPP (Volume 6B), the residual effect is likely to be reversible over a period of less than 10 years.
- Magnitude: low to high – depending on the difference in water quality between the two aquifers.
- Probability: low – this effect is unlikely to occur if the local groundwater conditions are understood and proper practices are observed during drilling and trenching.
- Confidence: moderate – based on professional experience of the assessment team.

Contamination of an Aquifer as a Result of a Spill During Construction

Contamination of an aquifer may result if the spilled material migrates through the developed soil near the surface through the surficial materials into the first water-bearing unit. The rate of migration is dependent upon the permeability of the materials, presence or absence of fractures, the properties of the spilled contaminant (density, viscosity) and the vertical hydraulic gradients. A spill during the construction phase of the Project is likely to be noted quickly and be of small volume, and evidence suggests that the effects of most minor spills are localized.

The impact balance of this residual effect is considered negative since this could potentially affect water quality in the aquifer. This residual effect is unlikely to extend beyond the Water Quality and Quantity LSA; it is considered to represent a short to medium-term influence on the natural groundwater and surface water systems depending upon the volume of the spill, and the properties of the aquifer and overlying material. Spills where the spilled material contaminates an aquifer within the Water Quality and Quantity LSA may occur accidentally over the construction phase of the Project (Table 7.2.3-3, point 3[c]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Water Quality and Quantity LSA – a spill during construction activities may extend beyond the proposed pipeline corridor but based on professional experience the effects of most minor spills are localized.
- Duration: immediate – the event causing potential contamination of the aquifer is a spill, the period of which is less than one day.
- Frequency: accidental – a spill into groundwater during construction is rare.
- Reversibility: short to medium-term – the effects of a spill are not expected to last beyond 1 year, but may last longer depending upon the extent and source of the spill.
- Magnitude: low to high – depending upon the volume, location and contaminant released.
- Probability: low – due to mitigation measures in place to reduce the potential for spills migrating into the subsurface and affecting groundwater quality.
- Confidence: moderate – spill location and effects of accidental spills cannot be accurately predicted.

Water Quality and Quantity Indicator – Groundwater Quantity

The following provides the evaluation of significance of potential residual effects on the groundwater quantity indicator.

Natural Groundwater Pathways May Be Bisected and Create a Sink (Drain) for Shallow Groundwater

Excavation of the trench in areas of shallow groundwater or springs, during pipeline construction, can alter groundwater and surface water flow patterns. This may result in the trench becoming a sink. That is, both groundwater and surface water intersecting the trench will flow into the trench resulting in changed flow patterns.

The backfill of the trench around the pipeline will consist of native backfill as much as practical in order to maintain the soil/formation permeability similar to the pre-construction permeability. For example, if the trench was backfilled with a higher permeability material, the filled trench could become a preferred pathway for groundwater flow and, consequently, permanently change the natural flow pattern. Where there is concern for increased permeability, a trench breaker would be installed.

Upon backfilling the trench with native backfill, groundwater flow patterns will typically revert to their pre-construction state. Where springs are encountered, advice will be sought for the Hydrogeological or Geotechnical Resource Specialist so that cross drainage within the trench can be maintained. The impact balance of this residual effect is considered negative since groundwater flow down-gradient could temporarily decrease because flow is directed along the pipeline (Table 7.2.3-3, point 4[a]). Where there is concern for increased permeability, a trench breaker would be installed. A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Water Quality and Quantity LSA – depending upon the site-specific conditions, dewatering activities and groundwater discharge could extend beyond the Footprint and into the LSA.
- Duration: short-term – the events causing the potential alteration of groundwater flow are construction of the pipeline and maintenance activities, the latter of which are limited to any 1 year during operations.
- Frequency: periodic – the events causing alteration of natural groundwater flow (*i.e.,* pipeline construction and maintenance activities) occur intermittently but repeatedly over the assessment period.
- Reversibility: short-term – residual effects are expected to reverse within 1 year.
- Magnitude: low – the potential for changes to groundwater flow exists but experience with past projects demonstrates that proper design and remedial work will reduce the effects.
- Probability: low – although the proposed pipeline corridor crosses areas of shallow groundwater, areas with highly permeable materials near rivers and at crossings with fluvial or colluviums substrates and known springs, with the implementation of the mitigation measures outlined in Table 7.2.3-2, alteration of groundwater flow as a result of pipeline construction is unlikely.
- Confidence: moderate – based on previous experience of the assessment team and shallow groundwater mapping has been completed using available provincial mapping and existing well log reports.

Flooding on the Up-Gradient Side of the Pipeline May Result in Creation of Wet Zones on Ground Surface

A reduction in the permeability of materials along the groundwater flow path may result in a rise in the groundwater table to the extent that ground to surface flooding occurs. This may occur if the trench spoil is not backfilled in the correct order or soils are not properly salvaged resulting in a change in permeability of the upper trench materials and blocking of near surface groundwater flows. The impact balance of this residual effect is considered negative since this could potentially affect recharge to shallow aquifers or local streams or wetlands and create permanently wet areas. This residual effect is considered to have a short-term influence on the natural groundwater and surface water systems as long as mitigation measures are applied (Table 7.2.3-3, point 4[b]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Water Quality and Quantity LSA – depending upon the site-specific conditions, dewatering activities and groundwater discharge away from the Footprint could affect an area within the LSA.
- Duration: short-term – the events causing the potential alteration of groundwater flow are construction of the pipeline and maintenance activities, the latter of which are limited to any 1 year during operations.
- Frequency: periodic – the events causing alteration of natural groundwater flow (*i.e.,* pipeline construction and maintenance activities) occur intermittently but repeatedly over the assessment period.
- Reversibility: short-term – the effects of pipeline trench construction are not expected to last beyond 1 year once the trench has been backfilled as long as mitigation measures are applied.
- Magnitude: low – the potential for changes to groundwater flow exists but professional experience demonstrates that proper design and remedial work will reduce the effect.
- Probability: low – the proper construction of the pipeline trench will reduce the occurrence of this effect.
- Confidence: moderate – based on previous experience and on data pertinent to the Project area.

Reduction of Base Flow to Local Streams

Dewatering of the pipeline trench during construction may result in lowering of the local water table which in the case of local streams may reduce the groundwater inflow (base flow) to streams. As indicated in Table 7.2.3-3 (point 4[d]), the extracted groundwater may be released to the ground or directly into a nearby stream in which case there would be minimal disruption of flow in the stream. The impact balance of this residual effect is considered negative due to the potential decrease of groundwater flow into local streams. This residual effect likely will not extend beyond the Water Quality and Quantity LSA to the watershed level, and, it is considered to represent a short-term influence on the natural groundwater and surface water systems (Table 7.2.3-3, point 4[c]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Water Quality and Quantity LSA – depending upon the site-specific conditions, dewatering activities and groundwater discharge away from the Footprint could affect an area within the LSA.
- Duration: short-term – the events causing the reduction in baseflow are the result of discharge during dewatering and occur while the trench is being constructed (either for pipeline installation or for pipeline daylighting during integrity digs).
- Frequency: periodic – the events causing alteration of natural groundwater flow (*i.e.,* pipeline construction and maintenance activities) occur intermittently but repeatedly over the assessment period.
- Reversibility: short-term – the effects of pipeline trench construction are not expected to last beyond 1 year once the trench has been backfilled.
- Magnitude: low – the potential for changes to groundwater flow exists but professional experience demonstrates that proper design and remedial work will reduce effect magnitude.
- Probability: low – the proper construction of the pipeline trench will reduce the occurrence of this effect.

- Confidence: moderate – based on previous experience and on data pertinent to the Project area.

Change in Natural Groundwater Levels and Stream Recharge Due to the Discharge of Groundwater to Surface Water Systems if Not Practical to Discharge Trench Water to Ground

Shallow groundwater will be present in the subsurface in many areas along the proposed pipeline corridor. During pipeline construction, it is common practice to dewater the trench to allow the pipe to be laid down in a dry environment. Extracted groundwater from the dewatering operations will be disposed to ground where possible, but in areas where this is not practical, the water may be discharged away from the area, directly into a water body (post-treatment), or stormwater discharge system causing local groundwater levels and flow patterns to be temporarily disrupted. The impact balance of this residual effect is considered negative since this could potentially affect recharge to local streams or shallow aquifers. This residual effect is confined to the Water Quality and Quantity LSA and is considered to represent a short-term influence on the natural groundwater and surface water systems. Dewatering activities where the extracted groundwater cannot be returned to ground are unlikely to occur given the proposed mitigation measures in Table 7.2.3-2 and in the Pipeline EPP (Volume 6B). The residual effects in areas of discharge of collected groundwater are expected to reverse within 1 year when seasonal precipitation replenishes the aquifer (Table 7.2.3-3, point 4[d]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Water Quality and Quantity LSA – depending upon the site-specific conditions, dewatering activities and groundwater discharge away from the Footprint could extend to the LSA.
- Duration: short-term – the event causing the discharge of groundwater from the trench is the construction of the pipeline.
- Frequency: isolated – dewatering activities are expected to occur at specific locations/times over the construction phase of the Project.
- Reversibility: short-term – residual effects are expected to reverse within 1 year once seasonal precipitation recharges the aquifer.
- Magnitude: low – it is not expected that dewatering activities will noticeably affect groundwater flow patterns given the implementation of mitigation measures.
- Probability: low – it is unlikely that groundwater flow patterns will be affected by dewatering activities given the implementation of proposed mitigation measures.
- Confidence: moderate – shallow groundwater mapping has been completed using available provincial mapping and existing well log reports.

Flooding from Artesian Flow May Occur During Trenchless Crossing Installation

There is a potential for a trenchless crossing or open cut to compromise the integrity of a confining unit that isolates an underlying productive aquifer (especially in valley bottom). A breach of the confining unit during pipeline construction activities may result in uncontrollable artesian flow at the entry or exit point of the trenchless crossing or along the alignment in the open cut. This condition may lead to the development of saturated surface conditions and permanent wet conditions at the discharge areas. In addition, loss of circulation that could occur during trenchless crossing may result in drilling fluids entering the creek bed or discharging to surface along the valley slope.

If areas of artesian conditions are encountered, the annulus of the borehole in the trenchless crossing (space between the pipe and the borehole wall) must be sealed (*e.g.,* with bentonite or grout). If this is not possible, construction of the trenchless crossing should not continue and the contingency trenched crossing should be implemented. The impact balance of this residual effect is considered negative since this could potentially result in adverse flooding conditions. This residual effect is not expected to extend beyond the Water Quality and Quantity LSA to the watershed level.

A complete understanding of the hydrogeological and geotechnical conditions, identification of risks before commencing the trenchless crossing is necessary. In addition, completion of an alignment site reconnaissance, possibly supported by a drilling and testing program designed to confirm hydrogeological and geotechnical conditions and designing the trenchless crossing and pipeline installation to prevent artesian flow to surface are also necessary to reduce the potential effects.

With these mitigation measures, the residual effect of flooding from artesian flow on the natural groundwater and surface water systems is considered to be reversible in the short-term and of low to medium magnitude (Table 7.2.3-3, point 4[e]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Groundwater Water Quality and Quantity LSA – depending upon the site-specific conditions, trenchless crossing activities could affect an area within the LSA.
- Duration: immediate to short-term – the event causing this effect is drilling during trenchless crossing activities which may extend more than two days depending on the size of the watercourse.
- Frequency: isolated – the event causing this effect occurs only during the pipeline construction phase.
- Reversibility: short-term – flooding associated with artesian flow will be reversed in 1 year.
- Magnitude: low to medium – the potential for changes to groundwater flow exists but experience with past projects demonstrates that proper design will mitigate the magnitude of the effect.
- Probability: low – experience with past projects demonstrates that proper design will mitigate the effect.
- Confidence: moderate – based on previous experience and on data pertinent to the Project area.

Reduction of Water Quantity if Blasting Damages the Well or the Surrounding Formation

A reduction in water quantity may occur if blasting closes or clogs fractures supplying an existing water well. Based on previous experience, this condition is unlikely to occur, although blasting or the movement of heavy equipment in the vicinity of a well may damage a well casing or cause collapse of a borehole.

The impact balance of this residual effect is considered negative since this could potentially affect the water supply to the wellbore. This residual effect is unlikely to extend beyond the Water Quality and Quantity LSA to the watershed level. It is considered to represent a short-term influence on the natural groundwater and surface water systems. In the case of a water supply well, should a well be damaged as a result of construction activities, Trans Mountain will re-establish or replace the potable water supply (see Table 7.2.3-2). Blasting activities where the integrity of the water well is affected within the Water Quality and Quantity LSA would accidentally occur over the construction phase of the Project (Table 7.2.3-3, point 4[f]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Water Quality and Quantity LSA – depending upon the site-specific conditions, it is unlikely that blasting activities would affect an area extending more than 300 m from the corridor.
- Duration: immediate – the event causing this effect is blasting which occurs over a period of less than or equal to two days.
- Frequency: accidental – a reduction in well water quantity as a result of blasting occurs rarely over the assessment period.
- Reversibility: short-term – once either the well has been damaged or the formation fractures have been closed or clogged, it is unlikely that they will re-open without outside influence. However, repair or replacement of the water supply well will ensure this effect is reversible.
- Magnitude: low to medium – the potential for well damage or changes to fracture systems as a result of blasting exists but experience with past projects demonstrates that proper design will reduce the magnitude of the effect.
- Probability: low – past experience indicates that this effect, although possible, occurs relatively rarely.

- Confidence: moderate – based on previous experience.

Enhancement of Water Quantity if Blasting Opens or Unclogs Fractures Supplying Existing Water Well

An increase in water quantity may occur if blasting opens or unclogs fractures supplying an existing water well. The blasting, if in proximity to a water well, may further prop open fractures increasing the amount of groundwater flow through the fractures. Blasting, if it occurs sufficiently close to the water well, may also loosen formation particles and scale (from well infrastructure) in the wellbore resulting in temporary increased turbidity of the water. In addition, damage to the well screen and casing may occur as a result of the blasting.

The impact balance of this residual effect may be considered negative since this could potentially increase the water supply or yield of the well at the expense of well integrity and well water quality. This residual effect is unlikely to extend beyond the Water Quality and Quantity LSA. It is considered to represent a short-term influence on the natural groundwater and surface water systems. Blasting activities resulting in enhanced water quantity within the Water Quality and Quantity LSA may occur accidentally during the construction phase of the Project. Blasting as well as the movement of heavy equipment should be conducted 100 m (non-explosives) to 200 m (explosives) away from existing water wells (Table 7.2.3-3, point 4[g]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Water Quality and Quantity LSA - depending upon the site-specific conditions, it is unlikely that blasting activities would affect an area extending more than 300 m from the proposed pipeline corridor.
- Duration: immediate – the event causing this effect is blasting which lasts less than one day.
- Frequency: accidental – an increase in water quantity as a result of blasting occurs rarely over the assessment period.
- Reversibility: short-term – once fractures have been opened or unclogged they may remain open; however, the groundwater flow in a large scale will be unaffected and the well water supply may return to the pre-blasting balance.
- Magnitude: negligible – the potential for changes to fracture systems as a result of blasting exists but experience with past projects demonstrates that proper design will reduce effect magnitude as mentioned above.
- Probability: low – this is unlikely to occur if proper precautions are taken during blasting operations.
- Confidence: moderate – based on previous experience.

7.2.3.7 Summary

As identified in Table 7.2.3-3, there are no situations where there is a high probability of occurrence of a permanent or long-term residual environmental effect on water quality and quantity indicators of high magnitude that cannot be technically or economically mitigated. Consequently, it is concluded that the residual environmental effects of pipeline construction and operations on water quality and quantity will be not significant.

7.2.4 Air Emissions

This subsection describes the potential Project effects on air emissions. The Air Quality and Greenhouse Gas Technical Report of Volume 5C provides further information pertaining to existing air quality conditions along the proposed pipeline corridor.

7.2.4.1 Assessment Indicators and Measurement Endpoints

Selection of indicators for air emissions considered: the filing requirements in the NEB *Filing Manual*; experience gained during previous projects with similar conditions/potential issues; feedback from Aboriginal engagement, landowners, regulatory authorities, stakeholders and the general public; available research literature; and professional judgment of the assessment team. The assessment indicator selected for use in the assessment of construction and operation of the pipeline on air quality is listed in Table 7.2.4-1. The proposed air emissions indicator for pipeline construction and operation (*i.e.*, primary emissions of criteria air contaminants [CACs] and volatile organic compounds [VOCs]) was discussed during the Edmonton, Kamloops and Surrey ESA Workshops. There was general consensus among workshop participants that the proposed air emissions indicator was appropriate for evaluating effects of pipeline construction and operations on air emissions. Consideration was also given to Canadian National Ambient Air Quality Objectives, Canadian Ambient Air Quality Standards, Provincial Ambient Air Quality Objectives of Alberta and BC and World Health Organization Guidelines. Input on indicator selection was sought from Environment Canada, BC MOE, FVRD, Metro Vancouver and PMV (Section 3.0); no additional indicators were suggested for consideration in assessment of pipeline construction and operations.

Both quantitative and qualitative measurement endpoints are applied to assess potential effects of pipeline construction and operation on the air emissions indicator. No direct air emissions are expected from operation of the pipeline itself except for pipeline inspection and maintenance activities.

The indicators of secondary particulate matter and ozone, and hydrogen sulphide and mercaptans emissions, are included in Table 7.2.4-1 and apply to the proposed terminal expansions. Further information on the selection of these indicators and measurement endpoints is provided in Sections 7.5.4 and 7.6.4.

TABLE 7.2.4-1

ASSESSMENT INDICATORS AND MEASUREMENT ENDPOINTS FOR AIR EMISSIONS

Air Emissions Indicator	Measurement Endpoints	Rationale for Indicator Selection
Primary emissions of CACs (PM, CO, NO_2 and SO_2) and speciated VOCs (*e.g.*, BTEX)	• Emissions from Project construction and comparison to existing emissions • Emissions from Project operation and comparison to existing emissions	The selection of the indicator and measurement endpoints considered NEB *Filing Manual* requirements for the air emissions element in Table A-2, addressed concerns raised through stakeholder engagement and were informed by regulatory authorities (*i.e.*, Environment Canada, BC MOE, Metro Vancouver, FVRD and PMV).
Formation of secondary ozone	• Predicted levels of ambient ground-level ozone concentrations and comparison to ambient air quality criteria	
Hydrogen sulphide (H_2S) and mercaptans emissions which have the potential to cause nuisance odours	• Predicted levels of ambient ground-level concentrations and comparison to odour detection thresholds	

7.2.4.2 Spatial Boundaries

The following spatial boundaries are used in the air emissions effects assessment:

- a Footprint Study Area (as defined in Section 7.1.3); and
- an Air Quality RSA.

The Air Quality RSA includes the area where the direct and indirect influences of other activities could overlap with the Project-specific effects from the pipeline and cause cumulative effects on the air quality indicator. The Air Quality RSA width varies by indicator. For example, it consists of a 5 km wide band generally extending from the proposed pipeline corridor (*i.e.*, the Footprint plus 2.5 km on both sides of the proposed pipeline corridor). For the five terminal facilities, the Air Quality RSA is 24 km by 24 km centred on the facility. Being only 3 km apart, Burnaby Terminal and the Westridge Marine Terminal were combined with a common Air Quality RSA. The spatial boundaries of the Air Quality RSA are shown on Figures 5.4-1 to 5.4-4.

The Air Quality RSA was discussed during the Edmonton, Kamloops and Surrey ESA Workshops. There was general agreement that the spatial boundaries for air emissions were appropriate to assess the effects of pipeline and associated facilities construction and operations, and no alternative boundaries were suggested for consideration by the assessment team.

Photochemical modelling of secondary formation of $PM_{2.5}$ and ozone and visibility requires the inclusion of a broader set of emissions from residential, transportation, and industrial sources, changes in land use and terrain, and varying meteorological conditions. In addition, adequate time is needed for atmospheric chemical reactions and predictions at locations well outside the smaller Air Quality RSAs, which are sufficient for dispersion modelling. Over the long modelling period, chemical and meteorological influences are carried into the Project area, requiring large outer modelling domains as well as a larger inner domain that includes the Lower Fraser Valley (LFV; shown in Figure 4.2-4 of the Air Quality and Greenhouse Gas Technical Report of Volume 5C). In the context of photochemical modelling, this inner domain is essentially the photochemical RSA. However, to avoid confusion with the Air Quality RSA and to emphasize that it includes the entire Lower Fraser Valley, the term ‘LFV photochemical model domain’ is used. It comprises a 412 km x 688 km area at 4 km resolution centred on the LFV and covering southern BC and northern Washington State, including Vancouver Island, Juan De Fuca Strait, and the Salish Sea. This inner domain is embedded in a larger 1,068 km x 840 km intermediate domain at 12 km resolution covering the southern half of BC plus Washington and Oregon states in the US. The intermediate domain is embedded in a 3,420 km x 3,348 km parent domain at 36 km resolution covering much of Western North America including BC and Alberta and the US Pacific States. Emissions scenarios for TMEP were implemented over the inner 4 km domain, with the boundary condition determined from Baseline 36 km and 12 km model results. The spatial boundary of the LFV photochemical modelling domain takes into account the results of consultation conducted to date with the FVRD as well as BC MOE and Environment Canada. This regional model domain is also consistent with an earlier study conducted by the University of British Columbia (Steyn *et al.* 2011).

7.2.4.3 Project Associated Air Emissions

During the construction phase, land clearing for right-of-way and facilities and other construction activities will result in fugitive dust emissions, while the operation of vehicles and equipment will result in emissions of CACs and VOCs. During operations, service and maintenance vehicles and aerial patrols will emit CACs and VOCs. Fugitive VOC emissions are expected at connectors, flanges, and valves. In a few cases, CACs and VOCs will be emitted where local fossil fuel burning is required (*e.g.,* for propane heaters).

Emissions from Project activities during the construction phase were estimated using available information. All Project construction emissions will be intermittent and limited in duration. Furthermore, the spatial and temporal characteristics of Project-related construction activities are difficult to define. For these reasons, dispersion modelling of the estimated emissions was not deemed valuable for the assessment of potential air quality effects from Project construction. For Project operations, dispersion modelling was performed where expected emissions warranted an estimation of associated ambient concentrations. This will be discussed in the following subsections under pump stations, tank installation and operations, and Westridge Marine Terminal.

Table 7.2.4-2 summarizes the estimated total construction and annual operation emissions by pollutant for each component or facility type associated with the Project, not including existing emissions. For ease of comparison, construction and operations emissions for all components and facility types are shown in the table and discussed in the following subsections. Subsequent subsections on pump stations, tanks, and the Westridge Marine Terminal refer back to this subsection.

TABLE 7.2.4-2

EMISSIONS OF AIR CONTAMINANTS RELATED TO CONSTRUCTION AND OPERATION (EXPRESSED AS NET CHANGE FROM EXISTING CONDITIONS) (in kg)

Component or Facility	Oxides of Nitrogen (NO_x)	Carbon Monoxide (CO)	Sulphur Dioxide (SO_2)	Inhalable Particulate Matter ($PM_{2.5}$)	Respirable Particulate Matter (PM_{10})	Ammonia (NH^3)	Total Volatile Organic Compounds (TVOCs)	Hydrogen Sulphide (H_2S)	Total Mercaptans
Construction (Total)									
Pipeline	402,600	114,800	665.6	15,630	16,500	0	27,000	0	0
Pump Stations	303,800	68,730	417.4	12,030	12,570	0	17,930	0	0
Tanks	175,000	79,980	419.4	6,681	7,036	0	12,240	0	0
Westridge Marine Terminal	99,890	27,690	1,266	3,070	3,255	0	7,427	0	0
Net Change in Operations (Annual)[1]									
Pipeline	Negligible	Negligible	Negligible	Negligible	Negligible	0	Negligible	Negligible	Negligible
Pump Stations	Negligible	Negligible	Negligible	Negligible	Negligible	0	21,450	Negligible	Negligible
Tanks	<0.05	<0.05	<0.05	<0.05	<0.05	0	14,780	0.1	1.6
Westridge Marine Terminal[2]	77,790	-98,390	3,821	-153,000	-155,000	9	802,400	1.0	34.2

Notes: 1 Operations expressed as net change from existing emissions, and negative values may reflect use of new emission controls.

2 Ammonia emission sources include marine vessels in transit.

New Pipeline

Emissions from construction of the pipeline segments are higher than for other components and facilities associated with the Project, and constitute roughly 40% of total Project construction emissions. This is expected given the substantially larger spatial Footprint of new pipeline segments compared to other Project components and facilities. In addition, estimated air emissions resulting from pipeline construction are reduced through the implementation of the mitigation measures outlined in Table 7.2.4-3.

CAC and VOC emissions during pipeline operations are negligible. During operation of the pipeline, emissions will be limited to aerial patrols. No net increase in the frequency or duration of aerial patrols is expected, and there is no anticipated increase in emissions due to pipeline operations. Therefore, it was not necessary to estimate ambient concentrations of CACs or VOCs associated with pipeline operations. Emissions associated with maintenance activities could not be broken down into specific facilities or components; therefore, no appropriate scaling of these emissions to account for the pipeline expansion could be established. It is expected, however, that the annual operations emissions are small compared to total construction emissions.

Pump Stations

During the construction of pump stations, site preparation, operation of vehicles and equipment, and other construction activities will result in air emissions. It is assumed that no burning of slash will be required for the construction of pump stations. Detailed design information was not available, yet, to estimate slash burning and clear cutting for pump stations, for example for access roads or additional power lines. However, estimates of clear cutting for pipeline right-of-way are conservative; the overestimates are substantially larger than clear cutting required for pump stations. At this stage it was also assumed that all 'new' or relocated pump stations and pressure control stations require construction of a complete new pump station facility. However, in most cases, pump stations might only require the addition of pumps to an existing building, and there is substantially less activities required for the construction of pressure control stations. With this conservative assumption, pump stations are expected to be the second largest source of CAC and VOC emissions during construction, roughly 30% of total construction emissions. This result is reasonable by comparison with smaller sources (tank installations and Westridge Marine Terminal expansion), because construction activities associated with a new pump station facility are substantial, and it is assumed that there are more pump stations being constructed than there is work at the existing terminals.

During operations, increases of fugitive VOC emissions are expected from flanges, control valves, compressor pump seals, and open ended lines. Also, CACs and VOCs will be emitted where local fossil fuel burning is required (*e.g.,* for propane heaters), but these are expected to be negligible. Service and maintenance vehicles will emit CACs and VOCs intermittently. These emissions are considered to be negligible compared to other vehicle emissions in the area that are not associated with the Project. In the absence of detailed information, it is assumed that aerial patrols will primarily serve pipeline segments and that the Project will not cause an increase in aerial patrols.

Tank Installation and Operation

Construction equipment used for tank installation will emit CACs and VOCs. These emissions for all tanks range from 7% to 24% of total Project construction emissions, dependent on the emission type.

During tank operations, Project-related CAC emissions are less than one gram per year, and emissions of H_2S and mercaptans are small. Most emissions are fugitive VOC, including benzene, toluene, ethylbenzene, and xylene, known collectively as BTEX. These are associated with fluctuating fluid levels of product in the storage tanks (working losses) and changes in barometric pressure and ambient temperature (standing losses). The pump rates for filling and withdrawal of product and the physical design of the roof seals and tanks were used as input into the US Environmental Protection Agency (EPA) emission model called TANKS. Fugitive emission rates for a selected set of pollutants were calculated for each product stored in the tanks. The CALPUFF dispersion model was used to evaluate the combined effect of the fugitive emissions from each tank terminal at off-site receptors. At the Sumas, Burnaby, and Westridge Marine Terminals, and based on very preliminary design engineering, Trans Mountain is proposing to include emission control systems (Tank Vapour Activation Units or TVAUs) to reduce emissions of reduced sulphur and VOCs using an H_2S scavenging technology called SULFATREAT and activated carbon filters for the new tanks. The TVAUs were accounted for in the emission calculations for these tanks in the dispersion model.

Dispersion modelling was conducted in accordance with the air quality modelling guidelines in Alberta (AESRD 2013a) and BC (BC MOE 2008). Interpretation of the predicted results (plus ambient background concentrations) was also conducted using the modelling guidelines. The predicted results were assessed in terms of applicable ambient air quality objectives from several regulatory authorities specific to each terminal location including Metro Vancouver, BC MOE, AESRD and Environment Canada. These objectives are based on environmental or human health effects and include several averaging periods such as 24-hour and annual.

The addition of tanks to the Edmonton, Sumas, and Burnaby terminals will increase fugitive emissions. In the absence of more detailed information, it was assumed that the additional tanks will not increase fleet operation and the use of space heating. It can also be assumed that these emissions would be small compared to ambient concentrations.

In addition to emissions of primary pollutants from the Project, secondary pollutants will be formed from reactions between primary pollutants in the atmosphere. In the presence of sunlight, precursors such as NO_X and VOCs undergo a complex sequence of reactions to form ozone. Secondary PM can be formed from reactions between NO_X, SO_X, and NH_3. Primary and secondary PM can absorb and scatter sunlight, causing haze and obscuring visibility.

Advanced photochemical modelling using Community Multiscale Air Quality (CMAQ) was performed to estimate the difference in the formation of secondary PM and ozone between baseline emissions and total emissions after the addition of Project-related emissions of: CAC and VOC in the Lower Fraser Valley (LFV) from increased Project-related transportation by ship; fugitives at tanks in the Burnaby and Sumas terminals; and CAC from equipment and fugitives associated with loading products on ships and tank storage at the Westridge Marine Terminal. Note that the chemical interaction between primary pollutants and the formation of secondary PM and ozone is non-linear, hence not additive. It is therefore not possible to determine the contribution of individual sources to overall PM and ozone formation and visibility in the LFV. Results for land-based receptors are reported in terms of the net effect of all changes associated with the Project.

Westridge Marine Terminal Expansion and Operation

Construction equipment used for the Westridge Marine Terminal Expansion will emit CACs including VOCs. These are the smallest emissions among the components and facilities listed in Table 7.2.4-2 above, roughly 10% of total construction emissions with the exception of SO_2. Approximately half of all construction related SO_2 emissions are estimated to occur during Westridge Marine Terminal expansion. The main source of this SO_2 is sulphur contained in the marine diesel oil that is combusted by the vessels used during berth construction.

Emissions from operations at the Westridge Marine Terminal include the same sources as tank operation, which was described above. In addition, CAC emissions from equipment operations are expected, and fugitive emissions from ships at berth are considered terrestrial operation emissions at the Westridge Marine Terminal. During ship loading, roughly 90% of fugitive emissions are flared with a VCU, which is currently a substantial source of CAC and VOC emissions at the Westridge Marine Terminal. However, emissions of all CACs with the exception of NH_3 will be reduced after the installation of the TVAUs described above. Emissions of total VOCs, H_2S, and mercaptans are expected to increase. Exhaust emissions from Project-related increases of ships at berth are expected to cause net increases in NO_x and SO_2 emissions.

The formation of secondary PM and ozone and reductions in visibility are affected by CAC and fugitive VOC emissions during operations at the Westridge Marine Terminal. Refer to the discussion on tank installation and operations above for details.

7.2.4.4 Potential Effects and Mitigation Measures

Effects Considerations

Two concerns related to air emissions were raised during the Edmonton, Kamloops, and Surrey ESA Workshops: radioactive dust from pipeline construction activities; and black carbon from the burning of timber associated with land clearing. Radioactive dust and black carbon were not included as assessment indicators but are discussed indirectly. Under the authority of the *Environmental Management Act*, the BC MOE has the mandate to regulate smoke emissions that would include radioactive dust and black carbon from open burning activities through the application of the *Open Burning Smoke Control Regulation*. Trans Mountain will burn slash when conditions exist that allow for adequate dispersion of smoke and will observe the appropriate setback distances and other best management practices. In the Lower Fraser Valley where air quality is an issue, Trans Mountain will avoid burning slash. Instead, mulching will be performed in place or slash will be shipped/hauled to an approved disposal location.

Identified Potential Effects

Potential effects of the construction and operations of the proposed pipeline on the air emissions indicator are listed in Table 7.2.4-3. These interactions are based on the results of the literature review, desktop analysis, field work, engagement with Aboriginal communities, landowners, stakeholders and the general public (Section 3.0), as well as the professional experience of the assessment team. Mitigation measures summarized in Table 7.2.4-3 were developed in accordance with Trans Mountain standards and accepted pipeline construction methods for construction-related activities.

TABLE 7.2.4-3

POTENTIAL EFFECTS, MITIGATION MEASURES AND RESIDUAL EFFECTS OF PIPELINE CONSTRUCTION AND OPERATIONS ON AIR EMISSIONS

Potential Effect	Pipeline Segment(s)	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
1. Air Emissions Indicator – Primary Emissions of Criteria Air Contaminants and Volatile Organic Compounds				
1.1 Project contribution to emissions	All	RSA	• Trans Mountain will consult with and inform landowners of the potential to be affected by emissions from construction activities prior to commencement of these activities in proximity to the respective landowners [Section 7.0]. • Restrict the duration that vehicles and equipment are allowed to sit and idle to less than one hour, unless air temperatures are less than 0°C [Section 7.0]. • Ensure equipment is well-maintained during construction to minimize air emissions [Section 7.0]. • Use multi-passenger vehicles for the transportation of crews to and from the job sites, where feasible [Section 7.0].	• Increase in air emissions during construction. • Increase in air emissions during site-specific maintenance and inspection activities.
1.2 Dust and smoke during construction	All	RSA	• Trans Mountain will consult with and inform landowners with the potential to be affected by dust emissions from construction activities prior to commencement of these activities in proximity to the respective landowners [Section 8.2]. • Water down construction sites and access roads, when warranted, as directed by Trans Mountain, to reduce or avoid the potential for dust emissions [Section 8.2]. • Conduct burning in accordance with burning permit requirements and A Smoke Management Framework for British Columbia, as applicable. Comply with local government bylaws, the *Forest and Prairie Protection Act* (Alberta), *Open Burning Smoke Control Regulation* (BC) and the *Forest Fire Prevention and Suppression Regulation* (BC) when burning slash [Section 7.0]. • Avoid burning slash in the Lower Mainland where air quality is an issue. Mulch in place or ship/haul slash to an approved disposal location [Section 7.0]. • Limit smoke production during slash disposal by limiting pile size, reducing fuel moisture content, maintenance of loose burning piles free of soil and by using burning sloops or large capacity shredders [Section 7.1]. • Permit burning only when conditions exist that allow for adequate dispersion of smoke so that high concentrations of smoke do not locally affect human health or wildlife. Avoid burning when temperature inversions are present or predicted [Section 8.1].	• Increase in fugitive dust and smoke during construction.

Notes: 1 RSA = Air Quality RSA.
2 Detailed mitigation measures are outlined in the Pipeline EPP (Volume 6B).

7.2.4.5 Potential Residual Effects

The potential residual environmental effects on the air emissions indicator associated with the construction and operations of the pipeline (Table 7.2.4-3) are:

- an increase in air emissions during construction;
- an increase in air emissions during site-specific maintenance and inspection activities; and
- an increase in fugitive dust and smoke during construction.

7.2.4.6 Significance Evaluation of Potential Residual Effects

A combination of a quantitative and qualitative assessment of air emissions was determined to be the most appropriate approach to evaluate the significance of potential residual environmental effects. Emissions from Project activities during the construction phase were estimated using available information (Table 7.2.4-2). A qualitative assessment of air emissions during maintenance activities was considered appropriate given the short duration of these activities and anticipated volumes of emissions, relying on the professional judgment of the assessment team.

Table 7.2.4-4 provides a summary of the significance evaluation of the potential residual environmental effects of the construction and operations of the proposed pipeline on air emissions. The rationale used to evaluate the significance of each of the residual environmental effects is provided below.

TABLE 7.2.4-4

SIGNIFICANCE EVALUATION OF POTENTIAL RESIDUAL EFFECTS OF PIPELINE CONSTRUCTION AND OPERATIONS ON AIR EMISSIONS

Potential Residual Effects	Impact Balance	Spatial Boundary[1]	Temporal Context			Magnitude	Probability	Confidence	Significance[2]
			Duration	Frequency	Reversibility				
1. Air Emissions Indicator – Primary Emissions of Criteria Air Contaminants and Volatile Organic Compounds									
1(a) Increase in air emissions during construction.	Negative	RSA	Short-term	Isolated	Short-term	Medium	High	Moderate	Not significant
1(b) Increase in air emissions during site-specific inspection and maintenance activities.	Negative	RSA	Short-term	Periodic	Short-term	Low	High	Moderate	Not significant
1(c) Increase in fugitive dust and smoke during construction.	Negative	RSA	Short-term	Isolated	Short-term	Medium	High	Moderate	Not significant
1(d) Combined effects on the primary emissions of CACs and VOCs indicator (1[a] to 1[c]).	Negative	RSA	Short-term	Periodic	Short-term	Medium	High	Moderate	Not significant

Notes: 1 RSA = Air Quality RSA.

2 Significant Residual Environmental Effect: A high probability of occurrence of a permanent or long-term residual effect of high magnitude that cannot be technically or economically mitigated.

Air Emissions Indicator – Primary Emissions of Criteria Air Contaminants and Volatile Organic Compounds

The following provides an evaluation of the significance of potential residual effects on the primary emissions of CACs and VOCs indicator.

Increase in Air Emissions During Construction

Participants at the Clearwater and Langley Community Workshops expressed concerns about vehicle emissions during construction and operations. The primary sources of air emissions during construction will be from fuel combustion while transporting crews to and from the work site and along the proposed pipeline corridor, as well as from the operation of heavy equipment required for construction. Implementation of accepted pipeline construction methods as outlined in Table 7.2.4-3 is the preferred approach to reducing air emissions from pipeline construction.

The amount of CAC and VOC emissions associated with construction activities will be reduced by using multi-passenger vehicles for the transportation of crews to and from the job sites, to the extent feasible, as well as using well-maintained equipment. The residual effects of increased air emissions during construction are considered to have a negative impact balance, but they are expected to dissipate within the Air Quality RSA. Ambient concentrations of CAC and VOC are expected to be within provincial objectives and standards (AESRD 2013b, BC MOE 2013a) and, therefore, of medium magnitude. Air emissions resulting from construction activities are considered to be reversible in the short-term (Table 7.2.4-4, point 1[a]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Air Quality RSA – potential increases in air emissions resulting from construction activities will dissipate within the Air Quality RSA.
- Duration: short-term – the event resulting in increased air emissions is construction of the pipeline.
- Frequency: isolated – the event resulting in increases in air emissions (*i.e.*, construction of the pipeline) is confined to a specific period.
- Reversibility: short-term – the residual effects are expected to reverse within less than 1 year for all contaminants after completion of construction.
- Magnitude: medium – an increase in air emissions will occur and may approach but are not expected to exceed environmental or regulatory standards; the increase will be short-lived and localized to the construction area.
- Probability: high – the equipment and vehicles used for construction will emit air contaminants.
- Confidence: moderate – based on a good understanding of the cause-effect relationship but reliant on vehicle and equipment estimates from previous projects.

Increase in Air Emissions During Site-Specific Inspection and Maintenance Activities

Participants at the Clearwater and Langley Community Workshops expressed concerns about vehicle emissions during construction and operation. The primary sources of air emissions during operations will be from fuel combustion while transporting crews to and from the proposed pipeline corridor during site-specific maintenance activities. Aerial patrols along the pipeline segments are unlikely to cause measurable increases of near-surface ambient CAC concentrations above background levels. Furthermore, in the absence of more detailed information, it was assumed that the current frequency and duration of aerial patrols will be sufficient to serve the pipeline expansion associated with the Project.

The amount of air emissions associated with site-specific maintenance activities will be reduced by using multi-passenger vehicles for the transportation of crews to and from the job sites, to the extent feasible, as well as using well-maintained equipment. The residual effects of increased air emissions during site-specific maintenance activities are considered to have a negative impact balance. However, they are expected to dissipate within the Air Quality RSA and be well within provincial objectives and standards (AESRD 2013b, BC MOE 2013a) and, therefore, will be of low magnitude. Air emissions resulting from site-specific inspections and maintenance activities are considered to be reversible in the short-term (Table 7.2.4-4, point 1[b]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Air Quality RSA – potential increases in air emissions resulting from site-specific maintenance activities (*e.g.*, vegetation management, integrity digs) will dissipate within the Air Quality RSA.
- Duration: short-term – the events resulting in increases in air emissions, are individual maintenance activities (*e.g.*, vegetation management, integrity digs) and each maintenance event will be completed within 1 year.
- Frequency: periodic – maintenance and operations-related activities (*e.g.*, vegetation management, integrity digs) will occur intermittently but repeatedly over the assessment period.
- Reversibility: short-term – the residual effects are expected to reverse within less than 1 year for all contaminants after completion of individual maintenance activities.
- Magnitude: low – periodic increases in air emissions during site-specific maintenance will be detectable but within normal variability of existing conditions with the implementation of proposed mitigation measures.

- Probability: high – the equipment and vehicles used for site-specific activities (*e.g.*, vegetation management, integrity digs) will emit air contaminants.
- Confidence: moderate – based on a good understanding of the cause-effect relationship and reliable data from current pipeline operations in the same regions; however, detailed information on equipment and vehicle usage for site-specific activities and the duration and frequency of future aerial patrol are not available.

Increase in Fugitive Dust and Smoke During Construction

Smoke will be associated with the burning of slash along discrete segments of the proposed pipeline corridor. In accordance with applicable provincial legislation pertaining to mulching depth requirements, not all non-merchantable timber can be disposed of by mechanical means; therefore, slash burning is required. Since the maximum depth of mulch will not exceed 5 cm or will be in accordance with the applicable provincial legislation, whichever is less, any remaining vegetation and non-salvageable timber not retained for rollback will be burned. The impact balance of this potential residual effect is considered to be negative since smoke could reduce local air quality. In some areas of BC, burning restrictions may be a concern in the summer when the risk of fire is high, as noted by participants of the Blue River Community Workshop. Participants in the Clearwater and Langley Community Workshops were also concerned about smoke from burning during construction. In the Lower Mainland, air quality is an issue and burning slash will be avoided. This residual effect is reversible immediately or in the short-term after cessation of burning, depending on the size of the slash piles and conditions during burning, and of medium magnitude given the anticipated volume of slash along the proposed pipeline corridor.

Emissions of particulate matter related to earth moving activities and use of heavy equipment during pipeline construction are expected to be greater than particulate matter emissions during pipeline operation. Fugitive dust from equipment travelling on disturbed soil can be a major dust contributor during dry summer periods. An increase in dust on unpaved access roads will be confined to construction and reclamation activities completed during relatively dry, non-frozen conditions. Implementing accepted pipeline construction methods as outlined in Table 7.2.4-3 is the preferred approach to reducing air emissions from pipeline construction.

The impact balance of this potential residual effect is considered to be negative since dust and smoke could reduce air quality. Larger particles of fugitive dust and smoke will settle out via gravitational settling within a relatively short timeframe at any given location, while finer particles might remain suspended for more than two days. Therefore, this residual effect is reversible in the short-term. With the implementation of the recommended mitigation measures provided in Table 7.2.4-3, fugitive dust and smoke during construction will be reduced. However, under some environmental conditions, the residual effect may still approach provincial objectives and standards (AESRD 2013b, BC MOE 2013a); therefore, its magnitude is rated as medium (Table 7.2.4-4, point 1[c]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Air Quality RSA – potential increases in dust and smoke resulting from construction may extend beyond the Footprint and into the Air Quality RSA.
- Duration: short-term – the event resulting in increases in dust and smoke is construction of the pipeline.
- Frequency: isolated – the event resulting in increases in dust and smoke (*i.e.*, construction of the pipeline) is confined to a specific period.
- Reversibility: short-term – the effects are expected to reverse within several days once construction or the maintenance activity is complete.
- Magnitude: medium – a small volume of slash along the proposed pipeline corridor is expected, and the mitigation measures provided in Table 7.2.4-3 will reduce fugitive dust and smoke during construction.
- Probability: high – disposal of slash by burning is planned, unpaved roads will be used to access the right-of-way, and construction and maintenance activities will occur during non-frozen conditions.

- Confidence: moderate – based on a good understanding of the cause-effect relationship, but the quantification of fugitive dust and smoke emissions (*e.g.*, from slash burning) is based on data from outside the Project and reliable data for slash burning in the Project data are unavailable.

Combined Effects on Primary Emissions of Criteria Air Contaminants and Volatile Organic Compounds

An evaluation of the combined effects considers those residual effects that are likely to occur. The potential exists for increases in air emissions to occur simultaneously with increases in fugitive dust and smoke during construction. The combined effects of pipeline construction on CACs and VOCs are reversible in the short-term and of low to medium magnitude (Table 7.2.4-4, point 1[d]). A summary of the rationale for all of the significance criteria of combined effects on primary emissions of CACs and VOCs is provided below.

- Spatial Boundary: Air Quality RSA – combined effects on air emissions from construction will dissipate within the regional airshed.
- Duration: short-term – the event causing combined effects on air emissions is construction of the pipeline.
- Frequency: periodic – the events causing combined effects on air emissions (*i.e.*, construction and site-specific inspection and maintenance activities) occur intermittently but repeatedly over the assessment period.
- Reversibility: short-term – combined effects are expected to reverse within several days once construction or inspection and maintenance activities are complete.
- Magnitude: medium – the implementation of the proposed mitigation measures is expected to effectively reduce combined effects on air emissions, but under certain environmental conditions, provincial ambient air quality objectives and standards may be approached.
- Probability: high – disposal of slash by burning is planned, unpaved roads will be used to access the right-of-way, and construction and maintenance activities will occur during non-frozen conditions.
- Confidence: moderate – based on a good understanding of the cause-effect relationship; however, where reliable Project data were unavailable, outside data were used.

7.2.4.7 Summary

As identified in Table 7.2.4-4, there are no situations where there is a high probability of occurrence of a permanent or long-term residual environmental effect on air emissions indicators of high magnitude that cannot be technically or economically mitigated. Consequently, it is concluded that the residual environmental effects of pipeline construction and operations on air emissions will be not significant.

7.2.5 Greenhouse Gas Emissions

This subsection describes the potential Project effects on greenhouse gas (GHG) emissions. The Air Quality and Greenhouse Gas Technical Report of Volume 5C provides further information pertaining to GHG emissions associated with the construction and operation of the Project.

The assessment of effects on GHG emissions has been conducted considering all the Project components in an integrated manner (*e.g.,* pipeline, temporary facilities, pump stations [including power lines], tanks, Westridge Marine Terminal and pipeline reactivation), since GHG emissions associated with the construction and operation of each Project component are aggregated for the Project as a whole and then compared to provincial and federal GHG inventory totals.

7.2.5.1 Assessment Indicators and Measurement Endpoints

The assessment indicators selected for use in the assessment of Project related activities on GHG emissions are listed in Table 7.2.5-1. Selection of indicators for GHG emissions considered: filing requirements in the NEB *Filing Manual*; experience gained during previous projects with similar conditions/potential issues; feedback from Aboriginal engagement, regulatory authorities, and stakeholders; available research literature; and the professional judgment of the assessment team. The proposed GHG indicators were discussed during the Edmonton, Kamloops and Surrey ESA Workshops. There was general consensus among workshop participants that the proposed GHG emissions indicators were appropriate for evaluating effects of Project related activities on GHG emissions and the effect of these emissions on the environment. Input on indicator selection was sought from Environment Canada, BC MOE, FVRD, Metro Vancouver and PMV (Section 3.0); no additional indicators were suggested for consideration in assessment of Project related activities.

Both quantitative and qualitative measurement endpoints are applied to assess potential effects of Project related activities on the GHG indicators.

Three GHGs (carbon dioxide [CO_2], methane [CH_4], and nitrous oxide [N_2O]) are explicitly considered in the GHG emission indicators. GHGs accumulate in the atmosphere and have the potential to contribute incrementally to climate change on a global scale (NRC 2011). Therefore, the terrestrial effects assessment of GHG emissions is based on total Project related construction activities and annual total Project related operation activities.

Among other GHGs, only emissions of SF_6 (sulfur hexafluoride) and black carbon are expected from Project construction and operations. SF_6 emissions occur in the context of power generation and transmission and are incorporated in the estimation of GHG emissions from the Project through provincial emission factors for consumed electrical energy. Black carbon will be emitted mostly from burning associated, for example, with land clearing. However, regional, provincial and federal legislation (Metro Vancouver 2011a; AENV 2004; BC MOE 2013a; Government of Canada 2013) currently do not recognize black carbon as a GHG. This is partly due to evolving scientific understanding of the role of black carbon in the global climate system.

Federal and provincial legislation are in place to address GHG emissions. All facilities emitting more than 50,000 tonnes of GHGs are required to submit a report under Environment Canada's *Greenhouse Gas Emissions Reporting Program* (Environment Canada 2013a). Facilities in Alberta emitting more than 50,000 tonnes of GHGs are also required to submit reports under AESRD's *Specified Gas Reporting Regulation* (AENV 2004); for facilities emitting more than 100,000 tonnes, verification is required. BC's *Reporting Regulation under the Greenhouse Gas Reduction (Cap and Trade) Act* sets out the requirements for reporting GHG emissions from BC facilities emitting 10,000 tonnes or more of GHGs (BC MOE 2013a). Facilities emitting 25,000 tonnes or more are required to have emissions reports verified by a third party.

Note that no absolute GHG emission limits are set by the legislation discussed in the previous paragraph. Therefore, the following numbers are provided for comparison, only. Environment Canada's National Inventory Report estimates total GHG emissions from Canada to be 702 Mt in 2011. Of the 702 Mt, 242.0 Mt, and 59.1 Mt were Alberta and BC's contributions, respectively (Environment Canada 2013b).

TABLE 7.2.5-1

ASSESSMENT INDICATORS AND MEASUREMENT ENDPOINTS FOR GHG EMISSIONS

GHG Emissions Indicators	Measurement Endpoints	Rationale for Indicator Selection
Emissions of CO_2, CH_4 and N_2O	• Emissions of CO_2e (carbon dioxide equivalent) from Project construction and comparison to local, provincial and national totals. • Emissions of CO_2e from Project operation and comparison to local, provincial and national totals.	The selection of the indicator and measurement endpoints considered NEB *Filing Manual* requirements for the GHG emissions element under Table A-2, addressed concerns raised through Aboriginal engagement and stakeholder consultation and are supported by regulatory authorities (*i.e.*, Environment Canada, BC MOE, Metro Vancouver, FVRD and PMV).
Effect on overall climate change	• Effects of CO_2e emissions from Project construction on change in environmental parameters such as global average temperatures. • Effects of CO_2e emissions from Project operation on change in environmental parameters such as global average temperatures.	

7.2.5.2 Spatial Boundaries

Greenhouse gas emissions have a global effect that cannot easily be measured on a local or regional scale. The spatial boundary for GHG is therefore beyond regional (*i.e.,* international) and encompasses all sources of GHG emissions from the Project.

7.2.5.3 GHG Emissions Associated with Individual Project Components

The methods and assumptions used to calculate the GHG emissions associated with the construction and operations of the Project are provided in the Air Quality and Greenhouse Gas Technical Report of Volume 5C.

<u>GHG Emissions Associated with Pipeline Construction and Operations</u>

During the construction phase, land clearing for construction right-of-way and facilities, operation of vehicles and equipment, and other construction activities will result in GHG emissions. During operation of the pipeline, the main sources of GHG emissions will be regular transportation and equipment use during maintenance activities. Pipeline related GHG emissions are summarized in Table 7.2.5-2.

Emissions from pipeline construction activities were estimated using available information. All pipeline construction emissions will be intermittent and limited in duration. Since the construction schedule is subject to change, construction related emissions were not estimated on an annual basis. Instead, these emissions are estimated and reported as overall totals. Emissions associated with pipeline operation occur periodically over the life of the operating pipeline and were estimated as annual totals.

More than 90% of all estimated construction emissions are expected from land clearing. GHG emissions during pipeline operations are not expected to change from existing operations. In the absence of specific information, it is assumed that the current frequency of aerial patrols will suffice to also cover the expanded pipeline. Emissions associated with maintenance activities include combustion products from fossil fuel use for space heating and vehicle operation. These emissions could not be broken down into specific facilities or components, and therefore, no appropriate scaling of these emissions to account for the pipeline expansion could be established. It is expected, however, that the annual operation emissions will be small compared to total construction emissions.

TABLE 7.2.5-2

GHG EMISSIONS GENERATED BY PIPELINE CONSTRUCTION AND OPERATIONS

	Pipeline-Related Activity	GHG Emissions (t CO_2e)
Construction (total)	Land clearing	831,000
	Operation of construction equipment	68,530
Construction subtotal		899,500
Operation (annual)	Maintenance and inspection activities	Negligible

<u>GHG Emissions Associated with Temporary Facilities Construction and Operations</u>

During the construction of temporary facilities, site preparation, operation of vehicles and equipment, and other construction activities will result in GHG emissions. During operation of the temporary facilities, GHG emissions are caused by transportation and activities associated with the residence of workers (*e.g.,* space heating and electricity use). All GHG emissions associated with construction and operation of temporary facilities will be intermittent and limited in duration to the construction phase of the Project.

Information on construction and operation activities for temporary facilities was not available separately from construction activities for permanent facilities and pipelines. Therefore, associated GHG emissions are estimated as total construction-related emissions for permanent and temporary facilities.

<u>GHG Emissions Associated with Pump Station Construction and Operations</u>

During the construction phase, land clearing for pump station facilities and associated power lines, site preparation, operation of vehicles and equipment, and other construction activities will result in GHG emissions. During operation of the pump stations, direct GHG emissions are caused by fuel combustion for space heating, and fugitive emissions from valves, connectors, and pumps. Electricity consumption by the pump assemblies will result in indirect GHG emissions. Pump station related GHG emissions are summarized in Table 7.2.5-3.

In the absence of information on construction activities in pump stations, GHG estimates of construction equipment use from previous projects were used as a basis to estimate construction related emissions at pump stations. Emissions from land clearing were not estimated since these are location specific. All construction emissions will be intermittent and limited in duration. Since the construction schedule is subject to change, construction related emissions were not estimated on an annual basis. Instead, these emissions are estimated and reported as overall totals. Emissions associated with pump station operation occur continuously over the life of the operating pump stations and were estimated as annual totals. However, for the assessment of overall Project effects on climate change, the total cumulative emissions over the 50 year period are represented.

GHG emissions from equipment use for pump station construction are expected to be of the same order of magnitude as emissions from pipeline construction. This is a reasonable result given that the Footprint of the pump stations is smaller than that of the pipeline but the construction effort per station is greater. Note that no additional land clearing specifically for the construction of pump stations is taken into consideration beyond land clearing required for the pipeline right-of-way because the early engineering design did not provide enough information to estimate the required clear cutting for pump stations, but it is expected to be small compared to conservatively high estimates for pipeline land clearing.

The greatest source of GHG emissions across all construction and operation activities associated with the Project is indirect emissions from the use of electricity to operate the pump assemblies at pump stations. The conservatively high estimate (assuming pump operations at maximum capacity all the time) is 1.069 Mt CO_2e of indirect GHG emissions per year. All other operational GHG emissions at pump stations are much lower than the uncertainties in the estimates of the indirect emissions.

TABLE 7.2.5-3

GHG EMISSIONS GENERATED BY PUMP STATION CONSTRUCTION AND OPERATIONS

	Pump Station Related Activity	GHG Emissions (t CO_2e)
Construction (total)	Operation of construction equipment	49,790
Operation (annual)	Fuel combustion for space heating	115.1
	Fugitive emissions	14.3
	Electricity consumption	1,069,000
Operation subtotal		1,069,000

GHG Emissions Associated with Tank Installation and Operations

During the installation of the proposed tanks and associated terminal work, site preparation, operation of vehicles and equipment, and other construction activities will result in GHG emissions. During operations, the main sources of direct GHG emissions will be regular transportation and equipment use during maintenance activities and normal operations, as well as fugitive emissions from working and standby losses from storage tanks and the fugitive emissions from the corresponding valves and connectors. Electricity consumption at the terminals, mainly by the booster pumps, will result in large amounts of indirect GHG emissions. Assuming that these pumps will be working at full capacity at all times, a conservative estimate of emissions from the operation of the storage tanks is approximately 58.5 kt CO_2e emissions. Tank-related GHG emissions are summarized in Table 7.2.5-4.

Emissions from tank installation activities were estimated using available information. All construction emissions will be intermittent and limited in duration. Since the construction schedule is subject to change, construction related emissions were not estimated on an annual basis. Instead, these emissions are estimated and reported as overall totals. Emissions associated with operation of tanks occur continuously over the life of the operating tanks and were estimated as annual totals.

GHG emissions from equipment use for tank installation are expected to be of the same order of magnitude as emissions from pump station construction. It is assumed that no land clearing is required for tank installation. Fugitive GHG emissions are higher at tanks than pump stations, but are small compared to most other operational emissions at facilities and components. No information was available to estimate an increase, if any, of GHG emissions associated with maintenance activities (*e.g.*, fossil fuel combustion for vehicle operation and space heating). It is expected that the increase in these emissions is small compared to total construction emissions, and annual electricity-related emissions.

TABLE 7.2.5-4

GHG EMISSIONS GENERATED BY TANK INSTALLATION AND OPERATIONS

	Tank Installation Related Activity	GHG Emissions (t CO_2e)
Construction (total)	Operation of construction equipment	26,370
Operation (annual)	Personnel transportation	Negligible
	Fuel combustion for space heating	Negligible
	Fugitive emissions	32.1
	Electricity consumption	58,460
Operation subtotal		58,490

GHG Emissions Associated with Westridge Marine Terminal Construction and Operations

During the construction phase at the Westridge Marine Terminal, dredging, dewatering, and other construction activities as well as the operation of vehicles and product loading will result in GHG emissions. During the operations phase, most of the GHG emissions associated with the Westridge Marine Terminal will result from fugitives released during vapour combustion and product loading. Regular transportation, space heating, and equipment use during maintenance activities and normal operations, as well as fugitive emissions from storage tanks, associated valves and connectors, and ship holds are also sources of direct GHG emissions. Electricity consumption at the terminal will result in indirect GHG emissions. GHG emissions related to the construction and operations of the Westridge Marine Terminal are summarized in Table 7.2.5-5.

Emissions from activities at the Westridge Marine Terminal were estimated using available information. All construction emissions will be intermittent and limited in duration. Since the construction schedule is subject to change, construction-related emissions were not estimated on an annual basis. Instead, these emissions are estimated and reported as overall totals. Emissions associated with operation of tanks are expected to occur continuously over the life of the operating terminal and were estimated as annual totals.

Construction-related GHG emissions at the Westridge Marine Terminal are less than those at other facilities and components but are of a similar order of magnitude. This is reasonable given the smaller scope and spatial extent of construction at the Westridge Marine Terminal.

Fugitive emissions from ships at berth are considered to be terrestrial operation emissions at the Westridge Marine Terminal. Combustion of about 90% of these fugitive emissions with a VCU is currently a substantial source of GHG emissions at the Westridge Marine Terminal. These emissions will be reduced by nearly 45 kt CO_2e after the installation of vapour recovery units (VRU), and new removal media, combined with the standby VCU. No information was available to estimate an increase, if any, of GHG emissions associated with maintenance activities, space heating, and electricity consumption. It is expected that the increase in these emissions is small compared to the decrease in GHG emissions related to ship fugitive emissions.

TABLE 7.2.5-5

GHG EMISSIONS GENERATED BY CONSTRUCTION AND OPERATIONS OF THE WESTRIDGE MARINE TERMINAL

	Westridge Marine Terminal Related Activity	GHG Emissions (t CO_2e)
Construction (total)	Operation of construction equipment	10,120
Operation (annual)	Personnel transportation	Negligible
	Fuel combustion for space heating	Negligible
	Vapour flaring of fugitive emissions from tanker loading and uncaptured fugitive emissions	-44,740
	Electricity consumption	Negligible
Operation subtotal		-44,740

GHG Emissions Associated with Pipeline Reactivation Activities

During operation of the reactivated pipeline segments, the main sources of GHG emissions will be regular transportation and equipment use during maintenance activities. Pipeline reactivation related GHG emissions are summarized in Table 7.2.5-6. These emissions occur periodically over the life of the operating pipeline and were estimated as annual totals. No information was provided to estimate GHG emissions during reactivation and associated activities such as the installation of automated valves, but can be assumed to be small compared to emissions during operations of the reactivated pipeline.

TABLE 7.2.5-6

GHG EMISSIONS GENERATED BY PIPELINE REACTIVATION

	Pipeline Reactivation Related Activity	GHG Emissions (t CO_2e)
Operation (annual)	Maintenance and inspection activities	Negligible

GHG Emissions Associated with Facilities Located Within Pipeline Right-of-Way

Some elements interact with associated pipeline facilities (*e.g.*, block valves) within the proposed pipeline right-of-way. No information was available to quantify potential GHG emissions from these facilities, but if GHG emissions occur, they are expected to be negligible compared to other GHG emissions from Project-related activities.

7.2.5.4 Potential Effects and Mitigation Measures

Effects Considerations

Burning of timber associated with land clearing will emit black carbon. Provincial and federal legislation currently does not recognize black carbon as a GHG, partly due to evolving scientific understanding of the role of black carbon in the global climate system. Consequently, emissions of black carbon were scoped out of the effects assessment of GHG emissions.

Identified Potential Effects

Potential effects associated with the construction and operation of the Project on the GHG emissions indicators are listed in Table 7.2.5-7. These interactions are based on the results of the literature review, desktop analysis, engagement with Aboriginal communities, regulatory authorities, stakeholders and the general public (Section 3.0), and the professional experience of the assessment team.

A summary of mitigation measures provided in Table 7.2.5-7 was principally developed in accordance with Trans Mountain standards on the basis of industry best practices, professional judgment of the assessment team, and experience from previous projects.

TABLE 7.2.5-7

POTENTIAL EFFECTS, MITIGATION MEASURES AND RESIDUAL EFFECTS OF PROJECT CONSTRUCTION AND OPERATIONS ON GHG EMISSIONS

Potential Effect	Project Components	Spatial Boundary	Key Recommendations/Mitigation Measures [EPP Reference][1]	Potential Residual Effect(s)
1. GHG Emissions Indicator – Emissions of CO_2, CH_4, and N_2O				
1.1 Increase in CO_2e emissions	New Pipeline Segments Temporary Facilities Pump Stations including power lines Terminals Westridge Marine Terminal Pipeline Reactivation	International	• Restrict the duration that vehicles and equipment are allowed to sit and idle to less than one hour, unless air temperature is less than 0°C [Section 7.0]. • Ensure equipment is well-maintained during construction to minimize air emissions and unnecessary noise [Section 7.0]. • Use multi-passenger vehicles for the transportation of crews to and from the job sites, to the extent feasible [Section 7.0].	• Increase in CO_2e emissions.
2. GHG Indicator – Effect on Overall Climate Change				
2.1 Changes in environmental parameters (*e.g.,* increase in global average temperature)	New Pipeline Segments Temporary Facilities Pump Stations including power lines Terminals Westridge Marine Terminal Pipeline Reactivation	International	• Restrict the duration that vehicles and equipment are allowed to sit and idle to less than one hour, unless air temperature is less than 0°C [Section 7.0]. • Ensure equipment is well-maintained during construction to minimize air emissions and unnecessary noise [Section 7.0]. • Use multi-passenger vehicles for the transportation of crews to and from the job sites, to the extent feasible [Section 7.0].	• Changes in environmental parameters (*e.g.,* increase in global average temperature).

Note: 1 Detailed mitigation measures are outlined in the Pipeline EPP (Volume 6B).

7.2.5.5 Potential Residual Effects

The potential residual environmental effects on GHG indicators associated with Project related activities are (Table 7.2.5-7):

- an increase in CO2e emissions; and
- changes in environmental parameters (*e.g.*, increase in global average temperature).

7.2.5.6 Significance Evaluation of Potential Residual Effects

A combined quantitative and qualitative analysis was undertaken to evaluate the significance of the potential residual environmental effects for GHG emission indicators as these changes over the existing data were quantifiable and this approach was preferable based on discussions with federal, provincial and local regulatory authorities. Changes over the existing conditions were quantifiable and details on the calculations are summarized in the Air Quality and Greenhouse Gas Technical Report (Volume 5C). However, there are no standards, guidelines, objectives or other established and accepted thresholds to define quantitative rating criteria for GHG emissions or changes in environmental parameters. Therefore, the magnitude was evaluated qualitatively based on available research literature and professional judgment.

Table 7.2.5-8 provides a summary of the significance evaluation of the potential residual environmental effects of an increase in Project related construction and operation activities on the GHG emissions indicators. The rationale used to evaluate the significance of each of the residual environmental effects is provided below.

TABLE 7.2.5-8

SIGNIFICANCE EVALUATION OF POTENTIAL RESIDUAL EFFECTS OF PROJECT CONSTRUCTION AND OPERATION ON GHG EMISSIONS

Potential Effect	Impact Balance	Spatial Boundary	Temporal Context: Duration	Temporal Context: Frequency	Temporal Context: Reversibility	Magnitude	Probability	Confidence	Significance[1]
1. GHG Emissions Indicator – Emissions of CO_2, CH_4, and N_2O									
1(a) Increase in CO_2e emissions.	Negative	International	Short to long-term	Isolated to continuous	Permanent	Low	High	Moderate	Not significant
2. GHG Emissions Indicator - Effect on Overall Climate Change									
2(a) Changes in environmental parameters (*e.g.*, increase in global average temperature).	Negative	International	Short to long-term	Isolated to continuous	Permanent	Negligible	High	High	Not significant

Note: 1 Significant Residual Environmental Effect: A high probability of occurrence of a permanent or long-term residual effect of high magnitude that cannot be technically or economically mitigated.

GHG Emissions Indicator - Emissions of CO_2, CH_4, and N_2O

The following provides the evaluation of significance of potential residual effects on the emissions of CO_2, CH_4 and N_2O indicator.

Increase in CO_2e Emissions

Project emissions of GHG are summarized and compared with provincial and national emissions in Table 7.2.5-9. Note that construction emissions are only reported as overall totals for the entire construction period and, therefore, cannot be directly compared with provincial and national emissions which are reported annually. GHG emissions were estimated based on the most appropriate and conservative assumptions about Project activities where detailed information was unavailable.

Mitigation measures are provided in Table 7.2.5-7. Their implementation ensures that GHG emissions during construction are comparable to emissions of similar projects. Construction activities are of short-term duration and, therefore, of less concern for stakeholders than long-term operation emissions. Mitigation measures will reduce direct GHG emissions from maintenance and service activities during operation of the Project. The vast majority of annual operation emissions are indirect emissions from electricity use by the pump assemblies. The pumps are specified to operate as closely as possible to maximum efficiency. GHG emissions will cease immediately when Project activities stop and are, therefore, immediately reversible.

In 2011, Canada had total GHG emissions of 702 Mt of CO_2e as reported in the National Inventory Report 1990-2011 (Environment Canada 2013b). Alberta's contribution to national GHG emissions in 2011 was 242 Mt CO_2e, which is 34.5% of total Canadian emissions, while BC had 59.1 Mt of CO_2e emissions, corresponding to 8.4% of national emissions. Project operations in Alberta will result in a 0.46% increase in provincial emissions. In BC, the decrease in emissions will be 0.05%. Total Project operations are estimated to result in a 0.15% increase on Canada's national GHG emissions. While the GHG emissions are quantifiable, they are of low magnitude compared to provincial and federal total annual emissions.

TABLE 7.2.5-9

TOTAL GHG EMISSIONS GENERATED BY PROJECT CONSTRUCTION AND OPERATIONS

	Total Project Construction Emissions (t CO_2e)	Annual Project Operation Emissions (t CO_2e)	Provincial and Canadian Annual Emission Totals (2011) (t CO_2e)	Change in Provincial and Canadian Annual Emission Totals Caused by Project Operations
Alberta	176,900	1,114,000	242,000,000	0.46%
BC	808,800	-30,930	59,100,000	-0.05%
Total	985,800	1,083,000	702,000,000 (Canada)	0.15%

Events associated with the construction of the pipeline, pump stations, (including power lines), installation of the storage tanks, and expansion of the Westridge Marine Terminal as well as operation of temporary facilities and pipeline reactivation activities are limited to the duration of the construction phase and, therefore, isolated. Conversely, operation-related events for maintenance and inspection, building space heating and electricity use, and vapour combustion and vessel loading at the Westridge Marine Terminal are expected to occur periodically over the life of the operating terminal. Finally, electricity use by pump assemblies will occur continuously over the life of the operating facilities. A summary of the rationale for all of the significance criteria is provided below (Table 7.2.5-8, point 1[a]).

- Spatial Boundary: international – Project emissions of GHG disperse globally.
- Duration: short to long-term – the events causing Project emissions of GHG occur over a range of durations, from short-term for construction to long-term for operation activities of Project components.
- Frequency: isolated to continuous – the events causing Project emissions of GHG occur over a range of frequencies, from isolated construction events to periodic (*e.g.* maintenance and inspection activities) and continuous events (*e.g.,* fugitive emissions) during Project operations.
- Reversibility: permanent – Project emissions will result in a permanent addition to global GHG. Emissions of GHG cease immediately when Project activities end.
- Magnitude: low – Project emissions of GHG can be estimated and will be detectable. Total Project operations are estimated to result in a 0.35% increase on Canada's national GHG emissions. In the absence of environmental or regulatory emission limits for GHG emissions, the magnitude is rated as low.
- Probability: high – Project-related activities will result in emissions of GHG.
- Confidence: moderate – residual effects assessment is based on a good understanding of cause-effect relationships between the Project and GHG emissions; however, equipment-specific data are limited and, in some cases, obtained from outside the Project.

GHG Emissions Indicator – Effect on Overall Climate Change

The following provides the evaluation of significance of potential residual effects on the overall climate change indicator.

Changes in Environmental Parameters

The National Research Council (NRC) in its report on climate stabilization targets (NRC 2010), based on the most current modelling results, evaluated an approximately linear warming per cumulative emissions ranging from roughly 0.27°C to 0.68°C per 1,000,000 Mt CO_2e, or roughly 20 years of 2010 annual global GHG emissions. A best representative estimate of 0.47°C per 1,000,000 Mt CO_2e is selected as the climate response to cumulative GHG emissions. The NRC further pointed out that other changes in the climate system and physical environment (*e.g.,* precipitation changes and decreases in crop yields) are likewise proportional to cumulative GHG emissions. It is further noted, that these changes last over very long periods of time and, therefore, are practically permanent.

On the basis of these expected changes per cumulative GHG emissions, the effect of the Project on climate change can estimated. Assuming that the operation-related emissions will stay the same over the life of the operating pipeline and associated facilities, total estimated Project emissions, including construction emissions and operation emissions over a 50 year period, will add up to 55.1 Mt CO_2e. The effects of these emissions on global temperature and other environmental parameters are presented in Table 7.2.5-10.

TABLE 7.2.5-10

EFFECT OF THE PROJECT ON OVERALL CLIMATE CHANGE

Change in Environmental Parameter	Best Estimate
Global warming (°C)	2.6×10^{-5}
Precipitation changes (%)	±0.00022
Increase in heavy rainfall (%)	0.00021
Yield reduction in a number of crops (%)	0.00032
Changes in streamflows (%)	±0.00022
Decrease in the extent of annually averaged Arctic sea ice (%)	0.00058
Decrease in the extent of September Arctic sea ice (%)	0.00058

Although these effects can be estimated, they are approximately five orders of magnitude smaller than natural year-to-year variability or variations due to local microclimate changes. The estimated changes in Table 7.2.5-10 cannot be measured and, therefore, the magnitude is rated negligible. Local or regional changes of climate that may be of concern to stakeholders are caused by the sum of all global GHG emissions and, therefore, require international initiatives to reduce overall climate change.

Mitigation measures to reduce potential effects of all Project-related activities on overall climate change are the same as for the potential effects of all Project-related activities on GHG emissions as listed in Table 7.2.5-7. Their implementation ensures that the effects on overall climate change during construction are comparable to those of similar projects.

The events during construction of the pipeline, pump stations (including power lines), installation of the storage tanks, and expansion of the Westridge Marine Terminal as well as operation of temporary facilities and pipeline reactivation activities are limited to the duration of the construction phase, and therefore, are considered short-term. Operation-related events that cause climate change effects are expected to occur over the life of the operating pipeline and associated facilities and, therefore, are considered long-term.

The events associated with the construction of the pipeline, pump stations (including power lines), installation of the storage tanks, and expansion of the Westridge Marine Terminal as well as operation of temporary facilities and pipeline reactivation activities are limited to the construction phase and, therefore, are considered to be isolated in frequency. Maintenance and inspection activities, building space heating and electricity use, and fugitive vapour combustion from vessel loading at the Westridge Marine Terminal are expected to occur periodically (intermittently but repeatedly) over the life of the operating pipeline and associated facilities. Finally, fugitive GHG emissions and electricity use by pump assemblies are expected to occur continuously over the life of the operating pipeline and associated facilities.

The modelling results in NRC (2010) show no substantial decrease in the change of environmental parameters presented in Table 7.2.5-10 for hundreds to thousands of years; therefore, reversibility is effectively permanent.

A summary of the rationale for all of the significance criteria is provided below (Table 7.2.5-8, point 2[a]).

- Spatial Boundary: international – effects on climate change are global in nature.
- Duration: short to long-term – the events resulting in potential effects on climate change occur over a range of durations, from short-term construction to long-term operations events.

- Frequency: isolated to continuous – the events resulting in potential effects on climate change occur over a range of frequencies from isolated construction activities to continuous electricity use by pump assemblies.
- Reversibility: permanent – potential effects on climate change are considered irreversible.
- Magnitude: negligible – changes in environmental parameters (*e.g.*, increase in global average temperature) resulting from Project-related activities are not detectable from existing (baseline) climate variability.
- Probability: high – Project-related activities will contribute, albeit a small amount, to global GHG emissions and resultantly global climate change.
- Confidence: high – determination of significance is based on a good understanding of cause-effect relationships between GHG emissions from Project activities and overall climate change. Observational and numerical modelling data also support the significance determination.

7.2.5.7 Summary

As identified in Table 7.2.5-8, there are no situations where there is a high probability of occurrence of a permanent or long-term residual environmental effect on GHG emissions indicators of high magnitude that cannot be technically or economically mitigated. Consequently, it is concluded that the residual environmental effects of Project construction and operation on GHG emissions will not be significant.

7.2.6 Acoustic Environment

This assessment considers both sound and vibrations as components of the Acoustic Environment. The Project will employ heavy equipment for construction of the Project and mechanical equipment for the tanks, pump stations and Westridge Marine Terminal operations. These are all sources of sound that may change the acoustic environment at sensitive locations (primarily places people live) and so are evaluated in the assessment of Project effects. Similarly, blasting may be required for pipeline construction which may generate vibrations at sensitive locations. This subsection evaluates the effects due to the Project on the Acoustic Environment.

7.2.6.1 Assessment Indicators and Measurement Endpoints

Assessment indicators identified for the acoustic environment element are sound levels and vibrations. Sound levels refer to the amount of sound in the outdoor environment, as may be experienced by people or wildlife. Vibrations refer to airborne or ground borne vibrations that occur from blasting, as may be experienced by people or wildlife. Assessment indicators and measurement endpoints for acoustic environment are listed in Table 7.2.6-1.

The NEB *Filling Manual* also requires that potential for cumulative effects with residual sound be evaluated. Specific noise criteria are not cited in the NEB *Filing Manual*, however, the guidance provided specifically refers to the Alberta Energy Regulator (AER) and BC Oil and Gas Commission (OGC) noise limits. Though not specifically referenced in the NEB *Filing Manual*, the Health Canada guidance can be used to provide context around sound level changes, specifically in urban areas with multiple receptors.

The assessment indicators and endpoints for sound in the acoustic environment are those defined in AER *Directive 038: Noise Control* (Alberta Energy Resources Conservation Board [ERCB] 2007) and the BC OGC *Noise Control Best Practices Guideline* (BC OGC 2009). These methods are focussed on the human environment, specifically residences.

The indicators for the acoustic environment are sound levels, specifically at noise sensitive receptors. As defined in AER *Directive 038* and the BC OGC *Noise Control Best Practices Guideline*, noise sensitive receptors are any dwelling or residence occupied at least six weeks per year within 1.5 km of the Project Footprint. From the wildlife perspective, noise sensitive receptors are habitat areas where sensitive species are present.

Since both Alberta and BC do not have generally accepted guidelines for the evaluation of airborne/ground-borne vibration, guidance from another Canadian province was used. The *Cautionary Limit from the Noise Pollution Control Publication 119 (NPC-119)* by the Ontario Ministry of Environment (ON MOE) guidance was found to be the most stringent, therefore, was used to compare against the calculations of airborne/ground-borne vibration from blasting for the Project.

No direct feedback regarding noise indicators was received from the ESA Workshops, except that some participants sought assurance that existing provincial requirements were to be used. Since the provincial noise requirements are well defined, there was no additional consultation with provincial regulatory authorities about the indicators. PMV was consulted, as ports are federal facilities that are not required to meet provincial or municipal regulations or guidance. PMV noted that it has no specific noise criteria but generally follows Health Canada and municipal bylaws regarding noise issues. BC and Alberta provincial requirements as well as Health Canada and municipal bylaws are all considered in the assessment.

Endpoints represent measureable attributes of the assessment endpoints that can be quantified, predicted and compared to existing conditions, guidelines or other similar criteria suitable for evaluating change. One endpoint from the AER/BC OGC criteria has been selected for sound in the acoustic environment:

- the energy equivalent (L_{eq}) sound level measured in A-weighted decibels.

Two endpoints from the ON MOE NPC-119 criteria have been selected for the airborne and ground-borne vibration acoustic environment:

- the Peak Pressure Level or L_{peak} measured in linear (un-weighted) decibels (airborne); and
- the Peak Particle Velocity or PPV measured in millimeters per second (ground-borne).

TABLE 7.2.6-1

ASSESSMENT INDICATORS AND MEASUREMENT ENDPOINTS FOR ACOUSTIC ENVIRONMENT

Acoustic Environment Indicators	Measurement Endpoints	Rationale for Indicator Selection
Sound levels	• Energy equivalent (Leq) sound level measured in A-weighted decibels	Indicator as defined by the assessment methods cited under the acoustic environment element in Table A-2 of the NEB *Filing Manual*.
Vibration	• Peak Pressure Level or Lpeak measured in linear (un-weighted) decibels • Peak Particle Velocity or PPV measured in millimeters per second	Both indicators are used to define the potential affects from blasting. Methods from ON MOE used in absence of guidance in other documentation.

7.2.6.2 Spatial Boundaries

The spatial boundaries used in the effects assessment of acoustic environment considered one or more of the following areas:

- a Footprint Study Area (as defined in Section 7.1.3);
- an Acoustic Environment LSA; and
- an Acoustic Environment RSA.

As defined in AER *Directive 038* and the BC OGC *Noise Control Best Practices Guideline*, the Acoustic Environment LSA is defined as 1.5 km from the fenceline or Footprint of the Project. For construction, this includes the pipeline, pump stations and terminals. For operations, this includes the pump stations and terminals only.

In the absence of a setback distance listed in the Health Canada guidance document, the AER and BC OGC criteria was used at all locations. The AER and BC OGC criteria require that noise be controlled at the 1.5 km distance from the fenceline or Footprint. Therefore, potential effects of the Project on human receptors are not anticipated to extend beyond the Acoustic Environment LSA, however, cumulative effects from other developments could occur within 1.5 km of those other developments, so an Acoustic Environment RSA of 5 km is considered. Vibration levels are discussed within the Acoustic Environment RSA, which is the area potentially affected by construction vibration, consisting of a 10 km wide band extending from the proposed pipeline corridor (*e.g.,* Footprint plus 5 km on both sides of the proposed pipeline corridor). The Acoustic Environment RSA is shown in Figures 5.4-1 to 5.4-4.

The Acoustic Environment LSA and RSA for sound levels were discussed during the ESA Workshops held in March 2013. No specific comments or suggestions were received regarding the sound level LSA and RSA boundaries.

7.2.6.3 Acoustic Environment Context

The acoustic environment will vary based on the level of development and geography along the proposed pipeline corridor. Human developments, the presence of infrastructure, the amount of foliage, the density of wildlife and weather all influence sound level in the outdoor environment. It is normal for sound levels to fluctuate over the course of a day or night, with the amount and timing of those fluctuations being influenced by the local sources of sound.

The proposed pipeline corridor travels through varying levels of human development, such as urban, sub-urban, rural and unoccupied areas. Urban and sub-urban areas will be influenced by people's daily activities and local industry. Rural areas are influenced by local infrastructure (*e.g.,* traffic or trains) and existing pipeline sources (*e.g.,* pump stations or maintenance activities) equally with the natural environment while the natural environment dominates in undeveloped areas. Noise will have greater natural fluctuations in rural and undeveloped areas. Urban areas will have more consistent sound levels over time, but also higher sound levels due to the level of local activity.

The AER *Directive 038* and BC OGC *Noise Control Best Practices Guideline* used as the basis for the assessment in the Terrestrial Noise and Vibration Technical Report (Volume 5C) define both an expected existing environment and allowable thresholds for sound levels at homes. The Health Canada guidance also used, either looks at an upper limit or bases the degree of change on existing conditions. The directive and guidelines all take into account the natural fluctuations in outdoor sound.

The perception of change in sound levels for people will depend on the amount of sound that occurs on average over time, rather than moment by moment. People can typically start to notice a change in sound level of 3 dBA (Crocker 2007). The assessment looked at thresholds for noise on day and night average basis given by the guidelines as well as the potential for long-term of average sound level changes of 3 dBA.

Vibration from blasting is experienced as singular events. The airborne and ground-borne vibration can result in a physical sensation if the blast impulse is strong enough. Blasting may be required for some segments of the pipeline construction, and the vibrations from blasts could be noticed by nearby residents if present. However, blast designs for the Project construction also need to consider existing infrastructure, so the blasts will be limited in size and scope.

7.2.6.4 Potential Effects and Mitigation Measures

<u>Effects Considerations</u>

The review of regulatory requirements and the outcome of the ESA Workshops indicate that no indicators, other than those outlined in the AER *Directive 038* and BC OGC N*oise Control Best Practices Guideline* are to be considered in the evaluation of effects on the Acoustic Environment. Both these documents use similar indicators for long-term average sound levels (on a day and night basis).

The potential for Low Frequency Noise (LFN) is a consideration for sound emitted from industrial facilities. Both the AER *Directive 038* and BC OGC *Noise Control Best Practices Guideline* indicate that LFN should be evaluated where data is available at the initial assessment stage and the detailed analysis of

LFN is a requirement when investigating complaints. Equipment sound emissions of sufficient detail to evaluate LFN are typically not available until a later stage of design or construction planning, generally after vendor and contractor selection. Therefore, the potential for LFN based on the theoretical values used in this assessment was studied in the Terrestrial Noise and Vibration Technical Report (Volume 5C). However, the LFN indicator was not carried into the effects assessment since compliance with this indicator is not a primary requirement of the AER or BC OGC, and due to the theoretical nature of the data used in the assessment.

Identified Potential Effects

Potential effects associated with the construction and operations of the proposed pipeline on acoustic environment indicators are listed in Table 7.2.6-2. These interactions are based on the results of the literature review, desktop analysis, modelling, Aboriginal engagement and consultation with landowners, regulatory authorities and other stakeholders (Section 3.0), and the professional experience of the assessment team.

A summary of mitigation measures provided in Table 7.2.6-2 was principally developed in accordance with Trans Mountain standards as well as provincial regulatory guidelines including BC MOE (2012a).

TABLE 7.2.6-2

POTENTIAL EFFECTS, MITIGATION MEASURES AND RESIDUAL EFFECTS OF PIPELINE CONSTRUCTION AND OPERATIONS ON THE ACOUSTIC ENVIRONMENT

Potential Effect	Pipeline Segment(s)	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
1. Acoustic Environment Indicator – Sound Levels				
1.1 Changes in sound level during construction	All	LSA	• Adhere to all federal (*i.e.,* Environment Canada, *Motor Vehicle Safety Act*, *Oil and Gas Occupational Safety and Health Regulations*, Health Canada) and provincial (*i.e.,* Directive 038: Noise Control, *BC Noise Control Guideline Best Practices Guideline*, *Worker's Compensation Act*, section 7.2 of the *Occupational Health and Safety Regulations* [BC Reg 296/97 as amended] Section 7.2 [BC Reg. 382/2004, s.1]) guidelines and regulations and legislation for noise management [Section 7.0]. • Noise abatement and construction scheduling will be considered at noise sensitive locations (*i.e.,* neighbouring landowners) and during noise sensitive periods [Section 7.0]. • Schedule intermittent noise producing events to avoid, where feasible, important habitat of wildlife species at risk/sensitive species/livestock during sensitive periods, where feasible [Section 7.0]. • Enforce vehicle speed limits and inform contractor truck drivers and equipment operators that engine retarder braking in urban areas is prohibited [Section 7.0]. • Maintain equipment in good working condition and in accordance with manufacturer guidelines [Section 7.0]. • Maintain noise suppression equipment on all construction machinery and vehicles in good order [Section 7.0]. • Enclose noisy equipment and use baffles, where and when feasible, to limit the transmission of noise beyond the construction site [Section 7.0]. • Use only the size and power of tools necessary limit noise from power tool operations. Locate stationary equipment, such as compressors and generators located away from noise receptors, to the extent feasible, and follow applicable municipal, provincial and federal guidelines [Section 7.0]. • Implement mitigation measures where residences are located within 300 m of the construction right of way or facility site as outlined in the Noise Management Plan [Section 7.0].	• Increase in sound levels during construction period.

TABLE 7.2.6-2 Cont'd

Potential Effect	Pipeline Segment(s)	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
1.1 Changes in sound level during construction (cont'd)	See above	See above	• Implement mitigation measures where night time activity (*e.g.,* HDD) on the construction right of way or facility site is located within 500 m of residences as outlined in the Noise Management Plan [Section 7.0].	• See above
1.2 Changes in sound level during operation	All	LSA	• Limit helicopter inspections to weekdays only to the extent practical. • Use of off-road vehicles for inspection should be limited to weekdays if feasible. • Maintain equipment in good working condition and in accordance with manufacturer guidelines. • Maintain noise suppression equipment on all construction machinery and vehicles in good order.	• Periodic noise events due to maintenance and inspections.
2. Acoustic Environment Indicator – Vibrations				
2.1 Changes in vibrations during construction	All	RSA	• Implement mitigation measures where residences are located within 300 m of the construction right of way or facility site as outlined in the Noise Management Plan [Section 7.0]. • Noise Management Plan will limit vibrations to acceptable levels.	• Increase in airborne/ground-borne vibrations during blasting aspects of construction period.
2.2 Changes in vibrations during operation	All	RSA	• None required, buried pipeline.	• No residual effects identified.

Notes: 1 LSA = Acoustic Environment LSA; RSA = Acoustic Environment RSA.
2 Detailed mitigation measures are outlined in the Pipeline EPP (Volume 6B).

7.2.6.5 Potential Residual Effects

The potential residual environmental effects on acoustic environment indicators associated with the construction and operations of the pipeline (Table 7.2.6-2) are:

- increase in sound levels during construction;
- periodic noise events due to maintenance and inspections; and
- increase in airborne/ground-borne vibrations during blasting aspects of construction period.

No residual effects associated with changes in vibrations during operations were identified since the pipeline will be buried and largely unaffected by above ground noise sources.

7.2.6.6 Significance Evaluation of Potential Residual Effects

A quantitative assessment of the acoustic environment was determined to be the most appropriate approach to evaluate the significance of potential residual environmental effects. The evaluation of significance of each of the potential residual effects for the acoustic environment relies primarily on the magnitude, duration and frequency of the potential change. The general definitions for these criteria are provided in Table 7.1-2. However, magnitude of residual effects requires further definition for the acoustic environment evaluation and is indicator specific. Magnitude for sound level has been defined based on the degree of compliance with provincial and Health Canada guidelines. Magnitude for vibration levels have been defined based on the degree of compliance with the ON MOE blasting guidance NPC-119. The evaluation is also based on the professional judgment of the assessment team. Details on the guidelines and legislation used to establish the magnitude ratings can be found in the Terrestrial Noise and Vibration Technical Report of Volume 5C.

The definitions of magnitude for the L_{eq} in dBA sound level indicator are:

Negligible: Below BC OGC and AER ambient sound level (ASL).

Low: Below BC OGC/AER permissible sound level (PSL) limits and Health Canada limit.

Medium: Less than Health Canada 75 dBA guideline limit for construction but greater than the temporary activity AER/BC OGC daytime PSL of 60 dBA in rural areas to 76 dBA in heavily urbanized areas.

High: Greater than the Health Canada 75 dBA guideline limit for construction.

The definitions of magnitude for the vibration indicators are:

Negligible: No change to ambient vibration levels.

Low: Below ON MOE limits of 120 dBL (airborne) and 10 mm/s (ground-borne).

Medium: Equal to or slightly below ON MOE limits of 120 dBL (airborne) and 50 mm/s (ground-borne).

High: Greater than ON MOE limits of 120 dBL (airborne) and/or 50 mm/s (ground-borne).

Table 7.2.6-3 provides a summary of the significance evaluation of the potential residual environmental effects of the construction and operations of the proposed pipeline on the acoustic environment. The rationale used to evaluate the significance of each of the residual environmental effects is provided below.

TABLE 7.2.6-3

SIGNIFICANCE EVALUATION OF POTENTIAL RESIDUAL EFFECTS OF PIPELINE CONSTRUCTION AND OPERATIONS ON ACOUSTIC ENVIRONMENT

Potential Residual Effects	Impact Balance	Spatial Boundary[1]	Temporal Context			Magnitude	Probability	Confidence	Significance[2]
			Duration	Frequency	Reversibility				
1. Acoustic Environment Indicator – Sound Levels									
1(a) Increase in sound levels during construction period.	Negative	LSA	Short-term	Isolated	Short-term	Low to medium	High	Moderate	Not significant
1(b) Periodic noise events due to maintenance and inspections.	Negative	LSA	Short-term	Periodic	Immediate to short-term	Negligible to medium	High	Moderate	Not significant
1(c) Combined effects on the sound level indicator (1[a] and 1[b].)	Negative	LSA	Short-term	Isolated	Short-term	Low to medium	High	Moderate	Not significant
2. Acoustic Environment Indicator – Vibration									
2(a) Increase in airborne/ground-borne vibrations during blasting aspects of construction period.	Negative	LSA	Short-term	Isolated	Short-term	Low to medium	High	Moderate	Not significant

Notes: 1 LSA = Acoustic Environment LSA; RSA = Acoustic Environment RSA.

2 Significant Residual Environmental Effect: A high probability of occurrence of a permanent or long-term residual effect of high magnitude that cannot be technically or economically mitigated.

Acoustic Environment Indicator – Sound Levels

The following provides the evaluation of significance of potential residual effects on the sound level indicator.

Increase in Sound Levels During Construction Period

The potential for the increase in daytime or night time sound levels for human receptors associated with pipeline construction is considered to have a negative impact balance. Participants of several of the Community Workshops (*e.g.*, Edmonton, Wabamun, Edson, Valemount, Blue River, Clearwater, Kamloops Merritt, Hope, Abbotsford, Langley, Surrey) noted that construction was a concern for local residents and could potentially affect other users in the area (*e.g.*, recreational users in provincial parks, campers, hunters) if construction were to coincide with summer months. The latter concern is further discussed under the human occupancy and resource use element in Volume 5B and in the Socio-Economic Technical Report (Volume 5D). Based on the results of the analysis in the Terrestrial Noise and Vibration Technical Report (Volume 5C), the spatial extent of changes to sound levels from pipeline construction were limited to the Acoustic Environment RSA. However, the significance of changes is based on the compliance with regulatory guidance for noise. Compliance with regulatory requirements occurs within the Acoustic Environment LSA.

The duration of the sounds experienced at receptors is dependent on the activity; each type of sound will last only for the particular phase of construction (*e.g.,* clearing, trenching, welding, and reclamation). As described in Section 2.0, construction is expected to last for approximately 3 months at any location along the propose pipeline corridor. However, within that period, the various phases of construction will occur consecutively. Given the need to transition each phase, the time for maximum activity during each phase is limited. Maximum activity from construction phases may occur within the closest proximity of a particular residential receptor for one to two weeks. In urban areas, activities are expected to be limited to one week.

The frequency of sound emissions during each construction phase will be isolated, as construction is cyclic and involves use of mobile equipment and intermittent use of tools. The period over which the change in noise extends is the construction period and, therefore, the residual effect is conservatively considered to be of short-term reversibility. However, as soon as construction activity stops, the sound level changes are reversed.

The results of predictive modelling for construction of the pipeline indicates the magnitude of changes in sound levels that will be experienced by people living within 1.5 km of the proposed pipeline corridor for a variety of construction activities. Noise controls that will be in use during the construction phase, particularly the use of silencers on mobile equipment and executing a communications plan with receptors are expected to control the amount of sound to within acceptable levels as established in the Terrestrial Noise and Vibration Technical Report of Volume 5C. Controlling the magnitude of sound level changes also limits the spatial extent of the potential change.

A generic model for various types of construction activities was developed, which indicates the maximum expected sound levels from an activity at various distances from that activity on an hourly basis. Given the normal variation in activity during the day for construction, actual sound levels over the full day are expected to be less, although planning for activity cycles is not conducted until later in the Project development process. The maximum hour is being compared to longer term (15 hour day) criteria as an indication of the potential for effect. The summary of results for construction activity is shown in Figure 7.2.6-1.

As shown in Figure 7.2.6-1, the magnitude of effect due to sound from Project construction varies depending on the distance between the construction activities and the surrounding receptors. As such, the evaluation of magnitude has been broken down into each of the applicable five segments of proposed pipeline corridor to allow for consideration of receptors along the length of the corridor.

The types of equipment used and in turn, the sound emissions used for the assessment are similar to those used for construction of other developments such as highways or industrial parks. Day-long sound levels and the degree of variation in sound levels experienced from pipeline construction are expected to be similar to sounds perceived near these types of activities.

<u>Edmonton to Hinton Segment</u>

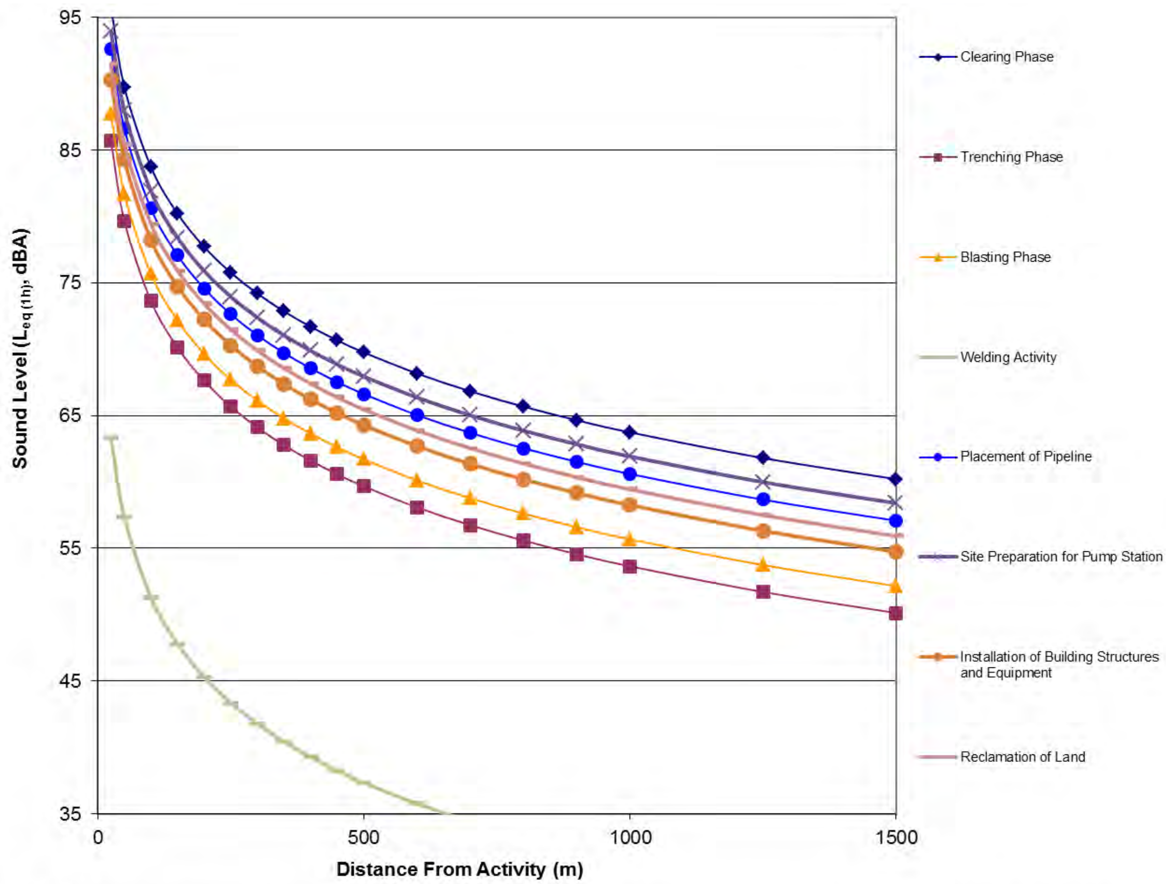
The setback distances from edge of the proposed pipeline corridor to the noise sensitive receptors along the Edmonton to Hinton Segment of the proposed pipeline corridor ranges from close by in urban areas, such as the City Edmonton, Town of Hinton and the Town of Edson, to distant, as far as the boundary of the Acoustic Environment LSA in rural areas. The closest urban receptor to the proposed pipeline corridor was found to be approximately 40 m away in the City of Edmonton near RK 33. The closest rural receptor is immediately adjacent to the pipeline corridor (less than 20 m) located near RK 79. Based on Figure 7.2.6-1, the anticipated sound level at the closest receptor is greater than 85 dBA depending on the activity. The magnitude for this receptor is rated as high. The number of potentially affected receptors at various distances from the proposed pipeline corridor was estimated through review of available mapping and land use data. Estimates rounded to the nearest 50 homes are presented in Table 7.2.6-4. Note that the number of potentially affected receptors is conservative as it is based on available map data. Actual numbers are anticipated to be lower based on a finalized route and receptor ground-truthing.

TABLE 7.2.6-4

DISTANCES TO NOISE SENSITIVE RECEPTORS WITHIN THE ACOUSTIC ENVIRONMENT LSA OF PROPOSED PIPELINE CORRIDOR WITHIN THE EDMONTON TO HINTON SEGMENT

Distance from Proposed Pipeline Corridor (m)	Number of Potentially Affected Receptors (approximate)	Magnitude of Potential Residual Effects
0-300	8,150	High
300-1,500	54,300	Low to medium

Figure 7.2.6-1 Predicted Construction Sound Level Estimates



Notes:
- Predicted noise levels account for distance attenuation (geometric spreading) only. Actual sound levels at distances greater than 300 m would be expected to be much less than those shown.
The quantity and type of each equipment used in each actvity phase is presented in the Terrestrial Noise and Vibration Technical Report (Volume 5C)

While the prediction results indicate there is potential for high magnitude effects at homes within 300 m of the proposed pipeline corridor due to construction noise, these sounds will vary throughout the day, and can be controlled to meet municipal bylaws. The detailed construction planning required to fully assess urban sound levels is not available at this stage of Project planning. However, should specific and localized construction activities necessitate operating on a 24 hour basis to completion, such as horizontal directional drilling of a watercourse, a noise management plan will be prepared in the event human receptors are present within 300 m of the watercourse. In addition, a noise management plan to be prepared for use during construction in urban environments is expected to bring potential sound levels to within levels that result in medium magnitude effects.

Hargreaves to Darfield Segment

The setback distances from the edge of the proposed pipeline corridor to the noise sensitive receptors along the Hargreaves to Darfield Segment of the proposed pipeline corridor range from close, in moderately urbanized areas such Village of Valemount, Community of Blue River, Community of Avola and the Hamlet of Blackpool, to distant, as far as the boundary of the Acoustic Environment LSA in rural areas. The closest identified receptor to the proposed pipeline corridor was found to be adjacent to the corridor (less than 20 m away) near RK 614. Based on Figure 7.2.6-1, the anticipated sound level at the closest receptor is greater than 85 dBA, depending on the type of activity. The magnitude for this receptor is rated as high. The number of potentially affected receptors at various distances from the proposed pipeline corridor was estimated through review of available mapping and land use data. Estimates rounded to the nearest 50 homes are presented in Table 7.2.6-5. Note that the number of potentially affected receptors is conservative as it is based on available map data. Actual numbers are anticipated to be lower based on a finalized route and receptor ground-truthing.

TABLE 7.2.6-5

DISTANCES TO NOISE SENSITIVE RECEPTORS WITHIN THE ACOUSTIC ENVIRONMENT LSA OF PROPOSED PIPELINE CORRIDOR WITHIN THE HARGREAVES TO DARFIELD SEGMENT

Distance from Proposed Pipeline Corridor (m)	Number of Potentially Affected Receptors	Magnitude of Potential Residual Effects
0-300	750	High
300-1,500	2,100	Low to medium

While the prediction results indicate there is potential for high magnitude effects at homes within 300 m of the proposed pipeline corridor due to construction noise, these sounds will vary throughout the day, and can be controlled to meet municipal bylaws. The detailed construction planning required to fully assess urban sound levels is not available at this stage of Project planning. However, should specific and localized construction activities necessitate operating on a 24 hour basis to completion, such as horizontal directional drilling of a watercourse, a noise management plan will be prepared in the event human receptors are present within 300 m of the watercourse. In addition, a noise management plan to be prepared for use during construction in urban environments is expected to bring potential sound levels to within the 75 dBA threshold that results in medium magnitude effects.

Black Pines to Hope Segment

The setback distances from the edge of the proposed pipeline corridor to the noise sensitive receptors along the Black Pines to Hope Segment of the proposed pipeline corridor range from close in urban areas such as the City of Kamloops, City of Merritt and the District of Hope to the boundary of the Acoustic Environment LSA in rural areas. The closest identified receptor to the proposed pipeline corridor was found to be adjacent to the corridor (less than 20 m away) near RK 845. Based on Figure 7.2.6-1, the anticipated sound level at the closest receptor is greater than 85 dBA, depending on the type of activity. The magnitude for this receptor is rated as high. The number of potentially affected receptors at various distances from the proposed pipeline corridor was estimated through review of available mapping and land use data. Estimates rounded to the nearest 50 homes are presented in Table 7.2.6-6. Note that the number of potentially affected receptors is conservative as it is based on available map data. Actual numbers are anticipated to be lower based on a finalized route and receptor ground-truthing.

TABLE 7.2.6-6

DISTANCES TO NOISE SENSITIVE RECEPTORS WITHIN THE ACOUSTIC ENVIRONMENT LSA OF PROPOSED PIPELINE CORRIDOR WITHIN THE BLACK PINES TO HOPE SEGMENT

Distance from Proposed Pipeline Corridor (m)	Number of Potentially Affected Receptors	Magnitude of Potential Residual Effects
0-300	2,300	High
300-1,500	9,450	Low to medium

While the prediction results indicate there is potential for high magnitude effects at homes within 300 m of the proposed pipeline corridor due to construction noise, these sounds will vary throughout the day, and can be controlled to meet municipal by-laws. The detailed construction planning required to fully assess urban sound levels is not available at this stage of Project planning. However, should specific and localized construction activities necessitate operating on a 24 hour basis to completion, such as horizontal directional drilling of a watercourse, a noise management plan will be prepared in the event human receptors are present within 300 m of the watercourse. In addition, a noise management plan to be prepared for use during construction in urban environments is expected to bring potential sound levels to within levels the 75 dBA threshold that results in medium magnitude effects.

Hope to Burnaby Segment

The setback distances from the edge of the proposed pipeline corridor to the noise sensitive receptors along the Hope to Burnaby Segment of the proposed pipeline corridor range from close in urban areas, such as the Township of Langley, the City of Surrey and the City of Burnaby, to distant, as far as the edge of the Acoustic Environment LSA in rural areas. The closest urban receptors to the proposed pipeline corridor were found to be adjacent to the corridor (less than 20 m away) and occur at multiple locations along the proposed pipeline corridor, particularly as the corridor enters urban areas east of Burnaby. Based on Figure 7.2.6-1, the anticipated sound level at the closest receptors is greater than 85 dBA, depending on the type of activity. The magnitude for this receptor is rated as high. The number of potentially affected receptors at various distances from the proposed pipeline corridor was estimated through review of available mapping and land use data. Estimates rounded to the nearest 50 homes are presented in Table 7.2.6-7. Note that the number of potentially affected receptors is conservative and actual numbers are anticipated to be lower based on a finalized route.

TABLE 7.2.6-7

DISTANCES TO NOISE SENSITIVE RECEPTORS WITHIN THE ACOUSTIC ENVIRONMENT LSA OF PROPOSED PIPELINE CORRIDOR WITHIN THE HOPE TO BURNABY SEGMENT

Distance from Proposed Pipeline Corridor (m)	Number of Potentially Affected Receptors	Magnitude of Potential Residual Effects
0-300	14,00	High
300-1,500	57,100	Low to medium

While the prediction results indicate there is potential for high magnitude effects at receptors within 300 m of the proposed pipeline corridor due to construction noise, these sounds will vary throughout the day, and can be controlled through detailed planning and use of sound reduced equipment in densely populated areas. The detailed construction planning required to fully assess urban sound levels is not available at this stage of project planning. A detailed noise management plan to be prepared for use during construction in urban environments is expected to bring potential sound levels to within the 75 dBA threshold that results in medium magnitude levels.

Burnaby to Westridge Segment

The setback distances from the edge of the proposed pipeline corridor to the noise sensitive receptors along the Burnaby to Westridge Segment of proposed pipeline corridor are considered short due to the degree of urbanization along this segment of the proposed pipeline corridor. The closest identified receptors to the proposed pipeline corridor were found to be adjacent to the corridor (less than 20 m away) and were locations along the final 1.5 km of the pipeline. Based on Figure 7.2.6-1, the anticipated sound level at the closest receptor is greater than 85 dBA, depending on the type of activity. The magnitude for this receptor is rated as high. The number of potentially affected receptors at various distances from the proposed pipeline corridor was estimated through review of available mapping and land use data. Estimates rounded to the nearest 50 homes are presented in Table 7.2.6-8. Note that the number of potentially affected receptors is conservative as it is based on available map data. Actual numbers are anticipated to be lower based on a finalized route and receptor ground-truthing.

TABLE 7.2.6-8

DISTANCES TO NOISE SENSITIVE RECEPTORS WITHIN THE ACOUSTIC ENVIRONMENT LSA OF PROPOSED PIPELINE CORRIDOR WITHIN THE BURNABY TO WESTRIDGE SEGMENT

Distance from Proposed Pipeline Corridor (m)	Number of Potentially Affected Receptors	Magnitude of Potential Residual Effects
0-300	1,376	High
300-1,500	6,950	Low to medium

While the prediction results indicate there is potential for high magnitude effects at receptors within 300 m of the proposed pipeline corridor due to construction noise, these sounds will vary throughout the day, and can be controlled through detailed planning and use of a noise management plan. The detailed construction planning required to fully assess urban sound levels is not available at this stage of project planning. A detailed noise management plan to be prepared for use during construction in urban environments is expected to bring potential sound levels to within medium magnitude levels.

Residential dwellings are located within sufficient proximity of construction activity for sound level changes to occur along much of the proposed pipeline corridor. Therefore, the probability of occurrence is high.

The predictive modelling used in the assessment of the acoustic environment has a level of uncertainty that is dependent on three factors: the accuracy of the sound source data; the precision of the noise propagation model; and the accuracy of locations and quantities of noise sources. Conservative choices were made regarding the sound source data. Where practical, measured data of similar equipment were used but often theoretical data was required which increases uncertainty in the results. A model that uses key international standards for outdoor sound propagation with a known uncertainty was used and the locations and quantities of sources are based on Section 2.0 of Volume 5A. The confidence that the results are conservative, yet representative is considered moderate.

A summary of the rationale for all of the significance criteria is provided below (Table 7.2.6-3, point 1[a]).

- Spatial Boundary: Acoustic Environment LSA – compliance with the AER *Directive 038* and BC OGC *Noise Control Best Practices Guideline* are achieved within the Acoustic Environment LSA.
- Duration: short-term – the events causing changes in sound levels occur only during the construction phase.
- Frequency: isolated – the events causing changes in sound level occur at residential dwellings occur during the construction phase.
- Reversibility: short-term – the period over which the change in sound level extends is the construction period. However, at any specific location along the proposed pipeline corridor, all sound level changes will cease when construction activities have finished.
- Magnitude: low to medium – in urban areas, with the implementation of a detailed noise management plan for construction, the changes in sound level are considered to be medium while in rural areas, the change in sound level ranges from low to medium depending on the distance from construction activity.

- Probability: high – based on the proximity of residences to the proposed pipeline corridor.
- Confidence: moderate – based on the nature of data inputs.

Periodic Noise Events Due to Maintenance and Inspections

Noise from pipeline operations is limited to regular aerial and ground patrols vegetation management and integrity digs. Sounds would be similar to those already heard in areas where the proposed pipeline corridor is adjacent to the existing TMPL right-of-way. Similar to noise during construction, noise resulting from periodic site-specific maintenance will be limited to the same receptors in close proximity to the proposed pipeline corridor.

The spatial extent of the change sound level is limited to the Acoustic Environment LSA. Since maintenance activities are typically completed at any given location within a few minutes to hours (aerial patrols, vegetation management) or within several weeks (*e.g.*, integrity digs), the duration of the maintenance and inspection activities is short-term. The frequency of maintenance activities occur intermittently but repeatedly over the assessment period and, therefore, are considered to be periodic. The effect is reversible in the immediate to short-term as sound level changes due to maintenance activity will cease as soon as the maintenance activity stops.

While aerial patrols or vegetation management during operations may cause momentary sound levels to increase, the day and night average levels are not expected to change due to such short duration events. Although integrity digs may extend over several weeks, the amount and size of the equipment used during this activity is generally smaller than that used during pipeline construction. Nevertheless, the magnitude of the change in sound level during operations of the pipeline is considered to be of negligible magnitude for most operational activities and of medium magnitude for integrity digs where there are nearby human receptors.

The inspections and maintenance are essential to safe pipeline operations so the probability of occurrence is rated as high. The confidence is considered moderate based on the uncertainty in the data used for the evaluation of fly-by noise. A summary of the rationale for all of the significance criteria is provided below (Table 7.2.6-3, point 1[b]).

- Spatial Boundary: Acoustic Environment LSA – the change in sound level during operations is confined to the Acoustic Environment LSA.
- Duration: short-term – the events causing changes in sound levels during operations (*i.e.*, maintenance activities) are completed within any 1 year during operations.
- Frequency: periodic – the events causing changes in sound levels during operations (*i.e.*, aerial patrols, vegetation management, integrity digs) occur intermittently but repeatedly over the assessment period.
- Reversibility: immediate to short-term – the changes in sound level associated with maintenance activities at any given location range from a few minutes to hours for aerial patrols and vegetation management (immediate) to a few weeks for integrity digs (short-term). All sound level changes are reversible as the sound will cease when the inspection/maintenance is finished.
- Magnitude: negligible to medium – the sound level events associated with aerial patrols and vegetation management will have a short timeline, so changes to the day or night average levels are not expected. However, integrity digs that occur near residents may result in sound level changes that could affect day or night average levels.
- Probability: high – changes to sound levels will occur since inspections and maintenance are essential to safe pipeline operation.
- Confidence: moderate – based on the uncertainty in the data used for the evaluation of fly-by noise.

Combined Effects on Sound Levels

The evaluation of the combined effects of pipeline construction and operations on the acoustic environment considers collectively the assessment of the likely potential residual effects on the sound levels indicator. The residual effects for changes in sound level do not combine between the two elements to result in new ratings. Both effects are different types of sounds as well as time periods for occurrence; they do not combine into a singular effect. Therefore, the combined effects on sound levels in Table 7.2.6-3 point 1(c) represents the worst-case or most adverse effect for each evaluation criteria between the two residual effects. Effectively, this reflects effects from pipeline construction, as pipeline operations have comparatively lower sound generating activity.

A summary of the rationale for all of the significance criteria of combined effects on sound levels is provided below.

- Spatial Boundary: Acoustic Environment LSA – compliance with the AER *Directive 038* and BC OGC *Noise Control Best Practices Guideline* are achieved within the Acoustic Environment LSA.
- Duration: short-term – the events causing combined effects on sound level occur only during the construction phase.
- Frequency: isolated – the events causing combined effects on sound level will occur at residential dwellings during the construction phase
- Reversibility: short-term – the period over which the combined effects on sound levels extend is the construction period. However, at any specific location along the proposed pipeline corridor, all sound level changes will cease when construction activities have finished.
- Magnitude: low to medium – in urban areas, with the implementation of a detailed noise management plan for construction, the combined effects on sound level are considered to be medium while in rural areas, the combined effects on sound level ranges from low to medium depending on the distance from construction activity.
- Probability: high – combined effects on sound level is likely to occur based on the proximity of residences to the proposed pipeline corridor.
- Confidence: moderate – based on the nature of data inputs.

Acoustic Environment Indicator – Vibration Levels

The following provides details on the significance of the potential residual effects that are present in the acoustic environment due to vibration levels cause by the blasting activities of the proposed pipeline construction component of the Project.

Increase in Airborne/Ground-Borne Vibrations During Blasting Aspects of Construction Period

The potential for the increase in vibration (airborne and ground-borne) levels for human receptors associated with increased Project construction is considered to have a negative impact balance. Based on the results of the analysis in the Terrestrial Noise and Vibration Technical Report of Volume 5C, the spatial extent of changes to vibration levels from pipeline construction are limited to a blast design specification of 50 mm/sec peak particle velocity (PPV) at the nearest structure or infrastructure within or near the proposed pipeline corridor. This is usually the existing pipe at a minimum 5 m distance. Blast size is modified to ensure the 50 mm/s requirement is met. Where the 50 mm/s requirement is met, the airborne component of the vibration meets 120 dB at 50 m distance. This results in medium magnitude effects. The duration of the vibration levels experienced at receptors is very short (dependent on size and formation of blasting pattern). The frequency of vibration emissions during construction will be limited, since it should only be used in areas that are needed and where ripping is not feasible (heavy equipment limitations, bedrock). All changes in vibration levels are immediately reversible. As soon as blasting construction activity stops, the vibration level changes are reversed.

Vibration controls that will be in use during the construction phase, limit blasting to daytime hours, vary shape and charge with respect to proximity to local receptors and executing a communications plan with receptors are expected to limit vibration levels to within acceptable levels as established in the Terrestrial Noise and Vibration Technical Report. Controlling the magnitude of vibration level also limits the spatial extent of the potential change.

The only variation in residual effects along the pipeline corridor is the magnitude of potential effects. The magnitude of the effect will vary depending on the distance between the blasting zone and the surrounding receptors. As the exact blasting zones have not been determined, the closest potential rural receptor in each segment has been used for evaluation. Blasting will not occur in urbanized areas. This resulted in the most conservative estimates for the highest magnitude of potential effects. A summary of potential magnitude of effects from vibration is provided in Table 7.2.6-9. The analysis lists each of the five segments along with both the estimated distance to receptor and the resulting magnitude of potential effects. As presented in Table 7.2.6-9, the magnitude of residual effect from vibration is medium for all segments of the proposed pipeline corridor.

TABLE 7.2.6-9

SUMMARY OF DISTANCES TO NOISE SENSITIVE RECEPTORS WITHIN EACH SEGMENT OF THE PROPOSED PIPELINE CORRIDOR

Pipeline Segment	Distance from Proposed Pipeline Corridor (m)	Magnitude of Potential Residual Effects
Edmonton to Hinton	<20	Medium
Hargreaves to Darfield	<20	Medium
Black Pines to Hope	<20	Medium
Hope to Burnaby	<20	Medium
Burnaby to Westridge	N/A (no rural receptors)	N/A (no rural receptors)

Residences are within sufficient proximity of construction activity for vibration level changes to occur along most of the proposed pipeline corridor. Therefore, the probability of occurrence is high.

The predictive modelling used in the assessment of the acoustic environment has a level of uncertainty that is dependent on three main factors: the blasting source data; the precision of the vibration propagation model; and the accuracy of locations of blasting locations. Blasting configuration and design data were not available at this stage of the Project. The blasting limit for effects on the existing pipeline corridor was used to estimate vibration levels at each representative receptor along each segment of proposed pipeline corridor. Modelling was completed that uses key international standards for outdoor vibration propagation with a known uncertainty. Therefore, the confidence in the results was considered moderate.

A summary of the rationale for all of the significance criteria is provided below (Table 7.2.6-3, point 2[a]).

- Spatial Boundary: Acoustic Environment LSA – effects associated with changes to vibration level extend to less than 100 m from the right-of-way in most areas, but are dependent on the location of the activity. In an area that is greenfield with no existing rights-of-way, or where receptors are more distant, higher charge weights may be used. The type of blasting required for a pipeline uses smaller charges. Charge weights sufficient for vibrations to reach 1,500 m (the edge of the LSA) would be greater than 1,000 kg which would not occur for this Project.
- Duration: short-term – the changes to vibration levels occur only during the construction phase.
- Frequency: isolated – the event causing changes to vibration levels occur only during the construction phase in which the activity is planned.
- Reversibility: short-term – the changes to vibration levels are associated with blasting activities which may occur over a period longer than two days. All vibration level changes are reversible as the vibration will cease when construction is finished.

- Magnitude: low to medium – based on the anticipated effects at receptors, PPV at residences is expected to be less than the 50 mm/s design specification due to the blasting limit for the existing pipeline corridor.
- Probability: high – based on the proximity of receptors to the proposed pipeline corridor.
- Confidence: moderate – based on the nature of data inputs.

7.2.6.7 Summary

As identified in Table 7.2.6-3, there are no situations where there is a high probability of occurrence of a permanent or long-term residual environmental effect on the acoustic environment indicators of high magnitude that cannot be technically or economically mitigated. Consequently, it is concluded that the residual environmental effects of pipeline construction and operations on the acoustic environment will be not significant.

7.2.7 Fish and Fish Habitat

This subsection describes the potential Project effects on fish and fish habitat. The Fisheries (Alberta) Technical Report and Fisheries (British Columbia) Technical Report of Volume 5C provide further information pertaining to fish and fish habitat at watercourses affected by the Project.

Pipeline construction and maintenance activities have the potential to directly and indirectly affect fish and fish habitat through riparian and instream habitat contamination, loss or alteration of riparian and instream habitat during construction and maintenance, contamination of instream or riparian habitat from spills and increase the risk of contamination through accidental drilling mud release during construction.

Fish mortality or injury may increase during construction due to an increase in suspended sediment concentration, increased site access, blockage of fish movements and effects on fish species of concern. Pipeline construction and maintenance may also result in combined effects on each indicator species resulting from contamination, loss or alteration of riparian or instream habitat and mortality or injury.

The assessment of effects on fish and fish habitat has been conducted considering all the Project components in an integrated manner (*e.g.,* pipeline, temporary facilities, pump stations [including power lines], tanks and pipeline reactivation), since potential effects related to riparian habitat, instream habitat and fish mortality and injury are experienced in a combined manner on fish indicator species and cannot be meaningfully disaggregated by Project component. Construction of the Westridge Marine Terminal will not cause any interactions with fish and fish habitat.

7.2.7.1 Assessment Indicators and Measurement Endpoints

Assessment indicators identified for the fish and fish habitat element are: riparian habitat (Alberta and BC); instream habitat (Alberta and BC); fish mortality or injury (Alberta and BC); Arctic grayling (Alberta); Athabasca rainbow trout (Alberta); bull trout (Alberta); burbot (Alberta); northern pike (Alberta); walleye (Alberta); bull trout/Dolly Varden (BC); Chinook salmon (BC); coho salmon (BC); cutthroat trout (BC); and rainbow trout/steelhead (BC). Assessment indicators and measurement endpoints for fish and fish habitat are listed in Table 7.2.7-1. Potential effects related to the fish and fish habitat are considered under Section 7.2.7.4.

The selection of indicators for fish and fish habitat included; consideration of the filing requirements in the NEB *Filing Manual*; experience gained during previous projects with similar conditions/potential issues; feedback from Aboriginal communities, regulatory authorities and stakeholders; feedback from ESA Workshops; available research literature; public issues raised through media; and the professional judgment of the assessment team.

It was determined by the assessment team that each province traversed by the proposed pipeline corridor (*i.e.*, Alberta and BC) should have its own set of fish species indicators. This is due to a variety of factors, including regional differences in fish community compositions, species abundance, and species important for recreational, commercial or traditional use. Three general fish and fish habitat indicators (*i.e.*, riparian habitat, instream habitat and fish mortality and injury) were determined to be appropriate for both provinces and for all project components. The indicator species in Alberta are Arctic grayling, Athabasca rainbow trout, bull trout, burbot, northern pike and walleye. The BC fish indicator species are bull trout/Dolly Varden, Chinook salmon, coho salmon, cutthroat trout and rainbow trout/steelhead. Table 7.2.7-1 provides the rationale for the selection of each indicator species.

The determination of fish and fish habitat indicator species for each province considered sportfish species, species of management concern and species of conservation concern. Species in each province were selected due to their presence throughout the Aquatics RSA and because they are known to be found in many of the watercourses crossed by the proposed pipeline corridor. Although additional species at risk (listed federally and/or provincially) are found in watercourses crossed by the proposed pipeline corridor, not every species at risk is considered to be an appropriate indicator since some of these species have limited range within the Aquatics RSA.

Federally and provincially listed species found in Project watersheds in Alberta include lake sturgeon, sauger, spoonhead sculpin and northern redbelly dace (Section 4.4 in the Fisheries [Alberta] Technical Report of Volume 5C). Fish species of conservation concern found in Project watersheds in BC include Salish sucker, nooksack dace, green sturgeon, white sturgeon, mountain sucker, coastrange sculpin, western brook lamprey, eulachon, chiselmouth and sockeye salmon (Sections 4.4 and 4.5 in the Fisheries [British Columbia] Technical Report of Volume 5C). Other species of management concern are described in Section 4.5 of the Fisheries (Alberta) and Section 4.6 of the Fisheries (British Columbia) Technical Report of Volume 5C and include several exotic (*i.e.,* non-native) species and sportfish species

Although these listed species were not selected as indicators in this assessment, they will be used as indicators in the watercourses in which they are found. The mitigation measures at a given watercourse are expected to also be effective at reducing potential effects to these species (Section 7.0 of the Fisheries [Alberta] and Fisheries [British Columbia] Technical Reports of Volume 5C). Scientific names corresponding to the common fish species names used in this document can be found in the Fisheries [Alberta] and Fisheries [British Columbia] Technical Reports of Volume 5C.

The proposed indicators for fish and fish habitat were discussed during the Edmonton, Kamloops and Surrey ESA Workshops. There was general consensus by the participants at the workshops that the proposed fish and fish habitat indicators were appropriate for evaluating the effects of the Project on fish and fish habitat. The addition of burbot as an Alberta indicator species was suggested by representatives from AESRD at the Edmonton ESA Workshop since it is being more frequently targeted by anglers throughout the Aquatics RSA. Upon consideration by the assessment team, burbot was adopted as an indicator species in Alberta given the rationale proposed by AESRD, as well as because burbot spawns in the winter, which is unique among the Alberta indicator species. In addition, burbot is found throughout the Aquatics RSA in Alberta.

Lake sturgeon was suggested as an Alberta indicator species by participants at the Edmonton ESA Workshop. Lake sturgeon in Alberta is listed as Threatened under the Alberta *Wildlife Act* and *Wildlife Regulation* and Endangered under the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) (2006a, 2013). Although lake sturgeon was considered as an indicator species in Alberta, it was decided that lake sturgeon is not an appropriate indicator since it has a limited distribution in the Project watersheds and is only found in one watercourse (*i.e.*, North Saskatchewan River) crossed by the proposed pipeline corridor. Therefore, potential effects to lake sturgeon would not be representative of overall effects to fish and fish habitat.

The Fraser Valley Regional District suggested the use of Nooksack dace as an indicator species in BC. Nooksack dace is Endangered under COSEWIC (2013) and Schedule 1 of *SARA* (Environment Canada 2013c) and has a very limited distribution in BC. Historical data and the results of the field program (see Section 4.4.4 of the Fisheries [British Columbia] Technical Report of Volume 5C) indicate that Nooksack dace is only found in two watercourses (*i.e.*, Salmon River, Stoney Creek) crossed by the proposed pipeline corridor. Since Nooksack dace has a limited distribution in watercourses crossed by the proposed pipeline corridor, it was determined that this species would not be useful as an indicator species since potential effects to Nooksack dace would not be representative of potential effects to all fish and fish habitat.

Sockeye salmon was suggested as a BC indicator by participants at the Surrey ESA Workshop. Sockeye is Endangered under COSEWIC (2013). Sockeye are not as well distributed throughout the Project area as Chinook or coho salmon, therefore, sockeye salmon would not be representative of potential effects to overall fish and fish habitat.

The use of benthic invertebrates as an indicator was considered and it was determined that they are not appropriate as an indicator for pipeline projects as discussed in Section 7.2.7.4.

The measurement endpoints for the selected indicators include both quantitative and qualitative measurements of potential Project effects. Table 7.2.7-1 provides a summary of the indicators and measurement endpoints used in the assessment of potential effects on fish and fish habitat.

TABLE 7.2.7-1

ASSESSMENT INDICATORS AND MEASUREMENT ENDPOINTS FOR FISH AND FISH HABITAT

Fish and Fish Habitat Indicators	Measurement Endpoints	Rationale for Indicator Selection
Riparian habitat (Alberta and BC)	• Overall area of riparian habitat (m^2) altered along watercourses and non-classified drainages (NCDs) crossed by the proposed pipeline corridor.	• Area of riparian habitat disturbance can be used as an indicator of overall watershed health (Salmo *et al.* 2003, Sawyer and Mayhood 1988, Scrimgeour *et al*. 2003). • Disturbances in riparian areas can contribute to increased sediment yields (*e.g*., Anderson 1998, Beaudry 1998) and affect fish community assemblages (*e.g.*, Haas 2001, Sloat *et al*. 2001). • Meets NEB *Filing Manual* requirements for the fish and fish habitat element in Table A-2 to describe "sensitive areas and sensitive habitats, including wetlands and riparian habitat".
Instream habitat (Alberta and BC)	• Overall area of instream habitat (m^2) altered in watercourses and NCDs crossed by the proposed pipeline corridor.	• Valuable for sport, commercial and subsistence fisheries.
Fish mortality or injury (Alberta and BC)	• Mortality or Injury to fish during construction	• Will be used as a qualitative indicator of potential effects on fishes (e.g., damage to gill tissue, physiological stress, growth reduction and mortality) (Kerr 1995, Newcombe and MacDonald 1991).
Arctic grayling (Alberta)	• Qualitative assessment of changes to Arctic grayling riparian habitat, instream habitat and injury or mortality to Arctic grayling.	• Geographically distributed throughout four Project watersheds in Alberta (Table 5.7-14 in Section 5.7.6). • A general status of Sensitive (ASRD 2010) and considered a Species of Special Concern by the Alberta Endangered Species Conservation Committee (ESCC) (AESRD 2012a). A management and recovery plan has been implemented (Berry 1998). • Meets NEB *Filing Manual* requirements for the fish and fish habitat element in Table A-2 to "identify fish species and life stages of ecological, economic or human importance in the study area".
Athabasca rainbow trout (Alberta)	• Qualitative assessment of changes to Athabasca rainbow trout riparian habitat, instream habitat and injury or mortality to Athabasca rainbow trout.	• Geographically distributed throughout three Project watersheds in Alberta (Table 5.7-14 in Section 5.7.6). • A general status of At Risk (ASRD 2010); although Athabasca rainbow trout are not a distinct subspecies, COSEWIC guidelines recognize Athabasca rainbow trout populations as a "designatable unit" below the species level (ASRD and Alberta Conservation Association [ACA] 2009). • Meets NEB *Filing Manual* requirements for the fish and fish habitat element in Table A-2 to "identify fish species and life stages of ecological, economic or human importance in the study area".
Bull trout (Alberta)	• Qualitative assessment of changes to bull trout riparian habitat, instream habitat and injury or mortality to bull trout.	• Geographically distributed throughout four Project watersheds in Alberta (Table 5.7-14 in Section 5.7.6). • Bull trout – listed under COSEWIC as Threatened and Species of Special Concern (population dependent) (COSEWIC 2013) and as a Species of Special Concern under the Alberta *Wildlife Act* and *Wildlife Regulation* (AESRD 2012a). This species also has a general status of Sensitive (ASRD 2010). A management and recovery plan has been implemented (ASRD 2012, Berry 1994). • Meets NEB *Filing Manual* requirements for the fish and fish habitat element in Table A-2 to "identify fish species and life stages of ecological, economic or human importance in the study area".

TABLE 7.2.7-1 Cont'd

Fish and Fish Habitat Indicators	Measurement Endpoints	Rationale for Indicator Selection
Burbot (Alberta)	• Qualitative assessment of changes to burbot riparian habitat, instream habitat and injury or mortality to burbot.	• Geographically distributed throughout eight Project watersheds in Alberta (Table 5.7-14 in Section 5.7.6). • Burbot – sportfish species (Government of Alberta 2013d) and suggested by AESRD participants at the Edmonton ESA Workshop to be included as an indicator species. • Meets NEB *Filing Manual* requirements for the fish and fish habitat element in Table A-2 to "identify fish species and life stages of ecological, economic or human importance in the study area".
Northern pike (Alberta)	• Qualitative assessment of changes to northern pike riparian habitat, instream habitat and injury or mortality to northern pike.	• Geographically distributed throughout eight Project watersheds in Alberta (Table 5.7-14 in Section 5.7.6). • Northern pike – a sportfish species (Government of Alberta 2013d) and a management and recovery plan is in place (Berry 1999). • Meets NEB *Filing Manual* requirements for the fish and fish habitat element in Table A-2 to "identify fish species and life stages of ecological, economic or human importance in the study area".
Walleye (Alberta)	• Qualitative assessment of changes to walleye riparian habitat, instream habitat and injury or mortality to walleye.	• Geographically distributed throughout six Project watersheds in Alberta (Table 5.7-14 in Section 5.7.6). • Walleye – sportfish species (Government of Alberta 2013d) and a management and recovery plan is in place (Berry 1995). • Meets NEB *Filing Manual* requirements for the fish and fish habitat element in Table A-2 to "identify fish species and life stages of ecological, economic or human importance in the study area".
Bull trout/Dolly Varden (BC)	• Qualitative assessment of changes to bull trout/Dolly Varden riparian habitat, instream habitat and injury or mortality to bull trout/Dolly Varden.	• Geographically distributed throughout 10 Project watersheds in BC (Table 5.7-15 in Section 5.7.6). • Bull trout and Dolly Varden are both sportfish species (BC MFLNRO 2013a) and bull trout is Blue-listed (BC CDC 2013) provincially and also a Species of Special Concern under COSEWIC (2013). • Meets NEB *Filing Manual* requirements for the fish and fish habitat element in Table A-2 to "identify fish species and life stages of ecological, economic or human importance in the study area". • These two species were combined due to overlapping species distributions in Coast Mountain drainages which makes each species difficult to differentiate except for morphological differences (*i.e.,* head shape, upper jaw length, anal fin base) (Fisheries [British Columbia] Technical Report Section 4.3.4 of Volume 5C, McPhail 2007).
Chinook salmon (BC)	• Qualitative assessment of changes to Chinook salmon riparian habitat, instream habitat and injury or mortality to Chinook salmon.	• Geographically distributed throughout 10 Project watersheds in BC (Table 5.7-15 in Section 5.7.6). • Meets NEB *Filing Manual* requirements for the fish and fish habitat element in Table A-2 to "identify fish species and life stages of ecological, economic or human importance in the study area". • Chinook salmon – sportfish species (BC MFLNRO 2013a), Okanagan population listed under COSEWIC as Threatened (COSEWIC 2013).
Coho salmon (BC)	• Qualitative assessment of changes to coho salmon riparian habitat, instream habitat and injury or mortality to coho salmon.	• Geographically distributed throughout 11 Project watersheds in BC (Table 5.7-15 in Section 5.7.6). • Meets NEB *Filing Manual* requirements for the fish and fish habitat element in Table A-2 to "identify fish species and life stages of ecological, economic or human importance in the study area". • Coho salmon – sportfish species (BC MFLNRO 2013a) and widely distributed. Interior Fraser River population listed by COSEWIC as Endangered (COSEWIC 2013).
Cutthroat trout (BC)	• Qualitative assessment of changes to cutthroat trout riparian habitat, instream habitat and injury or mortality to cutthroat trout.	• Geographically distributed throughout five Project watersheds in BC (Table 5.7-15 in Section 5.7.6). • Cutthroat trout (coastal and westslope) – westslope subspecies provincially listed as a Species of Special Concern (COSEWIC 2013); Coastal cutthroat is Blue-listed provincially (BC MOE 2013b). • Meets NEB *Filing Manual* requirements for the fish and fish habitat element in Table A-2 to "identify fish species and life stages of ecological, economic or human importance in the study area".

TABLE 7.2.7-1 Cont'd

Fish and Fish Habitat Indicators	Measurement Endpoints	Rationale for Indicator Selection
Rainbow trout/steelhead (BC)	• Qualitative assessment of changes to rainbow trout/steelhead riparian habitat, instream habitat and injury or mortality to rainbow trout/steelhead.	• Geographically distributed throughout 13 Project watersheds in BC (Table 5.7-15 in Section 5.7.6). • Rainbow trout/steelhead trout – sportfish species (BC MFLNRO 2013a). • Meets NEB *Filing Manual* requirements for the fish and fish habitat element in Table A-2 to "identify fish species and life stages of ecological, economic or human importance in the study area". • Rainbow trout is a salmonid species that may occur both as a freshwater resident and anadromous (steelhead) population (*i.e.*, rainbow trout and steelhead are the same species).

7.2.7.2 Spatial Boundaries

The spatial boundaries used in the effects assessment of fish and fish habitat considered one or more of the follow areas:

- a Footprint Study Area (as defined in Section 7.1.3);
- a Fish and Fish Habitat LSA; and
- an Aquatics RSA.

The Fish and Fish Habitat LSA is defined as the zone of influence (ZOI) likely to be affected by direct disturbance and sediment deposition during construction and operations, consisting of the area extending 100 m upstream of the centre of the proposed pipeline corridor to a minimum of 300 m downstream of the centre of the proposed pipeline corridor at defined watercourses (BC MOE 2001). The Fish and Fish Habitat LSA also includes the area of riparian vegetation to a width of 30 m back from each bank edge within the width of the construction right-of-way.

Each watercourse crossed by the proposed pipeline corridor has an individually determined downstream LSA based on the ZOI. The ZOI was determined for each crossing in the field based on the professional experience and judgment of the QAES in Alberta or the QEP in BC, who took into account a variety of factors (*e.g.,* stream gradient, channel width, channel depth, substrate composition, channel morphology, flow velocity and discharge and instream cover). The ZOI is typically the reach of a watercourse where 90% of the sediment load caused by construction activities is expected to fall out of suspension (Government of Alberta 2013b,c). At some watercourses the study extent was extended beyond the proposed pipeline corridor in both directions to accommodate for any minor changes to crossing location that may be required. Due to the number of proposed watercourse crossings and differences in the downstream length of the Fish and Fish Habitat LSA based on the estimated ZOI, it was not feasible to map the Fish and Fish Habitat LSA for each individual crossing location. Figures 7.2.7-1 and 7.2.7-2 provide examples of the Fish and Fish Habitat LSA at Zeb-Igler Creek and the Fraser River.

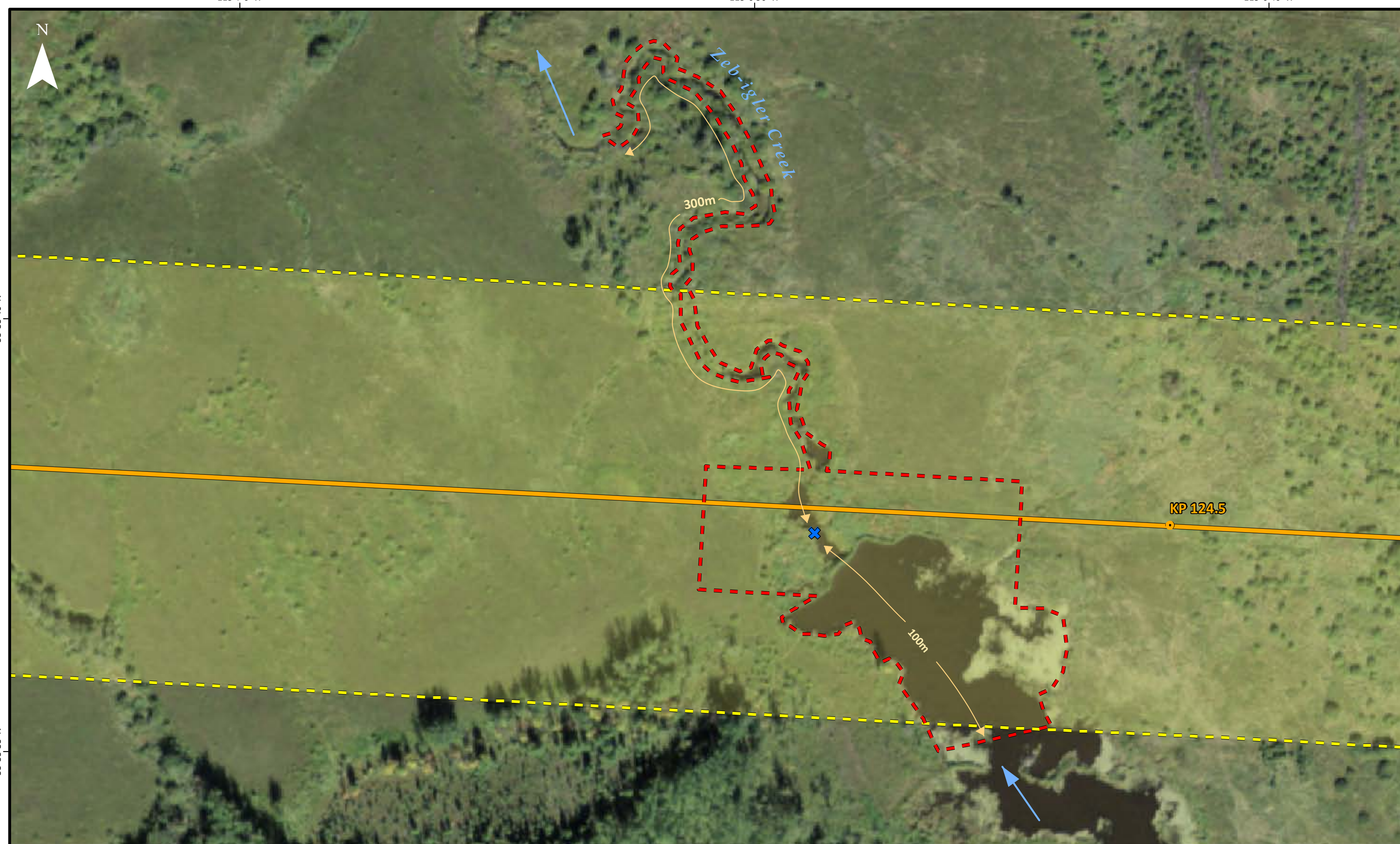
The Aquatics RSA is defined as the area where the direct and indirect influence of other land uses and activities could overlap with Project-specific effects and cause cumulative effects on the fish and fish habitat indicators and includes all watersheds (see Section 5.7) directly affected by the Project. This Aquatics RSA was also considered appropriate due to the recognized presence of several migratory fish species (*e.g.,* Chinook salmon, coho salmon and bull trout) in the vicinity of the Project. The migratory nature of these and other fish species may result in Project-related activities affecting fish populations beyond the Fish and Fish Habitat LSA, but within the Aquatics RSA. The Aquatics RSA is shown in Figures 5.3-1 and 5.3-2.

7.2.7.3 Ecological Context

The proposed Project lies within four drainage basins including the North Saskatchewan and Athabasca river basins in Alberta and the Fraser and Columbia river basins in BC. Twenty-one Project watersheds are crossed by the proposed pipeline corridor as described in Section 4.1 of the Fisheries (Alberta) and Fisheries (British Columbia) Technical Reports of Volume 5C.

Potential watercourse crossings along the proposed pipeline corridor were originally identified during helicopter overflights and from desktop analysis. The 2012 and 2013 fisheries field program investigated 928 potential watercourses crossed by the proposed pipeline corridor (including 10 watercourses that were assessed based on historical information). Ongoing fisheries field studies are discussed in Section 9.0. It was determined that 88 defined watercourses are crossed by the proposed pipeline corridor in Alberta and 386 in BC. Named rivers crossed by the proposed pipeline corridor in Alberta include the North Saskatchewan, Pembina, and McLeod rivers. The proposed pipeline corridor crosses 14 named rivers in BC, including the Fraser and North Thompson rivers. The construction of temporary facilities may require access roads and temporary vehicle crossings, though the location of the facilities and roads has not yet been determined. Hydrostatic testing will be required for the Hinton to Hargreaves and Darfield to Black Pines reactivated segments (in the Athabasca and Fraser river basins, respectively) and the Edmonton, Sumas and Burnaby Terminals (Lower North Saskatchewan, Chilliwack and Lower Fraser river watersheds, respectively).

The Black Pines Pump Station is located in the Lower North Thompson River Watershed. The Kingsvale Pump Station is located in the Lower Nicola River Watershed, although the associated power line extends into the Similkameen River Watershed. The power lines associated with these pump stations cross seven defined watercourses, including the North Thompson River.



tera
ENVIRONMENTAL CONSULTANTS

0 20 40 60 80 m
ALL LOCATIONS APPROXIMATE

MAP NUMBER		PAGE
201311_MAP_TERA_AQ_00476_REV0_01		SHEET 1 OF 2
DATE December 2013	TERA REF. 7894	REVISION 0
SCALE 1:2,000	PAGE SIZE 8.5 x 11	DISCIPLINE AQ
DRAWN AJS	CHECKED TGG	DESIGN TGG

Kilometre Post (KP)
Trans Mountain Pipeline (TMPL)
Trans Mountain Expansion Project Proposed Pipeline Corridor
Approximate Watercourse Crossing Location
Flow Direction
Approximate Fish and Fish Habitat Local Study Area at Zeb-igler Creek

Projection: NAD83 UTM Zone 10N. Baseline TMPL, provided by KMC, 2012; Study Corridor V6 provided by IPP, August 2013; Facilities: Provided by KMC, 2012; Transportation: IHS Inc., 2013, BC Forests, Lands and Natural Resource Operations, 2012 & Natural Resources Canada, 2012; Geopolitical Boundaries: Natural Resources Canada, 2003, IHS Inc., 2011, BC FLNRO, 2007 & ESRI, 2005; First Nation Lands: Government of Canada, 2013 & IHS Inc., 2011; Hydrology: Natural Resources Canada, 2007 & BC Crown Registry and Geographic Base Branch, 2008; Wildlife: BC Ministry of Environment, 2005; Colour Imagery: KMC, 2012, NASA Geospatial Interoperability Program 2005 & ESRI, 2005.

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Although there is no reason to believe that there are any errors associated with the data used to generate this product or in the product itself, users of these data are advised that errors in the data may be present.

TRANS MOUNTAIN

FIGURE 7.2.7-1

EXAMPLE TYPICAL FISH AND FISH HABITAT LOCAL STUDY AREA – ZEB-IGLER CREEK

TRANS MOUNTAIN EXPANSION PROJECT

201311_MAP_TERA_AQ_00476_Rev0_01.mxd

0 100 200 300 400 m
ALL LOCATIONS APPROXIMATE

MAP NUMBER 201311_MAP_TERA_AQ_00476_REV0_02		PAGE SHEET 2 OF 2
DATE December 2013	TERA REF. 7894	REVISION 0
SCALE 1:10,000	PAGE SIZE 8.5 x 11	DISCIPLINE AQ
DRAWN AJS	CHECKED TGG	DESIGN TGG

Kilometre Post (KP)

Trans Mountain Pipeline (TMPL)

Trans Mountain Expansion Project Proposed Pipeline Corridor

Approximate Watercourse Crossing Location

Flow Direction

Approximate Fish and Fish Habitat Local Study Area at Fraser River

Projection: NAD83 UTM Zone 10N. Routing: Baseline TMPL & Facilities: provided by KMC, 2012; Proposed Pipeline Corridor V6: provided by UPI, Aug. 23, 2013; Facilities: Provided by KMC, 2012; Transportation: IHS Inc., 2013, BC Forests, Lands and Natural Resource Operations, 2012 & Natural Resources Canada, 2012; Geopolitical Boundaries: Natural Resources Canada, 2003, IHS Inc., 2011, BC FLNRO, 2007 & ESRI, 2005; First Nation Lands: Government of Canada, 2013 & IHS Inc., 2011; Hydrology: Natural Resources Canada, 2007 & BC Crown Registry and Geographic Base Branch, 2008; Wildlife: BC Ministry of Environment, 2005; Colour Imagery: KMC, 2012, NASA Geospatial Interoperability Program 2005 & ESRI, 2005.

FIGURE 7.2.7-2

EXAMPLE EXTENDED FISH AND FISH HABITAT LOCAL STUDY AREA – FRASER RIVER

TRANS MOUNTAIN EXPANSION PROJECT

201311_MAP_TERA_AQ_00476_Rev0_02.mxd

7.2.7.4 Potential Effects and Mitigation Measures

Effects Considerations

The effects to benthic invertebrates and the use of benthic invertebrates as an environmental indicator of overall stream health were discussed at the Edmonton, Kamloops and Surrey ESA Workshops. Benthic invertebrates were also suggested as an indicator for surface water quality (Section 7.2.3.4). Although invertebrates are an excellent indicator of overall stream health, they are not a good indicator of disturbance or potential effects of pipeline construction on fish habitat (Newcombe 1994, Reid and Anderson 1999, Tsui and McCart 1981, Wood and Armitage 1997, Young and Mackie 1991).

Newcombe's work on sediment dose-response relationships (Newcombe 1994) identified that effects to benthic invertebrates are directly related to concentration and duration of TSS in a watercourse. Previous studies on pipeline watercourse crossings (*e.g.,* Reid and Anderson 1999, Reid *et al.* 2002, Tsui and McCart 1981, Wood and Armitage 1997, Young and Mackie 1991) showed that benthic invertebrate populations are normally able to withstand short-term increases in suspended sediment and recover quickly following open cut crossings. Therefore, it was determined by the assessment team that this potential effect on benthic invertebrates would not be carried through the assessment.

Identified Potential Effects

Potential effects associated with the construction and operations of the proposed Project on fish and fish habitat indicators are listed in Table 7.2.7-2. These interactions are based on the results of the literature review, desktop analysis, field work, TEK, Aboriginal engagement and consultation with landowners, regulatory authorities and stakeholders (Section 3.0), and the professional experience of the assessment team.

TEK participants identified concerns related to the potential effects of Project construction activities on fish and fish habitat and riparian habitats along the Edmonton to Hinton Segment. Along the Hope the Burnaby Segment, TEK participants have requested that community monitors be on-site during watercourse crossing construction and, in particular, at fish-bearing watercourses. Additional issues and concerns related to fish and fish habitat identified by participating Aboriginal communities through the biophysical field studies for the Project are described in the Fisheries (Alberta) and Fisheries (British Columbia) Technical Reports of Volume 5C. A comprehensive review of the issues raised by participating Aboriginal communities was conducted with each community during the field surveys (Section 3.6.7 of the Fisheries [Alberta] Technical Report and Section 3.2.10 of the Fisheries [British Columbia] Technical Report of Volume 5C).

Appropriate watercourse crossing methods have been selected in consideration of the size, environmental sensitivities of the watercourse (inclusive of TEK) and period of construction (Appendix A of the Fisheries [Alberta] and Fisheries [British Columbia] Technical Reports of Volume 5C). A summary of mitigation measures provided in Table 7.2.7-2 was principally developed in accordance with Trans Mountain standards as well as industry and provincial regulatory guidelines including BC MWLAP (2004a), CAPP (2004), CAPP *et al.* (2005), DFO (1995, 2008a,b) and Government of Alberta (2010a, 2013b,c). TEK participants have not recommended any additional mitigation strategies than those described in Table 7.2.7-2 to be implemented for the Project.

TABLE 7.2.7-2

POTENTIAL EFFECTS, MITIGATION MEASURES AND RESIDUAL EFFECTS OF PROJECT CONSTRUCTION AND OPERATIONS ON FISH AND FISH HABITAT

Potential Effect	Project Component(s)	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
1. Fish and Fish Habitat Indicator – Riparian Habitat				
1.1 Riparian habitat loss or alteration during construction and maintenance activities	Edmonton to Hinton Hargreaves to Darfield Black Pines to Hope Hope to Burnaby Burnaby to Westridge Temporary Facilities Access roads Black Pines Pump Station Power line Kingsvale Pump Station Power line	Footprint	• Mark acquired additional temporary workspace (TWS) prior to the initiation of instream work. Ensure additional TWS does not encroach within vegetated riparian buffers [Section 8.7]. • Ensure power line poles or towers are sited outside of the channel width and/or riparian buffer areas of watercourses/wetlands/lakes [Section 11.1]. • See similar measures in Section 11.0 of the Facilities EPP. Vehicle Crossings • Install, use and remove bridges in accordance with the measures identified in the DFO *Operational Statement for Clear-Span Bridges* and *Operational Statement for Bridge Maintenance* [Section 8.7]. Clearing and Grading • Prohibit clearing of extra TWS within the riparian buffer, only the trench and TWS areas will be cleared [Section 8.1]. • Clear vegetation located within the watercourse/wetland/lake vegetation buffer area crossed by the pipeline right-of-way and TWS only if absolutely necessary [Section 8.1]. • Fell trees away from watercourses and away from limits of the construction right-of-way to reduce damage to streambanks, beds and adjacent trees. Hand clear the area, if necessary, to reduce disturbance [Section 8.1]. • Adhere to clearing guidelines for protection of streams and wetlands provided in the *Forest Practices Code*, and the *Riparian Management Area Guidebook* in BC, where riparian management zones (widths) are identified based on stream or wetland class [Section 8.1]. Bank and Riparian Restoration • Recontour the construction right-of-way and stabilize approach slopes at watercourse crossings [Section 8.6]. • Return the bed and banks of each crossing as close as feasible to their pre-construction contours (slope and height). Take appropriate measures to reduce the risk of sloughing of the streambanks following construction [Section 8.7]. • Install coir or other biodegradable erosion control fabric approved by the Inspector(s) on disturbed portions of the banks [Section 8.7]. • Maintain sediment fences or equivalent sediment control structure in place at the base of approach slopes until revegetation of the construction right-of- way is complete [Section 8.7].	• Riparian habitat loss or alteration due to construction activities.

TABLE 7.2.7-2 Cont'd

Potential Effect	Project Component(s)	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
1.1 Riparian habitat loss or alteration during construction (cont'd)	Edmonton to Hinton Hargreaves to Darfield Black Pines to Hope Hope to Burnaby Burnaby to Westridge Temporary Facilities Access roads Black Pines Pump Station Power line Kingsvale Pump Station Power line	Footprint	• Seed riparian areas with an approved annual or perennial grass cover crop or native grass mix as soon as feasible after construction. Install temporary erosion control measures such as temporary berms, sediment fences, mounds or cross ditches within 24 hours of backfilling banks and approach slopes of water crossings at any location where runoff from the construction right-of-way may flow into a watercourse [Section 8.6]. • Seed disturbed areas on the banks and approaches as soon as practical with an approved grass cover crop species or native grass seed mix and implement sediment control measures to stabilize watercourse banks and prevent sedimentation of the watercourse, respectively [Section 8.7].	• See above.
1.2 Riparian habitat alteration during maintenance and operation	Edmonton to Hinton Hargreaves to Darfield Black Pines to Hope Hope to Burnaby Burnaby to Westridge Pipeline Reactivation Hinton to Hargreaves Darfield to Black Pines (hydrostatic testing)	RSA	• See recommended mitigation measures outlined in potential effect 1.1 of this table.	• Clearing or disturbance of riparian habitat during maintenance and operation.
1.3 Riparian habitat loss and alteration from accidental drilling mud release	Edmonton to Hinton Hargreaves to Darfield Black Pines to Hope Hope to Burnaby	RSA	• Excavate the entry and expected exit sites to provide for the containment of drilling mud and cuttings during a HDD. Ensure the excavations are located far enough from the watercourse and in containment berms or tanks that are large enough to contain the anticipated maximum volume of drilling mud above the high watermark of the watercourse [Section 8.7]. • Follow the drilling mud frac-out monitoring and other measures outlined in the Drilling Mud Release Contingency Plan (see Appendix B) during horizontal directional drilling [Section 8.7].	• Alteration of riparian habitat from accidental drilling mud release and associated clean up activities.
1.4 Contamination from spills during construction and maintenance	Edmonton to Hinton Hargreaves to Darfield Black Pines to Hope Hope to Burnaby Burnaby to Westridge Black Pines Pump Station Power line Kingsvale Pump Station Power line Terminals Edmonton Sumas Burnaby (hydrostatic testing) Pipeline Reactivation Hinton to Hargreaves Darfield to Black Pines (hydrostatic testing)	RSA	• Review and adhere to the general mitigation measures provided in Section 7.0 related to equipment washing, inspection of hydraulic, fuel and lubrication systems of equipment, equipment servicing and refuelling as well as fuel storage in proximity to watercourses during water crossing construction [Section 8.7]. • Use non-toxic, biodegradable hydraulic fluids in all equipment that will work instream if/when flowing water will be encountered during construction or in wetland and/or lakes if requested by the Inspector(s) [Section 8.7]. • Do not store fuel, oil or hazardous material within 300 m of a watercourse/wetland/lake [Section 7.0]. • Ensure that any approvals, licenses and permits that are necessary are in place prior to commencing applicable hydrostatic testing activities [Section 8.5]. • Obtain all applicable regulatory authority approvals for water withdrawal and discharge to allow for hydrostatic testing of the facility and ensure conditions of approvals are satisfied during water withdrawal for hydrostatic testing [Section 8.3 of the Facilities EPP].	• Contamination of riparian habitat from spills during construction and maintenance.

TABLE 7.2.7-2 Cont'd

Potential Effect	Project Component(s)	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
1.4 Contamination from spills during construction and maintenance (cont'd)	See above	See above	• Ensure that test water withdrawn from one drainage basin will not enter surface waters in another drainage basin [Section 8.5]. • Ensure pump intakes are placed in a manner that reduces or avoids disturbance to the streambed and are screened in accordance with the DFO screening requirements, to prevent the entrapment of fish or wildlife (*Freshwater Intake End-of-Pipe Fish Screen Guideline)* [Section 8.5]. • Utilize screen pump intakes with a maximum mesh size of 2.54 mm and with a maximum approach velocity of 0.038 m/s, where fish habitat is present [Section 8.5].	• See above.
2. Fish and Fish Habitat Indicator – Instream Habitat				
2.1 Instream habitat alteration	Edmonton to Hinton Hargreaves to Darfield Black Pines to Hope Hope to Burnaby Burnaby to Westridge Temporary Facilities Terminals Edmonton Sumas Burnaby (hydrostatic testing) Pump Stations Black Pines Kingsvale (vehicle crossings for power line construction) Pipeline Reactivation Hinton to Hargreaves Darfield to Black Pines (hydrostatic testing)	RSA	General • Adhere to water crossing requirements provided in environment resource-specific mitigation tables for aquatic resources provided in Appendix I [Section 7.0]. • Trans Mountain will work with regulatory authorities to determine the necessary approvals, licenses and permits needed for construction of the pipeline or associated components prior to the commencement of the permitted activity on any given pipeline spread. The contractor(s), subcontractors and the Inspector(s) will be provided with copies of all approvals/licenses and permits including the most recent updates and revisions, and will comply with all conditions presented to Trans Mountain. Trans Mountain will resolve any inconsistencies between approval/permit conditions and contract documents prior to commencement of the construction activity [Section 3.0]. • Review and adhere to applicable instream timing constraints (RAP/least-risk window) and all resource-specific measures outlined in the mitigation tables for aquatic resources provided in Appendix I [Section 8.7]. • Follow applicable DFO Operational Statements outlining conditions and measures to avoid serious harm to fish or any permanent alteration to, or destruction of, fish habitat when working in or near a watercourse/wetland/lake that has been identified as providing fish habitat [Section 8.7]. • Ensure all necessary equipment, personnel and materials are on-site and ready for installation prior to commencing instream work. Complete all work as quickly as practical to limit the duration of disturbance [Section 8.7]. • Re-establish streambanks and approaches immediately following construction of water crossings as outlined in the Reclamation Management Plan (see Appendix C) [Section 8.6]. Vehicle Crossings • Install, use and remove bridges in accordance with the measures identified in the DFO *Operational Statement for Clear-Span Bridges* and *Operational Statement for Bridge Maintenance* [Section 8.7].	• Alteration of instream habitat within the ZOI.

TABLE 7.2.7-2 Cont'd

Potential Effect	Project Component(s)	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
2.1 Instream habitat alteration (cont'd)	See above	RSA	• Design, construct and abandon ice bridge and snow fill vehicle crossings at watercourses/wetlands/lakes in accordance with the applicable DFO *Operational Statement for Ice Bridges and Snow Fills* [Section 8.7]. Trenched Crossing Technique • Conduct an open-cut crossing of seasonally dry or frozen to the bottom watercourses and an isolated crossing at select crossings (see Appendix I) in Alberta in accordance with the *Alberta Operational Statement for Isolated or Dry Open-cut Stream Crossings* (see Drawing [Watercourse Crossing – Open Cut Method for Dry/Frozen Watercourses] provided in Appendix R) [Section 8.7]. • Conduct typical open cut of seasonally dry or frozen to the bottom watercourses in BC in accordance with the Pacific Region *Operational Statement for Dry Open-cut Stream Crossings* [Section 8.7]. • Isolated BC pipeline crossings are not included under the Pacific Region DFO's *Operational Statement for Isolated or Dry Open-cut Stream Crossings* [Section 8.7]. • Ensure all water intakes are screened in accordance with the DFO's *Freshwater End-of-Pipe Fish Screen Guideline*. Ensure the screens are free of debris during pumping [Section 8.7]. • Ensure that pump intakes avoid or reduce disturbance of the streambed and are screened with a maximum mesh size of 2.54 mm and sized to limit the approach velocity to not exceed 0.038 m/s [Section 8.7]. Trenchless Crossings • Construct trenchless crossings in accordance with the COP requirements and the conditions of the DFO's *Operational Statement for High-pressure Directional Drilling* (Alberta and the DFO's Operational Statement for Directional Drilling (BC) [Section 8.7]. • Plan for and use the procedures for a HDD or other trenchless crossing in accordance with those provided in the Horizontal Directional Drilling/Trenchless Planning and Procedures Management Plan (see Appendix C) [Section 8.7]. • Cease trenchless crossing work immediately and refer to the Drilling Mud Release Contingency Plan (see Appendix B) in the event that an inadvertent release of drilling mud has occurred and the material is or may enter the watercourse or affect other sensitive environmental or land use features [Section 8.7]. Monitoring • Monitor to assess the immediate effects of crossing construction, where warranted. Also monitor sediment release (*i.e.*, turbidity and total suspended solids) throughout the crossing construction period, when warranted in accordance with the monitoring measures provided in the Water Crossing Construction Monitoring Plan [Section 8.7]. • See additional monitoring measures in Section 8.7 of the Pipeline EPP.	• See above.

TABLE 7.2.7-2 Cont'd

Potential Effect	Project Component(s)	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
2.1 Instream habitat alteration (cont'd)	See above	RSA	Hydrostatic Testing • Confirm that approvals/notifications are in place for the intended test water sources and that adequate streamflow/volume is present for the testing program [Section 8.5]. • The withdrawal rate and volume will not exceed 10% of the flow rate of the watercourse or of the volume of the body of water unless otherwise approved by the appropriate authority when withdrawing water in Alberta [Section 8.5]. • Utilize screen pump intakes with a maximum mesh size of 2.54 mm and with a maximum approach velocity of 0.038 m/s, where fish habitat is present [Section 8.5]. • See additional notification, sampling and reporting measures in Section 8.5 of the Pipeline EPP.	• See above.
2.2 Instream habitat alteration from accidental drilling mud release	Edmonton to Hinton Hargreaves to Darfield Black Pines to Hope Hope to Burnaby	LSA	• Construct trenchless crossings in accordance with the COP requirements and the conditions of the *DFO's Operational Statement for High-pressure Directional Drilling* (Alberta) and the DFO's Operational Statement for Directional Drilling (BC) [Section 8.7]. • Monitor to assess the immediate effects of crossing construction, if warranted. Also monitor sediment release (*i.e.,* turbidity and total suspended solids) throughout the crossing construction period, if required [Section 8.7]. • Cease trenchless crossing work immediately and refer to the Drilling Mud Release Contingency Plan (see Appendix B) in the event that an inadvertent release of drilling mud has occurred and the material is or may enter the watercourse or affect other sensitive environmental or land use features [Section 8.7]. • Assign the Inspector(s), Qualified Aquatic Environmental Specialist (QAES) or Qualified Environmental Professional (QEP) with expertise in the containment of inadvertent release of drilling mud and clean up to HDDs under a watercourse (see Drilling Mud Release Contingency Plan in Appendix B) [Section 8.7].	• Alteration of instream habitat from drilling mud release.
2.3 Contamination from spills during construction	Edmonton to Hinton Hargreaves to Darfield Black Pines to Hope Hope to Burnaby Burnaby to Westridge Terminals Edmonton Sumas Burnaby (hydrostatic testing) Black Pines Pump Station Power line Kingsvale Pump Station Power line Pipeline Reactivation Hinton to Hargreaves Darfield to Black Pines (hydrostatic testing)	RSA	• Review and adhere to the general mitigation measures in Section 7.0 related to equipment washing, inspection of hydraulic, fuel and lubrication systems of equipment, equipment servicing and refuelling as well as fuel storage in proximity to watercourses during water crossing construction [Section 8.7]. • Do not store fuel, oil, or hazardous material within 300 m of a watercourse/wetland/lake [Section 7.0]. • Use non-toxic, biodegradable hydraulic fluids in all equipment that will work instream if/when flowing water will be encountered during construction or in wetland and/or lakes if requested by the Inspector(s) [Section 8.7].	• Contamination of instream habitat from spills during construction.

TABLE 7.2.7-2 Cont'd

Potential Effect	Project Component(s)	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
2.3 Contamination from spills during construction (cont'd)	See above	See above	• Maintain the identified separation distances between the following areas and a watercourse/wetland/lake when constructing the facility site, unless otherwise approved: • fuel or hazardous material storage site - 300 m; • cleared area – 100 m; • burning site – 100 m; • subsoil pile – 100 m; and • oil change area – 100 m [Section 7.0 of the Facilities EPP]. • See recommended mitigation measures for potential effect 1.4 of this table.	• See above.
2.4 Increased access to instream habitat during operation	Edmonton to Hinton Hargreaves to Darfield Black Pines to Hope Hope to Burnaby Burnaby to Westridge Temporary Facilities Access roads	RSA	• Follow the measures in the Traffic and Access Control Management Plan (see Appendix C) [Section 8.7]. • Install tree/shrub plantings at potential access points to the construction right-of-way to visually screen the construction right-of-way (see Drawing [Vegetation Screen] provided in Appendix R) [Section 8.6]. • Rollback slash and salvageable timber at locations indicated on Environmental Alignment Sheets to prevent access along the construction right-of-way. Spread evenly over the construction right-of-way. Rollbacks will not be walked on [Section 8.6].	• Disturbance to instream habitat due to a potential increase in access during operations.
3. Fish and Fish Habitat Indicator – Fish Mortality or Injury				
3.1 Fish mortality or injury during construction	Edmonton to Hinton Hargreaves to Darfield Black Pines to Hope Hope to Burnaby Burnaby to Westridge Temporary Facilities Access roads Pump Stations Black Pines Kingsvale (vehicle crossings for power line construction) Terminals Edmonton Sumas Burnaby (hydrostatic testing) Pipeline Reactivation Hinton to Hargreaves Darfield to Black Pines (hydrostatic testing)	RSA	• Review and adhere to applicable instream timing constraints (RAP/least-risk window) and all resource-specific measures outlined in the mitigation tables for aquatic resources provided in Appendix I [Section 8.7]. • Determine the presence of any aquatic or riparian plants and pests prior to the commencement of construction activities within the riparian buffer. Notify the contractor of any special measures to be implemented to prevent the transfer of these organisms from one watercourse to another [Section 8.7]. • Follow applicable DFO Operational Statements outlining conditions and measures to avoid serious harm to fish or any permanent alteration to, or destruction of, fish habitat when working in or near a watercourse/wetland/lake that has been identified as providing fish habitat [Section 8.7]. • Prohibit recreational fishing by Project personnel on or in the vicinity of the construction right-of-way. The use of the construction right-of-way to access fishing sites is prohibited [Section 7.0]. • Follow appropriate procedures provided in *Guidelines for the Use of Explosives in or near Canadian Fisheries Waters* if blasting is necessary. Blasting within 300 m of a watercourse/wetland/lake will be reduced or avoided to the extent feasible (see Watercourse Crossing Management Plan provided in Appendix C) [Section 8.3].	• Increased fish mortality or injury due to construction activities.

TABLE 7.2.7-2 Cont'd

Potential Effect	Project Component(s)	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
3.1 Fish mortality or injury during construction (cont'd)	See above	RSA	• Ensure all water intakes are screened in accordance with the DFO's *Freshwater End-of-Pipe Fish Screen Guideline*. Ensure the screens are free of debris during pumping [Section 8.7]. • Monitor to assess the immediate effects of crossing construction, if warranted. Also monitor sediment release (*i.e.,* turbidity and total suspended solids) throughout the crossing construction period, if required [Section 8.7]. • Assign a QAES/QEP to salvage fish with an electrofishing from the isolated area prior to and during dewatering and trenching at isolated water crossings in accordance with the Fish Research License in Alberta and the Fish Collection Permit in BC (see Appendix D) if those permits are determined to be necessary. Note that the application for a Fish Research Permit and a Fish Collection Permit is to be submitted 10 working days (minimum) prior to the scheduled isolation of the watercourse. Release all captured fish to areas downstream of the crossing that provide suitable habitat [Section 8.7]. • Clean fish salvage equipment (*e.g.,* waders, boots, nets) of soil, and disinfect with 100 mg/L chlorine bleach before using in any watercourse to prevent the spread of pathogens (*e.g.,* whirling disease) and/or invasive plant species. Ensure that washed off soil is disposed of at a location that will prevent the reintroduction of these untreated materials into a watercourse [Section 8.7]. • Prohibit recreational fishing by Project personnel on or in the vicinity of the facility footprint. The use of the facility by construction personnel to access fishing sites will be prohibited [Section 7.0 of the Facilities EPP]. • See recommended mitigation measures outlined in potential effect 1.4. • See hydrostatic testing measures outlined in potential effect 2.1 of this table.	• See above.
3.2 Fish mortality or injury from spills during construction	Edmonton to Hinton Hargreaves to Darfield Black Pines to Hope Hope to Burnaby Burnaby to Westridge Temporary Facilities Access roads Black Pines Pump Station Power line Kingsvale Pump Station Power line Terminals Edmonton Sumas Burnaby (hydrostatic testing)	RSA	• See recommended mitigation measures outlined in potential effect 3.1 of this table.	• Increased fish mortality or injury from spills during construction.

TABLE 7.2.7-2 Cont'd

Potential Effect	Project Component(s)	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
3.3 Fish mortality or injury due to accidental release of hazardous materials during power line construction	Black Pines Pump Station Power line Kingsvale Pump Station Power line	RSA	• See recommended mitigation measures outlined in potential effect 1.1 of Table 7.4.3.-1 Water Quality and Quantity.	• No residual effect identified.
3.4 Increased suspended sediment concentrations in the water column during instream construction	Edmonton to Hinton Hargreaves to Darfield Black Pines to Hope Hope to Burnaby Burnaby to Westridge Temporary Facilities Access roads Pump Stations Black Pines Kingsvale (vehicle crossings for power line construction) Terminals Edmonton Sumas Burnaby (hydrostatic testing) Pipeline Reactivation Hinton to Hargreaves Darfield to Black Pines (hydrostatic testing)	RSA	General • Grade away from watercourses/wetlands/lakes to reduce the risk of introduction of soil and organic debris. Do not place windrowed or fill material in watercourses/wetlands/lakes during grading. Keep wetland soils separate from upland soils [Section 8.2]. • Ensure temporary berms and/or sediment fence installed following grading (see Section 8.2) will adequately control runoff from entering the open trench in the vicinity of water crossings [Section 8.3]. • Install a temporary sediment barrier (*e.g.,* sediment fences), where warranted, to eliminate the flow of sediment from spoil piles and disturbed areas into nearby watercourses/wetlands/lakes (see Drawing [Sediment Fence] provided in Appendix R) [Section 8.7]. • Inspect temporary sediment control structures (*e.g.,* sediment fences, subsoil berms) installed on approach slopes, on a daily basis throughout crossing construction. Repair the structures, if warranted, before the end of the working day [Section 8.7]. • Ensure all necessary equipment, personnel and materials are on-site and ready for installation prior to commencing instream work. Complete all work as quickly as practical to limit the duration of disturbance [Section 8.7]. • Develop water quality monitoring plans, where required, to monitor for suspended sediment during HDD, and select isolated trenched crossings of watercourses with high sensitivity fish habitat, or open-cut crossing construction activities where flow is present. If monitoring reveals that sediment values are approaching threshold values, the water quality monitors will notify the Lead Environmental Inspector and Inspector(s) who, with the Construction Manager and contractor, will develop corrective actions [Section 8.7]. • Monitor temporary vehicle crossings to ensure that erosion control measures are adequate and streamflow is not disrupted [Section 8.7]. • See additional monitoring measures in Section 8.7 of the Pipeline EPP. Trenched Crossings • Conduct an open-cut crossing of seasonally dry or frozen to the bottom watercourses and an isolated crossing at select crossings (see Appendix I) in Alberta in accordance with the *Alberta Operational Statement for Isolated or Dry Open-cut Stream Crossings* (see Drawing [Watercourse Crossing – Open Cut Method for Dry/Frozen Watercourses] provided in Appendix R) [Section 8.7].	• Increased fish mortality or injury due to suspended sediment during instream construction.

TABLE 7.2.7-2 Cont'd

Potential Effect	Project Component(s)	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
3.4 Increased suspended sediment concentrations in the water column during instream construction (cont'd)	See above	RSA	• Construct the crossing in accordance with the COP (Alberta only) requirements and in accordance with the conditions of the DFO's *Operational Statement for Isolated or Dry Open-cut Stream Crossings* or other DFO conditions [Section 8.7]. • Isolated BC pipeline crossings are not included under the Pacific Region DFO's *Operational Statement for Isolated or Dry Open-cut Crossings* [Section 8.7]. • Dewater the segment of the watercourse between the dams, if feasible and safe to do so. Pump any sediment-laden water out between the dams to well-vegetated lands, away from the watercourse or to settling ponds [Section 8.7]. • Remove any accumulations of sediment within the isolation areas that resulted from crossing construction. Spread all sediment and unused trench spoil removed from the watercourse at a location above the high water mark where the materials will not directly re-enter the watercourse [Section 8.7]. • Ensure that water from flumes, dam and pumps, diversion or other methods does not cause erosion or introduce sediment into the channel. If warranted, place rock rip rap, tarpaulins, plywood sheeting or other materials to control erosion at the outlet of pump hoses and flumes. Supplement the erosion control materials, if warranted, to control any erosion [Section 8.7]. Vehicle Crossings • Use the vehicle crossings at watercourses crossed by access roads identified in Section 9.0 within the aquatic resources tables (see Appendix I) and on the Environmental Alignment Sheets [Section 8.7]. • Install temporary bridges at locations identified in the environmental resource-specific mitigation tables for Aquatic resources provided in Appendix I. Ensure bridges are clean prior to installation and dispose of soil at an appropriate location (see Drawing [Vehicle Crossing – Ramp and Culvert] provided in Appendix R) [Section 8.7]. • Implement erosion control measures as soon as a disturbance of the vegetation mat occurs [Section 8.7]. • Stabilize and revegetate areas disturbed during installation and removal of a bridge; install erosion control measures, where warranted, to control surface erosion until vegetation is established [Section 8.7]. • Install clean snowfills during frozen conditions at locations identified in the environmental resource-specific mitigation tables for aquatic resources provided in Appendix I, and at all minor and intermittent watercourses (see Environmental Alignment Sheets) [Section 8.7]. • See recommended mitigation measures for potential effect 1.2 outlined in Table 7.2.3-2 Water Quality and Quantity.	• See above.

TABLE 7.2.7-2 Cont'd

Potential Effect	Project Component(s)	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
3.5 Increased suspended sediment concentrations in the water column from accidental drilling mud release	Edmonton to Hinton Hargreaves to Darfield Black Pines to Hope Hope to Burnaby	LSA	• See recommended mitigation measures outlined in potential effect 2.2 of this table.	• Increased fish mortality or injury due to suspended sediment from drilling mud release.
3.6 Increased access to fish and fish habitat during operations	Edmonton to Hinton Hargreaves to Darfield Black Pines to Hope Hope to Burnaby Burnaby to Westridge	LSA	• See recommended mitigation measures outlined in potential effect 2.4 of this table.	• Increased fish mortality or injury due to a potential increase in access during operations.
3.7 Blockage of fish movements	Edmonton to Hinton Hargreaves to Darfield Black Pines to Hope Hope to Burnaby Burnaby to Westridge Temporary Facilities Access roads	LSA	• Ensure maintenance of downstream flow conditions (*i.e.,* quantity and quality) at all times when constructing an isolated crossing. If a pump-around method is used to maintain downstream flow, back-up pumping capacity must be onsite and ready to take over pumping immediately if operating pumps fail. Pumps are to be continuously monitored to ensure flow is maintained at all times until the dam materials are removed and normal flow is restored to the channel [Section 8.7]. • Design, construct and abandon ice bridge and snow fill vehicle crossings at watercourses/wetlands/lakes in accordance with the applicable DFO *Operational Statement for Ice Bridges and Snow Fills* [Section 8.7]. <u>Vehicle Crossings</u> • Ensure temporary vehicle crossing structures do not disrupt fish passage at fish-bearing watercourses [Section 8.7]. • Ensure temporary vehicle crossing structures do not disrupt fish passage at fish-bearing watercourses and do not interfere with or impede flow or navigation at any location [Section 8.7]. • Install crossings structures as identified in the Aquatics Resource-specific Mitigation Tables (see Appendix I) [Section 8.7]. • Construct or install temporary vehicle access across watercourses and adjacent to wetlands and lakes in a manner that follows provincial and federal guidelines [Section 8.7].	• Temporary blockage of fish movements.
3.8 Interbasin transfer of aquatic organisms	Edmonton to Hinton Hargreaves to Darfield Black Pines to Hope Hope to Burnaby Burnaby to Westridge Terminals Edmonton Sumas Burnaby (hydrostatic testing) Pipeline Reactivation Hinton to Hargreaves Darfield to Black Pines (hydrostatic testing)	RSA	• Determine the presence of any aquatic or riparian plants and pests prior to the commencement of construction activities within the riparian buffer. Notify the contractor of any special measures to be implemented to prevent the transfer of these organisms from one watercourse to another [Section 8.7]. • Ensure that test water withdrawn from one drainage basin is not allowed to enter natural waters of another drainage basin [Section 8.5]. • Clean fish salvage equipment (*e.g.,* waders, boots, nets) of soil, and disinfect with 100 mg/L chlorine bleach before using in any watercourse to prevent the spread of pathogens (*e.g.*, whirling disease) and/or invasive plant species. Ensure that washed off soil is disposed of at a location that will prevent the reintroduction of these untreated materials into a watercourse [Section 8.7].	• No residual effect identified.

TABLE 7.2.7-2 Cont'd

Potential Effect	Project Component(s)	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
3.8 Interbasin transfer of aquatic organisms (cont'd)	See above	See above	• Install trench breakers if the banks are composed of organic materials as noted in Section 8.0 [Section 8.7].	• See above.
3.9 Effects on fish species of concern	Edmonton to Hinton Hargreaves to Darfield Black Pines to Hope Hope to Burnaby Burnaby to Westridge Terminals Edmonton Sumas Burnaby (hydrostatic testing) Pipeline Reactivation Hinton to Hargreaves Darfield to Black Pines (hydrostatic testing)	RSA	• Implement applicable measures from the Fish Species of Concern Contingency Plan (see Appendix B) should fish species of concern be discovered during construction [Section 8.7]. • See recommended mitigation measures outlined in potential effects 3.1 to 3.6 of this table. • See recommended mitigation measures outlined in potential effect 2.3 of this table.	• Fish species of concern may be affected by an increase in suspended sediment concentration, habitat alteration within the ZOI and increased potential for mortality and injury.
4. Fish and Fish Habitat Indicator – Arctic Grayling (Alberta Indicator Species)				
4.1 Contamination, loss or alteration of Arctic grayling riparian habitat	Edmonton to Hinton Pipeline Reactivation Hinton to Hargreaves (hydrostatic testing)	RSA	• See recommended mitigation measures outlined in potential effects 1.1 to 1.4 of this table.	• Combined effects on Arctic Grayling resulting from contamination, loss or alteration of riparian habitat; contamination, loss or alteration of instream habitat; and mortality or injury.
4.2 Contamination, loss or alteration of Arctic grayling instream habitat		RSA	• See recommended mitigation measures outlined in potential effects 2.1 to 2.4 of this table.	
4.3 Mortality or injury of Arctic grayling		RSA	• See recommended mitigation measures outlined in potential effects 3.1 to 3.7 of this table.	
5. Fish and Fish Habitat Indicator – Athabasca Rainbow Trout (Alberta Indicator Species)				
5.1 Contamination, loss or alteration of Athabasca rainbow trout riparian habitat	Edmonton to Hinton Pipeline Reactivation Hinton to Hargreaves (hydrostatic testing)	RSA	• See recommended mitigation measures outlined in potential effects 1.1 to 1.4 of this table.	• Combined effects on Athabasca rainbow trout resulting from contamination, loss or alteration of riparian habitat; contamination, loss or alteration of instream habitat; and mortality or injury.
5.2 Contamination, loss or alteration of Athabasca rainbow trout instream habitat		RSA	• See recommended mitigation measures outlined in potential effects 2.1 to 2.4 of this table.	
5.3 Mortality or injury of Athabasca rainbow trout		RSA	• See recommended mitigation measures outlined in potential effects 3.1 to 3.7 of this table.	
6. Fish and Fish Habitat Indicator – Bull Trout (Alberta Indicator Species)				
6.1 Contamination, loss or alteration of bull trout riparian habitat	Edmonton to Hinton Pipeline Reactivation Hinton to Hargreaves (hydrostatic testing)	RSA	• See recommended mitigation measures outlined in potential effects 1.1 to 1.4 of this table.	• Combined effects on bull trout resulting from contamination; loss or alteration of riparian habitat; contamination, loss or alteration of instream habitat; and mortality or injury.
6.2 Contamination, loss or alteration of bull trout instream habitat		RSA	• See recommended mitigation measures outlined in potential effects 2.1 to 2.4 of this table.	
6.3 Mortality or injury of bull trout		RSA	• See recommended mitigation measures outlined in potential effects 3.1 to 3.7 of this table.	

TABLE 7.2.7-2 Cont'd

Potential Effect	Project Component(s)	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
7. Fish and Fish Habitat Indicator – Burbot (Alberta Indicator Species)				
7.1 Contamination, loss or alteration of burbot riparian habitat	**Edmonton to Hinton** **Edmonton Terminal** Hydrostatic testing **Pipeline Reactivation** Hinton to Hargreaves (hydrostatic testing)	RSA	• See recommended mitigation measures outlined in potential effects 1.1 to 1.4 of this table.	• Combined effects on burbot resulting from contamination, loss or alteration of riparian habitat; contamination, loss or alteration of instream habitat; and mortality or injury.
7.2 Contamination, loss or alteration of burbot instream habitat		RSA	• See recommended mitigation measures outlined in potential effects 2.1 to 2.4 of this table.	
7.3 Mortality or injury of burbot		RSA	• See recommended mitigation measures outlined in potential effects 3.1 to 3.7 of this table.	
8. Fish and Fish Habitat Indicator – Northern Pike (Alberta Indicator Species)				
8.1 Contamination, loss or alteration of northern pike riparian habitat	**Edmonton to Hinton** **Edmonton Terminal** (hydrostatic testing) **Pipeline Reactivation** Hinton to Hargreaves (hydrostatic testing)	RSA	• See recommended mitigation measures outlined in potential effects 1.1 to 1.4 of this table.	• Combined effects on northern pike resulting from contamination, loss or alteration of riparian habitat; contamination, loss or alteration of instream habitat; and mortality or injury.
8.2 Contamination, loss or alteration of northern pike instream habitat		RSA	• See recommended mitigation measures outlined in potential effects 2.1 to 2.4 of this table.	
8.3 Mortality or injury of northern pike		RSA	• See recommended mitigation measures outlined in potential effects 3.1 to 3.7 of this table.	
9. Fish and Fish Habitat Indicator – Walleye (Alberta Indicator Species)				
9.1 Contamination, loss or alteration of walleye riparian habitat	**Edmonton to Hinton** **Edmonton Terminal** Hydrostatic testing **Pipeline Reactivation** Hinton to Hargreaves (hydrostatic testing)	RSA	• See recommended mitigation measures outlined in potential effects 1.1 to 1.4 of this table.	• Combined effects on walleye resulting from contamination, loss or alteration of riparian habitat; contamination, loss or alteration of instream habitat; and mortality or injury.
9.2 Contamination, loss or alteration of walleye instream habitat		RSA	• See recommended mitigation measures outlined in potential effects 2.1 to 2.4 of this table.	
9.3 Mortality or injury of walleye		RSA	• See recommended mitigation measures outlined in potential effects 3.1 to 3.7 of this table.	
10. Fish and Fish Habitat Indicator – Bull Trout/Dolly Varden (BC Indicator Species)				
10.1 Contamination, loss or alteration of bull trout/Dolly Varden riparian habitat	**Hargreaves to Darfield** **Black Pines to Hope** **Hope to Burnaby** **Pump Stations** Black Pines Kingsvale (vehicle crossings for power line construction) **Terminal** Sumas (hydrostatic testing) **Pipeline Reactivation** Darfield to Black Pines (hydrostatic testing)	RSA	• See recommended mitigation measures outlined in potential effects 1.1 to 1.4 of this table.	• Combined effects on bull trout/Dolly Varden resulting from contamination, loss or alteration of riparian habitat; contamination, loss or alteration of instream habitat; and mortality or injury.
10.2 Contamination, loss or alteration of bull trout/Dolly Varden instream habitat		RSA	• See recommended mitigation measures outlined in potential effects 2.1 to 2.4 of this table.	
10.3 Contamination, mortality or injury of bull trout/Dolly Varden		RSA	• See recommended mitigation measures outlined in potential effects 3.1 to 3.7 of this table.	

TABLE 7.2.7-2 Cont'd

Potential Effect	Project Component(s)	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
11. Fish and Fish Habitat Indicator – Chinook Salmon (BC Indicator Species)				
11.1 Contamination loss or alteration of Chinook salmon riparian habitat	Hargreaves to Darfield Black Pines to Hope Hope to Burnaby Pump Stations Black Pines Kingsvale (vehicle crossings for power line construction) Terminal Sumas (hydrostatic testing) Pipeline Reactivation Darfield to Black Pines (hydrostatic testing)	RSA	• See recommended mitigation measures outlined in potential effects 1.1 to 1.4 of this table.	• Combined effects on Chinook salmon resulting from contamination, loss or alteration of riparian habitat; contamination, loss or alteration of instream habitat; and mortality or injury.
11.2 Contamination, loss or alteration of Chinook salmon instream habitat		RSA	• See recommended mitigation measures outlined in potential effects 2.1 to 2.4 of this table.	
11.3 Mortality or injury of Chinook salmon		RSA	• See recommended mitigation measures outlined in potential effects 3.1 to 3.7 of this table.	
12. Fish and Fish Habitat Indicator – Coho Salmon (BC Indicator Species)				
12.1 Contamination, loss or alteration of coho salmon riparian habitat	Hargreaves to Darfield Black Pines to Hope Hope to Burnaby Burnaby to Westridge Pump Stations Black Pines Kingsvale (vehicle crossings for power line construction) Terminals Sumas Burnaby (hydrostatic testing) Pipeline Reactivation Darfield to Black Pines (hydrostatic testing)	RSA	• See recommended mitigation measures outlined in potential effects 1.1 to 1.4 of this table.	• Combined effects on coho salmon resulting from contamination, loss or alteration of riparian habitat; contamination, loss or alteration; of instream habitat and mortality or injury.
12.2 Contamination, loss or alteration of coho salmon instream habitat		RSA	• See recommended mitigation measures outlined in potential effects 2.1 to 2.4 of this table.	
12.3 Mortality or injury of coho salmon		RSA	• See recommended mitigation measures outlined in potential effects 3.1 to 3.7 of this table.	
13. Fish and Fish Habitat Indicator – Cutthroat Trout (BC Indicator Species)				
13.1 Contamination, loss or alteration of cutthroat trout riparian habitat	Black Pines to Hope Hope to Burnaby Burnaby to Westridge Terminals Sumas Burnaby (hydrostatic testing)	RSA	• See recommended mitigation measures outlined in potential effects 1.1 to 1.4 of this table.	• Combined effects on cutthroat trout resulting from contamination, loss or alteration of riparian habitat; contamination, loss or alteration of instream habitat; and mortality or injury.
13.2 Contamination, loss or alteration of cutthroat trout instream habitat		RSA	• See recommended mitigation measures outlined in potential effects 2.1 to 2.4 of this table.	
13.3 Mortality or injury of cutthroat trout		RSA	• See recommended mitigation measures outlined in potential effects 3.1 to 3.7 of this table.	

TABLE 7.2.7-2 Cont'd

Potential Effect	Project Component(s)	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
14. Fish and Fish Habitat Indicator – Rainbow Trout/Steelhead (BC Indicator Species)				
14.1 Contamination, loss or alteration of rainbow trout/steelhead riparian habitat	Hargreaves to Darfield Black Pines to Hope Hope to Burnaby Burnaby to Westridge] Pump Stations Black Pines Kingsvale (vehicle crossings for power line construction) Terminals Sumas Burnaby (hydrostatic testing) Pipeline Reactivation Darfield to Black Pines (hydrostatic testing)	RSA	• See recommended mitigation measures outlined in potential effects 1.1 to 1.4 of this table.	• Combined effects on rainbow trout/steelhead resulting from contamination, loss or alteration of riparian habitat; contamination, loss or alteration of instream habitat;and mortality or injury.
14.2 Contamination, loss or alteration of rainbow trout/steelhead instream habitat		RSA	• See recommended mitigation measures outlined in potential effects 2.1 to 2.4 of this table.	
14.3 Mortality or injury of rainbow trout/steelhead		RSA	• See recommended mitigation measures outlined in potential effects 3.1 to 3.7 of this table.	

Notes: 1 LSA = Fish and Fish Habitat LSA; RSA = Aquatics RSA.
2 Detailed mitigation measures are outlined in the Pipeline EPP (Volume 6B) and Facilities EPP (Volume 6C).

7.2.7.5 Potential Residual Effects

The potential residual environmental effects on fish and fish habitat indicators associated with the construction and operations of the Project (Table 7.2.7-2) are:

- riparian habitat loss or alteration due to construction activities;
- clearing or disturbance of riparian habitat during maintenance and operations;
- alteration of riparian habitat from accidental drilling mud release and associated clean up activities;
- contamination of riparian habitat from spills during construction;
- alteration of instream habitat within the ZOI;
- alteration of instream habitat from drilling mud release;
- contamination of instream habitat from spills during construction and maintenance;
- disturbance to instream habitat due to a potential increase in access during operations;
- increased fish mortality or injury due to construction;
- increased fish mortality or injury due to spills during construction;
- increased fish mortality or injury due to suspended sediment during instream construction;
- increased fish mortality or injury due to suspended sediment from drilling mud release;
- increased fish mortality or injury due to a potential increase in access during operations;
- temporary blockage of fish movements;
- fish species of concern may be affected by an increase in suspended sediment concentration, habitat alteration within the ZOI and increased potential for mortality or injury;

- combined effects on Alberta indicator species (*i.e.*, Arctic grayling, Athabasca rainbow trout, bull trout, burbot, northern pike and walleye) resulting from contamination, loss or alteration of riparian habitat; contamination, loss or alteration of instream habitat; and mortality or injury; and
- combined effects on BC indicator species (*i.e.*, bull trout/Dolly Varden, Chinook salmon, coho salmon, cutthroat trout, rainbow trout/steelhead) resulting from contamination, loss or alteration of riparian habitat; contamination, loss or alteration of instream habitat; and mortality or injury.

The potential effects associated with the interbasin transfer of aquatic organisms are predicted to be eliminated through the implementation of mitigation measures (Table 7.2.7-2) and, therefore, no residual effect is identified.

The potential effects associated with the fish mortality or injury due to accidental release of hazardous materials during power line construction are predicted to be eliminated through the implementation of mitigation measures (Table 7.2.7-2) and, therefore, no residual effect is identified.

7.2.7.6 Significance Evaluation of Potential Residual Effects

A quantitative analysis was undertaken to evaluate the significance of the potential residual environmental effects for the disturbance of riparian habitat and instream habitat indicators as these changes over the baseline data were quantifiable. However, where there are no standards, guidelines, objectives or other established and accepted ecological thresholds to define quantitative rating criteria or where quantitative thresholds are not appropriate, the qualitative method that is based on available research literature, field experience and professional judgment is considered to be the appropriate method for determining the significance of the anticipated residual environmental effects. Consequently, the qualitative assessment of fish and fish habitat is considered to be the most appropriate method with the evaluation of significance of the potential residual effects relying on the professional judgment of the assessment team in consideration of CCME guidelines and federal and provincial guidelines, where applicable.

Table 7.2.7-3 provides a summary of the significance evaluation of the potential residual environmental effects of the construction and operations of the Project on fish and fish habitat indicators. The rationale use in the evaluation of significance of each of the residual environmental effects is provided below.

TABLE 7.2.7-3

SIGNIFICANCE EVALUATION OF POTENTIAL RESIDUAL EFFECTS OF PROJECT CONSTRUCTION AND OPERATIONS ON FISH AND FISH HABITAT

				Temporal Context						
	Potential Residual Effects	Impact Balance	Spatial Boundary[1]	Duration	Frequency	Reversibility	Magnitude	Probability	Confidence	Significance[2]
1.	Fish and Fish Habitat Indicator – Riparian Habitat									
1(a)	Riparian habitat loss or alteration due to construction activities.	Negative	Footprint	Short-term	Isolated	Medium to long-term	Low	High	High	Not significant
1(b)	Clearing or disturbance of riparian habitat during maintenance and operations.	Negative	Footprint	Immediate to short-term	Occasional	Medium to long-term	Low	High	High	Not significant
1(c)	Alteration of riparian habitat from accidental drilling mud release and associated clean up activities.	Negative	RSA	Immediate to short-term	Accidental	Short to long-term	Negligible to high	Low	High	Not significant
1(d)	Contamination of riparian habitat from spills during construction.	Negative	RSA	Immediate	Accidental	Short to long-term	Negligible to high	Low	Moderate	Not significant
1(e)	Combined effects of the Project on the riparian habitat indicator (1[a] and 1[b]).	Negative	RSA	Short-term	Isolated to occasional	Medium to long-term	Low	High	High	Not significant

TABLE 7.2.7-3 Cont'd

	Potential Residual Effects	Impact Balance	Spatial Boundary[1]	Temporal Context: Duration	Temporal Context: Frequency	Temporal Context: Reversibility	Magnitude	Probability	Confidence	Significance[2]
2.	Fish and Fish Habitat Indicator – Instream Habitat									
2(a)	Alteration of instream habitat within the ZOI.	Negative	RSA	Immediate to short-term	Isolated	Short to medium-term	Low	High	High	Not significant
2(b)	Alteration of instream habitat from drilling mud release.	Negative	LSA	Immediate to short-term	Accidental	Immediate to medium-term	Low to high	Low	High	Not significant
2(c)	Contamination of instream habitat from spills during construction and maintenance.	Negative	RSA	Immediate	Accidental	Short to medium-term	Low to high	Low	High	Not significant
2(d)	Disturbance to instream habitat due to a potential increase in access during operations.	Negative	RSA	Long-term	Occasional	Immediate to long-term	Low	Low	Moderate	Not significant
3.	Fish and Fish Habitat Indicator – Fish Mortality and Injury									
3(a)	Increased fish mortality or injury due to construction activities.	Negative	RSA	Immediate to short-term	Isolated	Medium-term	Low	Low to high	High	Not significant
3(b)	Increased fish mortality or injury from spills during construction activities.	Negative	RSA	Immediate	Accidental	Short to long-term	Negligible to high	Low	High	Not significant
3(c)	Increased fish mortality or injury due to suspended sediment during instream construction.	Negative	RSA	Immediate to short-term	Isolated	Medium-term	Low to medium	Low to high	High	Not significant
3(d)	Increased fish mortality or injury due to suspended sediment from drilling mud release.	Negative	LSA	Immediate	Accidental	Immediate to medium-term	Low to high	Low	High	Not significant
3(e)	Increased fish mortality or injury due to a potential increase in access during operations.	Negative	RSA	Long-term	Occasional	Short to long-term	Low	Low	Moderate	Not significant
3(f)	Temporary blockage of fish movements.	Negative	RSA	Immediate to short-term	Isolated	Immediate to short-term	Low	High	High	Not significant
3(g)	Fish species of concern may be affected by an increase in suspended sediment concentration, habitat alteration within the ZOI and increased potential for mortality or injury.	Negative	RSA	Immediate to short-term	Isolated	Short-term	Low	Low	Moderate	Not significant
3(h)	Combined effects of the Project on the fish mortality and injury indicator (3[a], 3[c] and 3[f]).	Negative	RSA	Immediate to short-term	Isolated	Medium-term	Low to medium	High	Moderate	Not significant
4.	Fish and Fish Habitat Indicator – Arctic Grayling (Alberta Indicator Species)									
4(a)	Combined effects of the Project on Arctic grayling resulting from contamination, loss or alteration of riparian habitat; contamination, loss or alteration of instream habitat; and mortality or injury.	Negative	RSA	Immediate to short-term	Isolated	Medium to long-term	Low	High	Moderate	Not significant
5.	Fish and Fish Habitat Indicator – Athabasca Rainbow Trout (Alberta Indicator Species)									
5(a)	Combined effects of the Project on Athabasca rainbow trout resulting from contamination, loss or alteration of riparian habitat; contamination, loss or alteration of instream habitat; and mortality or injury.	Negative	RSA	Immediate to short-term	Isolated	Medium to long-term	Low	High	Moderate	Not significant

TABLE 7.2.7-3 Cont'd

Potential Residual Effects		Impact Balance	Spatial Boundary[1]	Temporal Context			Magnitude	Probability	Confidence	Significance[2]
				Duration	Frequency	Reversibility				
6.	Fish and Fish Habitat Indicator – Bull Trout (Alberta Indicator Species)									
6(a)	Combined effects of the Project on bull trout resulting from contamination, loss or alteration of riparian habitat; contamination, loss or alteration of instream habitat; and mortality or injury.	Negative	RSA	Immediate to short-term	Isolated	Medium to long-term	Low	High	Moderate	Not significant
7.	Fish and Fish Habitat Indicator – Burbot (Alberta Indicator Species)									
7(a)	Combined effects of the Project on burbot resulting from contamination, loss or alteration of riparian habitat; contamination, loss or alteration of instream habitat; and mortality or injury.	Negative	RSA	Immediate to short-term	Isolated	Medium to long-term	Low	High	Moderate	Not significant
8.	Fish and Fish Habitat Indicator – Northern Pike (Alberta Indicator Species)									
8(a)	Combined effects of the Project on northern pike resulting from contamination, loss or alteration of riparian habitat; contamination, loss or alteration of instream habitat; and mortality or injury.	Negative	RSA	Immediate to short-term	Isolated	Medium to long-term	Low	High	Moderate	Not significant
9.	Fish and Fish Habitat Indicator – Walleye (Alberta Indicator Species)									
9(a)	Combined effects of the Project on walleye resulting from contamination, loss or alteration of riparian habitat; contamination, loss or alteration of instream habitat; and mortality or injury.	Negative	RSA	Immediate to short-term	Isolated	Medium to long-term	Low	High	Moderate	Not significant
10.	Fish and Fish Habitat Indicator – Bull Trout/Dolly Varden (BC Indicator Species)									
10(a)	Combined effects of the Project on bull trout/Dolly Varden resulting from contamination, loss or alteration of riparian habitat; contamination, loss or alteration of instream habitat; and mortality or injury.	Negative	RSA	Immediate to short-term	Isolated	Medium to long-term	Low	High	Moderate	Not significant
11.	Fish and Fish Habitat Indicator – Chinook Salmon (BC Indicator Species)									
11(a)	Combined effects of the Project on Chinook salmon resulting from contamination, loss or alteration of riparian habitat; contamination, loss or alteration of instream habitat; and mortality or injury.	Negative	RSA	Immediate to short-term	Isolated	Medium to long-term	Low	High	Moderate	Not significant
12.	Fish and Fish Habitat Indicator – Coho Salmon (BC Indicator Species)									
12(a)	Combined effects of the Project on coho salmon resulting from contamination, loss or alteration of riparian habitat; contamination, loss or alteration of instream habitat;and mortality or injury.	Negative	RSA	Immediate to short-term	Isolated	Medium to long-term	Low	High	Moderate	Not significant
13.	Fish and Fish Habitat Indicator – Cutthroat Trout (BC Indicator Species)									
13(a)	Combined effects of the Project on cutthroat trout resulting from contamination, loss or alteration of riparian habitat; contamination, loss or alteration of instream habitat; and mortality or injury.	Negative	RSA	Immediate to short-term	Isolated	Medium to long-term	Low	High	Moderate	Not significant

TABLE 7.2.7-3 Cont'd

Potential Residual Effects		Impact Balance	Spatial Boundary[1]	Temporal Context: Duration	Temporal Context: Frequency	Temporal Context: Reversibility	Magnitude	Probability	Confidence	Significance[2]
14.	Fish and Fish Habitat Indicator – Rainbow Trout/Steelhead (BC Indicator Species)									
14(a)	Combined effects of the Project on rainbow trout/steelhead resulting from contamination, loss or alteration of riparian habitat; contamination, loss or alteration of instream habitat; and mortality or injury.	Negative	RSA	Immediate to short-term	Isolated	Medium to long-term	Low	High	Moderate	Not significant

Notes: 1 LSA = Fish and Fish Habitat LSA; RSA = Aquatics RSA.

2 Significant Residual Environmental Effect: A high probability of occurrence of a permanent or long-term residual effect of high magnitude that cannot be technically or economically mitigated.

Fish and Fish Habitat Indicator – Riparian Habitat

The following provides the evaluation of significance of potential residual effects on the riparian habitat indicator related to construction, operations and maintenance activities and contamination from small spills during construction.

Riparian Habitat Loss or Alteration Due to Construction

The components of the Project which may affect the riparian habitat include the construction and operations of the proposed pipeline, temporary facilities (*i.e.,* through construction of access roads), and pump stations (*i.e.,* power lines at Black Pines and Kingsvale), activities associated with pipeline reactivation and the tanks and associated terminals are not expected to cause a loss or alteration of riparian habitat. No potential effects were identified for riparian habitat resulting from construction and operations activities at the Westridge Marine Terminal.

Riparian vegetation within the construction right-of-way and temporary workspace will be disturbed at all trenched (*i.e.*, isolated or open cut) watercourse crossings and watercourses where a temporary vehicle crossing will be installed. The impact balance of this residual effect is considered to be negative. During construction, disturbance to riparian vegetation will be kept to a minimum, leaving as much existing riparian vegetation intact as practical and efforts to control sedimentation and erosion in disturbed areas will be implemented. Alteration to riparian vegetation will also be reduced during frozen ground conditions. Disturbed riparian areas will be seeded following construction with appropriate native seed mix along with a quick establishing cover crop. Grasses are expected to be restored within the growing season following construction, but it will take several years for the canopy to be restored. Revegetation mitigation measures are presented in the Pipeline EPP (Volume 6B).

Riparian habitat revegetation plans for the TMX Anchor Loop Project included determining riparian plant species and numbers to be used at each site based on detailed site assessments to determine the biophysical parameters at each watercourse crossing (TERA 2009a). Monitoring 1 year after construction revealed that remedial planting was required at 10 fish-bearing watercourses (of 34 assessed) (TERA 2009b). Only 3 of 39 fish-bearing watercourses required supplemental planting 2 years following construction (TERA 2011a). By 4 years post-construction, all outstanding issues relating to riparian loss and/or alteration at all watercourses (*i.e.*, fish-bearing and nonfish-bearing) were resolved (TERA 2013a). Results of the post-construction environmental monitoring also indicated the effectiveness of several mitigation measures recommended for the Project in Table 7.2.7-2. When grubbing was avoided in riparian areas adjacent to watercourse crossings, deciduous plants re-sprouted in the spring following clearing and native plants established from seed in the undisturbed surface soil (TERA 2013a). In addition, the manual removal of vegetation in riparian areas was found to be effective in the control or suppression of non-native broadleaf weeds (TERA 2013a). If necessary, trees will be cleared by hand to reduce disturbance to riparian areas (Section 8.1 of the Pipeline EPP [Volume 6B]).

Silt runoff from construction activities was a concern raised by participants at the Burnaby Community Workshop. According to participants, Brunette River, Silver, Eagle and Stoney creeks are watercourses of most concern for riparian habitat loss or alteration in this area. The successful implementation of the recommended mitigation measures should address the concerns of participants at the Burnaby Community Workshop.

The maximum riparian area that may be disturbed by construction of the proposed pipeline is 334.6 ha, or 0.05% of the total riparian area within the Aquatics RSA (Table 7.2.7-4). This maximum disturbance as a result of pipeline construction would occur if the entire riparian area, to the width of the construction right-of-way and 30 m from the top of the bank was removed at every watercourse crossing, however, the actual disturbance to riparian habitat is expected to be less. Some watercourses will be crossed using a trenchless method (reducing the effects to riparian habitat), in addition, some crossings will not have 30 m of riparian habitat from the top of the banks (*i.e.,* in the White Area of Alberta). Furthermore, clearing of riparian vegetation will only occur within the pipeline easement and temporary workspace will not be cleared within the riparian buffer. Additional riparian habitat disturbance may occur at vehicle crossings for access roads to temporary facilities and other Project components, however, these details are currently unknown and this disturbance is expected to be minor.

TABLE 7.2.7-4

PROJECT DISTURBANCE OF RIPARIAN HABITAT WITHIN THE AQUATICS RSA

Province	Area of Riparian Habitat in RSA (ha)	Area of Disturbed Riparian Habitat (ha)	% of Riparian Habitat Disturbed
Alberta[1]	193,182.1	63.1	0.03
British Columbia[2]	524.747.0	271.5	0.05
TOTALS	717,929.1	334.6	0.05

Notes: 1 The Middle North Saskatchewan River watershed is not included because disturbance of riparian areas as the Project is located within the City of Edmonton in this watershed, and the City of Edmonton has been excluded from the quantitative analysis (Section 8.1.5).

2 The Lower Fraser River and Squamish watersheds are not included because disturbance of riparian areas as the Project is located within the Lower Mainland Developed Area (LMDA) in both of these watersheds, and the LMDA has been excluded from the quantitative analysis (Section 8.1.5).

3 Calculations based on an average of 30 m riparian area on each bank at all waterbodies.

4 Calculations based on footprint disturbances provided in Table 8.1-1 and are approximate.

The residual effect of pipeline construction on clearing riparian vegetation, although negative, is considered to be of low magnitude given the implementation of industry standard and provincially and federally recommended mitigation measures and monitoring of revegetation success at water crossings post-construction. The residual effect is also considered to be reversible in the medium to long-term, depending on the pre-existing vegetation community (*e.g.,* shrubs regenerate within several years, however, tree regrowth is expected to extend into the long-term) (Table 7.2.7-3, point 1[a]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Footprint – clearing or disturbance of riparian vegetation is confined to the Project Footprint.
- Duration: short-term – the event causing the alteration of riparian vegetation is construction of the various components of the Project (*e.g.*, pipeline and temporary vehicle crossings).
- Frequency: isolated – the event causing clearing or disturbance of riparian vegetation (*i.e.,* construction of the pipeline and temporary vehicle crossings) is confined to a specific period.
- Reversibility: medium to long-term – depending upon the pre-existing vegetation community (*e.g.,* grasses, shrubs and/or trees).
- Magnitude: low – based on implementation of mitigation measures, including revegetation, and the results of post-construction environmental monitoring programs which demonstrate the effectiveness of the measures proposed.

- Probability: high – alteration of riparian vegetation is expected to occur at all trenched (*i.e.*, isolated or open cut) watercourse crossings and vehicle crossings where riparian vegetation exists.
- Confidence: high – based on a good understanding by the assessment team of trenched and vehicle crossing methods and associated affects on riparian vegetation.

Clearing or Disturbance of Riparian Habitat During Maintenance and Operations

Routine vegetation control along the proposed pipeline right-of-way and reactivated pipeline segments during operations will exclude riparian areas. However, a situation may occur during the life of the operating pipeline where riparian vegetation disturbance may be necessary to accommodate maintenance activities (*e.g.,* in the event of a flood event that causes scouring over the pipeline trench that would require measures to restore depth of cover and pipe integrity or an integrity dig). The residual effect of clearing riparian habitat during pipeline operations is of low magnitude and reversible in the medium to long-term (Table 7.2-7.3, point 1[b]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Footprint – clearing or disturbance of riparian vegetation is confined to the Project Footprint.
- Duration: immediate to short-term – the event causing alteration of riparian vegetation during operations is maintenance activities which may take less than two days (*i.e.,* immediate) or may take more than two days but less than 1 year (*i.e.,* short-term).
- Frequency: occasional – any maintenance activities required at watercourse crossings will occur intermittently and sporadically over the assessment period.
- Reversibility: medium to long-term – depending upon the pre-existing vegetation community (*e.g.,* shrubs or trees) and the extent of clearing or alteration of riparian vegetation required for maintenance activities to take place.
- Magnitude: low – based on the implementation of industry standard and provincially and federally recommended mitigation measures during operations phases of the Project and the results of post-construction environmental monitoring programs which demonstrate the effectiveness of the measures proposed.
- Probability: high – clearing within the riparian area may occur as a result of integrity digs during operations.
- Confidence: high – based on the professional experience of the assessment team.

Alteration of Riparian Habitat from Accidental Drilling Mud Release and Associated Clean Up Activities

During HDD crossings for the Project, monitoring of drilling fluid volumes and pressure, as well as monitoring of sediment concentrations in the watercourse and terrestrial frac-outs are expected to reduce the potential for a drilling mud release to affect a watercourse. If a release on-land (*i.e.*, terrestrial) were to occur, the inert nature of the bentonite clay used would not contaminate the riparian area. However, clean up and reclamation measures may result in some riparian habitat alteration. During the Surrey ESA Workshop, participants raised concerns over the introduction of large quantities of sand into watercourses, as has happened with past events (*i.e.,* construction of a gas pipeline in 1979). However, this is not anticipated for the Project given the use of bentonite clay in the drilling mud. There were no trenchless crossings during construction of the TMX Anchor Loop Project (TERA 2009a); however, other recent pipeline projects have conducted successful trenchless crossings of major watercourses. To avoid or reduce effects of drilling mud release on riparian habitat, Trans Mountain will continually monitor for sediment release (*i.e.,* turbidity and TSS) throughout the crossing construction period. In the event of a release into a watercourse, Trans Mountain will immediately suspend drilling activities and implement measures outlined in the Drilling Mud Release Contingency Plan to reduce effects of drilling mud release into the watercourse. Any releases would be reported to DFO and AESRD or BC MOE and clean up and monitoring will be carried out until water quality is returned to existing (background) conditions.

Appropriate drill paths will be established and drilling mud pressures and returns monitored to reduce the risk of inadvertent releases of drilling mud during an HDD. The post-construction environmental monitoring program will identify any locations with altered drainage patterns (*e.g.,* ponded water) and remedial work will be conducted, where warranted. Results of the post-construction environmental monitoring from previous projects also indicated the effectiveness of several mitigation measures recommended for the Project in Table 7.2.7-2.

With the implementation of mitigation and reclamation measures, the residual effects of a drilling mud release on riparian habitat are negligible to high in magnitude (depending on the volume of the release and area affected) and reversible in the short to long-term (depending on the pre-existing vegetation community) and the concerns of participants at the Surrey ESA Workshop should be addressed (Table 7.2.7-3, point 1[c]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Aquatics RSA – a drilling mud release on land may flow beyond the construction right-of-way, which is also the limit of the Fish and Fish Habitat LSA.
- Duration: immediate to short-term – the event causing an alteration of riparian habitat is the accidental release of drilling mud, the period of which may be less than or equal to two days for small releases or could extend longer.
- Frequency: accidental – the release of drilling mud occurs rarely over the assessment period.
- Reversibility: short to long-term – depending upon the length of time it takes for vegetation to recolonize the area disturbed by mud (*e.g.,* if the release occurs over a small area and if only grasses are affected, they could recover within one growing season; however, if shrubs or trees are affected recovery may extend into the long-term).
- Magnitude: negligible to high – depending upon the location and sensitivity of the receiving environment and the volume of drilling mud released.
- Probability: low – mitigation measures will be implemented during HDD operations to prevent drilling mud release.
- Confidence: high – based on the professional experience of the assessment team.

Contamination of Riparian Habitat from Spills During Construction

In the event of a spill such as a fuel truck rollover, the adverse residual effects would, depending on the volume of the spill and the sensitivity of the receiving environment, range from negligible to high magnitude with potentially long lasting ramifications to riparian vegetation. However, spill contingency and clean up measures would reduce the magnitude and reversibility of the residual effects.

Since spills rarely occur within the construction right-of-way during construction activities, the probability of a significant adverse residual effect is low (Table 7.2-7.3, point 1[d]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Aquatics RSA – spills resulting in the contamination of riparian habitat may extend beyond the construction right-of-way and, consequently, beyond the Fish and Fish Habitat LSA.
- Duration: immediate – the event causing contamination is a spill, the period of which is less than or equal to two days.
- Frequency: accidental – contamination from spills occurs rarely over the assessment period.
- Reversibility: short to long-term – depending upon the nature and volume of the spill as well as the level of sensitivity of the receiving environment and the pre-existing vegetation community (*e.g.,* shrubs or tress).
- Magnitude: negligible to high – depending on the sensitivity of the receiving environment and volume of the spill.

- Probability: low – based on established mitigation measures to prevent a spill.
- Confidence: moderate – based on the professional experience of the assessment team.

Combined Effects on Riparian Habitat

The components of the Project which may affect the riparian habitat indicator include the construction and operations of the proposed pipeline, temporary facilities (*i.e.,* through construction of access roads), and pump stations (*i.e.,* power lines at Black Pines and Kingsvale), as well as pipeline reactivation activities. No potential effects were identified for riparian habitat resulting from construction and operations activities at the Westridge Marine Terminal or for proposed storage tanks and associated terminals.

The evaluation of the combined effects of the Project on the riparian habitat indicator considers collectively the assessment of the combined effects on this indicator from construction and operations of all applicable Project components. TEK participants have reported a steady decline in water quality and fish populations over the past 30 years in the region (*i.e.*, Edmonton to Hinton Segment), which they consider to be due to the cumulative effects of pollution and industrial development. Overall, the Project has the potential to alter riparian habitat as a result of construction and operations activities in and around waterbodies and watercourses, which is considered to have a negative impact balance. Through implementation of industry standard and provincially and federally recommended mitigation measures during the construction and operations phases of the Project, the combined effects of the Project on the riparian habitat indicator are considered to be of low magnitude (Table 7.2.7-3, point 1[e]). A summary of the rationale for all of the significance criteria of combined effects on surface water quality is provided below.

- Spatial Boundary: Aquatics RSA – combined effects to riparian habitat may extend beyond the Fish and Fish Habitat LSA in consideration of some activities (*e.g.,* for hydrostatic testing).
- Duration: short-term – the duration of Project activities contributing to combined effects to the riparian habitat indicator vary, but are mostly confined to the construction phase or would not extend beyond a year during the operations phase (*e.g.,* integrity dig).
- Frequency: isolated to occasional – the events causing effects to riparian habitat will primarily occur during the construction phase (*i.e.,* isolated), however, some activities during operations will also contribute to effects to riparian habitat and occur intermittently and sporadically (*i.e.*, occasional).
- Reversibility: medium to long-term – areas in which riparian vegetation is disturbed during construction or operations are expected to be reversed in the medium to long-term, depending on the pre-existing vegetative community (*e.g.*, shrubs or trees).
- Magnitude: low – combined effects to riparian habitat as a result of Project construction and operations are considered to be of low magnitude given the implementation of industry standard and provincially and federally recommended mitigation measures.
- Probability: high – riparian habitat will be affected by some aspects of the Project (*i.e.,* clearing for watercourse crossing construction or at hydrostatic test locations).
- Confidence: high – based on the professional experience of the assessment team.

<u>Fish and Fish Habitat Indicator – Instream Habitat</u>

The following provides the evaluation of significance of potential residual effects on the instream habitat indicator related to construction activities, release of instream drilling mud, contamination from small spills during construction and increased access during operations.

Alteration of Instream Habitat within the ZOI

The components of the Project which affect the instream habitat indicator include the construction and operations of the proposed pipeline, temporary facilities (*e.g.,* through increased access and temporary vehicle crossings), terminals and associated tank facilities, and pipeline reactivation activities (*i.e.,* through hydrostatic testing). There are no effects to instream habitat identified with construction of the Westridge Marine Terminal.

The pipeline corridor selection criteria included reducing the number of watercourse crossings to the extent practical and crossing watercourses perpendicular to the banks. The proposed crossing techniques and mitigation measures have taken into consideration the sensitivity of the watercourses (inclusive of TEK), including habitat characteristics, fish species present, and instream work windows, in addition to the construction schedule, and technical and economic feasibility of each crossing (see Appendix A, Crossing Summary Table, of the Fisheries [Alberta] and Fisheries [British Columbia] Technical Reports of Volume 5C). The introduction of fine sediment to watercourses from instream activities, right-of-way runoff and erosion can have sub-lethal (*e.g.,* irritation of gill tissue) or lethal (*e.g.,* suffocation of developing embryos) effects on fish, and can also cause downstream sediment deposition that alters substrate composition and modifies the availability and suitability of habitat for spawning, overwintering and/or rearing (Anderson *et al.* 1996, Newcombe and MacDonald 1991).

Bank stabilization through the application of native seed mixes with quick germinating cover crops, in addition to enhanced revegetation efforts including geotextiles or biostabilization, will be the preferred methods of stabilizing watercourse banks disturbed as a result of pipeline construction.

The implementation of the proposed mitigation measures, in accordance with the applicable DFO Operation Statement (OPs) and the AESRD codes of practice (COPs), will reduce the potential for serious harm to fish or any permanent alteration to, or destruction of, fish habitat as a result of trenched pipeline crossings and temporary vehicle crossings. Nevertheless, a Section 35 Authorization from DFO will be applied for, and fish habitat compensation/offset will be implemented as defined in the Authorization, should serious harm to fish or any permanent alteration to, or destruction of, fish habitat be expected as a result of construction activities. In the event that serious harm to fish or any permanent alteration to, or destruction of, fish habitat is expected and a fish habitat compensation/offset plan is required, the fish habitat compensation/offset plan will be used to ensure compliance with DFO's Fisheries Protection Policy (DFO 2013a). Post-construction environmental monitoring for the TMX Anchor Loop Project included instream habitat assessments, particularly at fish-bearing watercourses where the harmful alteration, disruption and destruction (HADD) of fish habitat had been authorized by DFO. Results of the 2010 post-construction environmental monitoring (*i.e.*, 2 years after construction) indicated that the mitigation used during construction to mitigate potential effects to instream habitat was effective and all habitats were functioning as intended (TERA 2011a). Many of the same, standard mitigation measures used during construction of the TMX Anchor Loop Project will also be applied to the proposed Project.

The maximum area of instream habitat that may be disturbed by construction of the proposed pipeline is 8.52 ha. Because it will be unknown until closer to the time of construction as to whether a proposed trenchless crossing method will be successful at a given watercourse, this maximum area is based on the assumption that a trenched (*i.e.*, isolated or open cut) crossing method is used at every proposed crossing location and that the area of instream habitat disturbed will be the entire width of the Project Footprint. The actual disturbance to instream habitat is expected to be less, since some watercourses will be crossed using a trenchless method, which, if successful, will not alter instream habitat. The total area of instream habitat in the Aquatics RSA is approximately 60,271.14 ha and the disturbance caused by construction of the pipeline represents 0.01% of the instream habitat within the Aquatics RSA (Table 7.2.7-5). Instream habitat may also be disturbed during the construction of vehicle crossings associated with temporary facilities or power lines, however, these details are currently unknown and the disturbed area is anticipated to be minor.

TABLE 7.2.7-5

PROJECT DISTURBANCE OF INSTREAM FISH HABITAT WITHIN THE AQUATICS RSA

Province	Area of Riparian Habitat in RSA (ha)	Area of Disturbed Riparian Habitat (ha)	% of Riparian Habitat Disturbed
Alberta[1]	17,346.11	0.93	<0.01
British Columbia [2]	42,925.03	7.59	0.02
TOTALS	60,271.14	8.52	0.01

Notes: 1 The Middle North Saskatchewan River watershed is not included because Project instream disturbance in this watershed is located within the City of Edmonton, and the City of Edmonton has been excluded from the quantitative analysis (Section 8.1.5).

2 The Lower Fraser River and Squamish watersheds are not included because Project instream disturbance in these watersheds is located within the LMDA, and the LMDA has been excluded from the quantitative analysis (Section 8.1.5).

The Similkameen watershed is not included because there is no Project instream disturbance in this watershed.

3 Calculations based on footprint disturbances provided in Table 8.1-1 and are approximate.

The residual effects of the Project on instream habitat are expected to be of low magnitude and reversible in the short to medium-term for most watercourse crossings encountered by the Project. In addition, for watercourses where serious harm to fish or any permanent alteration to, or destruction of, fish habitat occurs and a fish habitat compensation/offset plan is required, the mitigation proposed will reduce the magnitude of effects to low (Table 7.2-7.3, point 2[a]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Aquatics RSA – alteration of instream habitat may extend beyond the Fish and Fish Habitat LSA for some activities (*e.g.,* for hydrostatic testing).
- Duration: immediate to short-term – the event causing alteration of instream habitat is watercourse crossing construction which can be completed within two days for small watercourses with no water but would take longer where water is present.
- Frequency: isolated – the event causing alteration of instream habitat is confined to the construction phase.
- Reversibility: short to medium-term – any sediments that result in deposition on the substrate of a watercourse are expected to be flushed from the system following the first annual flushing event after construction and, if any fish habitat compensation/offset measures are implemented, they should be implemented during construction and/or within the first year following construction of the watercourse crossing.
- Magnitude: low – based on the effectiveness of the proposed mitigation, the anticipated level of effects of the alteration of instream habitat and the implementation of a compensation/offset plan if serious harm to fish or any permanent alteration to, or destruction of, fish habitat is anticipated.
- Probability: high – some watercourses with documented fish presence will be crossed using trenched (*i.e.,* isolated or open cut) crossing methods.
- Confidence: high – based on a good understanding by the assessment team of trenched crossing methods and associated affects on instream habitat.

Alteration of Instream Habitat from Drilling Mud Release

During HDD crossings, monitoring of drilling fluid volumes and pressure, as well as monitoring of sediment concentrations in the watercourse and on-land frac-outs are expected to help reduce the potential for a drilling mud release to affect instream habitat.

A release of drilling mud into a watercourse could affect instream habitat by increasing suspended sediments and subsequent sediment deposition; however, with the implementation of the Horizontal Directional Drilling/Trenchless Planning and Procedures Management Plan (Appendix C of the Pipeline

EPP of Volume 6B), the residual effects of a drilling mud release on instream habitat are considered low to high, but of low probability.

Information acquired during an HDD feasibility assessment will be used to establish appropriate drill paths, and monitoring of drilling mud pressures and returns will be conducted to reduce the risk of an inadvertent release of drilling mud. This residual effect is considered reversible in the immediate to medium-term, depending on the volume of the release and flow rates of the watercourse (Table 7.2.7-3, point 2[b]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Fish and Fish Habitat LSA – drilling mud released into surface water may be carried downstream but should settle out within the ZOI.
- Duration: immediate to short-term – the event causing the alteration of instream habitat is the accidental release of drilling mud, the period of which may be less than or equal to two days (immediate) or could extend longer (short-term).
- Frequency: accidental – the release of drilling mud occurs rarely over the assessment period.
- Reversibility: immediate to medium-term – depending on the volume of release and flow rates of the watercourse.
- Magnitude: low to high – depending on the location of the release and quantity of drilling mud released.
- Probability: low – mitigation measures will be implemented during HDD operations to prevent drilling mud release.
- Confidence: high – based on the professional experience of the assessment team.

Contamination of Instream Habitat from Spills During Construction

In the event of a spill such as a fuel truck rollover in or near a stream, the adverse residual effects could, depending on the volume of the spill and the sensitivity of the receiving environment, be of high magnitude with potentially long lasting ramifications to the health of the watercourse. Such an event has the potential to occur during any activities in or near a watercourse (*e.g.,* watercourse crossing construction, hydrostatic testing). Although spill contingency and clean up measures would reduce the magnitude and reversibility of the residual effects, such an incident could be considered of high magnitude due to adverse residual effects if it were to occur in a highly sensitive environment.

Since spills rarely occur within the construction right-of-way during construction activities, and occur even more rarely instream, the probability of a significant adverse residual effect is low (Table 7.2.73, point 2[c]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Aquatic RSA – spills resulting in the contamination of instream habitat may extend beyond the Footprint which is also the Fish and Fish Habitat LSA.
- Duration: immediate – the event causing contamination is an accidental spill during construction.
- Frequency: accidental – contamination from spills occurs rarely, if at all, during the assessment period.
- Reversibility: short to medium-term – depending on the nature and volume of the spill as well as the level of sensitivity of a particular watercourse to adverse residual effects resulting from contamination.
- Magnitude: low to high – depending on the sensitivity of the receiving environment and the volume of the spill.
- Probability: low – based on established mitigation measures to prevent a spill.
- Confidence: high – based on the professional experience of the assessment team.

Disturbance to Instream Habitat Due to a Potential Increase in Access During Operations

If the Traffic and Access Control Management Plan (Appendix C of Volume 6B) does not completely prevent access to pipeline right-of-way during operations, increased access has the potential to alter instream habitat and this residual effect is considered to have a negative impact balance. However, it is noted that 89% of the proposed pipeline corridor parallels the existing TMPL right-of-way or other linear facilities and, consequently, the concern is limited to the potential for increased access at new rights-of-way and watercourse crossings.

Increased off-road vehicle access (*i.e.*, forded crossings), as a result of pipeline development, could result in disturbances to instream habitat during the operations phase of the pipeline through increased suspended sediment or damage to the watercourse substrate.

Trees and/or shrubs will be planted at locations where new access is created in an attempt to control access during operations. Post-construction environmental monitoring will evaluate the effectiveness of changes to access control measures. With the application of measures outlined in the Traffic and Access Control Management Plan (Appendix C of Volume 6B), the magnitude of the residual effect of increased access will be reduced to low (Table 7.2.7-3, point 2[d]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Aquatics RSA – increased access to instream habitat may occur outside the Fish and Fish habitat LSA (*e.g.,* as associated with temporary facilities).
- Duration: long-term – the event causing fish mortality or injury is increased access to watercourses which is initiated during construction and extends beyond the first year of the operations phase.
- Frequency: occasional – the events contributing to potential habitat alteration *(e.g.,* recreational off-road vehicles fording streams and causing sediment events) may occur intermittently and sporadically during the operations phase.
- Reversibility: immediate to long-term – although grasses in disturbed areas can be re-established relatively quickly, the regrowth of some plants that are planted as part of the mitigation measures identified in the Traffic and Access Control Management Plan could take more than 10 years to reach their desired size.
- Magnitude: low – with the proposed pipeline corridor adjacent to existing rights-of-way for 89% of its length and the implementation of mitigation measures, the residual effect is considered to be low.
- Probability: low – paralleling the existing TMPL right-of-way and other linear facilities and conditions within the Fish and Fish Habitat LSA will limit new opportunities for recreational off-road vehicle use.
- Confidence: moderate – based on the professional experience of the assessment team.

Fish and Fish Habitat Indicator – Fish Mortality and Injury

The following provides the evaluation of significance of potential residual effects on fish mortality or injury indicator related to construction and operations and maintenance activities, small spills during construction, suspended sediment during instream construction, suspended sediment from an instream drilling mud release, increased access during operations, blockage of fish movements and effects on fish species of concern.

Increased Fish Mortality or Injury Due to Construction and Maintenance Activities

Under non-frozen conditions, fish rescue during isolated watercourse crossing construction is unlikely to result in the mortality or injury of fish. Despite the implementation of industry accepted standard mitigation measures outlined in Table 7.2.7-2 and the Pipeline EPP (Volume 6B) during fish rescues, the likelihood of fish injury or mortality arising from an isolated crossing during winter conditions is considered high (Table 7.2.7-3, point 3[a]). This is because removing fish out of water for even a short period of time during very cold ambient temperatures (*e.g.,* 20^{o}C) has the potential to cause injuries to fish that may contribute to increased mortality. Ice may form on wet netting when it is held out of the water and this could cause injuries to fish and if fish are accidentally held out of the water for more than a few seconds, the potential for freezing temperatures to affect the fish themselves increases. Increased sedimentation from construction activities may also cause behavioural or sub-lethal/lethal effects to fish and is discussed in the following subsection. The magnitude of this potential residual effect is considered to be low with the successful implementation of the recommended mitigation measures and if necessary, regulatory authorization for the destruction of fish (DFO 2009). A summary of the rationale for all of the significance criteria is provided below

- Spatial Boundary: Aquatics RSA – fish mortality or injury may result from watercourse crossing construction activities and fish rescue and from construction of temporary vehicle crossings, which may occur outside the Fish and Fish Habitat LSA.
- Duration: immediate to short-term – the event causing fish mortality or injury is construction of the watercourse crossing which will take less than 1 year but may take more than two days at a given crossing location.
- Frequency: isolated – the event causing fish mortality or injury (*i.e.,* construction of the pipeline) is confined to a specific period.
- Reversibility: medium-term – loss of one or more individuals could affect population scale for several years, or until those individuals can be replaced.
- Magnitude: low – based on the implementation of mitigation measures proven to be effective and with appropriate regulatory authorizations where fish rescues are conducted during cold temperatures.
- Probability: low to high – depending on the construction spread and whether fish salvage will be required during winter conditions.
- Confidence: high – based on the professional experience of the assessment team.

Increased Fish Mortality or Injury from Spills During Construction

Spills accidentally released at watercourse crossings with fish habitat potential during construction and maintenance activities could cause behavioural or sub-lethal/lethal effects on fish within the ZOI. A spill, such as a fuel truck rollover in or near a stream, during construction could cause increased fish mortality or injury and would be considered to have a negative impact balance; however, proper spill contingency and clean up measures would reduce the magnitude and increase the reversibility of the residual effects. Depending on the volume of the spill and the sensitivity of the receiving environment, the adverse residual effects could range from negligible to high magnitude with potentially increased fish mortality or injury.

Since spills rarely occur within the construction right-of-way during construction activities, and occur even more rarely instream, the probability of a significant adverse residual effect is low (Table 7.2.7-3 point 3[b]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Aquatics RSA – fish mortality or injury may result from watercourse crossing construction activities which are generally confined to the Fish and Fish Habitat LSA but could extend to the Aquatics RSA in consideration of a spill at hydrostatic test sources for terminals.
- Duration: immediate – the event causing increased fish mortality or injury is a spill, the period of which is less than or equal to two days.
- Frequency: accidental – fish mortality of injury from spills occurs rarely over the assessment period.
- Reversibility: short to long-term – depending upon the nature and volume of the spill as well as the level of sensitivity of the receiving population.
- Magnitude: negligible to high – depending on the sensitivity of the receiving indicators and volume of the spill.

- Probability: low – mitigation measures will be implemented to prevent fish mortality or injury.
- Confidence: high – based on the professional experience of the assessment team.

Increased Fish Mortality or Injury Due to Suspended Sediment During Instream Construction

Pipeline corridor selection criteria included reducing the number of waterbody crossings to the extent practical. An increase in suspended sediment may also occur through hydrostatic testing (*e.g.,* as associated with reactivation of pipeline segments) and installation of temporary vehicle crossings. An evaluation of increased suspended solid concentrations during instream construction is provided in Section 7.2.3 Water Quality and Quantity. Through the selection of appropriate watercourse crossing techniques, vehicle crossing methods and the implementation of surface erosion controls and riparian area revegetation as outlined in Table 7.2.7-2 and in the Pipeline EPP (Volume 6B) and Facilities EPP (Volume 6C), the potential for adverse effects on aquatic systems along the proposed pipeline corridor due to suspended solids in the water column is reduced.

Suspended sediment released at isolated crossings during instream activities could cause behavioural or sub-lethal/lethal effects on fish within the ZOI. Suspended sediment concentrations will, where warranted, be monitored during instream activities at isolated crossings to confirm that TSS averages remain below the CCME standard of 25 mg/L above baseline (CCME 2007). This is the level, based on 24 hours exposure, when mortalities of the most sensitive life history stage can begin to occur (Newcombe 1994).

There is a level of risk to aquatic resources as a result of high levels of sediment discharge caused by instream construction activities. The Canadian Water Quality Guidelines for the Protection of Aquatic Life (CCME 2002) are often used to ensure aquatic resources are protected during instream activities. These guidelines indicate that a biologically important average increase in TSS concentration over a short-term period (*i.e.*, 24 h) is 25 mg/L above the background level (CCME 2002). DFO (2000) has identified risk levels to protect aquatic resources. The risk levels are determined based on the relationship between increasing suspended sediment concentrations and the level of risk that increasing sediment concentrations can have on fish and fish habitat. DFO (2000) indicates that concentrations <25 mg/L, 25-100 mg/L, 100-200 mg/L, 200-400 mg/L and >400 mg/L have very low, low, moderate, high and unacceptable risk, respectively. Additional background on these risk levels is discussed in Birtwell (1999).

An open cut crossing during flowing conditions is recommended as either the proposed or contingency crossing method for at least one watercourse. Although the specific need (*e.g.,* proposed or contingency crossing method), duration and scheduling of open cut crossing(s) during flowing conditions are still to be confirmed, it is expected that the duration and magnitude of sediment events resulting from an open cut crossing during flowing conditions will be longer and higher, respectively, and this may contribute to serious harm to fish or any permanent alteration to, or destruction of, fish habitat and fish mortality or injury. DFO authorization will be obtained should the destruction of fish and fish habitat be deemed unavoidable. Where this occurs, mitigation and compensation/offset requirements will be confirmed during the permitting stage through discussions with appropriate regulatory authorities.

Minor releases of sediment may be associated with the use of temporary vehicle crossings. Although elevated suspended sediment concentrations may result from instream construction and vehicle crossing use, pulses of suspended solids are generally expected to settle out of the water column within the ZOI in a timeframe measuring from minutes to a few hours.

With the implementation of mitigation measures outlined in Table 7.2.7-2 and the Pipeline EPP (Volume 6B), the likelihood of fish mortality or injury arising from suspended sediment during instream construction ranges from low for an isolated crossing to potentially high for an open cut of a large flowing watercourse crossing (Table 7.2.7-3, point 3[c]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Aquatics RSA – some Project activities causing an increase in suspended sediment will occur outside the Fish and Fish Habitat LSA.
- Duration: immediate to short-term – the event causing fish mortality or injury due to suspended sediment is instream construction, the period of which may be less than two days at some watercourse crossings (immediate) or could extend longer for others (short-term), depending on the

size of the watercourse and the nature of the activities (*e.g.*, open cut, vehicle crossing installation, hydrostatic test withdrawal).

- Frequency: isolated – the event causing fish mortality or injury (*e.g.*, Eagle Creek construction of trenched crossings) is confined to a specific period.
- Reversibility: medium-term – loss of one or more individuals could affect population scale for several years, or until those individuals can be replaced.
- Magnitude: low to medium – based on the implementation of mitigation measures proven to be effective, regulatory authorizations and, where warranted, the implementation of fish habitat compensation/offset.
- Probability: low to high – although mitigation measures will be implemented to prevent fish mortality or injury and are anticipated to be effective at most watercourse crossings, in the event of an open cut of a large flowing watercourse, there is potential to exceed CCME guidelines within the ZOI.
- Confidence: high – based on available research literature and the professional experience of the assessment team.

Increased Fish Mortality or Injury Due to Suspended Sediment from Drilling Mud Release

During HDD crossings, monitoring of drilling fluid volumes and pressure, as well as monitoring of sediment concentrations in the watercourse and on-land frac-outs are expected to help reduce the potential for a drilling mud release to affect instream habitat.

A release of drilling mud into a watercourse could affect instream habitat by increasing suspended sediments and sediment deposition. Increased sediment in the water column can increase the probability of fish mortality (see Table 7.2.7-3, point 3[d]); however, with the implementation of the Horizontal Directional Drilling/Trenchless Planning and Procedures Management Plan (Appendix C of the Pipeline EPP of Volume 6B), the residual effects of a drilling mud release on fish mortality or injury are considered low to high but of low probability.

Information acquired during an HDD feasibility assessment will be used to establish appropriate drill paths, and monitoring of drilling mud pressures and returns will be conducted to reduce the risk of an inadvertent release of drilling mud. This residual effect is considered reversible in the immediate to medium-term, depending on the volume of the release and flow rates of the watercourse (Table 7.2.7-3, point 3[d]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Fish and Fish Habitat LSA – drilling mud released into surface water may be carried downstream.
- Duration: immediate – the event causing fish mortality or injury is the accidental release of drilling mud, which is immediate.
- Frequency: accidental – the release of drilling mud occurs rarely over the assessment period.
- Reversibility: immediate to medium-term – depending on the volume of release and flow rates of the watercourse.
- Magnitude: low to high – depending on the location of the release and quantity of drilling mud released.
- Probability: low – mitigation measures will be implemented during HDD operations to prevent drilling mud release.
- Confidence: high – based on the professional experience of the assessment team.

Increased Fish Mortality or Injury Due to a Potential Increase in Access During Operation

If the Traffic and Access Control Management Plan (Appendix C of the Pipeline EPP of Volume 6B) does not prevent access to the pipeline right-of-way during operations phase, increased access has the potential to cause increased fish mortality or injury and this residual effect is considered to have a negative impact balance. Participants at the Kamloops ESA Workshop raised concerns about riparian habitat and the importance of the Project limiting access. Concerns were raised by participants at the Surrey ESA Workshop about the potential spread of invasive species and increased recreational use as a result of increased access. However, it is noted that 89% of the proposed pipeline corridor parallels the existing TMPL right-of-way and other linear facilities and, consequently, the concern is limited to the potential for increased access at new rights-of-way and watercourse crossings. Trees and/or shrubs will be planted where new access is created in an attempt to control access during operations (Appendix C of the Pipeline EPP of Volume 6B).

Increased off-road vehicle access (*i.e.*, forded crossings), as a result of pipeline development, could result in disturbances to instream habitat during the operations phase of the pipeline could potentially lead to fish mortality (*e.g.,* legal and illegal harvest of fish by anglers). Increased potential for fish mortality or injury may also occur if the pipeline increased off-road vehicle fordings through streams, resulting in increased suspended sediment, which could directly affect eggs, embryos or juveniles within the watercourse.

Increased access may contribute to angler overharvest, which has been reported as one of the primary sources of fisheries declines in western Canada (Post *et al.* 2002). Top level predators which may occur in the Fish and Fish Habitat LSA such as walleye, northern pike and Arctic grayling, are particularly vulnerable (Berry 1995, 1998, 1999). Restrictive harvest legislation is implemented in BC to protect sensitive species and minimize the potential for overharvest by anglers (BC MFLNRO 2013a).

In addition to effects on fish and fish habitat during the operations phase, pipeline construction and operations personnel represent an incremental source of anglers within the Aquatics RSA and potential source of angler-caused mortalities. To reduce potential harvest, construction staff will be prohibited from angling within the Fish and Fish Habitat LSA while on, or travelling to and from, the construction site. Nonetheless, some construction personnel may fish during their time off.

Trees and shrubs will be planted as part of the revegetation program at watercourse crossings which will prevent increased access. Post-construction environmental monitoring will evaluate the effectiveness of human access control measures. With the application of measures outlined in the Traffic and Access Control Management Plan, the residual effect of increased access will be reduced to low magnitude (Table 7.2.7-3, point 3[e]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Aquatics RSA – increased access is limited to the instream habitat within the Fish and Fish Habitat LSA at the location of a watercourse crossing but may be extended to the Aquatics RSA in consideration of temporary facilities.
- Duration: long-term – the event causing fish mortality or injury is increased access to watercourses which is initiated during construction and extends beyond the first year of the operations phase. Access may be limited at some watercourses when riparian vegetation is re-established. The time for this may vary and depending on the pre-existing vegetative community (*e.g.,* shrubs or tress).
- Frequency: occasional – the events contributing to fish mortality or injury (*e.g.,* recreational off-road vehicles fording streams causing sediment events and increased angling) may occur intermittently and sporadically during the operations phase of the pipeline.
- Reversibility: short to long-term – the regrowth of some plants that are planted as part of the mitigation measures identified in the Traffic and Access Management Plan could take more than 10 years to reach their desired size.
- Magnitude: low – with the proposed pipeline corridor adjacent to existing rights-of-way for 89% of its length and the implementation of mitigation measures, the residual effect is considered low.

- Probability: low – paralleling existing rights-of-way and conditions within the Fish and Fish Habitat LSA will limit new opportunities for recreational off-road vehicle use.

- Confidence: moderate – based on the professional experience of the assessment team.

Temporary Blockage of Fish Movements

As a result of construction activities, localized blockage of fish movements may occur for the duration of instream construction. The impact balance of this potential residual effect is considered negative since it could affect the ability of fish species to migrate upstream of downstream of the crossings.

Permanent crossings for vehicles can create barriers to fish passage and contribute to habitat fragmentation for fish communities (Harper and Quigley 2000, Johns and Ernst 2007, Marshall 1996, Park *et al*. 2008, Scrimgeour *et al*. 2003). Although bridges and open bottom arches are able to provide satisfactory fish passage, several investigators have reported fish passage problems are frequently associated with culvert crossings (*e.g.,* corrugated metal pipes) (*e.g.,* 53% in Gibson *et al.* 2005, 57% in Johns and Ernst 2007, 50% in Park *et al*. 2008). These fish passage problems are typically associated with poor design (*e.g.,* undersizing) and/or installation, culvert age, reach slope, debris blockages and increased flow velocity (Harper and Quigley 2000, Johns and Ernst 2007, Marshall 1996, Park *et al.* 2008, Scrimgeour *et al.* 2003).

The mitigation measures outlined in Table 7.2-7.2 and the Pipeline EPP (Volume 6B) will reduce the potential for blockage of fish movements by instream construction and temporary vehicle access used for pipeline construction, power line construction and temporary access roads. The residual effect of the construction of the blockage of fish movements is considered to be reversible in the immediate to short-term and well within environmental standards and, consequently, of low magnitude (Table 7.2-7.3, point 3[f]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Aquatics RSA – blockage of fish movements may extend immediately upstream and downstream of the construction right-of-way during instream construction and temporary vehicle access along the pipeline corridor; however, blockage of fish movements may also occur at temporary vehicle crossings along temporary access roads and power lines which extend past the Fish and Fish Habitat LSA.

- Duration: immediate to short-term – the event causing blockage of fish movements is Project construction (*i.e.*, instream construction of the pipeline, use of temporary vehicle crossings installed along the pipeline construction right-of-way, temporary access roads and power line construction right-of-way), the period of which is less than 1 year at any given watercourse crossing.

- Frequency: isolated – the event causing blockage of fish movements (*i.e.,* construction of the watercourse crossing and use of temporary vehicle crossings) is confined to a specific period at a given watercourse.

- Reversibility: immediate to short-term – any blockage due to instream watercourse construction would be removed upon completion of construction of a given watercourse crossing, which may take a couple days (*i.e.,* immediate) at some crossings but may take longer at others (*i.e.,* short-term); however, any blockage due to temporary vehicle crossings would be removed upon Project construction completion (*i.e.*, short-term).

- Magnitude: low – the implementation of the proposed mitigation measures is expected to effectively reduce the potential effects on fish movements.

- Probability: high – the proposed pipeline corridor crosses watercourses for which an isolated crossing is recommended if the water is present at the time of construction and temporary vehicle crossings may be installed along temporary access roads and for power line construction.

- Confidence: high – based on the professional experience of the assessment team.

Effects to Fish Species of Concern

Several fish species of concern (*i.e.*, federally and/or provincially listed) are known to occur within the Aquatics RSA and within specific watercourses crossed by the proposed pipeline corridor. No *SARA*-listed species are known within the Aquatics RSA in Alberta; however, Salish sucker, coastrange sculpin, nooksack dace, green sturgeon and white sturgeon are all *SARA*-listed and may occur within the Aquatics RSA in BC. COSEWIC and provincially listed species within the Aquatics RSA include lake trout, lake sturgeon, sauger, spoonhead sculpin, bull trout, Arctic grayling, Athabasca rainbow trout, and northern redbelly dace in Alberta, mountain sucker, eulachon, chiselmouth, bull trout, sockeye salmon (*Cultus* population) and both coastal and westslope cutthroat trout in BC. Details about the life history, habitat and distribution of these species within the Aquatics RSA can be found in Sections 4.3 and 4.4 of the Fisheries [Alberta] and Sections 4.3 to 4.5 of the Fisheries [British Columbia] Technical Reports of Volume 5C.

Vehicle and pipeline crossing methods have been selected to reduce Project-specific effects in consideration of presence and use by fish species of concern. The proposed pipeline crossing methods for watercourses with identified fish habitat are trenchless, and isolated (*i.e.*, if water is present) or open cut crossings (*i.e.*, if dry or frozen to bottom) as listed in the Watercourse Summary Table (Appendix A of the Fisheries [Alberta] and Fisheries [British Columbia] Technical Reports of Volume 5C).

The residual effect of the construction of the pipeline on fish species of concern is considered to be reversible in the short-term and of low magnitude (Table 7.2-7.3, point 3[g]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Aquatics RSA – fish species of concern may be affected by an increase in suspended sediment concentrations downstream of watercourse crossings or habitat alteration from trenched (*i.e.,* isolated or open cut) crossing methods.
- Duration: immediate to short-term – the event causing fish species of concern to be affected is instream construction of the pipeline.
- Frequency: isolated – the event causing fish species of concern to be affected (*e.g.,* watercourse crossing construction) is confined to a specific period.
- Reversibility: short-term – the residual effects of pipeline construction on fish species of concern is limited to the construction phase and a short time thereafter until habitat conditions are restored to their original state.
- Magnitude: low – the implementation of the proposed mitigation measures is expected to effectively reduce the potential effects on fish species of concern.
- Probability: low – construction timing, the proposed crossing methods and implementation of the mitigation outlined in Table 7.2.7-2 should reduce the probability of effects to fish species of concern.
- Confidence: moderate – based on the professional experience of the assessment team.

Combined Effects on Fish Mortality and Injury

The components of the Project which affect the fish mortality or injury indicator include the construction and operations of the proposed pipeline, temporary facilities (*i.e.,* through an increase in access due to access roads), terminals and associated tank facilities and pipeline reactivation activities (*i.e.*, from hydrostatic testing). However, only the residual effects associated with pipeline construction are considered likely to occur and, consequently, are included in the assessment of combined effects.

The evaluation of the combined effects of the Project on the fish mortality or injury indicator considers collectively the assessment of the combined effects on this indicator from construction and operations of all applicable Project components. Overall, the construction and operations activities of the Project in waterbodies watercourses have the potential to increase fish mortality or injury through fish rescues during cold temperatures, suspended sediment during open cut of a large flowing watercourse and the temporary blockage of fish movements during isolated watercourse crossings and at temporary vehicle installation for pipeline and power line construction and along temporary access roads. This combined effect is considered to have a negative impact balance. Through implementation of industry standard and provincially and federally recommended mitigation measures during the construction and operations phases of the Project, the combined effects of the Project on the fish mortality and injury indicator are considered to be of low to medium magnitude (Table 7.2.7-3, point 3[h]). A summary of the rationale for all of the significance criteria of combined effects on fish mortality and injury is provided below.

- Spatial Boundary: Aquatics RSA – combined effects may extend beyond the Fish and Fish Habitat LSA in consideration of temporary vehicle crossing installations for temporary access roads and power lines.
- Duration: immediate to short-term – the events resulting in combined effects to the fish mortality or injury indicator are confined to the construction phase of the Project (*i.e.*, pipeline and power line construction).
- Frequency: isolated – the event resulting in combined effects to the fish mortality and injury indicator is the construction of the Project.
- Reversibility: medium-term – combined effects may result in the loss of one or more individuals from Project construction and affect population scale for several years, or until those individuals can be replaced.
- Magnitude: low to medium – with the implementation of the mitigation measures, the magnitude of most effects on the fish mortality and injury indicator is expected to be low, though some effects (*e.g.*, increased injury or mortality due to suspended sediment at large flowing watercourses) may be of medium magnitude in view of CCME guidelines.
- Probability: high – increased sedimentation as a result of trenched crossings and vehicle crossings are of high probability and may cause injury to fish.
- Confidence: moderate – based on the professional experience of the assessment team.

Fish and Fish Habitat Indicator – Arctic Grayling (Alberta Indicator Species)

There was general consensus by the participants at the Edmonton ESA Workshop that the inclusion of Arctic grayling as a proposed fish and fish habitat indicator was appropriate since potential effects to Arctic grayling would be representative of effects overall to fish and fish habitat. Arctic grayling are distributed across three watersheds along the Edmonton to Hinton Segment, namely the Pembina, Lower McLeod and Upper McLeod river watersheds (Section 5.0, Table 5.7-1). Based on the existing data and the results of the aquatic assessment, Arctic grayling may be found in seven watercourses crossed by the proposed pipeline corridor in the Edmonton to Hinton Segment (Section 5.0, Table 5.7-6). Arctic grayling are distributed across the Hinton to Hargreaves pipeline reactivation segment which lies within the Athabasca River Basin in Alberta and the Fraser River Basin in BC. Watercourses supporting Arctic grayling will be affected by pipeline construction activities along the Edmonton to Hinton Segment. In addition, potential water sources for hydrostatic testing activities associated with the Hinton to Hargreaves pipeline reactivation may support this species.

Additional information about Arctic grayling distribution and species presence is provided in the Fisheries (Alberta) Technical Report of Volume 5C, particularly the Watercourse Crossing Summary Table (Appendix A) and the Fish-Bearing atlas (Appendix C), the Pipeline EPP (Volume 6B) and Facilities EPP (Volume 6C). Arctic grayling are provincially listed as Sensitive (ASRD 2010) and as a Species of Special Concern under the *Wildlife Act* (AESRD 2012a).

Although some potential effects to Arctic grayling are likely (*e.g.,* alteration of riparian and instream habitat) others are less likely to occur (*e.g.,* injury or mortality of Arctic grayling as a result of increased sedimentation). However, in general, Arctic grayling will be affected by changes to riparian and instream habitat and injury or mortality as a result of construction and operations of the Project. A discussion of the significance of potential effects relating to the indicators of riparian habitat, instream habitat and fish mortality and injury have been previously discussed and are relevant when considering the combined effects on Arctic grayling. The magnitude of the potential combined effects on Arctic grayling is expected to be low, with the successful implementation of recommended mitigation strategies, and within environmental standards (Table 7.2.7-3, point 4[a]). In addition, it is not expected that the Project will conflict with *Alberta's Arctic Grayling Management and Recovery Plan* (Berry 1998). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Aquatics RSA – the combined effects on Arctic grayling (*i.e.,* loss or alteration of riparian habitat, loss or alteration of instream habitat and mortality or injury) may extend beyond the Fish and Fish Habitat LSA (*e.g.,* through hydrostatic testing).
- Duration: immediate to short-term – the combined effects on Arctic grayling are only expected to occur during pipeline and temporary vehicle crossing construction and hydrostatic testing activities, which will be less than 1 year (*i.e.,* short-term) but less than two days (*i.e.,* immediate) at a given watercourse.
- Frequency: isolated – the combined effects on Arctic grayling are limited to a specific phase (*i.e.,* construction of the Project, including reactivation activities).
- Reversibility: medium to long-term – combined effects on Arctic grayling consider are expected to be reversed in the medium to long-term, depending on the pre-existing vegetative community (*e.g.,* shrubs or trees) and the establishment of effective access control during operations.
- Magnitude: low – with the successful implementation of mitigation measures and regulatory authorizations (as applicable), the combined effects to Arctic grayling are expected to be of low magnitude and are not expected to conflict with *Alberta's Arctic Grayling Management and Recovery Plan*.
- Probability: high – due to the multiple pathways of effects to Arctic grayling (*e.g.,* disturbance to riparian and instream habitat, mortality and injury of fish).
- Confidence: moderate – based on the professional experience of the assessment team.

Fish and Fish Habitat Indicator – Athabasca Rainbow Trout (Alberta Indicator Species)

No issues or concerns of Athabasca rainbow trout as an Alberta indicator species were raised at the Edmonton ESA Workshop or Community Workshops (Section 2.0 in the Fisheries [Alberta] Technical Report). There was general consensus by the participants at the ESA Workshop that the inclusion of Athabasca rainbow trout as a proposed fish and fish habitat indicator was appropriate since potential effects to Athabasca rainbow trout would be representative of effects overall to fish and fish habitat.

Athabasca rainbow trout are distributed across three watersheds along the Edmonton to Hinton Segment, namely Lower McLeod, Upper McLeod and Athabasca river watersheds (Section 5.0, Table 5.7-1). Based on the existing data, historical data and the results of the aquatic assessment, Athabasca rainbow trout may be found in 14 watercourses crossed by the proposed pipeline corridor in the Edmonton to Hinton Segment (Section 5.0, Table 5.7-6). The Athabasca rainbow trout present along the Edmonton to Hinton Segment may or may not include pure strains and may or may not be within the Aquatic RSA. Athabasca rainbow trout are distributed across the Hinton to Hargreaves pipeline reactivation segment which lies within the Athabasca River Basin in Alberta and the Fraser River Basin in BC. Watercourses supporting Athabasca rainbow trout may be affected by pipeline construction activities along the Edmonton to Hinton Segment. In addition, potential water sources for hydrostatic testing activities associated with the Hinton to Hargreaves pipeline reactivation may support this species.

Although Athabasca rainbow trout are not considered to be a distinct subspecies, COSEWIC guidelines recognize Athabasca rainbow trout populations as a "designatable unit" below the species level (ASRD and ACA 2009). Athabasca rainbow trout is provincially listed as at Risk (ASRD 2010) and In Process under the *Wildlife Act* (AESRD 2012a). Anthropogenic (*i.e.*, logging, road construction) and non-anthropogenic (*i.e.*, flooding) processes impact Athabasca rainbow trout habitat (Rasmussen and Taylor 2009). Loss of headwater instream habitat due to anthropogenic activities is the greatest contributor to combined effects for this indicator species. A provincial management plan has not been developed for this species.

Additional information about Athabasca rainbow trout distribution and species presence is provided in the Fisheries (Alberta) Technical Report of Volume 5C, particularly the Watercourse Crossing Summary Table (Appendix A) and the Fish-Bearing atlas (Appendix C), the Pipeline EPP (Volume 6B) and Facilities EPP (Volume 6C).

The construction and operations of the Project may result in combined effects on Athabasca rainbow trout and the significance evaluation of this residual effect is provided in Table 7.2.7-3 (point 5[a]). The magnitude of the potential combined effects to Athabasca rainbow trout is expected to be low, with the successful implementation of recommended mitigation strategies. The significance rationale of combined effects on Athabasca rainbow trout is considered to be similar to the rationale for combined effects provided above under the Arctic grayling indicator.

Fish and Fish Habitat Indicator – Bull Trout (Alberta Indicator Species)

There was general consensus by the participants at the Edmonton ESA Workshop that the inclusion of bull trout as a proposed fish and fish habitat indicator was appropriate since potential effects to bull trout would be representative of overall effects to fish and fish habitat.

Bull trout are distributed across four watersheds along the Edmonton to Hinton Segment, namely Pembina, Lower McLeod, Upper McLeod and Athabasca river watersheds (Section 5.0, Table 5.7-1). Based on existing data and the results of the aquatic assessment, bull trout may be found in six watercourses crossed by the proposed pipeline corridor in the Edmonton to Hinton Segment (Section 5.0, Table 5.7-6). Bull trout are distributed across the Hinton to Hargreaves pipeline reactivation segment which lies within the Athabasca River Basin in Alberta and the Fraser River Basin in BC. Watercourses supporting bull trout may be affected by pipeline construction activities along the Edmonton to Hinton Segment. In addition, potential water sources for hydrostatic testing activities associated with the Hinton to Hargreaves pipeline reactivation may support this species.

Bull trout are listed as considered to be a Species of Special Concern in Alberta (AESRD 2012a) and are listed under COSEWIC as Threatened and a Species of Special Concern depending on the population (COSEWIC 2013). Bull trout are highly receptive to degraded water and habitat conditions from land disturbance (*i.e.*, roads, oil and gas developments) (ASRD 2012, Brewin *et al.* 2001) which makes contamination, loss or alteration of instream and riparian habitat the greatest contributors to combined effects for this species.

Additional information about bull trout distribution and species presence is provided in the Fisheries (Alberta) Technical Report of Volume 5C, particularly the Watercourse Crossing Summary Table (Appendix A) and the Fish-Bearing atlas (Appendix C), the Pipeline EPP (Volume 6B) and Facilities EPP (Volume 6C).

The construction and operations of the Project may result in combined effects on bull trout and the significance evaluation of this residual effect is provided in Table 7.2.7-3 (point 6[a]). The magnitude of the potential combined effects to bull trout is expected to be low, with the successful implementation of recommended mitigation strategies. In addition, it is not expected that the Project will conflict with the *Bull Trout Conservation Management Plan* (ASRD 2012). Goals of the management plan include sustaining, restoring and developing bull trout habitat (ASRD 2012). The significance rationale of combined effects on bull trout is considered to be similar to the rationale for combined effects provided above under the Arctic grayling indicator.

Fish and Fish Habitat Indicator – Burbot (Alberta Indicator Species)

The inclusion of burbot as an indicator species was suggested at the Edmonton ESA Workshop (Section 2.0 in the Fisheries [Alberta] Technical Report). The assessment team agreed that the burbot was an appropriate indicator since potential effects to burbot would be representative of overall effects to fish and fish habitat.

Burbot are distributed across all eight watersheds along the Edmonton to Hinton Segment (Section 5.0, Table 5.7-1). Based on the existing data and the results of the aquatic assessment, burbot may be found in 10 watercourses crossed by the proposed pipeline corridor in the Edmonton to Hinton Segment (Section 5.0, Table 5.7-6). Burbot are distributed across the Hinton to Hargreaves pipeline reactivation segment which lies within the Athabasca River Basin in Alberta and the Fraser River Basin in BC. Watercourses supporting burbot will be affected by pipeline construction activities along the Edmonton to Hinton Segment. In addition, potential water sources for hydrostatic testing activities associated with the Edmonton Terminal and Hinton to Hargreaves pipeline reactivation may support this species. Burbot is not listed federally or provincially as a species of conservation concern and there is no provincial management strategy.

Burbot have become more susceptible to natural and anthropogenic habitat disturbance than in the past (Stapanian *et al.* 2010), thus, contamination, loss or alteration of riparian and instream habitat are the greatest contributors to combined effects for this species. Additional information about burbot distribution and species presence is provided in the Fisheries (Alberta) Technical Report of Volume 5C, particularly the Watercourse Crossing Summary Table (Appendix A) and the Fish-Bearing atlas (Appendix C), the Pipeline EPP (Volume 6B) and Facilities EPP (Volume 6C).

The construction and operations of the Project may result in combined effects on burbot and the significance evaluation of this residual effect is provided in Table 7.2.7-3 (point 7[a]). The magnitude of the potential combined effects on burbot is expected to be low, with the successful implementation of recommended mitigation strategies, and within environmental standards. The significance rationale of combined effects on burbot is considered to be similar to the rationale for combined effects provided above under the Arctic grayling indicator.

Fish and Fish Habitat Indicator – Northern Pike (Alberta Indicator Species)

No issues or concerns of northern pike as an Alberta indicator species were raised at the Edmonton ESA or Community Workshops (Section 2.0 in the Fisheries [Alberta] Technical Report). There was general consensus by the participants at the workshops that the inclusion of northern pike as a proposed fish and fish habitat indicator was appropriate since potential effects to northern pike would be representative of overall effects to fish and fish habitat.

Northern pike are distributed across all eight watersheds along the Edmonton to Hinton Segment (Section 5 Table 5.7-1). Based on the existing data and the results of the aquatic assessment, northern pike may be found in 15 watercourses crossed by the proposed pipeline corridor in the Edmonton to Hinton Segment (Section 5.0, Table 5.7-6). Northern pike are distributed across the Hinton to Hargreaves pipeline reactivation segment which lies within the Athabasca River Basin in Alberta and the Fraser River Basin in BC. Watercourses supporting northern pike will be affected by pipeline construction activities along the Edmonton to Hinton Segment. In addition, potential water sources for hydrostatic testing activities associated with the Edmonton Terminal and Hinton to Hargreaves pipeline reactivation may support this species.

Northern pike rely on weedy areas for their sedentary life and the removal of shoreline weed beds can contribute to population decline (Berry 1999) which makes contamination, loss or alteration of riparian habitat the greatest contributor to combined effects for this species. Northern pike is not listed federally or provincially as a species of conservation concern, however, a management plan is in place (Berry 1999). Additional information about northern pike distribution and species presence is provided in the Fisheries (Alberta) Technical Report of Volume 5C, particularly the Watercourse Crossing Summary Table (Appendix A) and the Fish-Bearing atlas (Appendix C), the Pipeline EPP (Volume 6B) and Facilities EPP (Volume 6C).

The construction and operations of the Project may result in combined effects on northern pike and the significance evaluation of this residual effect is provided in Table 7.2.7-3 (point 8[a]). The magnitude of the potential combined effects on northern pike is expected to be low, with the successful implementation of recommended mitigation strategies, and within environmental standards. In addition, it is not expected to conflict with *Alberta's Northern Pike Management and Recovery Plan* (Berry 1999). Goals of the management and recovery plan include restoring and maintaining northern pike habitat and restoring and maintaining northern pike distribution and diversity. The significance rationale of combined effects on northern pike is considered to be similar to the rationale for combined effects provided above under the Arctic grayling indicator.

Fish and Fish Habitat Indicator – Walleye (Alberta Indicator Species)

No issues or concerns of walleye as an Alberta indicator species were raised at the Edmonton ESA or Community Workshops (Section 2.0 in the Fisheries [Alberta] Technical Report). There was general consensus by the participants at the workshop that the inclusion of walleye as a proposed fish and fish habitat indicator was appropriate since potential effects to walleye would be representative of overall effects to fish and fish habitat.

Walleye are distributed across six watersheds along the Edmonton to Hinton Segment (Section 5.0, Table 5.7-1). Based on the existing data and the results of the aquatic assessment, walleye may be found in four watercourses crossed by the proposed pipeline corridor in the Edmonton to Hinton Segment (Section 5.0, Table 5.7-6). Walleye are distributed across the Hinton to Hargreaves pipeline reactivation segment which lies within the Athabasca River Basin in Alberta and the Fraser River Basin in BC. Watercourses supporting walleye may be affected by pipeline construction activities along the Edmonton to Hinton Segment. In addition, potential water sources for hydrostatic testing activities associated with the Edmonton Terminal and Hinton to Hargreaves pipeline reactivation may support this species.

Walleye is not listed as a species of conservation concern federally or provincially, however, a management and recovery plan is in place (Berry 1995). Walleye are sensitive to anthropogenic habitat changes (*i.e.*, land clearing along streams) (Berry 1995). Walleye rely on shoreline weeds to provide shelter for juveniles and spawning grounds (Berry 1995) which makes contamination, loss or alteration of riparian habitat the greatest contributor to combined effects for this species. Additional information about walleye distribution and species presence is provided in the Fisheries (Alberta) Technical Report of Volume 5C, particularly the Watercourse Crossing Summary Table (Appendix A) and the Fish-Bearing atlas (Appendix C), the Pipeline EPP (Volume 6B) and Facilities EPP (Volume 6C).

The construction and operations of the Project may result in combined effects on walleye and the significance evaluation of this residual effect is provided in Table 7.2.7-3 (point 9[a]). The magnitude of the potential combined effects to walleye is expected to be low, with the successful implementation of recommended mitigation strategies, and within environmental standards. In addition, it is not expected to conflict with *Alberta's Walleye Management and Recovery Plan* (Berry 1995). Goals of the management and recovery plan include, regulating walleye harvest in line with the production capability of walleye populations and recovering walleye populations to their maximum production. The significance rationale of combined effects on walleye is considered to be similar to the rationale for combined effects provided above under the Arctic grayling indicator.

Fish and Fish Habitat Indicator – Bull Trout/Dolly Varden (BC Indicator Species)

There was general consensus by the participants at the ESA Workshops that the inclusion of bull trout/Dolly Varden as a proposed fish and fish habitat indicator was appropriate since potential effects to bull trout/Dolly Varden would be representative of effects overall to fish and fish habitat.

Bull trout/Dolly Varden are distributed across 10 Project watersheds along the proposed pipeline corridor in BC (Section 5.0, Table 5.7-2). Based on the existing data and the results of the fisheries field program, bull trout/Dolly Varden may be found in 45, 17 and 10 fish-bearing watercourses crossed by the proposed pipeline corridor in the Hargreaves to Darfield, Black Pines to Hope and Hope to Burnaby segments, respectively (Section 5.0, Tables 5.7-9, 5.7-13, 5.7-17). Bull trout/Dolly Varden are distributed across the Darfield to Black Pines pipeline reactivation segment which lies within the Lower North Thompson River Watershed of the Fraser Basin in BC where hydrostatic test water may be drawn from. Bull trout/Dolly Varden may be found in watercourses crossed by the proposed power lines associated with the Black Pines and Kingsvale pump stations in the Lower North Thompson River and Lower Nicola and Similkameen river watersheds, and in potential hydrostatic test water sources for the Sumas and Burnaby Terminals in the Chilliwack and Lower Fraser river watersheds.

Bull trout are Blue-listed as a Species of Special Concern (BC Conservation Data Centre [CDC] 2013) and the South Coast population is considered a Species of Special Concern under COSEWIC (2013). No management plans for bull trout/Dolly Varden are in place in BC. Bull trout are susceptible to degraded water and habitat conditions from land disturbance (*i.e.*, roads, oil and gas developments, forest harvesting, mining developments) (ASRD 2012, Brewin et *al.* 2001, Hammond 2004) and obstructions to movement (*i.e.*, culverts) (Hammond 2004) which makes contamination, loss or alteration of instream habitat the greatest contributor to combined effects for the bull trout/Dolly Varden indicator. Additional information about bull trout/Dolly Varden distribution and species presence is provided in the Fisheries (British Columbia) Technical Report of Volume 5C, particularly the Watercourse Crossing Summary Table (Appendix A) and the Fish-Bearing Atlas (Appendix B), the Pipeline EPP (Volume 6B) and Facilities EPP (Volume 6C).

The construction and operations of the Project may result in combined effects on bull trout/Dolly Varden and the significance evaluation of this residual effect is provided in Table 7.2.7-3 (point 10[a]). The magnitude of the potential combined effects to bull trout/Dolly Varden is expected to be low, with the successful implementation of recommended mitigation strategies, and within environmental standards. The significance rationale of combined effects on bull trout/Dolly Varden is considered to be similar to the rationale for combined effects provided above under the Arctic grayling indicator.

Fish and Fish Habitat Indicator – Chinook Salmon (BC Indicator Species)

There was general consensus by the participants at the Kamloops and Surrey ESA Workshops that the inclusion of Chinook salmon as a proposed fish and fish habitat indicator was appropriate since potential effects to Chinook salmon would be representative of overall effects to fish and fish habitat.

Chinook salmon are distributed across 10 Project watersheds along the proposed pipeline corridor in BC segments (Section 5.0, Table 5.7-2). Based on the existing data and the results of the fisheries field program, Chinook salmon may be found in 20, 14 and 20 fish-bearing watercourses crossed by the proposed pipeline corridor in the Hargreaves to Darfield, Black Pines to Hope and Hope to Burnaby segments, respectively (Section 5.0, Tables 5.7-9, 5.7-13, 5.7-17). Chinook salmon are distributed across the Darfield to Black Pines pipeline reactivation segment which lies within the Lower North Thompson River Watershed of the Fraser Basin in BC where hydrostatic test water may be withdrawn. Chinook salmon may be found in watercourses crossed by the proposed power lines associated with the Black Pines and Kingsvale pump stations in the Lower North Thompson River and Lower Nicola and Similkameen river watersheds, and in potential hydrostatic test water sources for the Sumas and Burnaby terminals in the Chilliwack and Lower Fraser river watersheds.

Chinook salmon are not listed under COSEWIC or provincially as a species of conservation concern and are susceptible to direct and indirect loss of habitat (COSEWIC 2006b) which makes contamination, loss or alteration of instream and riparian habitat equal contributors to combined effects for this species. There is no provincial management strategy for Chinook salmon. Additional information about Chinook salmon mitigation measures, distribution and species presence is provided in the Fisheries (British Columbia) Technical Report of Volume 5C, particularly the Watercourse Crossing Summary Table (Appendix A) and the Fish-Bearing atlas (Appendix C), the Pipeline EPP (Volume 6B) and Facilities EPP (Volume 6C).

The construction and operations of the Project may result in combined effects on Chinook salmon and the significance evaluation of this residual effect is provided in Table 7.2.7-3 (point 11[a]). The magnitude of the potential combined effects on Chinook salmon is expected to be low, with the successful implementation of recommended mitigation strategies, and within environmental standards. The significance rationale of combined effects on Chinook salmon is considered to be similar to the rationale for combined effects provided above under the Arctic grayling indicator.

Fish and Fish Habitat Indicator – Coho Salmon (BC Indicator Species)

There was general consensus by the participants at the Kamloops and Surrey ESA Workshops that the inclusion of coho salmon as a proposed fish and fish habitat indicator was appropriate since potential effects to coho salmon would be representative of overall effects to fish and fish habitat.

Coho salmon are distributed across 11 Project watersheds along the proposed pipeline corridor in BC (Section 5.0, Table 5.7-2). Based on the existing data and the results of the fisheries field program, coho salmon may be found in 53, 16 and 44 fish-bearing watercourses crossed by the proposed pipeline corridor in the Hargreaves to Darfield, Black Pines to Hope and Hope to Burnaby segments, respectively (Section 5.0, Tables 5.7-9, 5.7-13, 5.7-17). Coho salmon are distributed across the Darfield to Black Pines pipeline reactivation segment which lies within the Lower North Thompson River Watershed of the Fraser Basin in BC where hydrostatic test water may be drawn from. Coho salmon may be found in watercourses crossed by the proposed power lines associated with the Black Pines and Kingsvale pump stations in the Lower North Thompson River and Lower Nicola and Similkameen river watersheds, and in potential hydrostatic test water sources for the Sumas and Burnaby terminals in the Chilliwack and Lower Fraser river watersheds.

Coho salmon are not listed federally or provincially as a species of conservation concern. According to TEK participants, coho are more durable than other salmon varieties and are best at adapting to changing conditions. However, the species is susceptible to natural and anthropogenic habitat degradation (COSEWIC 2002a) which makes contamination, loss or alteration of instream and riparian habitat equal contributors to combined effects for this species. There is no management strategy for Chinook salmon in BC. Additional information about coho salmon distribution and species presence is provided in the Fisheries (British Columbia) Technical Report of Volume 5C, particularly the Watercourse Crossing Summary Table (Appendix A) and the Fish-Bearing atlas (Appendix C), the Pipeline EPP (Volume 6B) and Facilities EPP (Volume 6C). There are no management or recovery plans for coho salmon.

The construction and operations of the Project may result in combined effects on coho salmon and the significance evaluation of this residual effect is provided in Table 7.2.7-3 (point 12[a]). The magnitude of the potential combined effects to coho salmon is expected to be low, with the successful implementation of recommended mitigation strategies, and within environmental standards. The significance rationale of combined effects on coho salmon is considered to be similar to the rationale for combined effects provided above under the Arctic grayling indicator.

Fish and Fish Habitat Indicator – Cutthroat Trout (BC Indicator Species)

There was general consensus by the participants at the Kamloops and Surrey ESA Workshops that the inclusion of cutthroat trout as a proposed fish and fish habitat indicator was appropriate since potential effects to cutthroat trout would be representative of overall effects to fish and fish habitat.

Cutthroat trout are distributed across five Project watersheds along the proposed pipeline corridor in BC and is only found in watersheds in the Black Pines to Hope, Hope to Burnaby and Burnaby to Westridge segments (Section 5.0, Table 5.7-2). Based on the existing data and the results of the fisheries field program, cutthroat trout may be found in 6 and 46 fish-bearing watercourses crossed by the proposed pipeline corridor in the Black Pines to Hope and Hope to Burnaby segments, respectively (Section 5.0, Tables 5.7-13 and 5.7-17). Cutthroat trout may be found in watercourses used as hydrostatic test water sources for the Sumas and Burnaby terminals in the Chilliwack and Lower Fraser river watersheds.

Cutthroat trout are susceptible to anthropogenic habitat manipulation and degradation (*i.e.*, mining, forestry, hydroelectric development) (COSEWIC 2006c) which makes contamination, loss or alteration of instream and riparian habitat equal contributors to combined effects for this species. Westslope cutthroat trout are considered a Species of Special Concern (COSEWIC 2013a) and are Blue-listed (BC CDC 2013). Coastal cutthroat trout is not listed federally or provincially. There are no management plans in place for either cutthroat trout species in BC. Additional information about cutthroat trout distribution and species presence is provided in the Fisheries (British Columbia) Technical Report of Volume 5C, particularly the Watercourse Crossing Summary Table (Appendix A) and the Fish-Bearing atlas (Appendix C), the Pipeline EPP (Volume 6B) and Facilities EPP (Volume 6C).

The construction and operations of the Project may result in combined effects on cutthroat trout and the significance evaluation of this residual effect is provided in Table 7.2.7-3 (point 13[a]). The magnitude of the potential combined effects to cutthroat trout is expected to be low, with the successful implementation of recommended mitigation strategies, and within environmental standards. The significance rationale of combined effects on cutthroat trout is considered to be similar to the rationale for combined effects provided above under the Arctic grayling indicator.

Fish and Fish Habitat Indicator – Rainbow Trout/Steelhead (BC Indicator Species)

There was general consensus by the participants at the Kamloops and Surrey ESA workshops that the inclusion of rainbow trout/steelhead as a proposed fish and fish habitat indicator was appropriate since potential effects to rainbow trout/steelhead would be representative of overall effects to fish and fish habitat.

Rainbow trout/steelhead are distributed across all 13 Project watersheds along the proposed pipeline corridor in BC (Section 5.0, Table 5.7-2). Based on the existing data and the results of the fisheries field program, rainbow trout/steelhead may be found in 45, 34 and 33 fish-bearing watercourses in the Hargreaves to Darfield, Black Pines to Hope and Hope to Burnaby segments, respectively (Section 5.0 Tables 5.7-9, 5.7-13, 5.7-17). Rainbow trout/steelhead are distributed across the Darfield to Black Pines pipeline reactivation segment which lies within the Lower North Thompson River Watershed of the Fraser Basin in BC where hydrostatic test water may be drawn from. Rainbow trout/steelhead may be found in watercourses crossed by the Black Pines and Kingsvale pump stations in the Lower North Thompson River and Lower Nicola and Similkameen river watersheds and in potential hydrostatic test water sources for the Sumas and Burnaby terminals in the Chilliwack and Lower Fraser river Watersheds.

Rainbow trout are not listed federally or provincially and there are no management plans in place for this species in BC. Rainbow trout are migratory in nature and will swim to new areas should habitat conditions change (Natural Resources Conservation Service 2000). However, contamination, loss or alteration of instream habitat is the greatest contributor to combined effects for this species because the probability of mortality or injury is low. Additional information about rainbow trout/steelhead mitigation measures, distribution and species presence is provided in the Fisheries (British Columbia) Technical Report of Volume 5C, particularly the Watercourse Crossing Summary Table (Appendix A) and the Fish-Bearing atlas (Appendix C), the Pipeline EPP (Volume 6B) and Facilities EPP (Volume 6C).

The construction and operations of the Project may result in combined effects on rainbow trout/steelhead and the significance evaluation of this residual effect is provided in Table 7.2.7-3 (point 14[a]). The magnitude of the potential combined effects to rainbow trout/steelhead is expected to be low, with the successful implementation of recommended mitigation strategies, and within environmental standards. The significance rationale of combined effects on rainbow trout/steelhead is considered to be similar to the rationale for combined effects provided above under the Arctic grayling indicator.

7.2.7.7 Summary

As identified in Table 7.2.7-3, there are no situations where there is a high probability of occurrence of a permanent or long-term residual environmental effect on fish and fish habitat indicators of high magnitude that cannot be technically or economically mitigated. Consequently, it is concluded that the residual environmental effects of the Project on fish and fish habitat will be not significant.

7.2.8 Wetland Loss and Alteration

This subsection describes the potential effects of pipeline construction and operations on wetland loss or alteration. The Wetland Evaluation Technical Report of Volume 5C provides further information pertaining to existing wetland function along the proposed pipeline corridor.

7.2.8.1 Assessment Indicators and Measurement Endpoints

The selection of indicators for wetland loss or alteration included: consideration of the filing requirements in the NEB *Filing Manual*; experience gained during previous projects with similar conditions and potential issues; feedback from Aboriginal communities, regulatory authorities and stakeholders; available research literature; feedback from participants in the ESA Workshops; public issues raised through the media; and the professional judgment of the assessment team. Initially, the proposed indicators of wetland loss or alteration included wetland function (functional condition) and wetlands of special concern (functional condition). These indicators were discussed during the Edmonton, Kamloops and Surrey ESA Workshops as well as with Aboriginal communities, stakeholders, the public and regulatory authorities. Participants of the workshops did not express any concerns about the proposed indicators of wetland loss or alteration and whether they were appropriate for evaluating the effects of the Project on wetlands. Although some participants did express the wish to see wetlands restored to a functional condition that was better than the current functional condition and emphasised the importance of ephemeral wetlands, no additional wetland indicators were suggested by participants. The ESA Workshops and meetings held with federal, provincial and municipal regulatory authorities did not reveal any site-specific wetland information. Input on the proposed wetland indicators was also sought from AESRD, BC MOE, BC MFLNRO and Environment Canada (Section 3.0); all four agencies were in agreement that the proposed wetland indicators were appropriate and suggested no additional indicators for consideration.

Through discussions with the assessment team for the Vegetation Technical Report (Volume 5C), it was determined that wetlands of special concern would be evaluated within one of the vegetation indicators (*i.e.*, vegetation communities of concern). To reduce assessment duplication of the same indicator, it was decided that wetlands of special concern will be presented in the Wetland Evaluation Technical Report (Volume 5C) but will be addressed within the scope of the vegetation effects assessment in Section 7.2.9 as an indicator (*i.e.*, vegetation communities of concern). Wetland-specific results are presented in the Wetland Evaluation Technical Report of Volume 5C. Therefore, only one indicator (*i.e.*, wetland function) will be assessed in this subsection. These changes were discussed during consultation with Environment Canada and were deemed appropriate with no additional suggestions being made.

The measurement endpoint for the wetland loss or alteration indicator, wetland function, includes quantitative measurements of potential Project effects. Wetland function was evaluated at each wetland encountered during the ground-based field work. The functions of wetlands crossed by the proposed pipeline corridor are reported on the premise that wetlands temporarily disturbed during construction would be revisited in the years following pipeline construction to document the progress of function returning to the wetland ecosystem and to ensure wetlands are on the trajectory of reaching pre-construction (*i.e.*, existing) conditions. Wetland functions documented during the evaluation of existing conditions (*i.e.*, pre-construction) will be compared to wetland functions observed along the reclaimed (*i.e.*, post-construction) construction right-of-way. The results of this comparison will be used to measure the effectiveness and efficiency of mitigation and reclamation measures, and provide support to the determination of loss or "no net loss" of wetland function. Details on each of the wetland functional categories are as follows.

- High Functional Conditions: wetlands that demonstrate many wetland functions expected for their type and class, with little to no anthropogenic disturbance, are high functioning wetlands. These wetlands are performing all expected wetland functions for their type and class (*e.g.*, vegetation and wildlife habitat function, hydrological function as well as water quality and substrate functions). Following construction, these wetlands are likely to recover to their wetland type and class, and no alterations to the existing wetland function qualities provided are anticipated.

- High-Moderate Functional Conditions: wetlands that demonstrate many wetland functions expected for their type and class, with light anthropogenic disturbance, are high-moderate functioning wetlands. These wetlands are mildly disturbed, which reduces the efficacy of the wetland to perform all wetland functions expected for the wetland type and class (*e.g.*, vegetation and wildlife habitat function, hydrological function as well as water quality and substrate functions). Following construction, these wetlands are likely to recover to their wetland type and class, and no alterations to the existing wetland function qualities provided are anticipated.

- Low-Moderate Functional Conditions: wetlands that demonstrate some the wetland functions expected for their type and class, with moderate anthropogenic disturbance are low-moderate functioning wetlands. They are moderately disturbed throughout or have considerable disturbance to the wetland margins and riparian area. The disturbance reduces the efficacy of the wetland to perform wetland functions expected for the wetland type and class (*e.g.*, vegetation and wildlife habitat function, hydrological function as well as water quality and substrate function). Following construction, these wetlands may recover to their wetland type and class. However, the potential for a land use change (*e.g.*, cultivation) following construction may alter the wetland's ability to recover its wetland function qualities, which may impact the recovery trajectory.

- Low Functional Conditions: wetlands that demonstrate limited wetland functions expected for their type and class due to severe anthropogenic disturbance. These wetlands are severely disturbed, which impacts the efficacy of the wetland to perform wetland functions expected for the wetland type and class (*e.g.*, vegetation and wildlife habitat function, hydrological function as well as substrate function). Following construction, these wetlands have unlikely potential to recover to their wetland type and class, which will alter the type of wetland functions that were documented during existing surveys. Alternatively, these wetlands may not recover as functional wetlands (*i.e.*, necessary hydrology, soil and vegetation characteristics).

Table 7.2.8-1 provides a summary of the indicator and measurement endpoint used in the assessment of potential effects on wetlands.

TABLE 7.2.8-1

ASSESSMENT INDICATOR AND MEASUREMENT ENDPOINTS FOR WETLAND LOSS OR ALTERATION

Wetland Indicator	Measurement Endpoint	Rationale for Indicator Selection
Wetland function	• Area (ha) of wetlands (*i.e.*, habitat, hydrology, biogeochemistry) disturbed/contaminated that are of High Functional Condition, High-Moderate Functional Condition, Low-Moderate Functional Condition and Low Functional Condition	The selection of the indicator and measurement endpoint considered NEB *Filing Manual* requirements for the wetland element in Table A-2, experience gained during previous projects with similar conditions and potential issues, feedback from Aboriginal communities, regulatory authorities, and stakeholders, available research literature, and professional judgment of the assessment team. These selections were also supported by participants of the ESA Workshops and by regulatory authorities (*i.e.*, AESRD, BC MOE, BC MFLNRO and Environment Canada). The indicator (*i.e.*, wetland function) complies with the "no net loss" of wetland function requirement of the Federal Policy on Wetland Conservation (Environment Canada 1991).

7.2.8.2 Spatial Boundaries

The spatial boundaries used in the effects assessment of wetlands considered one or more of the following areas:

- a Footprint Study Area (as defined in Section 7.1.3);
- a Wetland LSA; and
- a Wetland RSA.

A Wetland LSA was established to reflect the area in which Project construction and operations activities would most likely affect wetlands. The ZOI likely to be affected by direct disturbance during construction and operations aligns with the Vegetation LSA, where vegetation (*i.e.*, species composition, health and vigour) is one of the primary indicators of wetland function. The spatial boundary of the Wetland LSA for the Project is a 300 m wide band generally from the centre of the proposed pipeline corridor (*i.e.*, 150 m on both sides of the proposed pipeline corridor centre) with site-specific tailoring to extend around larger wetland complexes that are encountered by the proposed pipeline corridor. The 300 m wide band with site-specific modifications, is considered to be a sufficient size along the entire proposed pipeline corridor since the wetlands encountered in Alberta are commonly isolated basins or smaller wetland complexes located within agricultural lands with some forested areas, and those in BC are located within steep mountain valleys or exist as isolated basins or smaller wetland complexes within agricultural lands. The level of existing disturbance or the confining nature of the surrounding landscape is not conducive to a larger LSA boundary.

The spatial boundaries of the Wetland RSA are defined as the area where the direct and indirect influence of other land uses and activities could overlap with Project-specific effects and cause cumulative effects on wetland function. The Wetland RSA aligns in general with the Aquatics RSA where regional hydrology is the overall driver for wetland occurrence and includes all watersheds affected by the Project. The Wetland RSA is shown on Figure 5.8-1.

7.2.8.3 Ecological Context

The 2012 and 2013 helicopter reconnaissances and wetland field surveys confirmed that 638 wetlands (approximately 94.4 km and 570.4 ha) are crossed by the proposed pipeline corridor, comprising approximately 9.6% of the length of the Project. As the exact alignment of the construction right-of-way has not yet been determined, a conservative measurement of wetland lengths was taken from the widest expanse of each wetland within the proposed pipeline corridor. Wetlands crossed include 141 basin marshes, 67 riparian marshes, 4 lacustrine marshes, 7 slope marshes, 2 hummock marshes, 104 flat swamps, 78 riparian swamps, 2 discharge swamps, 6 slope swamps, 45 basin water, 19 riparian water, 13 basin fens, 26 horizontal fens, 13 riparian fens, 2 channel fens, 1 feather fens, 1 slope fen and 1 basin bog. It should be noted that the number of wetlands presented here has been updated following a late season wetland survey conducted in October 2013 along the Edmonton to Hinton Segment after the Environmental Alignment Sheets were finalized for filing. Therefore, some discrepancies maybe noted between the ESA, Wetland Evaluation Technical Report (Volume 5C) and the Environmental Alignment Sheets of Volume 6E. This discrepancy along with the number and classification of wetlands crossed by the proposed pipeline corridor will be updated following supplemental wetland surveys planned for 2014 targeting locations where access was not available in 2012 or 2013.

The proposed pipeline corridor is located within 4 Ecozones and 11 Ecoregions of Canada (Agriculture and Agri-Food Canada 2013, Ecological Stratification Working Group 1995), 7 Wetland Regions of Canada (Government of Canada 1986), 5 Natural Subregions of Alberta (Natural Regions Committee 2006) and 9 Biogeoclimatic Zones of BC (BC MFLNRO 2012a).

Wetlands along the proposed pipeline corridor were initially identified during helicopter overflights and through satellite imagery interpretation using key indicators such as terrain, surficial material (*i.e.*, mineral soils or organic peats), vegetation cover and the presence or absence of surficial hydrology. Wetland classification and delineations were confirmed during the 2012 and 2013 ground-based wetland field surveys. All wetlands that are encountered by the proposed pipeline corridor are identified on the Environmental Alignment Sheets (Volume 6E). Wetlands that were not visited during the 2012 and 2013 field surveys where land access was not available will be visited during the summer 2014 supplemental wetland field surveys (see Section 9.0).

Many of the wetlands crossed by the proposed pipeline corridor are also either crossed by or adjacent to the existing right-of-way, which was installed and has been in operation for 60 years. Generally, once pipelines (or even power lines) are constructed, the land along the right-of-way remains relatively undisturbed. That the proposed pipeline corridor encounters a large number and varied types of wetlands located directly on and adjacent to the existing right-of-way speaks to wetland resiliency and the fact that wetland ecosystems do recover and are able to thrive following the temporary construction disturbance. As well, over the past 60 years, wetland best management practices and mitigation measures have evolved to not only ensure an increased level of awareness to the importance of the preservation of these ecosystems, however, also to ensure an increased level of effort to assist with wetland recovery.

7.2.8.4 Potential Effects and Mitigation Measures

<u>Identified Potential Effects</u>

Potential effects associated with the construction and operations of the proposed pipeline on the wetland indicator are listed in Table 7.2.8-2. These potential interactions are based on the results of the literature review, available research literature, desktop analysis, field work, modelling and TEK, engagement with Aboriginal communities, landowners, regulatory authorities, stakeholders and the general public (Section 3.0), and the professional experience of the assessment team.

Participating Aboriginal communities (Section 3.0) identified the importance of wetland habitats that are capable of supporting a diverse range of wildlife and vegetation. The health of wetlands along the proposed pipeline corridor as well as the potential for the Project to adversely affect related wildlife, vegetation and water quality elements of the environment through the loss or alteration of wetland habitat were identified concerns of participating Aboriginal communities during the 2012 and 2013 biophysical field studies for the Project (Wetland Evaluation Technical Report of Volume 5C).

A summary of mitigation measures provided in Table 7.2.8-2 was principally developed in accordance with Trans Mountain standards as well as industry, federal and provincial regulatory guidelines including Stepping Back from the Water (AESRD 2012b), Provincial Wetland Restoration/Compensation Guide (AENV 2007) and Wetland Ways (Wetland Stewardship Partnership 2009), as well as learnings from wetland post-construction environmental monitoring for previous pipeline projects (*e.g.,* Enbridge Pipelines Inc. [Enbridge] [TERA 2011b,c,e, 2012b,c,d], Kinder Morgan Canada Inc. [Kinder Morgan] [Critchley and Foote 2009, TERA 2011f,g,h,i, 2012e, 2013d] and NOVA Gas Transmission Ltd. [NOVA

Gas] [TERA 2011j, 2012f]) and peer-reviewed publications on wetland function (Price *et al.* 2005, Ryder *et al.* 2005, Shem *et al.* 1993, Van Dyke *et al.* 1994).

TABLE 7.2.8-2

POTENTIAL EFFECTS, MITIGATION MEASURES AND RESIDUAL EFFECTS OF PIPELINE CONSTRUCTION AND OPERATIONS ON WETLAND LOSS OR ALTERATION

Potential Effect	Pipeline Segment(s)	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
1. Wetland Loss or Alteration Indicator – Wetland Function				
1.1 Loss or alteration of wetlands of High Functional, High-Moderate, Low-Moderate and Low Functional Condition (*i.e.*, habitat, hydrology, biogeochemistry)	All	LSA	<u>Habitat</u> • Ensure that all applicable approvals, licenses and permits are in place prior to commencing applicable construction activities [Section 6.0 of EPP]. • Adhere to applicable clearing guidelines for the protection of streams and wetlands provided in the *Forest Practices Code*, Riparian Management Area Guidebook in BC, where riparian management zones (widths) are identified based on stream or wetland class [Section 8.1]. • Follow applicable DFO Operational Statements outlining conditions and measures to avoid serious harm to fish or any permanent alteration to, or destruction of, fish habitat when working in or near a waterbody that has been identified as providing fish habitat [Section 8.7.1 of EPP]. • Fell all timber within the staked construction boundaries during survey line clearing. No fallen or leaning trees will be permitted outside of the staked construction boundaries or into watercourses/wetlands/lakes [Section 6.0]. • Protect vegetation mat from construction disturbance. Any TWS located within the boundary of a wetland must be approved by Trans Mountain's Inspector(s) [Section 7.0]. • Reduce the removal of vegetation in wetlands to the extent practical. Conduct ground level cutting, mowing or mulching or walking-down of wetland vegetation instead of grubbing. The method of removal of wetland vegetation is subject to approval by the Inspector(s) and Resource Specialist [Section 7.0]. • Narrow down the area of disturbance to the extent practical and clearly mark the area to be cleared [Section 7.0]. • Salvage flagged or fenced live trees or shrubs from the banks of wetlands if requested by the Inspector(s) or noted on the Environmental Alignment Sheets. Store salvaged trees and shrubs along the side of the construction right-of-way in a manner such that they do not dry out before replanting during reclamation [Section 7.0]. • Prohibit clearing of extra TWS within the riparian buffer, only the trench and TWS areas will be cleared. Ensure staging areas for watercourse/wetland crossing construction, grade/borrow areas for wetland ramps and spoil storage areas are located a minimum of 10 m from the banks of watercourses/wetland/lake boundaries. This distance may be reduced by the Lead Environmental Inspector and the Inspector(s) where appropriate controls are in place and where no riparian area is present (*e.g.,* cultivated or disturbed lands that abut the watercourse banks or boundaries of the wetland) [Section 8.1]. • Restrict root grubbing in wet areas, where practical, to avoid creation of bog holes [Section 8.1].	• Alteration of wetland habitat function during and following construction and maintenance activities until vegetation is re-established. • Alteration of wetland hydrological function during and following construction and maintenance activities until vegetation is re-established. • Alteration of wetland biogeochemical function during and following construction and maintenance activities until sedimentation is controlled and vegetation is re-established.

TABLE 7.2.8-2 Cont'd

Potential Effect	Pipeline Segment(s)	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
1.1 Loss or alteration of wetlands of High Functional, High-Moderate, Low-Moderate and Low Functional Condition (*i.e.*, habitat, hydrology, biogeochemistry) (cont'd)	All	LSA	• Restrict root grubbing to the area located outside of the vegetated riparian buffer adjacent to watercourses, wetlands and lakes. There will be no grubbing within vegetated buffers adjacent to watercourses, wetland and lakes except along the trench line and, where warranted, at vehicle crossing areas. See additional grubbing measures in Section 8.1 of the Pipeline EPP. • Allow wetlands to recover naturally (*i.e.*, do not seed wetland areas) [Section 8.6.3]. • Spread mulch to a depth of no more than 5 cm along the construction right-of-way in areas classified as treed peatlands [Section 8.6.3]. • Replant salvaged trees/shrubs along the disturbed riparian margins of the wetland as directed by Trans Mountain's Inspector(s) and as identified in the resource-specific mitigation tables for vegetation and wetlands provided in Appendices J and K, respectively [Section 8.7.4]. • See additional wetland measures in the Pipeline EPP. Hydrology • Install berms and/or cross ditches on approach slopes to wetlands, where warranted [Section 7.0]. • Maintain drainage across the construction right-of-way during all phases of construction [Section 7.0]. • Grade away from watercourses and wetlands to reduce the risk of introduction of soil and organic debris. Do not place windrowed or fill material in watercourses or wetlands during grading. Keep wetland soils separate from upland soils [Section 8.2]. • Install sack trench breakers back from the edge of watercourses where the banks consist of organic material to prevent sloughing of backfill into the channel (see Trench Breaker – Watercourse/Wetland Drawing in Appendix R) [Section 8.4]. • Install trench breakers, where warranted, at the edge of perched wetlands to prevent the pipeline trench from acting as a drain (see Trench Breaker – Watercourse/Wetland Drawing in Appendix R) [Section 8.4]. • Do not dewater any wetland during isolated crossing construction [Section 8.7.4]. • Ensure that wetlands are reclaimed to their pre-construction profile. Remove all corduroy and ramps through sloughs or wetlands, in all circumstances [Section 8.4]. • Leave a trench crown during clean-up of peatlands and non-peat wetlands to allow for settlement of backfilled material within the trench [Section 8.6.3]. • Re-establish surface drainage patterns in wetlands/peatlands to as close to the pre-construction contours as practical during reclamation. Leave frequent breaks in the trench crown in any areas identified as peatland to reduce the risk of ponding water and to re-establish drainage connectivity across the wetland [Section 8.6.3]. • Excavate the trench with wide pad, low-ground-pressure equipment or operate standard equipment from mats [Section 8.7.4]. • Store excavated material in a manner that does not interfere with natural drainage patterns. If necessary, haul spoil to a nearby location for storage (*e.g.,* for wet spoil that does not stack well) [Section 8.7.4].	• See above.

TABLE 7.2.8-2 Cont'd

Potential Effect	Pipeline Segment(s)	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
1.1 Loss or alteration of wetlands of High Functional, High-Moderate, Low-Moderate and Low Functional Condition (*i.e.*, habitat, hydrology, biogeochemistry) (cont'd)	All	LSA	• Use geotextile products and porous polypropylene materials in peatland areas and other poor drainage areas to: – increase the load bearing capacity; – prevent mixing of subgrade and fill; and – allow for the passage of water [Section 9.0]. • See additional wetland measures in the Pipeline EPP. Biogeochemistry • Install a temporary sediment barrier (*e.g.,* sediment fences), where warranted, to eliminate the flow of sediment from spoil piles and disturbed areas into nearby waterbodies including wetlands (see Sediment Fence Drawing in Appendix R) [Section 8.7.1]. • Implement the Wet/Thawed Soils Contingency Plan (see Appendix B) during wet/thawed soil conditions when wet or thawed soils are encountered during construction [Section 8.2]. • Avoid rutting and admixing of wetland soils during non-frozen soil conditions. Install appropriate ramps using mats (*e.g.,* swamp mats) or geotextile and spoil ramps [Section 8.7.4]. • Do not dispose of upland woody debris in mineral wetland [Section 8.1]. • Salvage surface material in unsaturated wetlands, giving extra attention to maintaining dormant root stocks for replacement, where feasible. Salvage a maximum of 40 cm of surface soil if the peat is deeper than 40 cm or to the depth of colour change where there is less than 40 cm of surface material. Ensure a minimum of 15 cm of surface and subsoil is stripped if peat is less than 15 cm [Section 8.2]. • Salvage the upper layer of root zone material (maximum of 0.5 m) over the trench area and retain for use in capping the trench following backfilling [Section 8.7.4]. • Use salvaged surface material or trench spoil as a containment/barrier (see Watercourse Crossing – Open Cut Method for Flowing Watercourses Drawing in Appendix R) if deep water is encountered and the trench area warrants isolation. Consider using spoil material from the trench line as a containment barrier where salvaged surface material is primarily composed of organic material and is likely not able to support a berm/barrier. Location to be determined by Inspector(s). Alternate dam devices such as an Aquadam or meter bags may also be used to isolate the trench area. Pump excess water from work area and trench to opposite side of berm or work ramp [Section 8.7.4]. • Pump water into stable and well-vegetated areas. Monitor discharge areas and change the hose discharge location if adequate natural filtration is no longer feasible and sedimentation could occur [Section 8.7.4]. • Backfill the trench with excavated trench spoil. Remove any excess trench spoil to an upland location approved by the appropriate regulatory authorities [Section 8.7.4]. • Backfill peat and mineral soils in the appropriate order such that peat material rather than the underlying mineral soils remain at the surface so that future drainage through the shallow peat material is not impeded [Section 8.7.4]. • Replace any remaining salvaged upper soil (root zone) material over the trench area. Reclaim the wetland to as close as feasible to its pre-construction profile and ensure no permanent trench crown is left following trench crown subsidence [Section 8.7.4].	• See above.

TABLE 7.2.8-2 Cont'd

Potential Effect	Pipeline Segment(s)	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
1.1 Loss or alteration of wetlands of High Functional, High-Moderate, Low-Moderate and Low Functional Condition (*i.e.*, habitat, hydrology, biogeochemistry) (cont'd)	All	LSA	• Install temporary erosion and sediment control structures (*e.g.,* sediment fences, coir logs) immediately following the completion of backfilling lands adjacent to water crossings and wetlands where the potential for sedimentation of the watercourse or wetland exists (see Sediment Fence Drawing and Coir/Straw Log Installation Drawing in Appendix R) [Section 8.4]. • Maintain sediment fences in place at (non-peat) wetland boundaries, where warranted, until a vegetation cover has stabilized the adjacent construction areas [Section 7.0]. • See additional measures in the Pipeline EPP. Monitoring • Conduct Wetland Function Post-Construction Environmental Monitoring (PCEM) to review the recovery of wetland function within the construction right-of-way. Operations • Implement mitigation measures provided in table during operations activities within a wetland.	• See above.
1.2 Contamination of wetland function (*i.e.*, habitat, hydrology, biogeochemistry) due to a spill during construction	All	LSA	• Bulk hazardous materials in temporary construction yards or other designated areas except for quantities required for the daily construction activities. Wastes will be stored in temporary construction yards or other designated areas and removed during final clean-up. Fuel, oil or hazardous materials required to be stored on-site will be stored within secondary containment that is to be located greater than 300 m from a watercourse, wetland or lake [Section 7.0]. • Ensure that during construction no fuel, lubricating fluids, hydraulic fluids, methanol, antifreeze, herbicides, biocides, or other chemicals are dumped on the ground or into waterbodies. In the event of a spill, implement the Spill Contingency Plan (see Appendix B) [Section 7.0]. • Do not store fuel, oil or hazardous material within 300 m of a watercourse or waterbody [Section 7.0]. • Do not wash equipment or machinery in watercourses, wetlands or lakes. Control wastewater from construction activities, such as equipment washing or cement mixing, to avoid discharge directly into any body of water [Section 7.0].	• Reduction of wetland habitat, hydrological and biogeochemical function in the event of a spill during construction (depending on the volume and type of substance spilled).

Notes: 1 LSA = Wetland LSA.
2 Detailed mitigation measures are outlined in the Pipeline EPP (Volume 6B).

Wetlands are complex ecological systems and, consequently, the evaluation of wetlands for the purposes of environmental impact assessments tends to focus on wetland function. The *Federal Policy on Wetland Conservation* (FPWC) commits all federal departments to the goal of "no net loss" of wetland function on federal lands and waters (Environment Canada 1991, Lynch-Stewart 1992, Lynch-Stewart *et al.* 1996).

The objective of the FPWC is to promote conservation of Canada's wetlands to sustain their ecological and socio-economic functions. Several goals have been established by the FPWC to support this objective, including:

- "No net loss" of wetland function on federal lands or projects;
- Enhancement and rehabilitation of wetlands in areas where the continuing loss or degradation of wetlands or their functions have reached critical levels; and
- Recognition of wetland functions in resource planning, management and economic decision-making with regard to all federal programs, policies and activities.

Trans Mountain understands the intent of the objective of the FPWC.

Where feasible, the proposed pipeline corridor has been routed to reduce potential effects on wetlands by implementing a routing decision framework that takes into consideration the following.

- Avoiding wetlands, where feasible.
- Minimizing length traversing environmentally sensitive areas such as protected areas, or areas containing vegetation and wildlife habitat for species with special conservation status.
- Where practical, following existing linear infrastructure (*e.g.,* pipelines, power lines, roads).
- Using the shortest route practical.
- Where avoidance is not technically or economically feasible, implementing construction and reclamation mitigation measures.
- Monitoring wetland function and recovery post-construction.

7.2.8.5 Potential Residual Effects

The potential residual environmental effects on the wetland indicator associated with the construction and operations of the pipeline (Table 7.2.8-2) are:

- loss or alteration of wetland function (*i.e.*, habitat, hydrological, biogeochemical) during and following construction and maintenance activities until vegetation is re-established, grade and natural flow patterns are restored and until sedimentation is controlled; and
- reduction of wetland habitat, hydrological and biogeochemical function in the event of a spill during construction (depending on the volume and type of substance spilled).

7.2.8.6 Significance Evaluation of Potential Residual Effects

A quantitative analysis was undertaken to evaluate the significance of the potential residual environmental effects for the wetland function indicator as these changes over the existing data within the Footprint Study Area were quantifiable. However, where there are no standards, guidelines, objectives or other established and accepted ecological thresholds to define quantitative rating criteria or where quantitative thresholds are not appropriate, the qualitative method that is based on available research literature, field experience and professional judgment is considered to be the appropriate method for determining the significance of the anticipated residual environmental effects. Consequently, the qualitative assessment of wetland loss or alteration is considered to be the most appropriate method with the evaluation of significance of the potential residual effects relying on the professional judgment of the assessment team.

The quantitative analysis revealed that there are approximately 2,124.5 ha of wetlands located within the Wetland LSA in Alberta and 1,206.2 ha of wetlands are located within the Wetland LSA in BC. Of this, approximately 570.4 ha of wetlands are encountered by the proposed pipeline corridor. It is estimated that the proposed pipeline corridor may disturb approximately 236.2 ha of wetlands with High Functional Condition, 175.3 ha of wetlands with High-Moderate Functional Condition, 28.7 ha of wetlands with Low-Moderate Functional Condition and 0.1 ha of wetlands with Low Functional Condition. Table 7.2.8-3 provides a summary of the area of wetlands disturbed by the proposed pipeline corridor.

TABLE 7.2.8-3

PROJECT DISTURBANCE OF WETLAND FUNCTION WITHIN THE PROPOSED PIPELINE CORRIDOR AND WETLAND LOCAL STUDY AREA

Province	Total Wetland Area (Within Corridor and LSA) (ha)	Area of Wetlands within Corridor (ha)	Proposed Pipeline Corridor (ha)			
			High Functional	High-Moderate Functional	Low-Moderate Functional	Low Functional[1]
Alberta	2,124.5	382.5 ha	176.9 ha	126.2 ha	15.1 ha	0.0 ha
BC	1,206.2	206.9 ha	59.3 ha	49.1 ha	13.6 ha	0.1 ha

Note: 1 Wetlands of Low Functional Condition were not documented during the 2012 and 2013 field program in Alberta. However, wetlands of this functional condition are expected to occur within the proposed pipeline corridor. These values will be updated following the 2014 supplemental surveys.

Table 7.2.8-4 provides a summary of the significance evaluation of the potential residual environmental effects of the construction and operations of the proposed pipeline on the wetland indicator. The rationale used to evaluate the significance of each of the residual environmental effects is provided below.

TABLE 7.2.8-4

SIGNIFICANCE EVALUATION OF POTENTIAL RESIDUAL EFFECTS OF PIPELINE CONSTRUCTION AND OPERATIONS ON WETLAND LOSS OR ALTERATION

Potential Residual Effects	Impact Balance	Spatial Boundary[1]	Temporal Context			Magnitude	Probability	Confidence	Significance[2]
			Duration	Frequency	Reversibility				
1. Wetland Loss or Alteration Indicator – Wetland Function									
1(a) Alteration of wetland habitat, hydrological and biogeochemical functions during and following construction and maintenance activities until vegetation is re-established, grade and natural flow patterns are restored and sedimentation is controlled.	Negative	LSA	Short-term	Periodic	Medium to long-term	Low	High	High	Not significant
1(b) Reduction of wetland habitat, hydrological and biogeochemical functions in the event of a spill during construction.	Negative	LSA	Immediate	Accidental	Short to long-term	Low to high	Low	High	Not significant

Notes: 1 LSA = Wetland LSA.

2 Significant Residual Environmental Effect: A high probability of occurrence of a permanent or long-term residual effect of high magnitude that cannot be technically or economically mitigated.

Wetland Loss or Alteration Indicator – Wetland Function

The evaluation of wetland functional condition was used to assess the level of significance of the potential residual effects associated with the proposed pipeline corridor. The functional conditions (*i.e.*, High Function, High-Moderate Function, Low-Moderate Function and Low Function) were determined based on the level of existing disturbance to the wetlands, the type of wetland (*i.e.*, ephemeral, seasonal, semi-permanent) and their capacity to provide certain functions on a landscape level. The evaluation of significance was based on the anticipated level of residual effect the pipeline construction and operations will have on these wetlands based on their pre-construction functional condition. Three components of wetland function (*i.e.*, wetland habitat, hydrological and biogeochemical) were used to help in this analysis.

Many concerns regarding wetlands were brought forth during several of the stakeholder engagement events held for the Project (*e.g.*, Edson, Valemount, Chilliwack and Burnaby Community Workshops) including difficulties in revegetating wetlands (especially bogs), potential recreational use of wetlands already disturbed during other pipeline projects, potential spills into protected areas (*e.g.*, Cheam Lake Wetlands Regional Park) and cumulative effects.

Alteration of Wetland Habitat Function

Pipeline construction and maintenance activities within wetlands will likely result in some disruption of the function of wetlands, and this is considered to have a negative impact balance. Examples of potential adverse environmental effects on wetland habitat function are: potential changes in species composition; stress on plant species; interruption of wildlife movements; and fragmentation of natural habitats.

With proper construction methods and mitigation measures (*i.e.*, profile contours returned and the appropriate protection and use of the seedbank), these adverse effects can be successfully reduced. For example, Zimmerman and Wilkey (1992) monitored wetlands for effects on vegetation for 20 years post-disruption from pipeline construction. Findings of these long-term monitoring programs show that: adjacent natural wetland areas were not altered in type when the proper construction and mitigation measures were carried out (*i.e.*, wetland contours and elevations match those off the construction right-of-way); no non-native plant species invaded natural areas; and the right-of-way increased diversity.

Additional studies on the effects of pipeline construction on wetland vegetation (Shem *et al.* 1993, Van Dyke *et al.* 1994) report the following observations.

- *Wetland community effects*: at most sites, many plants from adjacent natural areas re-establish themselves on the right-of-way. Rights-of-way that have been constructed in a manner that wetland function is not lost (*e.g.,* profile contours returned and the appropriate restoration or maintenance of the seedbank through ensuring equipment arrives on-site clean and kept free of vegetative debris during construction) appear to have little effect on vegetation in the natural areas.

- *Wetland species diversity*: A greater number of wetland plants have been observed on the right-of-way than in the adjacent natural area. Rights-of-way increase the number and types of habitats in wetlands due to the growth of a variety of succession species. Although the impact balance on wetlands resulting from the disturbance created by the pipeline construction is negative (see Table 7.2.8-4), increased biodiversity is viewed positively since the plants that are regenerating on the right-of-way are native species that occur within the natural wetland habitat, and the result is that habitat function is not negatively impacted.

- *Construction and management practices*: Overall, vegetative cover on rights-of-way in wetlands in a variety of control plots (*i.e.*, various wetland types in areas throughout the US) is generally well-established within 1 to 3 years after pipeline construction when mitigation measures included returning wetland contours and elevations to pre-construction conditions. Minor differences in the final right-of-way surface elevation can strongly influence the type of vegetation that re-establishes on the right-of-way. Other examples of construction and management practices that ensure wetland vegetation will re-establish include conducting ground-level cutting, mowing or mulching of wetland vegetation instead of grubbing, directing grading away from wetlands and allowing natural recovery (*i.e.*, not seeding wetlands).

The effects of construction of a pipeline right-of-way on wetland vegetation and bird communities were investigated up to 2 years following construction by Santillo (1993). Results showed that at 2 years post-construction, wetlands were dominated by native hydrophytic graminoids. Also, in wetlands with no standing water, plant community composition and structure were found to be similar at the end of 2 years post-construction to what was observed pre-construction. Finally, results also showed that no new bird species were introduced as a result of the different habitat provided by the right-of-way after pipeline construction was conducted using appropriate mitigation measures (*e.g.,* re-establishing pre-construction contours within wetland boundary to ensure cross right-of-way drainage) that ensured seedbanks were restored on the construction right-of-way.

Increased plant diversity is discussed here as a finding of research presented in peer-reviewed available research literature (Santillo 1993, Shem *et al.* 1993, Van Dyke *et al.* 1994, Zimmerman and Wilkey 1992). The conclusion of the research was that although there was increased native plant diversity as a result of pipeline construction, the overall habitat function of the wetlands was not negatively impacted.

Increased biodiversity is viewed positively since the plants that are regenerating on the right-of-way are native wetland species, therefore, wetland habitat is not substantially altered. By opening up the canopy, plant species that generally cannot grow beneath a tree or shrub overstory will return to begin the plant succession stages and additional species will begin to inhabit the area. This increase in biodiversity may occur along the proposed pipeline corridor since disturbed peatlands have tree/shrub cover removed during construction. Initially, wetlands that were previously dominated by woody vegetation recover as sedge-dominant marshes due to an increased moisture regime as a result of decreased rates of evapotranspiration.

Salvaging of soils during construction removes microtopography features (*i.e.*, hummocks and hollows) that provide important microclimates. Loss of the habitat variation provided by microtopography features can slow regeneration of wetland vegetation and habitat (Lee and Boutin 2006). Restoration of microtopography features and microclimate variation following construction (*e.g.,* natural recovery in wetlands) accelerates plant community development and re-establishment (Belyea 1996, Kellner and Halldin 2002, Malmar and Wallén 1999, Miller 2011).

Past construction projects in similar ecoregions have successfully reduced effects on wetlands. Post-construction environmental monitoring of wetland function (TERA 2011b,c,e, 2012b,c,d) at wetlands along recent large pipeline projects on agricultural lands have shown that mitigation measures implemented during construction (*e.g.,* profile reconstruction, allowing natural regeneration) can be successful; wetlands have proven to be resilient. In addition, the absence of environmental issues pertaining to wetland health and function restoration has been observed and documented in As-built Environmental Reports for the first, second and third-year Post-Construction Environmental Monitoring (PCEM) reports for numerous past pipeline projects (Interprovincial Pipe Line [IPL] 1995, Enbridge 2000, 2002, TERA Environmental Consultants [Alta] Ltd. 1995, 1996, 2000, 2001a,b, TERA 2002, 2003, 2004, 2009c, 2011b,c,e, 2012b,c,d). The TMX Anchor Loop Project (Critchley and Foote 2009, TERA 2011f,g,h,i 2012e, 2013d) is located within similar terrain as the proposed pipeline corridor; currently TERA is entering into the final year of post-construction environmental monitoring and has documented the successful return of wetland habitat function within 2 to 3 years for the temporarily disturbed marsh, swamp, fen, bog and shallow open water wetlands. By utilising the proven and effective mitigation measures from past projects, it is anticipated that approximately 236.2 ha of High Functional, 175.3 ha of High-Moderate, 28.7 ha of Low-Moderate and 0.1 ha of Low Functional wetland function (*i.e.*, habitat, hydrological and biogeochemical) within the proposed pipeline corridor will be effectively reclaimed within the medium to long-term.

Mitigation measures will be employed to reduce residual effects on wetlands, depending on site-specific conditions and requirements (Table 7.2.8-2 and the Pipeline EPP of Volume 6B). With the implementation of the proposed mitigation measures, the potential alteration of wetland habitat function is considered to be reversible in the medium to long-term for wetlands depending on the pre-construction vegetative cover, and of low magnitude.

Alteration of Wetland Hydrological Function

Pipeline installation or maintenance may cause potential changes to the hydrologic flow (*i.e.*, surface or groundwater flow) of a wetland by diverting water away from the wetland and/or impeding natural flow through the wetland. Excessive water diversion will result in an unnatural decrease of water flow within the wetland while flow impedance (*i.e.*, inadequate drainage) results in a more saturated wetland habitat.

Each of these alterations is an interruption to the natural hydrologic regime and is considered to have a negative impact balance. The vertical and horizontal water movements in wetlands are readily disrupted by any berm-like structure. For example, linear disturbances, such as pipelines and roads, can impound water on the upstream side of a wetland resulting in drying downstream and flooding upstream. Drying on the downslope face in treed wetlands (*i.e.*, treed bogs and fens) can increase tree productivity, water demand and evapotranspiration, which facilitates further drying (Baisley 2012, Miller *et al. in prep.*). In mineral wetlands, this type of disturbance (*i.e.*, drying downstream) may also result in increases in productivity of drought tolerant wetland plant species (*e.g.,* grasses, some sedges and rushes) and water demand, which, similar to treed wetlands, can lead to further drying. The compounded drying can result in permanent alteration of peatland and mineral wetland hydrologic regime, overall wetland function and potentially ecosystem type (*e.g.,* treed wetland to forest or marsh to wet meadow or moist grassland) (Baisley 2012, Miller *et al. in prep.,* Sherwood 2012). On the upstream side, increased saturation from impounded water can result in the loss of trees and other woody vegetation, while allowing for the establishment of emergent vegetation in peatlands (Miller 2011) whereas in seasonal mineral wetlands, increased inundation may result in the decrease of emergent vegetation, the increase in aquatic vegetation and open water characteristics. Prolonged impoundment may potentially convert a treed wetland to an open water or marsh wetland and a more seasonal mineral wetland into a more permanent open water wetland.

The hydraulic conductivity of the wetland's substrate can also be affected by salvaging, compacting or mixing of the soil structure. For example, salvaging of the acrotelm (*i.e.*, the unsaturated portion of the peat profile near the surface) during pipeline construction affects water storage capacity, evaporative losses as well as soil processes (*e.g.,* carbon storage) (Price *et al.* 2003). Pore structure is impacted through subsidence and compression when peat is drained, which affects water storage capacity and hydraulic conductivity (Price *et al.* 2003). Overlaying woody mulch on replaced peat following pipeline construction can increase the relative humidity on the peat surface and decrease evaporative loss thereby reducing the hydrologic impact (Groeneveld and Rochefort 2005, Price *et al.* 2003). However, lessons learned from post-construction environmental monitoring programs have shown that the thickness of mulch can have affect vegetation regrowth if placed too thickly. In mineral wetlands, improper handling (*i.e.*, admixing, salvaged material drying) of salvaged mineral soil and wetland substrate can result in loss of salvaged material through wind erosion (*i.e.*, drying of material while stockpiled). Improper replacement of bottom soils can affect the permeability of the material (*i.e.*, permeable substrate becoming impermeable) as the result of admixing and compaction. These issues can affect a wetland's ability to retain and slowly release flood waters to the groundwater, increase evaporative losses of stored water and limit a wetland's storage capacity (*i.e.*, volume of water a wetland can retain). Storing salvaged material separately (*i.e.*, mineral soil separate from wetland substrate) and maintaining the moisture content can mitigate the effect of wind erosion while replacing salvaged material in the correct order (*i.e.*, mineral soil followed by wetland substrate) following construction can help to maintain bottom soil permeability, therefore, maintaining a wetland's hydraulic conductivity capability.

Among the most important considerations for limiting disturbances to hydrological function are assuring that the restoration of pre-construction elevations and contours are achieved (Gartman 1991), and that there will be no unnatural impedance to flow. Short-term disturbances to wetlands are expected during pipeline construction. Some alteration of hydrological function in wetlands can be expected during trenching, however, the late summer/fall/winter construction schedule in certain areas will reduce potential hydrologic changes since water flow is likely to be diminishing from peak levels. Surface materials at shallow depth (*i.e.*, the mineral soil) should be salvaged and stored separately from other material and sequentially replaced. This will reduce potential changes in the hydrological function of wetlands. If the construction right-of-way in the wetland is restored to its pre-construction profile and proper hydrologic throughflow is ensured by replacement of salvaged wetland substrates/upper soils, long-term effects on wetland hydrological function are not expected. Post-construction environmental monitoring of wetland hydrological function (TERA 2011f,g,h,i 2012e, 2013d) at wetlands along the TMX Anchor Loop Project have shown that mitigation measures implemented during construction (*e.g.,* profile reconstruction) can be successful in returning surface water to pre-construction levels. Seedbank moisture regime recovery (*i.e.*, vegetation growth due to moisture), however, has proven to occur more slowly since surface material moisture levels are regulated either from vegetation removal (resulting in a wetter moisture regime than previous) or the drier conditions commonly present at wetland margins.

Standard pipeline construction and operational activities are designed to avoid circumstances that result in diversion and/or natural flow impedance of water in wetlands. With the implementation of the proposed mitigation measures, the residual effect of pipeline construction and maintenance activities on wetland hydrology is considered to be reversible in the medium to long-term and of low magnitude.

Alteration of Wetland Biogeochemical Function

Changes in wetland hydrologic regime can directly and indirectly affect wetland biogeochemical function. Directly, hydrologic regime can affect soil processes, nutrient availability and water chemistry. For example, soil decomposition rates are controlled by microbial respiration, which is affected by temperature and oxygen availability. Microbes preferentially use oxygen, however, under anaerobic, saturated conditions, the rate and type of respiration is altered (McLatchey and Reddy 1998). Additionally, the heat capacity of saturated soils is higher than that of dry soils. Therefore, decomposition rates are maintained by hydrologic regime through saturated conditions.

Impounding water flow due to linear disturbance can also directly impact wetland biogeochemistry. Fen peatlands receive nutrient inputs primarily from surface and groundwater sources. By impeding water flow, nutrient delivery to downstream parts of the wetland is limited. However, recontouring and/or installing trench crown breaks may alleviate some of this nutrient stress.

Activity in or near wetlands during pipeline construction may result in an increased sediment supply and turbidity of surface waters (particularly in mineral wetlands), thereby, affecting biogeochemical function of the wetland. However, given the implementation of sedimentation control mitigation measures (*i.e.*, sediment fencing), the likelihood of alteration in this manner is reduced.

Indirectly, hydrologic regime can impact biogeochemical function by altering wetland habitat function. For example, decreases in water table position can increase tree productivity rates, which could decrease the quality of litter deposited to soil to increase nutrient turnover-times. This can change understory community composition due to nutrient and light limitations, soil processes (*e.g.,* decomposition rates), as well as further stimulating changes in wetland hydrologic regime through increased transpiration and interception by root systems (Baisley 2012, Kotowska 2012, Laiho *et al.* 2003).

Due to historical peat accumulation, peatlands represent a large reservoir of soil carbon and are estimated to store approximately 30% of the world's soil carbon pool and about 85% of North America's soil carbon (Bridgeham *et al.* 2006, Zoltai and Martikainen 1996). Differences in peatland microtopography (*i.e.*, hummocks versus hollows) help maintain wetland biogeochemical function, particularly carbon cycling (Belyea 1996, Benscoter *et al.* 2011, Malmar and Wallén 1999, Rydin *et al.* 2006). Removing the microtopographical variation within these wetlands through construction and compaction removes the important role they have within ecosystem function (Lee and Boutin 2006, Turcheneck 1990). However, this effect can be reduced by narrowing the construction right-of-way through wetlands and allowing for natural recovery.

Mitigation measures employed during construction and maintenance activities will reduce the residual effect. Consequently, the residual effect of pipeline construction and maintenance activities on wetland biogeochemistry is considered to be reversible in the medium to long-term and is of low magnitude.

A summary of the rationale for all of the significance criteria for all three components of wetland function (*i.e.*, habitat, hydrological and biogeochemical) is provided below (Table 7.2.8-4, point 1[a]).

- Spatial Boundary: Wetland LSA - alteration of habitat (*e.g.,* changes in vegetation species composition, stress on plant species, interruption of wildlife movements and fragmentation of natural habitats), hydrological (*e.g.,* changes in water level, impeded drainage) and biogeochemical function (*e.g.,* water quality, nutrient uptake) resulting from pipeline construction or maintenance activities may extend beyond the construction right-of-way.
- Duration: short-term – the events causing alteration of habitat, hydrological and biogeochemical function are construction of the pipeline and maintenance activities, the latter of which will be completed within any 1 year during the operations phase.
- Frequency: periodic - the events causing alteration of habitat, hydrological and biogeochemical function (*i.e.*, construction of the pipeline and maintenance activities) occur intermittently but repeatedly over the assessment period.
- Reversibility: medium to long-term – depending on the growth time of wetland species (medium-term) found along the proposed pipeline corridor, the time required to reclaim pre-construction elevation and contours (medium-term) and the time for biogeochemical processes to be reclaimed (medium to long-term), the reversibility of the residual effect may take longer than 1 year with the possibility of being greater than 10 years.
- Magnitude: low – based on the proposed mitigation measures (*i.e.*, substrate being restored to pre-construction profile and allowing natural regeneration in wetlands) and the post-construction environmental monitoring literature demonstrates that wetlands are resilient provided habitat function is not permanently altered. If permanent loss or alteration of wetland habitat function is identified upon completion of the Wetland Function PCEM Program, Trans Mountain will consult with Environment

Canada regarding potential remedial or compensatory measures to offset functional loss. However, permanent loss or alteration of wetland function is not anticipated at wetlands crossed by the proposed pipeline construction right-of-way since pipeline construction through wetlands is considered a temporary disturbance and experience indicates that residual effects on wetland function can be mitigated. Reductions in wetland area as a result of the installation of power line structures, however, may be considered a loss but not necessarily a loss of function due to the size of the structures. This potential loss of wetland area will be discussed with Environment Canada.

- Probability: high – the proposed pipeline corridor crosses a number of wetlands and disturbances within these wetlands will likely occur during pipeline construction and site-specific maintenance activities.
- Confidence: high – based on available research literature, results of mitigation measures and post-construction environmental monitoring programs of past pipeline projects and the professional experience of the assessment team.

Effects on Wetlands from Spills During Construction

In the unlikely event of a fuel spill from equipment or a fuel truck near a wetland during construction, infiltration of fuel into surficial deposits and surface water is possible, and the effects would be considered to have a negative impact balance. The implementation of prevention measures (Table 7.2.8-2 and Pipeline EPP of Volume 6B) is expected to mitigate small spills in wetlands. Spill mitigation is expected to result in some loss or disturbance of soil and vegetation. With the implementation of mitigation efforts, the effects of small spills on wetland function (*i.e.*, habitat, hydrological and biogeochemical) are considered to be reduced to low to high magnitude and reversible in the short to long-term (Table 7.2.8-4, point 1[b]).

- Spatial Boundary: Wetland LSA – alteration of wetland function (*i.e.*, habitat, hydrologic and biogeochemical) resulting from a spill during pipeline construction or maintenance activities may extend beyond the construction right-of-way.
- Duration: immediate – the event causing reduction of wetland function is a spill during construction, the period of which is less than or equal to two days.
- Frequency: accidental – contamination of wetlands from spills occurs rarely over the assessment period.
- Reversibility: short to long-term – depending on the volume and area affected by the spill.
- Magnitude: low to high – for potential reduction of wetland habitat, hydrological and biogeochemical functions.
- Probability: low – spills are unlikely to occur within wetlands.
- Confidence: high – based on available research literature, results of mitigation measures and post-construction environmental monitoring programs of past pipeline projects and the professional experience of the assessment team.

7.2.8.7 Summary

As identified in Table 7.2.8-4, there are no situations where there is a high probability of occurrence of a permanent or long-term residual environmental effect on the wetland indicator of high magnitude that cannot be technically or economically mitigated. Consequently, it is concluded that the residual environmental effects of pipeline construction and operations on wetland loss or alteration will be not significant.

7.2.9 Vegetation

The NEB *Filing Manual* provides regulatory guidance for the assessment of vegetation resources where disturbance is expected to occur in previously undeveloped areas. Vegetation resources, including Species at Risk and Species of Special Status as defined by the NEB *Filing Manual*, may be affected by construction and operations activities associated with the Project. The scope and methods required to adequately assess vegetation resources were determined with the guidance of the NEB *Filing Manual*, in conjunction with published rare plant survey recommendations and guidelines (Alberta Native Plant Council [ANPC] 2012, Penny and Klinkenberg 2012).

The Vegetation Technical Report of Volume 5C provides further information pertaining to existing vegetation conditions along the proposed pipeline corridor.

7.2.9.1 Assessment Indicators and Measurement Endpoints

The selection of indicators for vegetation included: consideration of the filing requirements in the NEB *Filing Manual*; experience gained during previous projects with similar conditions/potential issues; feedback from Aboriginal communities, regulatory authorities and stakeholders; feedback from participants in the ESA Workshops; public issues raised through the media; and the professional judgment of the assessment team. A list of the proposed indicators for vegetation was discussed during the Edmonton, Kamloops and Surrey ESA Workshops. There was general consensus by the participants of the workshops that the proposed indicators were appropriate for evaluating the effects of the Project on vegetation.

The vegetation indicators chosen for the Project include:

- vegetation communities of concern;
- plant and lichen species of concern; and
- presence of infestations of Noxious, Provincial weed species and presence of other invasive non-native species identified as a concern.

See Table 7.2.9-1 for the list of vegetation indicators, their measurement endpoints and the rationale for inclusion.

The vegetation communities of concern indicator addresses rare ecological communities as identified by the Alberta Conservation Information Management System (ACIMS), the BC Identified Wildlife Management Strategy and the BC CDC, as well as the communities identified as the most affected by the Project (as determined through Terrestrial Ecosystem Mapping [TEM]). In addition this indicator addresses vegetation communities identified as of concern during consultation, specifically grassland communities within the Bunchgrass (BG) Biogeoclimatic (BGC) Zone. This indicator addresses the NEB *Filing Manual* requirement to consider avoidance of sensitive or rare communities.

Grassland communities in the Kamloops region and old growth forests were suggested as vegetation communities of concern. Upon consideration by the assessment team, all grassland communities in the Kamloops region were adopted as measurement endpoints for the vegetation communities of concern indicator. Old growth forests were determined to be better assessed at other scales and are further discussed in Section 7.2.9.4.

Native vegetation was not initially included as a vegetation community of concern because it is a very coarse measurement that combines many different types of vegetation communities. Additionally, taking each distinct vegetation community through the assessment process is not possible and there was concern in the ESA and Community Workshops that all native vegetation may be important for genetic diversity, habitat for rare plant species and habitat for traditionally used plants. Areas of native vegetation are also raised as a concern in numerous regional management plans (Alberta Energy and Utilities Board 2002, AENV 2003a, Fiera Biological Consulting 2009, Henderson 2011, Maslovat 2009). Therefore, native vegetation was included under the vegetation communities of concern indicator. In addition, the most affected vegetation communities are assessed separately.

Vegetation communities most affected by the proposed pipeline corridor is a measure of specific native vegetation communities which will have a greater areal disturbance as a result of the effects of construction and operations compared to other native vegetation communities in the Vegetation RSA. Vegetation communities most affected was chosen as a measurement endpoint rather than communities of limited distribution (*i.e.,* those communities which occur least frequently in the Vegetation RSA) due to the length of the proposed pipeline corridor and the diversity of habitats encountered by the Vegetation RSA.

The plant and lichen species of concern indicator addresses rare plant and lichen species as identified by the *Species at Risk Act*, COSEWIC, the Alberta *Wildlife Act*, ACIMS, the BC Identified Wildlife Management Strategy and the BC CDC. This addresses the NEB *Filing Manual* requirement to determine effects related to plant species at risk or of special status.

The third vegetation indicator addresses infestations of Noxious weeds, Provincial weed species and other invasive non-native species identified as a concern. Participants in the ESA Workshops also raised concern about invasive species that are not provincially listed as weeds (*e.g.,* crested wheatgrass). The assessment team decided to modify the weed indicator to include other non-native species discussed in consultation. This indicator will inform efforts to address the NEB *Filing Manual* requirements to consider weed control measures and seed mixes.

Input on the proposed vegetation indicators was also sought from Environment Canada and Canadian Wildlife Services (CWS) (Section 3.0); both agencies were in agreement that the proposed vegetation indicators were appropriate and suggested no additional indicators for consideration.

TABLE 7.2.9-1

ASSESSMENT INDICATORS AND MEASUREMENT ENDPOINTS FOR VEGETATION

Vegetation Indicators	Measurement Endpoints	Rationale for Indicator Selection
Vegetation communities of concern	• ha of native vegetation altered on the Footprint, in the Vegetation LSA and RSA • % potential alteration of the most affected vegetation communities (variant and/or ecosite) on the Footprint, in Vegetation LSA and RSA • ha of grassland communities within the Bunchgrass BGC altered on the Footprint, in the Vegetation LSA and RSA • Abundance and distribution of rare ecological communities altered on the Footprint, in the Vegetation LSA and RSA	The selection of indicators and measurement endpoints considered NEB *Filing Manual* requirements for the vegetation element, addressed concerns raised by participants of the ESA Workshops and was informed by regulatory authorities (*i.e.*, Environment Canada and CWS). All grassland communities in the Kamloops region were adopted as measurement endpoints for the vegetation communities of concern assessment indicator after concerns were raised during the ESA Workshops in the region. Native vegetation is important for genetic diversity, habitat for rare plant species and habitat for traditionally used plants, therefore, native vegetation was added as a community of concern.
Plant and lichen species of concern	• Abundance and distribution of observed rare plant and lichen populations on the Footprint	The selection of indicators and measurement endpoints considered NEB *Filing Manual* requirements for the vegetation element, addressed concerns raised by participants of the ESA Workshops and was informed by regulatory authorities (*i.e.*, Environment Canada and Canada Wildlife Service [CWS]).
Presence of infestations of Noxious, Provincial weed species and presence of other invasive non-native species identified as a concern	• Qualitative assessment of weed issues including weed species identified as being of concern in the vicinity of the Project, as well as the density and distribution of observed weeds and invasive non-native species	The selection of indicators and measurement endpoints considered NEB *Filing Manual* requirements for the vegetation element, addressed concerns raised by participants of the ESA Workshops and was informed by regulatory authorities (*i.e.*, Environment Canada and CWS). Participants in the ESA engagement workshops raised concerns about invasive species that are not provincially listed as weeds. The assessment team decided to modify the weed indicator to include other non-native invasive species discussed in consultation.

7.2.9.2 Spatial Boundaries

The spatial boundaries used in the effects assessment of vegetation considered one or more of the following areas:

- a Footprint Study Area (as defined in Section 7.1.3);
- a Vegetation LSA; and
- a Vegetation RSA.

The Vegetation LSA represents the ZOI in which vegetation resources are most likely to be affected by the construction and operations of the Project. Key considerations used to establish the spatial boundaries of the Vegetation LSA for the Project include the distance that edge effects are expected to extend from a disturbed area (*i.e.*, that impact plant species and vegetation communities). The spatial extent of changes in vegetation composition may be affected by a number of factors. In one study, increased light was shown to allow the invasion of shade-intolerant vegetation up to 30 m from the edge of the disturbance (Ranney *et al*. 1981). Some tree species exhibit increased growth and regeneration within 30-60 m of clear-cut edges; however, tree mortality can also increase (Bannerman 1998). Within an old growth Douglas-fir forest, air temperature and humidity were generally found to be influenced to a depth of 120-180 m in areas adjacent to a clear-cut edge, while soil temperature and moisture were influenced from 60-120 m from the edge (Chen *et al*. 1993). While some roadway effects are not applicable to pipeline construction, equipment traffic along the construction right-of-way, the use of temporary access and the removal of vegetation may result in some comparable effects. Forman *et al*. (2003) found that the greatest changes to microclimate and dust levels occurred within the first 30-50 m from road edges, while the greatest changes in hydrological function, salinity and nitrogen levels could extend 100-200 m from the disturbed area. Based on the above concepts, the Vegetation LSA generally consists of a 300 m wide band from the centre of the pipeline corridor (*e.g.*, 150 m on both sides of the centre of the proposed pipeline corridor) was established to assess Project-related effects to vegetation resources.

The Vegetation RSA represents the area where the direct and indirect influence of other land uses and activities could interact with Project-specific effects and may cause cumulative effects on vegetation. Key considerations used to establish the spatial boundaries of the Vegetation RSA for the Project included the separation distance typically used to distinguish one rare plant population from another; the dispersal of non-native, invasive species to or from the Project footprint; provision of baseline data and mapping sufficient to support accurate assessment of wildlife habitat resources within the respective LSA of that biophysical component; and the physical footprint of the Project within a regional landscape context.

An Element Occurrence (EO) is the area of land or water in which a rare species or rare ecological community of conservation interest is or was present (BC MOE 2013b, NatureServe 2002). EOs generally refer to a local population or metapopulation (NatureServe 2002). Although there are many factors which may be taken into account in determining individual EOs, the default minimum separation distance for plant species EOs is 1 km (NatureServe 2002, 2004).

Although dispersal distances depend on a number of factors, many weed species produce large numbers of seeds that are wind dispersed (Forman *et al*. 2003). For example, many of the species listed in the BC *Weed Control Regulation* belong to the sunflower family (*Asteraceae*), which is adapted for wind dispersal. Forman *et al*. (2003) found that the spread of non-native, invasive species could extend up to 1 km from the disturbed area.

Wildlife habitat resources are important vegetation-related components of ecosystems encountered by the Project. A 2 km wide Vegetation RSA corresponds with the Wildlife LSA for the Project, which will facilitate accurate mapping, modeling and assessment of wildlife habitat at a scale where it is most likely to be affected by Project construction and operations.

In addition, the physical footprint of the proposed construction right-of-way represents a non-trivial proportion of the land base within a 2 km wide Vegetation RSA buffer, allowing for meaningful assessment of potential effects to native vegetation species and communities within a greater ecological context.

Based on the above concepts, the Vegetation RSA generally consists of a 2 km wide band from the centre of the proposed pipeline corridor (*e.g.*, 1 km on both sides of the centre of the proposed pipeline corridor) was established to assess Project-related effects to vegetation resources. The spatial boundaries of the Vegetation RSA are shown on Figures 5.9-1 to 5.9-4.

7.2.9.3 Ecological Context

Different ecosystem classification systems are applied to portions of the proposed pipeline corridor within BC and Alberta. In BC, the Biogeoclimatic Ecosystem Classification (BEC) System identifies biogeoclimatic (BGC) zones and subzones. Alberta ecosystems are identified as Natural Regions and Subregions.

The proposed pipeline corridor encounters five Natural Subregions in Alberta: the Central Parkland; Dry Mixedwood; Central Mixedwood; Lower Foothills; and Montane Subregions (Natural Regions Committee 2006). The proposed pipeline corridor encounters 10 BGC zones in BC: the ICH Zone; the SBS Zone; the IDF Zone; the PP Zone; the BG Zone; the MS Zone; the CWH Zone; the ESSF; and the MH Zone. Further information regarding vegetation characteristics for the BGC Zone and Natural Subregions traversed by the proposed pipeline corridor are described in more detail in the Vegetation Technical Report of Volume 5C.

The pipeline corridor encounters a diversity of land uses including native vegetation (*e.g.,* treed, native prairie), agriculture (*e.g.,* cultivation, tame pasture, hay) and commercial/industrial development. The Edmonton to Hinton Segment traverses lands dominated by human impact (*i.e.*, cities, towns, agriculture, roads, pasture), with urban land use dominating in the east. Forested areas and other native land uses (*i.e.*, rivers, wetlands, regenerating burn areas) make up approximately 30% of this segment. The Hargreaves to Darfield Segment traverses a wide variety of terrain, including flat or gently undulating valley bottoms, hills, steep slopes and narrow valleys. Forested lands dominate this segment, with wetlands, streams and fens interspersed along the landscape, while urban land use and agriculture are encountered around the communities and towns along the corridor. The Black Pines to Hope Segment encounters a variety of land uses, including forested areas, grasslands, watercourses and wetlands. Human impacted land use in this segment includes agriculture and urban development around the communities, including the City of Kamloops. The Hope to Burnaby Segment is dominated by human land use, including agriculture and urban development primarily to the west in the Lower Mainland. To the east, native land uses include forested and riparian areas. The Burnaby to Westridge Segment is located within the Lower Mainland and is dominated by urban and industrial land use, with residual forest stands from RK 1.0 to RK 1.93 and RK 2.84 to RK 3.6. For more details on land use along the proposed pipeline corridor, see the Vegetation Technical Report of Volume 5C and the Environmental Alignment Sheets of Volume 6E.

Construction and operations of the proposed pipeline will create new forest clearing, increase the existing corridor width where existing linear disturbances are paralleled, remove potential site-specific vegetation communities, and require on-going clearing as part of vegetation management during operations. This will result in the long-term conversion of forest vegetation communities to earlier seral stages (forb and shrub stages) until the pipeline is abandoned and disturbed areas are reclaimed. Grassland/shrubland and wetland vegetation communities will be temporarily disturbed during construction but will be revegetated with native vegetation or allowed to revegetate naturally following pipeline construction.

Pipeline and operations activities have the potential to directly and indirectly affect vegetation resources through alteration of vegetation, terrain and drainage, causing changes in habitat availability and effectiveness. Direct effects on vegetation will occur during the construction phase of the Project, while the indirect effects on vegetation will occur post-construction and into the operations phase of the Project.

Construction of the proposed pipeline is expected to extend over approximately 2 years in total (including clearing and site preparation, construction and testing). An area over the centreline of the pipeline will be maintained with low vegetation over the life of the operating pipeline to meet regulatory and safety requirements, resulting in a long-term conversion of forested habitat to earlier seral stages along most of the pipeline length. Weed control and maintenance activities will be conducted throughout the operations of the Project.

The proposed Project parallels existing rights-of-way for approximately 89% of its length. Following construction, revegetation measures are planned to reclaim the lands affected by construction activities (see the Pipeline EPP of Volume 6B).

Native vegetation relates to other ecosystem components by providing: protection of gene pools for future use; protection of native plant and wildlife species and their habitats; protection of traditionally used plants and their habitats; preservation of climax ecosystems and native biodiversity; and conservation of representative samples of different habitat characteristics of the regions in which the proposed pipeline corridor is located.

Aboriginal people have used vegetation resources for a wide variety of cultural, social and economic uses: for consumption; to produce trade items; and for commercial sale to traders and non-indigenous people in contemporary and historical times (Lifeways of Canada Ltd 2012, Northern Gateway Pipelines Limited Partnership [NGPLP] 2010, Tomkins 2008). Today, Aboriginal communities continue to harvest medicinal and food plants on Crown land within their traditional territories (MacPherson Leslie & Tyerman LLP 2011, NGPLP 2010). During field surveys, it was reported by TEK participants that the plants of traditional economic value for food and cultural well-being include a variety of medicinal and berry species, as well as roots and bark of specific trees observed along the proposed pipeline corridor (see the Vegetation Technical Report of Volume 5C for more details of vegetation-related TEK).

Resilience is the capacity of a system to absorb disturbance, undergo change and still retain essentially the same function, structure, identity and feedbacks. It is generally understood that the resilience of some communities is greater than others (*e.g.,* lower elevation valley bottom communities are more resilient than higher elevation subalpine or alpine vegetation communities). Additionally, it is generally thought that upland mixedwood and moist coniferous forests are more resilient than wetland and drainage vegetation communities due to these communities' dependence upon the current hydrology.

The sensitivity of vegetation community types is complex and may vary depending on the age of the community, as well as local ecological components including species composition, topography, soil texture and hydrology. Disturbance to ecological components may influence the ability for a community to reclaim to pre-construction conditions. Selection of effective construction techniques and development of site-specific mitigation measures aim to reduce the magnitude of disturbance to these ecological conditions and effects in the affected vegetation community. Efforts will be made to successfully reclaim the areas traversed by the proposed pipeline corridor to an equivalent land use based on pre-construction conditions.

Vegetation species at risk include vascular and nonvascular (moss and liverwort) plant species and lichen species that are listed on Schedule 1 of the federal *Species at Risk Act* (Environment Canada 2013c). Plant species at risk that could occur in the study area were identified by referring to the list of COSEWIC and/or *Species at Risk Act*-designated plants (Environment Canada 2013c), using draft critical habitat maps (Environment Canada 2013d) and reviewing habitat/substrate preferences of species at risk and reviewing imagery using data from ACIMS (ACIMS 2012) and the BC CDC Species and Ecosystems Explorer tool (BC CDC 2013). Vegetation surveys were conducted for the Project in 2013.

Mapping of draft proposed critical habitat for whitebark pine and toothcup meadow-foam was provided by Environment Canada (Environment Canada 2013d). Environment Canada provided Project-specific hard-copy maps of critical habitat for species at risk in BC (Environment Canada 2013d). The information on critical habitat is provided in this report with permission from Environment Canada and this information is subject to change since critical habitat mapping is not final until posted in a final recovery strategy on the Species at Risk Public Registry. Environment Canada makes no representation and gives no warranty of any kind with respect to the accuracy, usefulness, novelty, validity, scope, completeness or currency of the Canada Digital Data and expressly disclaims any implied warranty of merchantability or fitness for a particular purpose of the Canada Digital Data.

Candidate Critical Habitat for Species at Risk have been developed by Environment Canada, though recovery strategies for toothcup meadow-foam and whitebark pine are not final (Environment Canada 2013c). The critical habitat for whitebark pine is in the "early candidate (pre-review)" stage, meaning that the Recovery Strategy has not yet completed an internal review. The toothcup meadow-foam critical habitat is in the "candidate (jurisdictional review)" stage, meaning that the Recovery Strategy has completed an internal review and has been partially vetted by the Government of BC and (if relevant) other *Species at Risk Act* participating agencies (*e.g.,* Fisheries and Oceans Canada or Parks Canada).

There are eight COSEWIC and/or *Species at Risk Act*-listed plant and lichen species that have the potential to occur within the Vegetation RSA and these are listed in Table 7.2.9-2.

TABLE 7.2.9-2

FEDERAL PLANT AND LICHEN SPECIES OF CONCERN WITH HISTORICAL OCCURRENCES RECORDED WITHIN THE VEGETATION REGIONAL STUDY AREA

Federal						
COSEWIC Designation[1]	*Species at Risk Act* Designation[2]	Common Name	Scientific Name	Type	Segment	Notes
Endangered	Endangered	silver hair moss	*Fabronia pusilla*	moss	Hope to Burnaby	In Canada, silver hair moss has only been found at two sites in BC: near Lower Arrow Lake in the Kootenay Valley and on the west end of Sumas Mountain east of Abbotsford. Silver hair moss grows on semi-exposed rock or the surface of tree bark (COSEWIC 2002b, 2012a). A previously recorded occurrence of silver hair moss was recorded approximately 1 km from the proposed pipeline corridor.
Endangered	Endangered	tall bugbane	*Actaea elata*	vascular plant	Hope to Burnaby	In Canada, there are seven extant populations of tall bugbane, as well as one historic and two unverified populations, all found sporadically in the Chilliwack River valley west of the Coast-Cascade Mountain range in BC (Penny and Douglas 2001). It grows in shady, moist, mixed, mature western redcedar, hemlock and Douglas-fir forest, but also in predominately deciduous stands. Previously recorded occurrences of tall bugbane range from approximately 1 km to 11 km from the proposed pipeline corridor and correspond to the locations in the Chilliwack River valley from Bridal Veil Provincial Park, BC to just west of Cultus Lake, BC.
Endangered	Endangered	toothcup meadow-foam	*Rotala ramosior*	vascular plant	Black Pines to Hope	In BC, toothcup meadow-foam is found along Kamloops Lake and Osoyoos Lake (COSEWIC 2012b). Previously recorded occurrences of toothcup meadow-foam range from less than 1 km to 4 km from the proposed corridor, corresponding to the Kamloops location. Candidate critical habitat for toothcup meadow-foam overlaps with the proposed corridor (Environment Canada 2013d).
Endangered	Endangered	whitebark pine	*Pinus albicaulis*	vascular plant	Hargreaves to Darfield Black Pines to Hope	In Canada, whitebark pine extends from the Canada-US border to about 200 km north of Fort Saint James in the Coast Mountains and to about 150 km north of Jasper in the Rocky Mountains (COSEWIC 2010a). It occurs typically in high elevation, upper subalpine habitats ranging from timberline down to closed subalpine forest. Previously recorded occurrences of whitebark pine range from approximately 5 km to greater than 100 km from the proposed corridor with the closest occurrences north of Valemount, BC and the other occurrences in Manning Provincial Park, BC. Early candidate critical habitat for whitebark pine occurs within 1 km of the proposed corridor in two locations (Environment Canada 2013d).
Threatened	Threatened	Haller's apple moss	*Bartramia halleriana*	moss	Hargreaves to Darfield	The Canadian range of Haller's apple moss includes western Jasper National Park, Alberta and adjacent BC along the Rocky Mountain trench. A total of 15 extant populations are known. The species is a habitat specialist, restricted to non-calcareous cliffs or talus in low elevation forests with high humidity and it has low dispersal ability (COSEWIC 2011a). Previously recorded occurrences of Haller's apple moss range from less than 1 km to 70 km from the proposed pipeline corridor with the closest occurrence at Avola, BC.
Threatened	Threatened	Mexican mosquito fern	*Azolla mexicana*	vascular plant	Hargreaves to Darfield	In Canada, Mexican mosquito fern is restricted to BC. The eight extant populations occur in three areas of south central BC: the Little Fort/North Thompson River area; the Shuswap Lake area; and Vernon (COSEWIC 2008). It is a shade-tolerant species found along the shores or in primarily still-waters of lakes, ponds, streams and other wetlands as well as in ditches. Previously recorded occurrences of Mexican mosquito fern range from approximately 100 m to 94 km from the proposed pipeline corridor, with the closest occurrence at Little Fort.

TABLE 7.2.9-2 Cont'd

Federal						
COSEWIC Designation[1]	*Species at Risk Act* Designation[2]	Common Name	Scientific Name	Type	Segment	Notes
Special Concern	Special Concern	Vancouver Island beggarticks	*Bidens amplissima*	vascular plant	Hope to Burnaby	In Canada, Vancouver Island beggarticks has been found in the Lower Fraser Valley (from east of Abbotsford to Richmond, BC) and on southern Vancouver Island, with one additional record on the mainland coast of BC just north of Vancouver Island (COSEWIC 2012c). It is a wetland species generally limited to habitat around ponds, lakes and stream margins where water levels fluctuate. Vancouver Island beggarticks show a distinct preference for silty alluvial soils. The species may also occur in tidal zones where it is inundated twice a day, and dries out between tides. Previously recorded occurrences of Vancouver Island beggarticks range from less than 1 km to greater than 100 km from the proposed corridor.
Special Concern	--	peacock vinyl lichen	*Leptogium polycarpum*	lichen	Hope to Burnaby	In Canada, peacock vinyl lichen is restricted to coastal BC. Populations have been found on southern Vancouver Island, mainland inlets and the main valleys of the Coast Range (COSEWIC 2011b). Previously recorded occurrences of peacock vinyl lichen range from less than 100 m to over 100 km from the proposed pipeline corridor with the closest occurrences near Bridal Falls and Hope.

Notes:

1. Committee on the Status of Endangered Wildlife in Canada (COSEWIC 2013). Species listed as Extirpated or Not at Risk were generally not included in the table without other noteworthy factors being present.

   Endangered: a species facing imminent extirpation or extinction.

   Threatened: a species likely to become Endangered if limiting factors are not reversed.

   Special Concern: a species that is particularly sensitive to human activities or natural events, but is not an Endangered or Threatened species.

2. *Species at Risk Act* (*SARA*). The *Act* establishes Schedule 1 as the list of species to be protected on all federal lands in Canada.

   Endangered: a species that is facing imminent extirpation or extinction.

   Threatened: a species that is likely to become an Endangered species if nothing is done to reverse the factors leading to its extirpation or extinction.

   Special Concern: a species that may become a Threatened or an Endangered species due to a combination of biological characteristics and identified threats.

7.2.9.4 Potential Effects and Mitigation Measures

Effects Considerations

Old growth forests are considered a vegetation community of concern. While old growth forests are not specifically listed by ACIMS or the BC CDC as specific rare ecological communities, they are identified in the regional management plans and environmental management plans of a number of regions and municipalities along the proposed pipeline corridor (Wildwood County, Yellowhead County, Chilliwack and Robson Valley). They were also mentioned during ESA Workshops and Community Workshops (*i.e.,* Burnaby and Clearwater) as a concern for stakeholders.

In general, definitions of old growth forest within the available research literature focus on the presence of structural characteristics such as large old living trees, large standing dead trees or snags (dead trees broken off at the top), complex canopy structure and coarse woody material (*i.e.*, logs) in both the terrestrial and aquatic environment (Franklin and Spies 1991, Geowest 1996, as reviewed in Braumandl and Holt 2000, Hilbert and Wiensczyk 2007). Old growth forests are widely recognized as being biologically diverse ecosystems (Franklin and Spies 1991). Structural characteristics result in microclimatic conditions utilized by specialized organisms (*e.g.,* lichens, amphibians) (Bunnell *et al.* 1999, Spies 1998) and provide habitat for fish, wildlife and plants (Bunnell *et al.* 1999, Geowest 1996, Spies 1998). The microhabitats available in old growth forests are high potential habitats for rare plant and lichen species, so old growth forest is discussed as it relates to habitat for rare plants/lichens and rare ecological communities in this assessment.

Approximately 33% of the total wildlife species found in BC occur in old growth forests (Bunnell *et al.* 1999). Obligate cavity nesters such as the pileated woodpecker are particularly abundant in old growth forest because of habitat preferences for large dead trees or snags (Bunnell *et al.* 1999, Franklin and Spies 1991). Old growth forests also constitute prime ungulate winter range because of high understory foliage availability, abundant litterfall (including lichens) and reduced snow depth due to canopy cover (Bunnell *et al.* 1999). Several species, including woodland caribou, are closely associated with old growth forests (Bunnell *et al.* 1999, Franklin and Spies 1991). For these reasons, and because the wildlife study areas consider larger areas than vegetation, old growth forest is also discussed in Section 7.2.10 Wildlife and Wildlife Habitat.

Old growth forests are also captured under the subsections discussing timber and Old Growth Management Areas (OGMAs) in the human occupancy and resource use sections (Sections 5.4 and 7.2.4) in Volume 5B. Late successional large trees are an important timber and forestry resource, and so are further discussed in the Managed Forest Areas and Forest Health Technical Report of Volume 5D.

Old growth forest also has spiritual and cultural value for many Aboriginal communities. Aboriginal communities along the Edmonton to Hinton, Black Pine to Hope and Hope to Burnaby segments raised concerns regarding clearing of old growth forest and mature tree stands. TEK will be discussed throughout this assessment and in more depth in the Vegetation Technical Report of Volume 5C and the Traditional Land and Resource Use Technical Report of Volume 5D.

Forest pests can pose a serious threat to mature coniferous forests. Management Strategies are provided by ASRD for mountain pine beetle and spruce budworm; however, only measures related to the management of mountain pine beetle pertain to activities associated with pipeline construction (*i.e.*, clearing, timber harvest and slash disposal). Bark beetles such as mountain pine beetle, Douglas-fir beetle and spruce beetle pose a serious threat to mature coniferous forests in BC. Emergency Bark Beetle Management Areas enable aggressive action in areas of bark beetle outbreak by way of designated emergency harvest strategies (BC Ministry of Forests and Range 2010). Although there are best practices which aim to prevent the introduction and spread of forest pests, many of the potential effects and mitigation is related to forestry practices and economic outcomes for forestry resources. Therefore, forest health was determined to be best discussed in the Managed Forest Areas and Forest Health Technical Report of Volume 5D, and an assessment of forest health is provided under the land and resource use indicator in Section 7.2.4 of Volume 5B. Therefore, forest pests are not further discussed in the vegetation assessment.

Vegetation communities of limited distribution are occasionally used to describe vegetation communities of concern. Communities of limited distribution are native ecosite or variant classes that cover less than 1% of the total Vegetation LSA or RSA. These communities contribute to landscape level diversity and have the potential to support plant species that do not occur elsewhere within the Vegetation LSA and RSA. This description is typically used for projects where the footprint is a facility or site in one particular region. This Project covers diverse landscapes and traverses a large number of Natural Subregions and BGCs. It was determined that interpreting the vegetation communities of concern indicator as communities of limited distribution would lose its meaning on a project of this scale where there are numerous areas of distinct and unique habitat. Instead, vegetation communities of limited distribution is represented by vegetation communities most affected, that investigates which communities (identified as variants in BC and ecosites in Alberta) in the Vegetation RSA occur along the Project Footprint more frequently than other vegetation communities in the RSA. These vegetation communities will be disproportionally affected by construction and maintenance activities and provide a focused discussion of effects to particular native vegetation communities.

Identified Potential Effects

Potential effects associated with the construction and operations of the proposed pipeline on vegetation indicators are listed in Table 7.2.9-3. These interactions are based on the results of the literature review, desktop analysis, field work, mapping, TEK, engagement with Aboriginal communities, landowners, regulatory authorities and other stakeholders (Section 3.0) and the professional experience of the assessment team.

The mitigation measures provided in Table 7.2.9-3 provide a summary of key mitigation measures selected to reduce effects to vegetation resources. These measures were principally developed in accordance with Trans Mountain standards as well as industry and provincial regulatory guidelines including, however, are not limited to, the following:

- Environmental Handbook for Pipeline Construction (AENV 1988);
- Guide for Pipelines Pursuant to the *Environmental Protection and Enhancement Act* and Regulations (AENV 1994a);
- Environmental Protection Guidelines for Pipelines: Conservation and Reclamation Information Letter, C&R/IL/94-5 (AENV 1994b);
- Best Management Practices for Pipeline Construction in Native Prairie Environments (AENV 2003b);
- Weeds on Industrial Development Sites: Regulations and Guidelines, R&R/03-4 (AENV 2003c);
- Recommended Land Use Guidelines for Protection of Selected Wildlife Species and Habitat within Grassland and Parkland Natural Regions of Alberta (ASRD 2011);
- Information Bulletin 2010-17 Preventing Spread of Invasive Plants and Noxious Weeds (BC OGC 2010b);
- Environmental Protection and Management Guidelines (BC OGC 2013);
- *Oil and Gas Activities Act* Environmental Protection and Management Regulation (BC Reg. 200/2010);
- Environmental Assessment Best Practice Guide for Wildlife at Risk in Canada (CWS 2004);
- Best Management Guidelines for the Enhanced Approval Process (Government of Alberta 2011);
- Integrated Standards and Guidelines: Enhanced Approval Process (Government of Alberta 2013a); and
- Guidelines for Translocation of Plant Species at Risk in British Columbia (Maslovat 2009).

Any quantitative assessment of potential effects is based generally on the centre of the proposed pipeline corridor.

TABLE 7.2.9-3

POTENTIAL EFFECTS, MITIGATION MEASURES AND RESIDUAL EFFECTS OF PIPELINE CONSTRUCTION AND OPERATIONS ON VEGETATION

Potential Effect	Pipeline Segment(s)	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
1. Vegetation Indicator – Vegetation Communities of Concern				
1.1 Loss or alteration of native vegetation	All	Footprint	• Confine all pre-clearing/mowing and general clearing activities within the staked/flagged construction right-of-way boundaries. Adhere to clearing/mowing restrictions associated with watercourses, wetlands, sensitive environmental features and buffer areas (at watercourse and wetland crossings) in addition to those areas outlined in the resource-specific mitigation tables [Appendices E through Q]. • Maintain low vegetation or vegetated ground mat within the riparian buffer zone of watercourses and the vegetated buffer zone of wetlands, to the extent practical, by clearing only trees, walking-down low vegetation so low-lying vegetation remains intact. Limit grubbing of cleared/mowed trees/shrubs only to the trench line and work side area needed for the vehicle crossing to protect riparian areas [Section 8.1]. • Use hand clearing methods where directed by Trans Mountain's Lead Environmental Inspector and Inspector(s) to avoid or reduce disturbance to the ground surface on sensitive terrain [Section 8.1]. • Restrict root grubbing to the trench line, if feasible, and restrict root grubbing in wet areas, where practical, to avoid creation of bog holes, minimize surface disturbance and encourage re-sprouting/natural regeneration of deciduous trees and shrubs. See additional clearing and grubbing measures in Section 8.1. • Determine the extent of disturbance to native grasslands (*e.g.*, compaction, rutting) and prepare the surface prior to seeding as per discussions with Trans Mountain's Lead Environmental Inspector and Inspector(s) [Section 8.6]. • Use natural recovery as the preferred method of reclamation on wetlands [Section 8.6]. • Place erosion control blankets or coir matting [Erosion Control Matting Drawing in Appendix R], woody slash or log diversions [Rollback Drawing in Appendix R] along the right-of-way on erodible soils or wind exposed sites to provide micro-habitat and support plant establishment [Brush Wind Barrier Drawing and Staked Logs for Erosion Control Drawing in Appendix R] [Section 7.0 of Appendix C]. • Within the vicinity of the construction right-of-way, collect dormant woody plant material (deciduous stakes/brush) and select suitably sized transplants (small conifer/deciduous trees/shrubs) from a suitable donor site following approval from the applicable land manager [Section 7.0 of Appendix C]. • Use a grass cover crop and/or native grass seed mix that has been developed for use at riparian areas to support the establishment of installed and naturally regenerating native woody plant material and plants and to provide erosion protection in the short-term [Section 7.0 of Appendix C].	• Alteration of the composition of approximately 2,058 ha of native vegetation.

TABLE 7.2.9-3 Cont'd

Potential Effect	Pipeline Segment(s)	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
1.1 Loss or alteration of native vegetation (cont'd)	All	Footprint	• Implement plant protection measures (*e.g.,* soil mounds and berms, wind fencing and rollback) that work to minimize environmental stresses (*i.e.*, wind exposure, low soil moisture stress [desiccation]), to the extent feasible [Section 7.0 of Appendix C]. • Seed disturbed lands with land uses that support native and non-native plant communities with native and non-native grass mixtures and rates, respectively, as identified in the Reclamation Management Plan as per results of the vegetation field surveys [Appendix C] [Section 8.6]. • For native seed, the highest seed grade available will be obtained. Do not accept seed lots that contain any Prohibited Noxious or Noxious weeds as identified in the Certificate of Analysis. Retain the Certificates of Analysis obtained for both agronomic and native seed for future documentation. The Certificates of Analysis will be presented to the landowner/Crown land authority upon request [Section 8.6]. • Minimize foot traffic on newly seeded areas until grass establishment has taken place. Vehicle traffic will be avoided on seeded areas until the sod is re-established [Section 8.6] [Section 10.0 of Appendix C]. • Plant native shrub/tree species, where warranted, depending on the site-specific objectives [Section 14.0 of Appendix C]. • Remove problem vegetation (*i.e.*, weeds or invasive species) when adjacent to or crossing a wetland or watercourse and replace it with compatible, low-growing plant species that will out-compete problem vegetation [Section 14.0 of Appendix C]. • Refer to the Problem Vegetation Management Plan [Sections 14 of Appendix C] for management of non-native or invasive species. • See potential effect 3.1 of this table for mitigation regarding non-native or invasive species during construction and operations. • Monitor the effectiveness of revegetation efforts during the PCEM of the construction rights-of-way. Conduct additional remedial work, where warranted.	• See above.
1.2 Loss or alteration of the most affected vegetation communities	Edmonton to Hinton[3] RK 0.5 to RK 2 RK 59 to RK 66 RK 80 to RK 83 RK 118.5 to RK 133.5 RK 126 to RK 127 RK 133 to RK 134 RK 152 to RK 165 RK 175 to RK 176.5 RK 207 to RK 207.5 Hargreaves to Darfield[3] RK 491 to RK 554 Black Pines to Hope[3] RK 981 to RK 1000	Footprint	• See potential effect 1.1 of this table for mitigation regarding alteration of native vegetation. • Conduct a pre-construction weed survey and record problem vegetation (designated weeds) infestations on and immediately adjacent to the construction right-of-way [Section 6.0] [Section 14.0 of Appendix C]. • Reduce grubbing of roots in shrubby communities within TWS areas, where feasible [Section 6.0 of Appendix C]. • Minimize grubbing of plant roots and stumps at non-graded areas, to the extent feasible, to promote re-sprouting of cleared/brushed deciduous vegetation and germination of the undisturbed soil seed bank to optimize the potential for the natural regeneration of vegetation and reduce the potential for terrain instability or soil erosion by wind or water at these sites [Section 7.0 of Appendix C]. • Mow or walk down rather than wholly remove shrubs, where feasible [Section 6.0 of Appendix C]. • Clear woody vegetation only to the extent warranted to reduce the loss of forest values and minimize the potential for terrain instability and erosion [Section 7.0 of Appendix C].	• Alteration of up to approximately 6.4% of a variant or ecosite.

TABLE 7.2.9-3 Cont'd

Potential Effect	Pipeline Segment(s)	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
1.2 Loss or alteration of the most affected vegetation communities (cont'd)	See above	Footprint	• Use protective matting and/or snow during the winter to mat over the vegetation community where it occurs and other areas where surface disturbance is not required, to protect communities from scraping and compacting [Section 6.0 of Appendix C]. • Monitor the amount of mulch (wood chips) produced during mulching of un-grubbed tree stumps where minimum disturbance construction techniques are used on the construction right-of-way (grubbing and topsoil salvage over the trench only) so as to maintain soil nutrients at levels (*i.e.*, maintain a suitable Carbon:Nitrogen ratio) that can support vegetation re-establishment following construction activities [Section 7.0 of Appendix C]. • Consider employing appropriate salvage, propagation and transplant techniques for component species [Section 6.0 of Appendix C]. • Manage all problem vegetation along the construction right-of-way during all pipeline construction phases (*i.e.*, pre-construction, construction, PCEM) and the operational phase [Section 14.0 of Appendix C]. • Monitor the effectiveness of revegetation efforts during the post-construction environmental monitoring of the construction rights-of-way. Conduct additional remedial work, where warranted.	• See above.
1.3 Loss or alteration of grasslands in the BG BGC Zone	Black Pines to Hope RK 829.4 to RK 848.8 RK 849.7 to RK 850.8 RK 896.8 to RK 897.0 RK 897.5 to RK 898.5 RK 899.0 to RK 899.1 RK 918.5 to RK 921.4 RK 922.7 to RK 933.0	LSA	• See potential effect 1.1 of this table for mitigation regarding alteration of native vegetation. • Supplemental vegetation and rare plant surveys will be conducted prior to construction. See Section 9.0 for details. • Conduct a pre-construction weed survey and record problem vegetation (designated weeds) infestations on and immediately adjacent to the construction right-of-way [Section 6.0] [Section 14.0 of Appendix C]. • Avoid environmentally sensitive areas, such as areas likely to have rare ecological communities. Where avoidance is impractical, develop site-specific mitigation measures in accordance with the Rare Ecological Community and Rare Plant Population Management Plan [Section 6.0 of Appendix C]. • Avoid creating new disturbances and use of treed areas or native grasslands when selecting ancillary sites, to the extent feasible [Section 12.0]. • Consider employing appropriate salvage, propagation and transplant techniques for component species [Section 6.0 of Appendix C]. • Retain sod and the vegetation mat on all lands if a competent sod layer exists. In these areas, grade only where safety considerations dictate in order to reduce disturbance to sod and the vegetation mat. Grading of well-sodded lands will not be permitted on level terrain [Section 8.2]. • Minimize trench width on native grasslands during trenching, to the extent feasible, in order to limit spoil storage requirements and sod disturbance [Section 8.3]. • Reduce the topsoil/root zone material salvage width at localized sensitive areas as shown on the Environmental Alignment Sheets or as directed by the Lead Environmental Inspector and Inspector(s) [Section 8.2].	• Some disturbance or alteration of grassland communities in the BG BGC Zone.

TABLE 7.2.9-3 Cont'd

Potential Effect	Pipeline Segment(s)	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
1.3 Loss or alteration of grasslands in the BG BGC Zone (cont'd)	See above	LSA	• Salvage a blade width of topsoil/root zone material centered over the trench at locations indicated on the Environmental Alignment Sheets. Disc well-sodded lands prior to topsoil/root zone material salvage in order to facilitate topsoil salvage operations [Section 8.2]. • Backfill the trench as soon as practical [Section 8.4]. • Conduct straw crimping on disturbed agricultural or native grassland soils where wind erosion may be problematic. Prior to spreading and crimping of straw, confirm that approval from the landowner or appropriate regulatory authority is in place, where warranted. Straw used will be obtained from: the landowner where the straw will be spread; a Certified seed grower; or fields or bales that have been inspected to be free of weeds [Section 8.6]. • Employ a subsoiler plow (*e.g.,* Paratiller) along segments of the construction right-of-way adjacent to the ditchline where topsoil salvage did not occur and subsoil compaction is severe. Do not use a subsoiler plow on native grasslands [Section 8.6]. • Avoid scalping of the vegetation mat/sod layer during topsoil/root zone material replacement on cleared/ungrubbed riparian vegetation, native grasslands, hay and tame pasture. Use specialized equipment (*e.g.,* clean-up bucket) that limits the risk of scalping during the final pass of topsoil/root zone material replacement and is approved by Trans Mountain's Inspector(s) [Section 8.6]. • Determine the extent of disturbance to native grasslands (*e.g.,* compaction, rutting) and prepare the surface prior to seeding as per discussions with Trans Mountain's Lead Environmental Inspector and Inspector(s) [Section 8.6]. • Manage all problem vegetation along the construction right-of-way during all pipeline construction phases (*i.e.*, pre-construction, construction, post-construction environmental monitoring) and the operational phase [Section 14.0 of Appendix C]. • Limit vehicle travel through problem vegetation infested areas [Section 14.0 of Appendix C]. • Refer to potential effect 3.1 of this table for mitigation regarding non-native or invasive species and herbicide use during construction and operations. • Monitor the effectiveness of revegetation efforts during the post-construction environmental monitoring of the construction rights-of-way. Conduct additional remedial work, where warranted.	• See above.
1.4 Loss or alteration of rare ecological communities	Edmonton to Hinton beaked sedge marsh (S2) RK 257.07 beaked willow/red-osier dogwood (S3?) RK 100.92 to RK 100.98 white birch/stiff club-moss woodland (S2?) RK 141.61 to RK 141.65 RK 141.79 to RK 141.82 RK 141.87 to RK 141.92 Hargreaves to Darfield common cattail marsh (S3, Blue)	LSA	• See potential effect 1.1 of this table for mitigation regarding alteration of native vegetation. • See recommended mitigation measures for wetland ecological communities of concern outlined in Table 7.2.8-2 Wetland Loss or Alteration. • Supplemental vegetation and rare plant surveys will be conducted prior to construction. See Section 9.0 for details. • Avoid environmentally sensitive areas, such as areas likely to have rare plant species or rare ecological communities. Where avoidance is impractical, implement site-specific mitigation measures in accordance with the Rare Ecological Community and Rare Plant Population Management Plan [Section 6.0 of Appendix C].	• Some disturbance or alteration of a rare ecological community, if avoidance is not practical and mitigation measures do not completely protect a site.

TABLE 7.2.9-3 Cont'd

Potential Effect	Pipeline Segment(s)	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
1.4 Loss or alteration of rare ecological communities (cont'd)	RK 728.75 to RK 728.77 lodgepole pine/velvet-leaved blueberry/clad lichens (S2S3, Blue) RK 509.4 RK 509.8 to RK 509.85 RK 510.49 to RK 510.59 RK 523.36 to RK 523.53 RK 534.83 to RK 535.14 RK 546.68 to RK 546.86 western redcedar - paper birch/oak fern (S2S3, Blue) RK 749.71 to RK 749.81 Black Pines to Hope amabilis fir - western redcedar/devil's club (S3, Blue) RK 1007.91 RK 1013.19 big sagebrush/bluebunch wheatgrass (S2, Red) RK 927.29 to RK 927.54 hybrid spruce species - Douglas-fir/subalpine fir (unique community) RK 978.12 narrow-leaf willow shrubland (S2, Red) RK 847.11 to RK 847.17 RK 847.26 to RK 847.27 Hope to Burnaby black cottonwood –red alder/salmonberry (S3, Blue) RK 1142.54 to RK 1142.76 RK 1145.62 to RK 1145.64 common cattail marsh (S3, Blue) RK 1116.58 to RK 1116.61 western redcedar – Sitka spruce/skunk cabbage (S3?, Blue) RK 1142.9 to RK 1143.03	LSA	• Conduct native seed collection for use in revegetation efforts at the site [Section 6.0 of Appendix C]. • Consider employing appropriate salvage, propagation and transplant techniques for component species [Section 6.0 of Appendix C]. • If previously unidentified occurrences of vegetation communities of concern are found during supplemental rare plant surveys, mitigation will be determined using the Rare Ecological Community and Rare Plant Population Management Plan [Section 6.0 of Appendix C]. • Site-specific mitigation will include avoidance, narrowing the construction right-of-way, fencing or protecting [Section 6.0 of Appendix C, Appendix J]. • Flag or fence-off resource-specific environmental features (*e.g.,* rare plant species, rare ecological communities) prior to commencing construction in the vicinity of the resource site. See additional mitigation in Section 6.0 of the Pipeline EPP. • Implement the resource-specific mitigation measures associated with vascular and non-vascular plant species of concern as well as rare and unique plant communities on or adjacent to the staked construction boundaries as outlined in the environmental resource-specific mitigation tables for rare plant/rare ecological communities provided in Appendix J and as shown in the Environmental Alignment Sheets [Section 6.0]. • Suspend activity if previously unidentified rare ecological communities are found on or adjacent to the construction right-of-way. Implement the Rare Ecological Communities or Rare Plant or Species Discovery Contingency Plan [Section 7.0 of Appendix B]. • Fence off the area where the rare plant community is traversed [Narrow Down Fencing Drawing in Appendix R] [Section 6.0 of Appendix C]. • Water down construction sites and access roads, when warranted, to reduce or avoid the potential for dust emissions. Increase the frequency of watering roads and sites during periods of high risk (*e.g.,* high winds). Implement additional dust abatement measures (*e.g.,* covering topsoil windrows, installing sediment fences, applying a tackifier) will be implemented, when warranted, during clearing and construction activities. See additional measures to control dust in Section 8.2 of the Pipeline EPP. • Place erosion control blankets or coir matting [Erosion Control Matting Drawing in Appendix R], woody slash or log diversions [Rollback Drawing in Appendix R] along the right-of-way on erodible soils or wind exposed sites to provide micro-habitat and support plant establishment [Brush Wind Barrier Drawing and Staked Logs for Erosion Control Drawing in Appendix R] [Section 7.0 of Appendix C]. • Conduct straw crimping on disturbed agricultural or native grassland soils where wind erosion may be problematic [Section 8.6]. • Seed disturbed erodible soils on non-cultivated land with a mixture of approved agronomic or native seed and cover crop seed such as fall rye if seeding in late summer or annual oats if seeding in the winter, spring or early summer [Section 8.6].	• If rare ecological communities are located adjacent to the construction right-of-way, they may be indirectly affected by changes in hydrology or light levels.

TABLE 7.2.9-3 Cont'd

Potential Effect	Pipeline Segment(s)	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
1.4 Loss or alteration of rare ecological communities (cont'd)	See above	LSA	• Implement plant protection measures (*e.g.,* soil mounds and berms, wind fencing and rollback) that work to minimize environmental stresses (*i.e.*, wind exposure, low soil moisture stress [desiccation]), to the extent feasible [Section 7.0 of Appendix C]. • Recontour the landscape to pre-construction conditions [Section 7.0 of Appendix C]. • Restrict the application of herbicide within 30 m of known rare plant populations or rare ecological communities. Spot spraying, wicking, mowing or hand-picking are acceptable weed control measures in proximity to rare plants, rare lichens and vegetation communities of concern [Section 7.0]. • Monitor the effectiveness of revegetation efforts during the post-construction environmental monitoring of the construction rights-of-way. Conduct additional remedial work, where warranted.	• See above.
2. Vegetation Indicator – Plant and Lichen Species of Concern				
2.1 Loss or alteration of rare plant and/or lichen occurrences	All (See Table J-1 of Appendix J of the EPP of Volume 6B for detailed locations)	LSA	• Supplemental vegetation and rare plant surveys will be conducted prior to construction. See Section 9.0 for details. • See potential effect 1.4 of this table for mitigation applicable to the loss or alteration of rare ecological communities. • Flag or fence-off resource-specific environmental features (*e.g.,* rare plant species, rare ecological communities) prior to commencing construction in the vicinity of the resource site See additional measures in Section 6.0 of the Pipeline EPP. • Apply only water or non-toxic and non-persistent chemical products as approved to access roads for dust control at park locations or sensitive areas including agricultural crop production areas, especially berries [Section 9.0]. • Water down construction sites and access roads, when warranted, to reduce or avoid the potential for dust emissions. Increase the frequency of watering roads and sites during periods of high risk (*e.g.,* high winds). Implement additional dust abatement measures (*e.g.,* covering topsoil windrows, installing sediment fences, applying a tackifier) will be implemented, when warranted, during clearing and construction activities. See additional measures to control dust in Section 8.2 of the Pipeline EPP. • Recontour the landscape to pre-construction conditions [Section 7.0 of Appendix C]. • Monitor the effectiveness of revegetation efforts during the post-construction environmental monitoring of the construction rights-of-way. Conduct additional remedial work, where warranted.	• Some disturbance or alteration of a rare plant occurrence, if avoidance is not practical and mitigation measures do not completely protect a site. • Some disturbance or alteration of a rare lichen occurrence, if avoidance is not practical and mitigation measures do not completely protect a site. • If rare plant or lichen sub-populations are located adjacent to the construction right-of-way they may be affected by changes in dust, hydrology or light levels. • If vegetation species at risk sub-populations are located adjacent to the construction right-of-way they may be affected by changes in dust, hydrology or light levels.

TABLE 7.2.9-3 Cont'd

Potential Effect	Pipeline Segment(s)	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
3. Vegetation Indicator – Presence of Infestations of Provincial Weed Species and Other Invasive Non-Native Species Identified as a Concern				
3.1 Weed introduction and spread	All	RSA	• Conduct a pre-construction weed survey and record problem vegetation (designated weeds) infestations on and immediately adjacent to the construction right-of-way [Section 6.0] [Section 14.0 of Appendix C]. • Implement weed management (*i.e.*, using proper application of chemical, mechanical or manual measures, or a combination of all) at locations identified within the pre-construction weed survey to a level that is consistent with weed management observed adjacent to the eventual construction right-of-way to reduce the potential for weed infestations following construction [Section 6.0]. Also refer to the Weed and Vegetation Management Plan [Section 14.0 of Appendix C]. • Ensure equipment arrives at all construction sites clean and free of soil or vegetative debris. Do not allow any equipment arriving in a dirty condition on site until it has been cleaned [Section 7.0]. • Power wash and misting stations will be established, where required, to clean equipment used during clearing and topsoil handling activities [Appendix F]. Basic shovel and sweep cleaning will be conducted on clearing and topsoil handling equipment before moving equipment off of cultivated fields. In addition, shovel and compressed air cleaning stations for topsoil handling equipment will be established at selected locations to prevent the spread of weeds [Appendix J] [Section 5.2]. • Restrict all vehicular traffic to the approved and staked construction right-of-way, workspace and access roads [Section 6.0]. • Monitor the topsoil and other soil piles for weed growth frequently during the growing season. Direct the contractor when warranted to take proactive measures to control weed growth [Section 7.0]. • Consider placing mats (*i.e.*, construction mats or swamp mats) over infested areas to reduce construction equipment transporting weed or plant material. Where mats are used, ensure they are free of soil, vegetation and debris prior to removing from the site [Section 7.0]. • Consider salvaging topsoil from the full construction right-of-way during non-frozen conditions if localized weed infestations are encountered, as outlined in the Weed and Vegetation Management Plan [Section 7.0] [Section 14.0 of Appendix C]. • Clean equipment (*i.e.*, shovel and sweep, pressurized water or compressed air) involved in topsoil/root zone material handling at weed-infested sites prior to leaving the location unless full right-of-way topsoil/root zone material salvage has been conducted. Clean equipment involved in topsoil handling at weed-infested sites prior to leaving the location [Section 7.0]. • Conduct straw crimping on disturbed agricultural or native grassland soils where wind erosion may be problematic. Prior to spreading and crimping of straw, confirm that approval from the land owner or appropriate regulatory authority is in place, where warranted. Straw used will be obtained from: the landowner where the straw will be spread; a Certified seed grower; or fields or bales that have been inspected to be free of weeds [Section 8.6].	• Weed introduction and spread.

TABLE 7.2.9-3 Cont'd

Potential Effect	Pipeline Segment(s)	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
3.1 Weed introduction and spread (cont'd)	All	RSA	• Use only Certified Canada No. 1 or the best available agronomic seed. For native seed, the highest seed grade available will be obtained. Do not accept seed lots that contain any Prohibited Noxious or Noxious weeds as identified in the Certificate of Analysis. Retain the Certificates of Analysis obtained for both agronomic and native seed for future documentation. The Certificates of Analysis will be presented to the landowner/Crown land authority upon request [Section 8.6]. • Limit vehicle travel through problem vegetation infested areas [Section 14.0 of Appendix C]. • The Weed and Vegetation Management Plan consists of vegetation management measures to be implemented in the short-term, during the pre-construction, construction and PCEM phases of Project construction and the long-term, during the regular operations and maintenance phase of the Project. Vegetation management measures to be implemented during both short-term and long-term periods [Section 14.0 of Appendix C]. • The use of herbicides for problem vegetation management along the construction right-of-way during construction and operations within the province of Alberta will be conducted in accordance with the *Environmental Code of Practice for Pesticides* as part of the Alberta *Environmental Protection and Enhancement Act*, and in BC will be conducted in accordance with the *Integrated Pest Management Regulation* of BC as part of the BC *Integrated Pest Management Act* [Section 14.0 of Appendix C]. • Monitor the effectiveness of revegetation efforts during the post-construction environmental monitoring of the construction rights-of-way. Conduct additional remedial work, where warranted. • During regular maintenance and operations activities, incidental ground inspections for problem vegetation along the construction right-of-way may be conducted to determine the extent (percent cover, composition, distribution, location of infestations) of problem vegetation (*i.e.*, presence of mature brush and trees, and weeds). Areas of new infestations, recommended treatment sites and adjacent landowner concerns will also be identified and documented during monitoring. To assist monitoring efforts, the baseline data collected during the pre-construction weed survey and the results of the PCEM Program will assist in establishing thresholds and determining if objectives of the Weed and Vegetation Management Plan are being met [Section 14.0 of Appendix C].	• See above.

Notes: 1 LSA = Vegetation LSA; RSA = Vegetation RSA.
2 Detailed mitigation measures are outlined in the Pipeline EPP (Volume 6B).
3 All locations are approximations based on TEM.

7.2.9.5 Potential Residual Effects

The potential residual environmental effects on vegetation indicators associated with the construction and operations of the pipeline (Table 7.2.9-3) are:

- alteration of the composition of approximately 2,058 ha of native vegetation;
- alteration of up to approximately 6.4% of a variant or ecosite;

- some disturbance or alteration of grassland communities in the BG BGC Zone;
- some disturbance or alteration of a rare ecological community, if avoidance is not practical and mitigation measures do not completely protect a site;
- if rare ecological communities are located adjacent to the construction right-of-way, they may be indirectly affected by changes in hydrology or light levels;
- some disturbance or alteration of a rare plant occurrence, if avoidance is not practical and mitigation measures do not completely protect a site;
- some disturbance or alteration of a rare lichen occurrence, if avoidance is not practical and mitigation measures do not completely protect a site;
- if rare plant or lichen sub-populations are located adjacent to the construction right-of-way, they may be affected by changes in dust, hydrology or light levels;
- if vegetation species at risk sub-populations are located adjacent to the construction right-of-way they may be affected by changes in dust, hydrology or light levels; and
- weed introduction and spread.

7.2.9.6 Significance Evaluation of Potential Residual Effects

A quantitative analysis was undertaken to evaluate the significance of the potential residual environmental effects for the disturbance of native vegetation in the Footprint and the disturbance to vegetation communities of limited extent and grassland communities in the BG BGC Zone as these changes over the baseline data were quantifiable. However, for other potential effects where there are no standards, guidelines, objectives or other established and accepted ecological thresholds to define quantitative rating criteria or where quantitative thresholds are not appropriate, the qualitative method is used. The qualitative method is based on available research literature, field experience and professional judgment and is considered to be the appropriate method for determining the significance of the anticipated residual environmental effects. Consequently, the qualitative assessment of vegetation is considered to be the most appropriate method with the evaluation of significance of the potential residual effects relying on the professional judgment of the assessment team.

Table 7.2.9-4 provides a summary of the significance evaluation of the potential residual environmental effects of the construction and operations of the proposed pipeline on vegetation. The rationale used to evaluate the significance of each of the residual environmental effects is provided below.

TABLE 7.2.9-4

SIGNIFICANCE EVALUATION OF POTENTIAL RESIDUAL EFFECTS OF PIPELINE CONSTRUCTION AND OPERATIONS ON VEGETATION

Potential Residual Effects		Impact Balance	Spatial Boundary[1]	Temporal Context			Magnitude	Probability	Confidence	Significance[2]
				Duration	Frequency	Reversibility				
1.	Vegetation Indicator – Vegetation Communities of Concern									
1(a)	Alteration of the composition of approximately 2,219 ha of native vegetation.	Negative	Footprint	Short-term	Periodic	Medium to long-term	Low to medium	High	High	Not significant
1(b)	Alteration of up to approximately 6.4% of a variant or ecosite.	Negative	Footprint	Short-term	Periodic	Medium to long-term	Low	High	Moderate	Not significant
1(c)	Some disturbance or alteration of grassland communities in the BG BGC Zone.	Negative	LSA	Short-term	Periodic	Medium to long-term	Medium	High	Moderate	Not significant

TABLE 7.2.9-4 Cont'd

	Potential Residual Effects	Impact Balance	Spatial Boundary[1]	Temporal Context: Duration	Temporal Context: Frequency	Temporal Context: Reversibility	Magnitude	Probability	Confidence	Significance[2]
1(d)	Some disturbance or alteration of a rare ecological community, if avoidance is not practical and mitigation measures do not completely protect a site.	Negative	Footprint	Short-term	Periodic	Medium to long-term	Medium	High	High	Not significant
1(e)	If rare ecological communities are located adjacent to the construction right-of-way they may be indirectly affected by changes in hydrology or light levels.	Negative	LSA	Short-term	Periodic	Medium to long-term	Low	High	Moderate	Not significant
1(f)	Combined effects on the vegetation communities of concern indicator (1[a] to 1[e]).	Negative	LSA	Short-term	Periodic	Medium to long-term	Low to medium	High	Moderate	Not significant
2.	Vegetation Indicator – Plant and Lichen Species of Concern									
2(a)	Some disturbance or alteration of a rare plant occurrence, if avoidance is not practical and mitigation measures do not completely protect a site.	Negative	Footprint	Short-term	Periodic	Medium to long-term	Medium	High	High	Not significant
2(b)	Some disturbance or alteration of a rare lichen occurrence, if avoidance is not practical and mitigation measures do not completely protect a site.	Negative	Footprint	Short-term	Periodic	Short to medium-term	Medium	High	High	Not significant
2(c)	If rare plant or lichen sub-populations are located adjacent to the construction right-of-way, they may be affected by changes in dust, hydrology or light levels.	Negative	LSA	Short-term	Periodic	Short to long-term	Low	High	High	Not significant
2(d)	If vegetation species at risk sub-populations are located adjacent to the construction right-of-way they may be affected by changes in dust, hydrology or light levels.	Negative	LSA	Short-term	Periodic	Medium to long-term	Medium	Low	High	Not significant
2(e)	Combined effects on the plant and lichen species of concern indicator (2[a] to 2[c]).	Negative	LSA	Short-term	Periodic	Medium to long-term	Medium	High	High	Not significant
3.	Vegetation Indicator – Presence of infestations of Provincial Weed Species and Other Invasive Non-Native Species Identified as a Concern									
3(a)	Weed introduction and spread.	Negative	RSA	Short-term	Periodic	Short to medium-term	Low to medium	High	High	Not significant

Notes: 1 LSA = Vegetation LSA; RSA = Vegetation RSA.

2 Significant Residual Environmental Effect: A high probability of occurrence of a permanent or long-term residual effect of high magnitude that cannot be technically or economically mitigated.

Vegetation Indicator – Alteration of Vegetation Communities of Concern

The following provides the evaluation of significance of potential residual effects on the vegetation communities of concern indicator.

Alteration of Native Vegetation

Although some previous clearing has occurred in the Vegetation RSA for the Project, most of the vegetation communities within the Vegetation RSA in BC remain intact. The Project parallels existing disturbance for 89% of its length. The east and west ends of the Project are areas with a high level of anthropogenic disturbance (*i.e.,* Edmonton and LMDA). The land use in the Vegetation RSA along the Edmonton to Hinton Segment is mostly anthropogenic (*e.g.,* cultivation, pasture, roads), with between 25-39% native vegetation. The amount of native vegetation in the Vegetation RSA in BC is much higher than Alberta, with between 63-76% native vegetation. There are agricultural areas around Kamloops, but the degree of anthropogenic disturbance in the Vegetation RSA is generally low along the BC segments of the Project.

The proposed pipeline corridor was routed along existing rights-of-way and other linear disturbance to the extent practical. Using a disturbance layer on GIS imagery to calculate undisturbed native vegetation, approximately 2,058 ha of native vegetation may be disturbed or altered on the Footprint during construction and operations of the proposed pipeline. The alteration of native vegetation is considered to have a negative impact balance.

Disturbed areas through native vegetation segments on generally level terrain will be allowed to naturally regenerate, and areas in parks and protected areas will be seeded with the appropriate native seed mix. Cover crops will be used for initial soil stabilization and weed control. Although areas disturbed during construction and periodic maintenance activities will revegetate with the appropriate native species, species composition in the disturbed Footprint will be altered. Clearing of the right-of-way and temporary workspace and the maintenance of the right-of-way will result in the perpetuation of early seral vegetation. The extent of altered vegetation communities will be limited by the implementation of mitigation measures outlined in Table 7.2.9-3 and in the Pipeline EPP (Volume 6B) and reclamation measures will speed the recovery.

Specific learnings from the TMX Anchor Loop Project PCM (TERA 2013a) relevant to the alteration of native vegetation include the following.

- Localized broadcast-seeding of native forb species resulted in limited establishment success.
- Timely salvage, storage and replacement of topsoil/root zone material allowed for the preservation of propagules (*e.g.*, seed, root pieces, spores) located in the surface soil to remain viable.
- Native sod salvage and replacement proved successful with no observed difference in sod and adjacent seeded sites after 5 years of monitoring.
- Where grubbing was avoided in riparian areas adjacent to crossings of streams and wetlands, native deciduous plants re-sprouted the spring after clearing and native plants established from seed located within the undisturbed surface soil.
- Willow staking was an effective means of re-vegetating the banks of watercourses when coordinated with construction clean-up and reclamation.
- Protection of installed woody plant species from ungulate browsing was achieved through the use of constructive panel fencing.
- The establishment success of installed woody plant species and naturally-regenerating native forb species was observed in riparian areas with limited grass establishment due to dry and/or low nutrient soils (*i.e.*, gravelly or with high woody debris content) or where a native riparian seed mix was not applied. To improve survival success of installed woody species and to encourage species diversity through the natural regeneration of native plants from the soil seed bank, seed riparian areas with a short-lived perennial native grass species to stabilize surface soils and reduce competition to installed and naturally-regenerating plants.

Alteration of native vegetation due to competition for light, soil nutrients and moisture may occur while the Footprint is revegetating. However, the establishment of early successional communities during reclamation and operations will resemble revegetation following natural disturbance since the species composition will favor early successional/colonial species, which are adapted for greater competition pressure for light, nutrients and moisture (excepting the competition resulting from weedy non-native species).

During construction, operations and reclamation of the Project, there will be a decrease in woody species richness and abundance due to site clearing within the Footprint, but due to edge effects there may be increases in woody species richness and abundance in areas adjacent to the Footprint. The extra temporary workspace will be allowed to revegetate after construction. Forb and graminoid species richness and abundance will increase over the operations phase of the Project as natural, low growing vegetation regenerates, but the Footprint will be maintained free of higher growing vegetation. During abandonment, the Footprint will be returned to an equivalent land capability compared to the pre-construction conditions.

TEK participants raised concerns about clearing of native vegetation along all segments of the pipeline. Along the Edmonton to Hinton Segment, participants described that forested land regulates climate and provides wildlife habitat and expressed concern over several forested areas, including stands of poplar, aspen, mature spruce and old growth forest (locations identified in Table 5.1.1-3 in the Vegetation Technical Report of Volume 5C). Participants along the Hargreaves to Darfield Segment expressed concern about the clearing of one tree stand (location identified in Table 5.1.2-3 in the Vegetation Technical Report of Volume 5C) and confirmed the importance of proper vegetation, tree and stump clearing to prevent resource waste. Participants along the Black Pines to Hope Segment expressed concern regarding loss of berry plants through clearing activities, namely huckleberries and soapberries, as well as concern about clearing of mature tree stands including Douglas-fir stands (locations identified in Table 5.1.3-3 in the Vegetation Technical Report of Volume 5C).

By preserving native vegetation using the mitigation highlighted in Table 7.2.9-3 and the Pipeline EPP of Volume 6B, the Project will achieve the objectives of the land use plans for the areas traversed by the proposed pipeline corridor. Objectives of the management plans include maintaining natural vegetation throughout the development process, preserving natural vegetation including trees in all undeveloped and riparian areas and discouraging further clearing or development in areas where native vegetation is important for soil conservation, water resources protection or wildlife habitat (City of Kamloops 2004, Strathcona County 2007, TNRD 2000, TNRD 2011b,c, Town of Edson 2006, Yellowhead County 2005, Yellowhead County 2006, Yellowhead County 2007). See Appendix 7.1 for more details of the land use plan objectives related to vegetation.

No locally or regionally adopted threshold or standard exists against which the incremental change in vegetation composition can be assessed. This residual effect is limited to the Footprint, reversible in the medium to long-term and of low to medium magnitude (Table 7.2.9-4, point 1[a]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Footprint – effects of pipeline construction and operations on the alteration of native vegetation is confined to the construction right-of-way.

- Duration: short-term – the events contributing to the alteration of native vegetation are clearing during construction of the pipeline or maintenance activities (*e.g.,* integrity digs, vegetation management), the latter of which are limited to any 1 year during the operations phase.

- Frequency: periodic – the events resulting alteration of native vegetation (*i.e.*, pipeline construction and maintenance activities) occur intermittently but repeatedly during the operations phase of the Project.

- Reversibility: medium to long-term – depending upon the associated land use and the growth time required for species in each affected area (*e.g.,* forb versus tree), changes to native vegetation community composition are considered reversible in the medium to long-term. The effects of the proposed pipeline on forb species (*e.g.,* grasses, bunchberry) is expected to be reversible in the medium-term, whereas the effects on tree species (*e.g.,* western redcedar, black spruce) are expected to be reversible in the long-term (more than 10 years) because the full right-of-way will be maintained free of higher growing vegetation until abandonment. Therefore, the overall alteration of the composition of vegetation along the Footprint will persist in the medium to long-term.

- Magnitude: low to medium – the proposed pipeline corridor is located adjacent to existing disturbances for 89% of the length and the construction of the pipeline will result in the clearing of approximately 2,058 ha of vegetation on the Footprint, which is considered to be within environmental standards given that best practices, objectives and provincial guidelines are being followed. Permanent loss of native vegetation is not anticipated to result from either the construction or operations of the proposed pipeline (low), however, returning the Footprint to an equivalent land capability during the abandonment phase could take years, as discussed under reversibility (medium). The indirect effects of Project construction and maintenance due to edge effects such as changes in light and moisture will be of low magnitude since they will not result in the loss of vegetation but only a localized change in vegetation community composition.

- Probability: high – the Footprint crosses native vegetation.
- Confidence: high – based on past pipeline projects and the professional experience of the assessment team.

Alteration of Up to 6.4% of a Variant or Ecosite

The proposed pipeline corridor was routed along existing rights-of-way and other linear disturbances to the extent practical. Certain vegetation communities, classified as variants and ecosites in BC and Alberta respectively, may be more affected than others due to the landscape and routing constraints. Vegetation communities located along the proposed pipeline corridor will have the potential to be altered such that their overall abundance may be reduced (although other native vegetation communities will be present).

Direct alteration of up to 6.4% of a variant or ecosite as a direct result of the Project has been quantitatively assessed within the Vegetation RSA using TEM.

Listed below in Table 7.2.9-5 are the ecosites whose total area (ha) on the Footprint, when compared to the ecosite total area (ha) in the Vegetation RSA, is more than 2.75% of the ecosite in the RSA.

Communities most affected were selected as those ecosites with more than 2.75% of the total ecosite located on the Footprint, based on the distribution of values between 0.5% and 6.4%. The total area of the ecosites listed in Table 7.2.9-5 within the Vegetation RSA may not be large; most of the ecosites (excluding the DMWk – rich fen) occupy less than 100 ha of the Vegetation RSA, while the Vegetation RSA occupies approximately 50,000 ha. However, these ecosites are disproportionately located along the Footprint (more than 2.75% of their total area within the Vegetation RSA is located along the Footprint), meaning that these ecosites will be more affected by the Project than other ecosites within the Vegetation RSA.

The most affected communities in Alberta are ecosites that are low lying to upland that occur on level to depressional areas (Beckingham and Archibald 1996, Beckingham *et al.* 1996). The ecosites vary from nutrient poor to medium with acidic soil conditions, dominated by lodgepole pine, black spruce, common Labrador tea, bog cranberry and common blueberry (Labrador tea-mesic), to alkaline nutrient rich fens characterized by tamarack, dwarf birch or willow and sedges (Beckingham and Archibald 1996). The ecosite most affected by the Project (6.4%) is a marsh ecosite found along shorelines of water bodies and riparian zones. This ecosite is thought of as successionally stable with changes in plant community composition being determined largely by disturbance regime (Beckingham *et al.* 1996).

TABLE 7.2.9-5

NATIVE VEGETATION COMMUNITIES MOST AFFECTED BY THE PROJECT IN ALBERTA[1]

Natural Subregion	Ecosite[2]	Area of Ecosite within Project Footprint (ha)	Area of Ecosite within Vegetation RSA (ha)	Proportion of Ecosite within Vegetation RSA Potentially Affected (%)
Lower Foothills	LFn - marsh	1.30	20.40	6.4
Central Mixedwood	CMWc - Labrador tea-mesic	3.16	56.76	5.6
Central Mixedwood	CMWh - Labrador tea/horsetail	3.71	87.18	4.3
Central Mixedwood	CMWk - rich fen	3.99	97.80	4.1
Lower Foothills	LFd - Labrador tea-mesic	3.00	75.85	4.0
Central Parkland	CPm - rich fen	2.91	84.78	3.4
Dry Mixedwood	DMWk - rich fen	8.26	255.82	3.2
Central Parkland	CPn - marsh	1.11	39.41	2.8

Note: 1 TEM data is unavailable for the segment between Edson and Hinton. See Appendix C of the Vegetation Technical Report of Volume 5C for TEM limitations and Section 9.0 of this volume for details on supplemental surveys.

2 Refer to the TEM Report (Appendix C) of the Vegetation Technical Report of Volume 5C for more information on ecosites.

It is estimated that approximately 70% of the Project Footprint within Alberta crosses non-native lands or land use characterized by anthropogenic activities (*e.g.,* roads, agriculture).

Listed below in Table 7.2.9-6 are the most affect BGC subzone variants in BC whose total area (ha) on the Footprint, when compared to the BGC subzone variant total area (ha) in the Vegetation RSA, is more than 2.75% of the total community. Communities most affected were selected as those with more than 2.75% of the total community located on the Footprint, based on the distribution of values between 0.05% and 3.75%.

These variants occur on moderately to steeply sloping terrain in valleys and lower level plateaus as well as in mid to high level elevations (Lloyd *et al.* 1990). The Cascade and McLennan variants are characterized by seral stands of lodgepole pine, hybrid white spruce, Douglas-fir (McLennan) and subalpine fir (Cascade) with thimbleberry, birch-leaved spirea, black huckleberry and falsebox common in the understory (Lloyd *et al.* 1990). The Moist Warm Engelmann Spruce - Subalpine Fir (ESSFmw) variant is dominated by Engelmann spruce and amabilis fir with white-flowered rhododendron, Sitka valerian and black huckleberry common in the understory (Lloyd *et al.* 2005). The McLennan Dry Hot Sub Boreal Spruce community only occurs along the Hargreaves to Darfield Segment, while the Cascade Moist Warm Montane Spruce variant and the Moist Warm Engelmann Spruce - Subalpine Fir variant occur only along the Black Pine to Hope Segment.

The variant most affected by the Project (3.75%) is the ESSFmw variant found within the high elevations of the ESSF zone in southern and central interior BC. Only 2.76% of the McLennan variant within the Vegetation RSA lies within the Footprint. However, it is also one of the five most common variants within the Vegetation RSA. The McLennan variant consists of shallow, coarse-textured soils and is vulnerable to nutrient deficiency if the forest floor is cleared (BC Ministry of Forests and Range 2007, 2010).

TABLE 7.2.9-6

NATIVE VEGETATION COMMUNITIES MOST AFFECTED BY THE PROJECT IN BRITISH COLUMBIA[1]

BGC Subzones	Variant	Area of Variant within Project Footprint (ha)	Area of Variant within Vegetation RSA (ha)	Proportion of Variant within Vegetation RSA Potentially Affected (%)
Moist Warm Engelmann Spruce - Subalpine Fir	ESSFmw	8.63	231.06	3.75
Moist Warm Montane Spruce	MSmw1 – Cascade	73.69	2,264.26	3.25
Dry Hot Sub-Boreal Spruce	SBSdh1 – McLennan	269.58	9,772.87	2.76

Note: 1 TEM data is unavailable for 24% of the proposed pipeline corridor in BC. See Appendix C of the Vegetation Technical Report of Volume 5C for TEM limitations and Section 9.0 of this volume for details on supplemental surveys.

The mitigation measures described in Table 7.2.9-3 and in the Pipeline EPP (Volume 6B) are expected to effectively address potential effects on the alteration of the most affected vegetation communities identified in Tables 7.2.9-5 and 7.2.9-6 within the Vegetation RSA.

It is anticipated that successful reclamation of the identified ecosites and variants can be achieved by seeding a cover crop for erosion control and weed control in areas where natural regeneration techniques are to be employed. Reduced grubbing within temporary workspace areas, where feasible and utilizing protective matting during winter months to protect from scraping and compacting will also increase the successful restoration of the identified ecosites and variants. Reduced grubbing of plant roots and clearing of shrubby communities and woody vegetation will reduce the loss of forested communities. Limiting vehicle traffic and managing problem vegetation during all construction phases will minimize weeds and invasive species in these areas. The Pipeline EPP of Volume 6B and Table 7.2.9-3 provides detailed mitigation measures.

Specific learnings from the TMX Anchor Loop Project post-construction environmental monitoring (TERA 2013a) relevant to reclamation of the most affected communities include the following.

- Placing restoration signage adjacent to areas that were being actively restored (*e.g.*, riparian areas, sensitive upland sites and where public misuse was anticipated), was effective in educating the public in regards to the sensitivity of the area and Project restoration methods implemented.

- Long-term wind protection structures (*e.g.,* wind fencing), creation of terrain undulations during final clean-up and reclamation and inclusion of wind-tolerant woody plant species within the planting prescription should be considered when planning revegetation in wind-exposed areas.

- Logs with a diameter of no less than 30 cm placed along and approximately perpendicular to slopes were effective in diverting overland water flow, accumulating sediment and providing wind exposure protection to establishing vegetation.

The potential residual effect of the alteration of up to 6.4% of a variant or ecosite is considered to have a negative impact balance. The residual effect is considered to be of low magnitude due to the expectation that the distribution of ecosites and variants will have a detectable difference from pre-construction conditions, but will not affect the viability of the remaining portion of the ecosite or variant. The residual effect is of medium to long-term reversibility since the effect will extend beyond the reclamation phase (Table 7.2.9-4, point 1[b]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Footprint – the alteration of up to 6.4% of an ecosite or variant is confined to the construction right-of-way.

- Duration: short-term – the events resulting in alteration of a variant or ecosite are clearing during construction of the pipeline or maintenance activities (*e.g.,* integrity digs, vegetation management), the latter of which are limited to any 1 year during the operations phase.

- Frequency: periodic – the events resulting in alteration of up to 6.4% of an ecosite or variant (*i.e.*, pipeline construction and maintenance activities) occur intermittently but repeatedly during the operations phase of the Project.

- Reversibility: medium to long-term – depending upon community type and the growth time required for the component species in each affected variant or ecosite (*e.g.,* forb versus tree), the alteration of up to 6.4% of a variant or ecosite is considered reversible in the medium to long-term. The effects of the proposed pipeline on communities like the Lower Foothills Marsh (LFn - Marsh) are expected to be reversible in the medium-term because the component species (*e.g.,* forbs, sedges) in this community tend to have good regeneration success within 10 years. The effects on ecosites and variants like the rich fens (*e.g.,* CMWk – Rich fen) or the Moist Warm Engelmann Spruce – Subalpine Fir (ESSFmw) are expected to be reversible in the long-term (more than 10 years) due to component species that include trees or specific hydrology regimes. Treed wetlands that are cleared for construction often have long-term regeneration periods due to hydrologic alteration resulting from the initial tree removal. When trees are removed from a wetland they can no longer uptake groundwater, and so the local water table rises, increasing the likelihood that the recovering wetland will be a sedge-dominant meadow rather than a treed fen, especially in cases where the trees will be kept mowed on the right-of-way for the life of the operating pipeline. Therefore, the overall alteration of a variant or ecosite along the footprint will persist in the medium to long-term.

- Magnitude: low – the potential alteration of up to 6.4% of an ecosite or variant is considered to be within environmental standards given that best practices, objectives and provincial guidelines are being followed. Permanent loss of an ecosite or variant is not anticipated to result from either the construction or operations of the proposed pipeline. Alteration of up to 6.4% of an ecosite or variant will likely not affect the viability of the remaining parts of the ecosites and variants within the Vegetation RSA. Though the affected vegetation communities will not have the same component species or diversity following construction, the function of these native vegetation communities will remain.

- Probability: high – the proposed pipeline corridor is located on the identified ecosites and variants.

- Confidence: moderate – the assessment of this residual effect is based on incomplete TEM data, but the analysis is informed by past pipeline projects and the professional experience of the assessment team.

Some Disturbance or Alteration of Grassland Communities in the BG BGC Zone

Approximately 158 ha of grassland is predicted to be directly disturbed or altered on the Footprint in the BG BGC Zone, while grassland communities in the LSA may be indirectly altered during construction and operations of the proposed pipeline, which is considered to have a negative impact balance.

Area of grassland was determined through the use of TEM (see Appendix C of the Vegetation Technical Report of Volume 5C). Polygons in the BG BGC with more than 50% grass dominated variants (*i.e.*, BGxh2 and BGxw1) were deemed to be a bunchgrass community polygon and were included in calculating this metric. Any bunchgrass vegetation community polygon intersected by the Vegetation Footprint is considered to be potentially altered. Bunchgrass communities were also mapped in the Vegetation RSA using the same method. The amount of bunchgrass community intersected by the Footprint (approximately 158 ha) is a small component of the amount of bunchgrass community in the Vegetation RSA (approximately 6,372 ha). Approximately 2.5% of bunchgrass communities in the Vegetation RSA are located on the Project Footprint.

The proposed pipeline corridor parallels existing rights-of-way and other linear disturbances to the extent practical. The proposed pipeline corridor intersects the BG BGC Zone at a few locations in the Black Pines to Hope Segment, while avoiding it for most of the pipeline length. The BG BGC Zone is intersected from approximately RK 829.4 to RK 848.8; RK 849.7 to RK 850.8; RK 896.8 to RK 897.0; RK 897.5 to RK 898.5; RK 899.0 to RK 899.1; RK 918.5 to RK 921.4; and RK 922.7 to RK 933.0 for a total of approximately 35 km.

The visual effects of construction on grassland vegetation communities were raised as a concern during Kamloops ESA and Community Workshops. The mitigation measures suggested in Table 7.2.9-3 and in the Pipeline EPP of Volume 6B take visual impact into consideration. Mitigation measures will be implemented before, during and after construction to minimize the residual effects on grassland vegetation communities. Specific mitigation to address visual effects includes:

- the trench will be backfilled as soon as practical (reducing moisture loss in the soil) (Section 8.4 of the Pipeline EPP);
- straw crimping will be conducted on native grassland soils where wind erosion may be problematic. Straw used will be obtained from: the landowner where the straw will be spread; a Certified seed grower; or fields or bales that have been inspected to be free of weeds (Section 8.6.3 of the Pipeline EPP);
- problem vegetation will be managed along the construction right-of-way during all pipeline construction phases (*i.e.*, pre-construction, construction, post-construction environmental monitoring) and the operational phase [Section 12.0 of Appendix C of the Pipeline EPP]; and
- the effectiveness of revegetation efforts during post-construction environmental monitoring will be monitored following construction, keeping in mind visual effects.

Disturbed areas through native grassland segments will be allowed to naturally regenerate. Although areas disturbed during construction and occasional maintenance activities will be allowed to naturally regenerate or revegetate with the appropriate native species, species composition in the disturbed Footprint will likely be altered. The extent of altered vegetation communities will be limited by the implementation of mitigation measures outlined in Table 7.2.9-3 and the Pipeline EPP (Volume 6B) and reclamation measures will speed the recovery.

For the purposes of this assessment, the mechanisms by which alteration of grasslands communities act outside the Footprint (*i.e.*, edge effects) are assumed to vary according to factors of local vegetation and ecology. Furthermore, the indirect alteration of native vegetation has been characterized according to the proximity from existing or proposed disturbance and does not address variation in magnitude of residual effects for areas where native vegetation has been or may be indirectly altered by multiple sources of disturbance.

Alteration of grassland vegetation communities due to competition for light, soil nutrients and moisture may occur while the Footprint is revegetating. However, the establishment of early successional communities during reclamation will resemble revegetation following natural disturbance since the species composition will favor early successional/colonial species, which are adapted for greater competition pressure for light, nutrients and moisture (excepting the competition resulting from weedy non-native species). As a result, changes in competition for light, nutrients and moisture will not measurably contribute to the overall effect of pipeline construction on alteration of native grassland vegetation over the life of the operating pipeline.

Seeding is the preferred method for revegetating the right-of-way, as prescribed in the Reclamation Management Plan, to facilitate the re-establishment of grassland communities. In addition, the effectiveness of bunchgrass restoration measures will be monitored during post-construction environmental monitoring following construction.

The mitigation measures proposed above have been used successfully on other major pipeline construction projects for other sensitive vegetation communities. Following are some examples of revegetation success from other major pipeline construction projects on grassland communities.

Narrowing down of the right-of-way for sensitive communities was successfully conducted during construction at several locations on a large pipeline in the Central Alberta area (Alliance 2000a,b,c). At the South Saskatchewan River, shrubby vegetation important for wildlife was temporarily covered with geotextile pads during construction (Alliance 2000c). In addition, sensitive grasslands with thorny buffaloberry, considered important for wildlife, was ramped over during construction. The thorny buffaloberry was cut low to the ground and the root mat preserved (Alliance 2000c).

In order to protect Wilcox's panicgrass (*Dichanthelium wilcoxianum*) (S1), a rare grass species, during construction of a pipeline project in 2001, the work site was narrowed by approximately 5 m, no grading was allowed and a blade width of sod was salvaged and placed on straw matting. The sod was then replaced and straw from the matting was then spread over the replaced sod. During post-construction environmental monitoring in 2004, approximately 3,000 plants were found (TERA 2004).

The TransCanada Keystone Pipeline Project intersected approximately 120 km of native rangeland, including lands within the Mixedgrass Natural Subregion of Alberta. A management plan was developed and implemented for the project, with the objective of establishing a positive successional trend towards plant communities present prior to construction. Second year post-construction environmental monitoring of the indicated that revegetation of desirable species continues to progress toward meeting the intent of the objective of the management plan (TransCanada Keystone Pipeline GP Ltd. 2012).

The Express Pipeline Ltd. Express Pipeline Project was approximately 435 km in length, most of which was situated in the Grassland Natural Region of Alberta. A long-term post-construction environmental monitoring project was conducted on native prairie lands along the construction right-of-way. Monitoring conducted in the 14th year following construction of the pipeline indicated that native plant communities had re-established on all monitoring sites where natural revegetation had been used (Kestrel Research Inc. and Gramineae Services Ltd. 2011).

Learnings from the TMX Anchor Loop Project (TERA 2013a) relevant to grassland communities of concern include the following.

- Where sufficient native seed cannot be collected on or adjacent to the construction right-of-way or where the volume requirements of certain species (*i.e.*, native grass seed) exceed the capacity for native collection prior to construction, seed may be sourced from commercial seed companies and native seed collectors with documented collection locations within the same or similar Natural Subregion/BGC zone as the project restoration site.
- Seeding of native grass species immediately following topsoil/root zone material replacement allowed for plant germination and emergence prior to soil crusting and at a time when establishing grass plants are able to compete with weed seedlings.

- Hydro-seeding with the use of a tackifier is an effective method of seeding areas with difficult access, when rapid vegetation establishment is required (aesthetic values) and where there is moderate to high risk of soil erosion due to wind or water on sloping terrain and/or erodible soils.

- Aerial seeding is an effective and efficient method of broadcast seeding the disturbed construction right-of-way where landscape features, wet soil conditions and a limited seeding window may restrict the use of other seeding methods.

- Bulldozer track packing (soil imprinting perpendicular to the slope) of the construction right-of-way during final clean-up allowed for the establishment of soil microsites that facilitated the capture of broadcast grass seed and precipitation, reduced the formation of rills from soil water erosion and promoted the establishment of vegetation cover.

Application of herbicides to grassland vegetation communities during all pipeline construction phases (*i.e.*, pre-construction and construction) and operations phase (*i.e.*, post-construction environmental monitoring) could cause an alteration in the composition of the vegetation community, depending on the area, quantity and specificity of herbicide applied. However, the use of best practices in weed control and vegetation management reduces the potential for herbicide drift or effects to unintended areas or species. Vegetation management conducted by mechanical means (*i.e.*, cutting or mowing) will be favoured; if vegetation management by chemical means is the only feasible method it should be conducted with equipment that ensures the specificity of the application.

During regular maintenance and operations activities, incidental ground inspections for problem vegetation along the construction right-of-way may be conducted to determine the extent (percent cover, composition, distribution, location of infestations) of problem vegetation (*i.e.*, presence of mature brush and trees, and weeds). Areas of new infestations, recommended treatment sites and adjacent landowner concerns will also be identified and documented during monitoring. To assist monitoring efforts, the baseline data collected during the pre-construction weed survey and the results of the post-construction environmental monitoring program will assist in establishing thresholds and determining if objectives of the Weed and Vegetation Management Plan are being met (Section 12.0 of Appendix C of the Pipeline EPP [Volume 6B]).

If the bunchgrass community cannot be avoided, then a narrowed strip of the bunchgrass community will be disturbed resulting in some alteration of the community, resulting in a negative impact balance. Based on the assessment of the bunchgrass vegetation communities that will be encountered during construction, the mitigation measures described above are considered to be appropriate and applicable to the Project. Consequently, the most acute and likely residual effects of pipeline construction on grassland vegetation communities are confined to the Vegetation LSA, are reversible in the medium to long-term and of medium magnitude (Table 7.2.9-4, point 1[c]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Vegetation LSA – although alteration of grasslands is generally confined to the disturbed portion of the construction right-of-way, potential changes in hydrology and species composition may extend beyond the pipeline right-of-way.

- Duration: short-term – the events resulting in alteration of grassland community vegetation are construction of the pipeline or maintenance activities (*e.g.,* integrity digs, vegetation management), the latter of which are limited to any 1 year during the operations phase.

- Frequency: periodic – the events resulting in alteration of grassland community vegetation (*i.e.*, construction of the pipeline and maintenance activities) will occur intermittently but repeatedly during the operations phase of the Project.

- Reversibility: medium to long-term – establishing a cover of native grassland species or a cover crop species will occur over the medium-term, but greater species diversity, including the establishment of some grassland species (*i.e.*, fescue if it is present within the communities encountered), may occur more slowly (long-term). Weed introduction can take years of management to remediate, depending on the non-native species (*i.e.*, non-native grasses) and the specificity of the herbicide.

- Magnitude: medium – the proposed pipeline corridor is located adjacent to existing disturbances to the extent practical and the construction of the pipeline will result in the clearing of approximately 158 ha of grassland vegetation, which is approximately 2.5% of all bunchgrass communities in the Vegetation RSA. The Project will contribute to a combined loss or alteration of native grassland vegetation, however, there are no standards or thresholds that would otherwise indicate loss or alteration of native grassland vegetation is unacceptable given that best practices, objectives and provincial guidelines are being followed.

- Probability: high – the proposed pipeline corridor crosses native grassland vegetation in the BG BGC Zone.

- Confidence: moderate – confidence would be high based on past pipeline projects, the assessment team's understanding of the effects and mitigation, but land access in the BG BGC was low and TERA was unable to survey many of grassland communities in the area, resulting in moderate overall confidence.

Some Disturbance or Alteration of a Rare Ecological Community, if Avoidance is Not Practical and Mitigation Measures Do Not Completely Protect a Site

Rare plant surveys were conducted during the growing season in 2013 on lands where access was granted as a component of the vegetation surveys. Supplemental ground-based rare plant surveys are planned to be conducted prior to construction on any new lands due to rerouting or where rare ecological communities were identified that need verification; see Section 9.0 for more details regarding supplemental surveys. In the event that additional rare ecological communities are identified in the Footprint during supplemental surveys, mitigation will be determined using the Rare Ecological Community and Rare Plant Population Management Plan (Section 5.0 of Appendix C of the Pipeline EPP [Volume 6B]).

During the 2013 rare plant surveys, 25 occurrences of ACIMS and BC CDC-listed rare ecological communities (12 distinct rare ecological communities) were observed, including wetland communities of concern, as well as one unique ecological community not listed by ACIMS or the BC CDC. Protection measures and environmental management techniques for rare ecological communities are provided in Appendix C of the Pipeline EPP of Volume 6B. Mitigation measures for rare ecological communities generally fall into categories of avoidance, (*e.g.,* realignment, change of work side, narrowing), reducing disturbance (*e.g.,* narrowing, adjusting workspaces, ramping/matting over) and alternative construction/reclamation techniques (*e.g.,* salvaging seed or sod, plant propagation, transplanting component species, separate root zone material salvage, delayed clearing, access management) (see the Vegetation Technical Report of Volume 5C and Appendix C of the Pipeline EPP [Volume 6B] for more details). These proposed mitigation measures have been used previously on other major pipeline construction projects with good success. Some examples are provided below.

Narrowing down the right-of-way for sensitive communities was successfully conducted during construction at several locations on a pipeline project in the Central Alberta area (Alliance 2000a,b). At the South Saskatchewan River, shrubby vegetation important for wildlife was temporarily covered with geotextile pads during construction (Alliance 2000c). In addition, sensitive grasslands with thorny buffaloberry, considered important for wildlife, was ramped over during construction. The thorny buffaloberry was cut low to the ground and the root mat preserved (Alliance 2000c). Covering a rare ecological community with geotextile or ramping over are measures that are expected to have higher success during construction in frozen conditions when plants are dormant and snow can be used to protect the vegetation.

During a pipeline project in the Dawson Creek area of BC, several aspen/thimbleberry/wild sarsaparilla communities (S2S3) were observed on the right-of-way. The locations were staked off and the right-of-way was also narrowed to the greatest extent feasible, in the vicinity of these communities. The proposed mitigation for these rare communities also included avoidance of grubbing, and where vehicle travel occurred, matting and temporary travel surfaces were used to limit vehicular disturbance. Post-construction environmental monitoring found that the communities had experienced minimal impact. Avoidance during construction by narrowing the right-of-way was found to have resulted in a near pre-construction level of species composition and abundance (TERA 2012g).

Learnings from the TMX Anchor Loop Project (TERA 2013a) pertinent to rare ecological communities (including wetland communities of concern) include the following.

- Natural regeneration is an effective means of revegetation in wetlands where construction disturbance is limited to the trench area and where accurate separation and replacement of trench materials is achieved.
- In wetlands, transplanting of sedge and bulrush species from local undisturbed donor sites into construction disturbed areas proved to be an effective method of revegetation as transfers established and spread within their respective habitats.

Mitigation is developed with a number of factors taken into account that include, however, are not limited to:

- component species;
- community size;
- rarity;
- construction timing;
- location of the community with respect to the proposed right-of-way;
- primary mode of component species reproduction;
- habitat and proximity of available habitat; and
- past mitigation success (of the community or similar communities).

Based on the assessment of the rare ecological communities that will be encountered during construction, the mitigation measures described above are considered to be appropriate and applicable to the Project. If mitigation measures do not completely protect the site, a disturbance or alteration of a portion of the community may occur and is considered to have a negative impact balance. For example, if a narrowed strip of the S1, S2 or S3 community will be disturbed it would result in some alteration of the community. In addition, temporarily covering of the site and implementing construction traffic restrictions may not completely protect the community. By basing mitigation on community ranking and abundance, in addition to its location on the construction right-of-way and the community type, any alteration of the local community, particularly S1 communities, will be reduced to a level such that the local community is not placed at risk. Consequently, the residual effect of pipeline construction on rare ecological communities and unique communities are of medium magnitude (Table 7.2.9-4, point 1[e]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Footprint – the potential disturbance or alteration of a rare ecological community is confined to the construction right-of-way.
- Duration: short-term – the events resulting in potential disturbance or alteration of a rare ecological community are construction of the pipeline or maintenance activities (*e.g.,* integrity digs), the latter of which are limited to any 1 year during the operations phase.
- Frequency: periodic – the events resulting in potential disturbance or alteration of a rare ecological community (*i.e.*, construction of the pipeline and maintenance activities) occur intermittently, however, repeatedly during the operations phase of the Project.
- Reversibility: medium to long-term – depending on the component species (*e.g.,* western redcedar and amabilis fir [amabilis fir - western redcedar/devil's club community] will take years to grow to mature trees, compared to common cattails [common cattail marsh] or beaked sedge [beaked sedge marsh] which can recolonize or re-establish in one growing season if the seed bank and habitat is available).

- Magnitude: medium – the potential disturbance or alteration of a rare ecological community is of medium magnitude since the effect is still within environmental standards given that best practices, objectives and provincial guidelines are being followed. Returning the footprint to an equivalent land capability and regrowth of a rare ecological community could take years, as discussed under reversibility (medium).

- Probability: high – there are 25 rare ecological communities identified within the proposed pipeline corridor during the vegetation surveys in 2013 and they may be traversed by the Footprint.

- Confidence: high – based on past pipeline projects, the professional experience of the assessment team and the results of post-construction environmental monitoring.

Indirect Effects to Rare Ecological Communities

With proper implementation of the industry-accepted standard mitigation practices that are proposed, disruption of surface flow patterns and light levels following construction or maintenance activities are expected to be minor along the proposed pipeline corridor. However, construction and maintenance activities (*e.g.*, integrity digs) may contribute to some localized alteration of light levels and natural surface drainage patterns until trench settlement is complete and seeded vegetation has matured. The impact balance of this potential residual effect is considered negative since it could alter the moisture regime and light levels.

Indirect alteration of rare ecological communities adjacent to the Footprint may occur due to soil erosion. Some rare ecological communities may be more susceptible to erosion than others. For example, the white birch – ground-pine - stiff club-moss (*Betula papyrifera/Lycopodium obscurum - Lycopodium annotinum*) woodland community identified during 2013 vegetation surveys is typically located in a midslope position where soils are exposed but potentially have a high litter cover. The location of the community on a slope and on exposed soils increases the potential for erosion if the litter cover is removed. Since the areas with greatest erosion risk will be seeded with native species or an annual cover crop (or otherwise stabilized with erosion control blankets, coir matting, woody slash, or straw crimping [Section 6.0 of Appendix C and Section 8.6.3 of the EPP]), the indirect alteration of native vegetation as a result of erosion will not measurably contribute to the overall effect of pipeline construction on the alteration of rare ecological communities.

Increased distance of light penetration due to clearing will result in an indirect alteration of native vegetation (*i.e.*, the native species making up the rare ecological community). For example, the western redcedar – sitka spruce/skunk cabbage (*Picea sitchensis/Lysichiton americanus*) community identified during the 2013 vegetation surveys is a forested community, characterized by low light penetration due to dense tree canopy. If part of the community is cleared, the light penetrating to the understory will change the species composition along the edges of the community where clearing occurred. However, this effect will not substantially contribute to the alteration of native vegetation beyond the effects detailed in relation to the clearing of native vegetation. Additionally, during the course of reclamation, as revegetation progresses, light penetration will generally decrease over time.

Given that indirect effects are, in part, caused by disturbance to vegetation structure associated with clearing activities, allowing disturbed areas to naturally revegetate may not alleviate indirect effects where vegetation management is conducted or long-term persistence of the disturbance exists. Consequently, indirect effects to vegetation are expected to persist until the pre-existing vegetation composition and structure is restored for the Footprint.

During the construction and operations of the pipeline, there will be a decrease in woody species richness and abundance due to clearing within the footprint, but due to edge effects there may be increases in woody species richness and abundance in areas adjacent to the Footprint. Forb and graminoid species richness and abundance will increase following construction as natural vegetation regenerates.

Alteration of native vegetation due to competition for light, soil nutrients and moisture may occur while the Footprint is revegetating. However, the establishment of early successional communities following construction will resemble revegetation following natural disturbance since the species composition will favor early successional/colonial species, which are adapted for greater competition pressure for light, nutrients and moisture (excepting the competition resulting from weedy non-native species).

The post-construction environmental monitoring program will identify any locations with altered drainage patterns (*e.g.,* ponded water) and remedial work will be conducted. Once pre-construction hydrology regimes are returned to a site, regeneration or revegetation of rare ecological communities will be more likely.

The effect of construction on adjacent rare ecological communities is deemed to have a negative impact balance. This residual effect is limited to the Vegetation LSA, reversible in the medium to long-term and of low magnitude since the proposed pipeline corridor parallels other pipeline rights-of-way and disturbance for 89% of its length (Table 7.2.9-4, point 1[e]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Vegetation LSA – although alteration of rare ecological communities is generally confined to the construction right-of-way, potential changes in hydrology, light levels and species composition may extend beyond the pipeline right-of-way.
- Duration: short-term – the events resulting in alteration of adjacent rare ecological communities are clearing during construction of the pipeline or maintenance activities (*e.g.,* integrity digs, vegetation management), the latter of which are limited to any 1 year during the operations phase.
- Frequency: periodic – the events resulting in alteration of adjacent rare ecological communities (*i.e.*, pipeline construction and maintenance activities) occur intermittently but repeatedly during the operations phase of the Project.
- Reversibility: medium to long-term – it may take more than 1 year plus adequate precipitation levels in order for the trench crown to settle and natural drainage patterns to be restored, and it will take several years for vegetation to grow back to former heights, which will prevent increased light from reaching surrounding plants in the ecological community.
- Magnitude: low – the proposed pipeline corridor is located adjacent to existing disturbances to the extent practical and the residual effects are detectable but are still considered to be within environmental standards given that best practices, objectives and provincial guidelines are being followed.
- Probability: high – the proposed pipeline corridor is adjacent to native vegetation with high potential to support rare ecological communities, including forested areas that will be affected by clearing vegetation during construction.
- Confidence: moderate – based on data pertinent to the Project area and the professional experience of the assessment team.

Combined Effects on Vegetation Communities of Concern

This subsection presents an evaluation of combined effects considering those residual environmental effects on vegetation communities of concern that are likely to occur. The potential residual environmental effects related to vegetation communities of concern evaluated in Section 7.2.9.6 (Table 7.2.9-4, points 1[a] to 1[e]), are of high probability, and consequently, were considered in the evaluation of combined effects on the vegetation communities of concern indicator.

The residual effects included:

- alteration of approximately 2,058 ha of native vegetation;
- alteration of up to approximately 6.4% of a variant or ecosite phase;
- some disturbance or alteration of grassland communities in the BG BGC Zone;
- some disturbance or alteration of a rare ecological community, if avoidance is not practical and mitigation measures do not completely protect a site; and

- if rare ecological communities are located adjacent to the construction right-of-way they may be indirectly affected by changes in hydrology or light levels.

The adverse effects identified contribute to combined effects on vegetation communities of concern encountered along the proposed pipeline corridor. The reversibility of the combined effects is considered medium to long-term depending on the species, the land use and the mitigation measures. However, the magnitude of the combined effects on the vegetation communities of concern indicator is considered to be low to medium since the combined effect is likely to be reduced by implementation of mitigation strategies for each of the residual effects (Table 7.2.9-4, point 1[f]). In addition, effects on vegetation communities of concern will be monitored as part of the post-construction environmental monitoring program (Volume 6A). A summary of the rationale for all of the significance criteria of combined effects on vegetation communities of concern is provided below.

- Spatial Boundary: Vegetation LSA – combined effects on the vegetation communities of concern indicator may extend beyond the pipeline right-of-way to the Vegetation LSA.
- Duration: short-term – the events contributing to the combined effects on the vegetation communities of concern indicator are clearing during construction of the pipeline or maintenance activities (*e.g.,* integrity digs, vegetation management), the latter of which are limited to any 1 year during the operations phase.
- Frequency: periodic – the events contributing to the combined effects on the vegetation community of concern indicator (*i.e.*, construction of the pipeline) are generally confined to the construction period but may occur intermittently but repeatedly during the operations phase of the Project.
- Reversibility: medium to long-term – depending upon the associated land use and the growth time required for component species in each affected area (*e.g.,* forb versus tree), changes to the composition of vegetation communities of concern are considered reversible in the medium to long-term.
- Magnitude: low to medium – combined effects on the vegetation community of concern indicator are anticipated to be largely mitigated during construction and post-construction environmental monitoring. The proposed pipeline corridor is located adjacent to existing disturbances for 89% of the length and the construction of the pipeline will result in the clearing of approximately 2,058 ha of native vegetation, which is considered to be within environmental standards given that best practices, objectives and provincial guidelines are being followed. Permanent loss of native vegetation is not anticipated to result from either the construction or operations of the proposed pipeline and most weed issues can be resolved during post-construction environmental monitoring (low). However, returning the Footprint to an equivalent land capability could take years, as discussed under loss of native vegetation and regeneration of a rare ecological community could take years (medium).
- Probability: high – the Footprint crosses native vegetation, rare ecological communities, grassland communities and is located adjacent to native vegetation with a high potential to support rare ecological communities.
- Confidence: moderate – based on available research literature, data pertinent to previous vegetation communities of concern encountered along the existing TMPL right-of-way and the professional experience of the assessment team.

<u>Vegetation Indicator – Plant and Lichen Species of Concern</u>

The following provides the evaluation of significance of potential residual effects on the plant and lichen species of concern indicator.

Some Disturbance or Alteration of a Rare Plant Occurrence, if Avoidance is Not Practical and Mitigation Measures Do Not Completely Protect a Site

During the 2013 rare plant surveys, which were a component of the vegetation surveys, 154 occurrences of ACIMS and BC CDC-listed rare plant species were observed, including 20 liverwort populations (8 unique species), 11 moss populations (7 unique species) and 123 vascular plant populations

(39 unique species) (see the Vegetation Technical Report of Volume 5C). Protection measures and environmental management techniques for rare plants are provided in Appendix C of the Pipeline EPP of Volume 6B. Mitigation measures for rare plant species generally fall into categories of avoidance, (*e.g.,* realignment, change of work side, narrowing), reducing disturbance (*e.g.,* narrowing, adjusting workspaces, ramping/matting over) and alternative construction/reclamation techniques (*e.g.,* salvaging seed or sod, plant propagation, transplanting, separate strippings salvage, delay clearing, access management) (see the Vegetation Technical Report of Volume 5C for more details). These proposed mitigation measures have been used previously on other major pipeline construction projects with good success. Some examples are provided below.

Golden saxifrage (*Chrysosplenium iowense*) (S2S3) was observed along the proposed corridor for a large pipeline project in Alberta and BC. During construction, in the winter of 1999/2000, the salvaged topsoil from the vicinity of this population was stored separately and replaced. During the second year of the post-construction environmental monitoring in 2001, plants were observed both on and off of the right-of-way (Alliance 2002).

Turned sedge (*Carex retrorsa*) (S2S3) was observed along a proposed pipeline right-of-way near Whitecourt (Alliance 2000b). The area was ramped over by cutting and laying down willows, covering them with geotextile and then ramping with subsoil. Upon completion of construction, the ramp was removed. During post-construction environmental monitoring in 2001, the turned sedge was found in very large numbers both on and off the right-of-way (Alliance 2002).

During a pipeline project, conic liverwort (*Conocephalum conicum,* S2) was observed on the pipeline right-of-way. The conic liverwort population location was staked off and the right-of-way was narrowed to the greatest extent feasible. The proposed mitigation for this population also included recontouring drainage bed and banks. The resulting post construction monitoring found that the conic liverwort population had experienced minimal impact (TERA 2012g).

Prior to construction of TMX Anchor Loop pipeline, Mingan grape fern (*Botrychium minganense*) (SU) plants were transplanted off the right-of-way and temporary workspace into immediately adjacent areas with similar habitat features. In 2010, the plant was observed at the transplant location and the transplant was considered to be successful (TERA 2011a).

Prior to construction of a proposed pipeline in northern BC in 2002, western Jacob's-ladder (*Polemonium occidentale* ssp. *occidentale*) (S2S3) plants were transplanted off the right-of-way and temporary workspace into immediately adjacent areas with similar habitat features. During the third year of post-construction environmental monitoring, the plants were persisting at most locations and the population was considered to be stable (TERA 2005).

During a pipeline project, yellow collar moss (*Splachnum luteum,* S2) was observed on the pipeline right-of-way. The yellow collar moss population was transplanted off right-of-way and no further monitoring was deemed warranted (TERA 2012g).

Rare plant surveys for the Project were conducted during the growing season in 2013 on lands where access was granted as a component of the vegetation surveys. Supplemental rare plant surveys are planned prior to construction on any new areas due to rerouting; see Section 9.0 for more details regarding supplemental surveys. In the event that additional rare plant species are identified in the Footprint during supplemental surveys, mitigation will be determined using the Rare Ecological Community and Rare Plant Population Management Plan (Section 7.0 of Appendix C of the Pipeline EPP [Volume 6B]). In the event that additional rare plant species are identified on or within 30 m of the construction right-of-way during construction, refer to the Rare Ecological Community and Rare Plant Population Discovery Contingency Plan (Section 7.0 of Appendix B of the Pipeline EPP [Volume 6B]).

Based on the assessment of the rare plants with potential to be encountered during construction, the mitigation measures described above are considered likely to be appropriate and applicable to the Project. However, if mitigation measures do not completely protect the site, a disturbance or alteration of a portion of the population or community may occur. Mitigation is developed with a number of factors taken into account that include, however, are not limited to:

- species;
- population size;
- rarity;
- growth form of the plant (*i.e.*, annual, biennial, perennial);
- construction timing;
- location of the population with respect to the proposed footprint;
- primary mode of species reproduction;
- mode and magnitude of propagule dispersal;
- habitat and proximity of available habitat; and
- past mitigation success (of the species or similar species).

By basing mitigation on these factors, any disturbance or alteration of a rare plant population, particularly those ranked S1, would be reduced to a level such that the population is not placed at risk (Table 7.2.9-4 point 2[a]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Footprint – the potential disturbance or alteration of a rare plant population is confined to the construction right-of-way.
- Duration: short-term – the events resulting in potential disturbance or alteration of a rare plant population are clearing during construction of the pipeline or maintenance activities (*e.g.,* integrity digs, vegetation maintenance), the latter of which are limited to any 1 year during the operations phase.
- Frequency: periodic – the events causing potential disturbance or alteration of a rare plant population (*i.e.*, construction of the pipeline and maintenance activities) occur intermittently but repeatedly at some locations during the operations phase of the Project.
- Reversibility: medium to long-term – depending on the species, the construction method (*e.g.,* narrowing the right-of-way or matting over, compared to transplanting) and the landscape. For example, golden saxifrage has been documented to revegetate previously disturbed rights-of-way within a few years following post-construction environmental monitoring (Alliance 2002) as long as the landscape is recontoured and the hydrology returns to pre-construction conditions (medium-term). Stalked moonwort and Michigan moonwort, were found along the proposed pipeline corridor in open, sandy areas with lodgepole pine. The area these plants inhibit will be prone to erosion and their associated species (lodgepole pine) will take more than 10 years to grow back (long-term).
- Magnitude: medium – the potential disturbance or alteration of a rare plant population is of medium magnitude since the effect is considered to be within environmental standards given that best practices, objectives and provincial guidelines are being followed.
- Probability: high – there are 146 rare plant populations identified within the proposed pipeline corridor that were identified during the rare plant surveys in 2013. It is likely that rare plant populations will be found within the Footprint.
- Confidence: high – based on past pipeline projects, the experience of the assessment team and the results of the rare plant surveys.

Some Disturbance or Alteration of a Rare Lichen Occurrence, if Avoidance is Not Practical and Mitigation Measures Do Not Completely Protect a Site

During the 2013 rare plant surveys, which were a component of the vegetation surveys, 14 ACIMS and BC CDC-listed rare lichen populations (11 unique species) were observed. Protection measures and environmental management techniques for rare lichens are provided in Appendix C of the Pipeline EPP (Volume 6B). Mitigation measures for rare lichen species generally fall into categories of avoidance, (*e.g.* realignment, change of work side, narrowing), reducing disturbance (*e.g.,* narrowing, protective matting, snow cover in winter) and alternative construction/reclamation techniques (*e.g.,* relocation of substrates, transplanting of thalli or peds, inoculation using vegetative fragments) (see the Vegetation Technical Report of Volume 5C for more details). These proposed mitigation measures have been used previously on other major pipeline construction projects with good success, but in general, fencing and avoiding is the mitigation that has the greatest likelihood of success, as compared to transplanting, and is the preferred conservation strategy.

Avoidance was highly successful in protecting rare species along the TMX Anchor Loop Project. Of the 82 sites monitored in 2010 where fence and avoid procedures were employed, 77 had retained the rare lichen species targeted for mitigation (TERA 2011a).

Based on the assessment of the rare lichens with potential to be encountered during pipeline construction, the mitigation measures described above are considered likely to be appropriate and applicable to the Project. However, if mitigation measures do not completely protect the site, a disturbance or alteration of a portion of the population may occur. Mitigation is developed with a number of factors taken into account that include, but are not limited to:

- species;
- population size;
- rarity;
- construction timing;
- location of the population with respect to the proposed footprint;
- preference substrate and proximity of available substrates; and
- past mitigation success (of the species or similar species).

By basing mitigation on these factors, any disturbance or alteration of a rare lichen population, particularly those ranked S1, would be reduced to a level such that the population is not placed at risk.

Supplemental ground-based rare plant surveys are planned prior to construction; see Section 9.0 for more details regarding supplemental surveys. In the event that additional rare lichen species are identified within the Footprint during supplemental surveys, mitigation will be determined using the Rare Ecological Community and Rare Plant Population Management Plan (Section 7.0 of Appendix C of the Pipeline EPP [Volume 6B]). In the event that additional rare plant species are identified on or within 30 m of the construction right-of-way during construction, refer to the Rare Ecological Community and Rare Plant Population Discovery Contingency Plan (Section 7.0 of Appendix B of the Pipeline EPP [Volume 6B]).

The effect of construction on rare lichen populations is deemed to have a negative impact balance. This residual effect is limited to the Vegetation Footprint, reversible in the short to medium-term and of medium magnitude since the proposed pipeline corridor parallels other pipeline projects and disturbance for 89% of its length (Table 7.2.9-4, point 2[b]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Footprint – the potential disturbance or alteration of a rare lichen population is confined to the construction right-of-way.

- Duration: short-term – the events resulting in potential disturbance or alteration of a rare lichen population are construction of the pipeline or maintenance activities (*e.g.,* integrity digs), the latter of which are limited to any 1 year during the operations phase.

- Frequency: periodic – the events resulting in potential disturbance or alteration of a rare lichen population (*i.e.*, construction of the pipeline and maintenance activities) occur intermittently but repeatedly during the operations phase of the Project.

- Reversibility: short to medium-term – depending on the species and the mitigation measures applied. Based on post-construction environmental monitoring results from TMX Anchor Loop, effects on rare lichens were generally resolved in 3 to 5 years (*i.e.,* it was obvious in 3 to 5 years of post-construction environmental monitoring whether the population would survive or not) (TERA 2011a).

- Magnitude: medium – the potential disturbance or alteration of a rare lichen population is of medium magnitude since the effect is still within environmental standards given that best practices, objectives and provincial guidelines are being followed.

- Probability: high – there are six rare lichen populations identified within the proposed pipeline corridor during the rare plant surveys in 2013 and it is likely that rare lichen populations will be found within the Project footprint.

- Confidence: high – based on past pipeline projects, the experience of the assessment team and the results of the rare plant surveys.

Indirect Effects to Rare Plant and Lichen Sub-Populations

With proper implementation of the industry-accepted standard mitigation practices that are proposed, disruption of surface flow patterns and light levels following construction or maintenance activities is expected to be minor along the proposed pipeline corridor. However, construction activities may contribute to some localized alteration of light levels and natural surface drainage patterns until trench settlement is complete and vegetation has matured. The impact balance of this potential residual effect is considered negative since it could alter the moisture regime and light levels. In addition, dust deposition and the chemicals used to suppress dust have the potential to impact rare plants and lichens.

Indirect alteration of rare plant and lichen populations adjacent to the Project may occur due to soil erosion. Since the areas with greatest erosion risk will be seeded with native species or an annual cover crop (or otherwise stabilized with mulch, straw, crimping), the indirect alteration of native vegetation as a result of erosion will not measurably contribute to the overall effect of the Project on the alteration of rare plant populations.

Increased distance of light penetration due to clearing will result in an indirect alteration of native vegetation (*i.e.*, the native species making up the habitat for rare plant populations). For example, western oak fern, goldthread and a rare lichen (*Usnea quasirigida*), identified during the 2013 rare plant surveys, are only found in forested communities characterized by low light penetration due to dense tree canopy and a specific amount of humidity. If part of the treed community is cleared, the light penetrating to the understory will change the species composition along the edges of the community where clearing occurred and the increased air flow will alter humidity within the area. However, this effect will not substantially contribute to the alteration of native vegetation beyond the effects detailed in relation to the clearing of native vegetation. Additionally, during the course of reclamation, as revegetation progresses, light penetration and air flow will generally decrease over time.

Given that indirect effects are, in part, caused by disturbance to vegetation structure associated with clearing activities, allowing disturbed areas to naturally revegetate may not alleviate indirect effects where vegetation management is conducted or long-term persistence of the disturbance exists. Consequently, indirect effects to rare plant and lichen populations are expected to persist until the pre-existing vegetation composition and structure is restored for the Footprint.

During construction and operations of the pipeline, vehicle traffic will increase dust deposition onto native vegetation adjacent to the Footprint which could include rare lichen populations. Use of dust suppressants has the potential to affect both plant and lichen species. During reclamation, dust due to Project traffic could also result in minor effects to rare lichens located adjacent to the right-of-way.

Alteration of native vegetation due to competition for light, soil nutrients and moisture may occur while the Footprint is revegetating. However, the establishment of early successional communities following construction will resemble revegetation following natural disturbance since the species composition will favor early successional/colonial species, which are adapted for greater competition pressure for light, nutrients and moisture (excepting the competition resulting from weedy non-native species).

Many rare species inhibit areas with specific hydrology and light regimes. If hydrology of an area is altered, rare plant or lichen species located adjacent to the construction right-of-way may be affected. For example, golden saxifrage requires moist but not submerged substrate to grow on. The post-construction environmental monitoring program will identify any locations with altered drainage patterns (*e.g.,* ponded water) and remedial work will be conducted. Consequently, the residual effect is reversible in the short to long-term. This residual effect is of low magnitude since the proposed pipeline corridor parallels other pipeline projects and disturbance for 89% of its length (Table 7.2.9-4, point 2[c]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Vegetation LSA – although alteration of rare plant and lichen populations is generally confined to the disturbed portion of the construction right-of-way, potential changes in hydrology, dust and light levels may extend beyond the pipeline right-of-way.
- Duration: short-term – the events resulting in alteration of rare plant and lichen populations are clearing during construction of the pipeline or maintenance activities (*e.g.,* integrity digs, vegetation management), the latter of which are limited to any 1 year during the operations phase.
- Frequency: periodic – the events resulting in alteration of rare plant and lichen populations via disruption of drainage patterns and altered light levels (*i.e.*, construction of the pipeline and maintenance activities) occur intermittently but repeatedly during the operations phase of the Project.
- Reversibility: short to long-term – it may take more than 1 year plus adequate precipitation levels in order for the trench crown to settle and natural drainage patterns to be restored and along extra temporary workspace it will take years for vegetation to grow back to former heights, which is what affects the light levels reaching surrounding plants. The full right-of-way will be maintained free of higher growing vegetation until abandonment (long-term). The potential for effects from dust and dust suppressants exist until construction activities are completed.
- Magnitude: low – the proposed pipeline corridor is located adjacent to existing disturbances to the extent practical. Residual effects are detectable, but are still considered to be within environmental standards given that best practices, objectives and provincial guidelines are being followed.
- Probability: high – the proposed pipeline corridor crosses forested vegetation communities that provide potential habitat for rare plant and lichen species and the forested vegetation will be affected by clearing activities during construction.
- Confidence: high – based on past pipeline projects, the experience of the assessment team and the results of the rare plant surveys.

Indirect Effects to Vegetation Species at Risk

Federally-listed vegetation species at risk (*i.e.*, designated by COSEWIC or on *Species at Risk Act* Schedule 1) identified as having potential to occur along the proposed pipeline segments are described in Section 4.3 of the Vegetation Technical Report (Volume 5C). For vegetation, species at risk are assessed together as an indicator group, due to the number of at risk species and their different, and often not well understood, habitat requirements.

The potential effects associated with the construction and operations of the proposed pipeline on vegetation species at risk were identified by the assessment team based on element occurrence records (within the Vegetation RSA) from ACIMS (2012) and the BC CDC (2013), as well as Candidate Critical Habitat mapping (Environment Canada 2013d).

TEK participants did not identify any concerns related to vegetation species at risk along any of the pipeline segments during the 2013 vegetation surveys, although they did relate that several areas along the entire proposed pipeline corridor were used for gathering medicinal plants, plants with utilitarian purposes and edible plants including berries.

The proposed pipeline corridor has been aligned to reduce disturbance to native vegetation by paralleling existing linear disturbances to the extent practical and by utilizing workspace on adjacent existing rights-of-way. Additional mitigation measures recommended in the Vegetation Technical Report (Volume 5C) to reduce the potential effects of pipeline construction and operations on vegetation species at risk have been incorporated into Table 7.2.9-4. These measures were developed in accordance with Trans Mountain standards and the provincial and federal regulatory guidelines listed in Table 7.2.9-4.

During the 2013 vegetation surveys, one species listed on Schedule 1 of the *Species at Risk Act* was potentially observed: Mexican mosquito fern (*Azolla mexicana*). This species is designated as Threatened by *Species at Risk Act* and COSEWIC, is globally ranked as G5. In BC it is ranked as S2 and is on the Red list. This potential occurrence requires confirmation; see Section 9.0 for details on supplemental surveys.

The *Species at Risk Act* states that no person shall destroy any part of the habitat of a species listed as Endangered or Threatened and that no species listed as Endangered or Threatened can be damaged or destroyed. Section 97 of *SARA* states that this is an indictable offense for which there are monetary penalties. For species designated as Endangered or Threatened on Schedule 1, a Recovery Strategy must be provided within 1 year of their designation. Critical habitat is defined in a species-specific Recovery Strategy and is based on the best available information. Mexican mosquito fern was last assessed by COSEWIC in 2008 and the recovery strategy is not yet finalized (Environment Canada 2013c).

Candidate critical habitat for whitebark pine occurs within 1 km of the proposed pipeline corridor in two locations; one along the Hargreaves to Darfield Segment; and the other along the Black Pines to Hope Segment (Environment Canada 2013d). There is proposed critical habitat for toothcup meadow-foam overlapping the proposed pipeline corridor in the Black Pines to Hope Segment (Environment Canada 2013d). Candidate critical habitat does not yet exist for Vancouver Island beggarticks, Haller's apple moss, tall bugbane, Mexican mosquito fern or peacock vinyl lichen (Environment Canada 2013c).

Protection measures and environmental management techniques for vegetation species at risk are provided in Appendix C of the Pipeline EPP of Volume 6B. Mitigation measures for vegetation species at risk should be those of avoidance (*e.g.* realignment, change of work side, narrowing). See the Vegetation Technical Report of Volume 5C for more details.

During pre-construction surveys of a large pipeline project, small-flowered sand verbena (*Trypterocalyx micranthus*) was located on the proposed right-of-way (Enbridge Pipelines Inc. 2011). Small-flowered sand verbena is listed as Endangered by COSEWIC and is protected under federal legislation by the *SARA* (Environment Canada 2013c). By extending the horizontal directional drill of the South Saskatchewan River, the population was avoided (TERA 2011c).

In southeastern Alberta the small-flowered sand verbena (*Tripterocalyx micranthus*), *SARA*-listed as Endangered, was identified and avoided during the routing of a small-diameter pipeline gathering system (Fryer pers. comm.). A targeted species survey was conducted of the appropriate habitat for the ephemeral annual within 300 m of the gathering system.

Rare plant surveys were completed during the growing season in 2013 for over 25% of the proposed pipeline corridor length. Supplemental rare plant surveys are planned prior to construction on new lands totaling less than 7% of the proposed pipeline corridor, as well as in areas where land access was not available in 2013 or where rare plant species were identified that need verification (see Section 9.0). The potential occurrence of Mexican mosquito fern will be confirmed during supplemental surveys. In the event that additional species at risk are identified in the Footprint during supplemental surveys, mitigation will be determined using the Rare Ecological Community and Rare Plant Population Management Plan (Section 7.0 of Appendix C of the Pipeline EPP).

Based on the assessment of the vegetation species at risk with potential to be encountered during construction, the mitigation measures described above are considered likely to be appropriate and applicable to the Project. Due to the restrictions around damaging or destroying *Species at Risk Act*-listed plant or lichen species, any populations should be avoided by construction and operations, so there should not be any disturbance or alteration of a portion of a population.

A summary of the rationale for all of the significance criteria is provided below (Table 7.2.9-4, point 2[d]).

- Spatial Boundary: Vegetation LSA – the potential disturbance or alteration of a vegetation species at risk would not occur on the construction right-of-way since mitigation will avoid any impacts, but could indirectly affect portions of a population adjacent to the right-of-way in the Vegetation LSA through changes to dust, light or moisture levels.

- Duration: short-term – the events resulting in potential disturbance or alteration of a vegetation species at risk is clearing during construction of the pipeline or maintenance activities (*e.g.,* integrity digs), the latter of which are limited to any 1 year during the operations phase.

- Frequency: periodic – the events resulting in potential disturbance or alteration of a vegetation species at risk will occur during construction and intermittently but repeatedly (*i.e.*, maintenance activities) during the operations phase of the Project.

- Reversibility: medium to long-term – depending on the species and the mitigation measures applied.

- Magnitude: medium – the potential disturbance or alteration of a vegetation species at risk would be of high magnitude since residual effects would exceed regulatory standards, but any vegetation species at risk populations will be avoided and indirect effects will be mitigated. Residual effects will not exceed regulatory standards.

- Probability: low – there was one vegetation species at risk potentially identified within the proposed pipeline corridor during the rare plant surveys in 2013. With mitigation from Table 7.2.9-3 and the Pipeline EPP of Volume 6B applied, it is unlikely that vegetation species at risk will interact with the Project Footprint.

- Confidence: high – based on past pipeline projects, the professional experience of the assessment team and the results of the rare plant surveys.

Combined Effects on Plant and Lichen Species of Concern

An evaluation of combined effects considers those residual environmental effects that are likely to occur. Most of the potential residual environmental effects related to plant and lichen of concern evaluated in Section 7.2.9.6 (points 2[a] through 2[c] of Table 7.2.9-4), are of high probability, and consequently, were considered in the evaluation of combined effects on the plant and lichen species of concern indicator. The potential residual environmental effect related to species at risk was determined to be of low probability and so was not included in the combined effects discussion.

The residual effects included:

- some disturbance or alteration of a rare plant occurrence, if avoidance is not practical and mitigation measures do not completely protect a site;

- some disturbance or alteration of a rare lichen occurrence, if avoidance is not practical and mitigation measures do not completely protect a site; and

- if rare plant or lichen sub-populations are located adjacent to the construction right-of-way they may be affected by changes in hydrology, dust or light levels.

The adverse effects identified have the potential to act in combination on plant and lichen species of concern encountered along the proposed pipeline corridor. The reversibility of this residual effect is considered medium to long-term depending on the species, the land use and the mitigation measures. However, the magnitude of the combined effects on the plant and lichen species of concern indicator is considered to be medium since the combined effect is likely to be reduced by implementation of mitigation strategies for each of the residual effects (Table 7.2.9-4, point 2[e]). In addition, effects on plant and lichen species of concern will be monitored as part of the post-construction environmental monitoring program (Volume 6A). A summary of the rationale for all of the significance criteria of combined effects on plant and lichen species of concern is provided below.

- Spatial Boundary: Vegetation LSA – combined effects on the plant and lichen species of concern indicator may extend beyond the pipeline right-of-way.
- Duration: short-term – the events causing the combined effects on the plant and lichen species of concern indicator are pipeline construction of the pipeline and maintenance activities (*e.g.,* integrity digs), the latter of which are limited to any 1 year during the operations phase.
- Frequency: periodic – the events causing the combined effects on the plant and lichen species of concern indicator (*i.e.*, pipeline construction and maintenance activities) is generally confined to the construction period but may occur intermittently but repeatedly during the operations phase.
- Reversibility: medium to long-term – depending on the species and the mitigation measures applied.
- Magnitude: medium - the potential disturbance or alteration of a rare plant and lichen population is of medium magnitude since the effect is still within environmental standards given that best practices, objectives and provincial guidelines are being followed.
- Probability: high – there are numerous rare plant and lichen species identified along the Project corridor and it is likely that they will interact with the Project Footprint.
- Confidence: high – based on available research literature, data from previous projects and the professional experience of the assessment team.

Vegetation Indicator – Presence of Infestations of Provincial Weed Species and Other Invasive Non-Native Species Identified as a Concern

The following provides the evaluation of significance of potential residual effects on the weed and invasive species indicator.

Weed Introduction and Spread

Non-native and invasive species tend to be pioneer species with characteristics that can exploit recently disturbed ecosystems. Non-native and invasive species that occur at high densities on the landscape can exert competitive pressure on native vegetation and result in alteration of native vegetation. Weeds and non-native, invasive species were identified as a concern in both ESA and Community Workshops (*i.e.,* Hope, Merritt, Hinton, Edson, Burnaby, Coquitlam, Abbotsford, Clearwater, Kamloops and Langley).

In general, invasive species are most prevalent where the ground has been disturbed by anthropogenic activity. During the 2013 vegetation surveys, any weed species encountered were noted and their density/distribution was recorded (see the Vegetation Technical Report of Volume 5C). The information collected during the vegetation surveys allows for an understanding of baseline weed conditions and the magnitude of weed infestations encountered in areas supporting native vegetation along the proposed corridor.

Mitigation measures outlined in Table 7.2.9-3 and in the Pipeline EPP of Volume 6B are effective industry standard measures to reduce the potential for the introduction and spread of weeds. These measures will be implemented during both construction and maintenance of the Project. All problem vegetation along the construction right-of-way will be monitored during all pipeline construction phases (*i.e.,* pre-construction and construction) and the operations phase (*i.e.*, post-construction environmental monitoring) (Section 12.0 of Appendix C of the Pipeline EPP of Volume 6B).

Experience during past pipeline construction programs has shown that, while weed infestations were encountered, the implementation of appropriate mitigation measures during construction resulted in limited weed issues (Alliance 2002, IPL 1995, Enbridge 2000, 2002, TERA 2012a).

Specific learnings from the TMX Anchor Loop Project (TERA 2013a) regarding weed introduction and spread include:

- chemical and mechanical weed treatments were effective at controlling or suppressing non-native invasive broadleaf species of concern along and off the right-of-way, at temporary facilities and permanent facilities; and
- hand (manual) removal of vegetation in riparian areas (areas where chemical treatment was not allowed due to proximity to water) was effective in controlling or suppressing non-native broadleaf weeds.

In addition, the final post-construction environmental monitoring report for the TMX Anchor Loop Project indicated that after 5 years, the post-construction vegetation management program had effectively controlled or suppressed non-native invasive broadleaf species of concern, identified during the pre-construction survey, along the right-of-way (TERA 2013a).

The potential introduction or spread of Noxious weeds and invasive, non-native species may vary in the period required to reverse the effect depending on the land use affected and the species. Consequently, the residual effect is considered to be reversible in the short to medium-term and of low to medium magnitude (Table 7.2.9-4, point 3[a]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Vegetation RSA – potential weed introduction and spread resulting from pipeline construction and maintenance activities may extend beyond the Footprint and Vegetation LSA to the Vegetation RSA.
- Duration: short-term – the events resulting in potential weed introduction and spread are construction of the pipeline or site-specific maintenance activities (*e.g.,* integrity digs), the latter of which are limited to any 1 year during the operations phase.
- Frequency: periodic – the events resulting in potential weed introduction and spread (*i.e.*, pipeline construction, operations and maintenance activities) occur during construction and intermittently, but, repeatedly over the assessment period.
- Reversibility: short to medium-term – depending on the weed species, the size/location of the weed occurrence and the associated land use.
- Magnitude: low to medium – the proposed pipeline corridor parallels existing disturbances for 89% of the length and the east and west ends of the proposed pipeline corridor are on highly developed agricultural and urban areas with higher densities of weeds than native land uses. Based on consultation, weeds are a concern in populated areas. Magnitude varies from low to medium depending on the weed or invasive plant species, affected land use and density/distribution of associated weed occurrences.
- Probability: high – pipeline construction is expected to cause some weed introduction and spread.
- Confidence: high – based on past pipeline projects, the professional experience of the assessment team and post-construction environmental monitoring results.

7.2.9.7 Summary

As identified in Table 7.2.9-4, there are no situations where there is a high probability of occurrence of a permanent or long-term residual environmental effect on vegetation indicators of high magnitude that cannot be technically or economically mitigated. Consequently, it is concluded that the residual environmental effects of pipeline construction and operations on vegetation will be not significant.

7.2.10 Wildlife and Wildlife Habitat

This subsection describes the potential interactions between the Project and wildlife and wildlife habitat. Project construction and operational activities have the potential to affect wildlife and wildlife habitat through changes in habitat, movement and mortality risk. The evaluation of potential Project effects on wildlife and wildlife habitat has been conducted considering all of the Project components in an integrated manner (*e.g.,* pipeline, temporary facilities, pump stations, power lines, and the Westridge Marine Terminal), because the components will have similar effect pathways (*i.e.,* changes in habitat, movement and mortality risk) on wildlife indicators, and disaggregation of effects by Project component is not meaningful at an individual or population level for wildlife indicators. The Wildlife Technical Report of Volume 5C and the Wildlife Habitat Modelling and Species Accounts Technical Report of Volume 5C provide further information on existing conditions related to wildlife and wildlife habitat.

7.2.10.1 Assessment Indicators and Measurement Endpoints

Narrowing the issues assessed and selecting indicators that reflect project issues, and public and regulator interests is an accepted approach used to focus impact assessments on issues that are non-trivial (Hegmann *et al.* 1999, Hegmann *et al.* 2002, Finely and Revel 2002, Antoniuk 2000, Antoniuk 2002). It is common practice in conservation biology to use focal or indicator species to illustrate a response to environmental changes that may apply to other species with similar ecological requirements (Niemi and McDonald 2004, Noss 1990). Beanlands and Duinker (1983) suggest that ecological scoping by way of studying indicators to allow useful predictions to be made for other valued ecosystem components is a useful tool in environmental impact assessments, which considers practical constraints posed by time limitations, natural variability, the state of ecological knowledge and the scientific tools available.

For the assessment of wildlife and wildlife habitat, indicators were selected based on their potential to interact with, and be adversely affected by, the Project. The potential adverse effects of the Project considered are related to changes in habitat, movement and mortality risk, and include both direct and indirect pathways arising from the construction and operations of the Project. Feedback on indicator selection was solicited from regulatory authorities and local biologists. Indicator selection was informed and verified by TEK collected during participation in field studies for the Project. A summary of consultation and engagement related to wildlife and wildlife habitat is provided in Section 3.0 of this volume. All comments and suggestions were considered, and many were incorporated in the selection of wildlife indicators. Of particular influence was the direction provided by Environment Canada to balance the indicators in a manner that would ensure the broader wildlife community (*e.g.*, common and more abundant species indicators) is evaluated, in addition to a selection of species at risk and individual species of concern (consultation information is provided in Table 2.1 of the Wildlife Technical Report in Volume 5C). As a result, a combination of wildlife indicators was selected to include:

- wildlife communities by habitat type (*e.g.,* pond-dwelling amphibians);
- species groups (*e.g.,* bats, forest furbearers);
- species at risk (*e.g.,* woodland caribou); and
- species of management concern or of social or cultural importance (*e.g.,* moose).

The indicators for wildlife and wildlife habitat are listed in Table 7.2.10-1. The selection of indicators for the wildlife and wildlife habitat assessment allows for a focused evaluation of potential Project effects. However, field studies and mitigation planning were designed to be inclusive of species, communities and habitats that are not specifically addressed as an indicator.

One or more 'measurement endpoints' are identified for each wildlife indicator to allow quantitative or qualitative measurement of potential Project effects (Table 7.2.10-1). The degree of change in these measurable parameters is used to inform the characterization of the magnitude of potential Project-related effects on the wildlife indicators. A selection of the measurement endpoints may comprise the variables for study in monitoring and follow-up programs. In addition, the selection of indicators and measurement endpoints took into consideration the requirements of the NEB *Filing Manual* for the wildlife and wildlife habitat element in Table A-2.

TABLE 7.2.10-1

WILDLIFE INDICATORS AND MEASUREMENT ENDPOINTS

Wildlife Indicators	Measurement Endpoints	Rationale for Indicator Selection
Grizzly bear	• Baseline information: incidental field observations (tracks, scat, signs, visual), literature/published research • Change in area (ha) of suitable spring and fall foraging habitat within LSA (habitat models) • Change in movement (qualitative) • Change in mortality risk quantified by change in motorized access density within RSA	Potential for Project interaction; conservation status; management and cultural importance; environmental indicator (sensitive to disturbance).
Woodland caribou	• Baseline information: literature/published research • Change in area (ha) of direct and functional habitat disturbance within Caribou RSA • Change in movement (qualitative) • Change in mortality risk (qualitative)	Potential for Project interaction; conservation status; management and cultural importance; environmental indicator (sensitive to disturbance).
Moose	• Baseline information: winter track density and abundance by route segment and Natural Region or Ecoprovince (relative abundance); incidental field observations; literature/published research • Change in area (ha) of suitable winter forage and winter security/thermal habitat within LSA (habitat models) • Change in movement (qualitative) • Change in mortality risk (qualitative)	Potential for Project interaction; management and cultural importance.
Forest furbearers	• Baseline information: winter track density and abundance route segment and Natural Region or Ecoprovince for fisher/marten and wolverine (relative abundance); incidental field observations; literature/published research • Change in area (ha) of suitable marten living habitat (habitat model) • Change in availability of suitable fisher reproductive habitat (habitat model) • Change in wolverine habitat (qualitative) • Change in movement (qualitative) • Change in mortality risk (qualitative)	Potential for Project interaction; several furbearer species (*e.g.,* marten, fisher and wolverine) are of conservation, management and cultural importance; environmental indicator (sensitive to environmental change).
Coastal riparian small mammals	• Baseline information: literature/published research • Change in area (ha) of suitable mountain beaver living habitat (habitat model) • Change in area (ha) of habitat capability rated moderate to high for Pacific water shrew (habitat model) • Change in movement (qualitative) • Change in mortality risk (qualitative)	Potential for Project interaction; group includes species with conservation status of concern; environmental indicator (sensitive to change); indicative of potential effects on species relying on coastal riparian habitat.
Bats	• Baseline information: incidental field observations of habitat features; literature/published research • Change in area (ha) of tree-roosting habitat (habitat model) • Change in movement (qualitative) • Change in mortality risk (qualitative)	Potential for Project interaction; group includes several species with conservation status of concern; environmental indicator (sensitive to change).
Grassland/shrub-steppe birds	• Baseline information: breeding bird density, diversity and richness by route segment and Natural Region or Ecoprovince; incidental field observations; literature/published research • Change in area (ha) of grassland and shrub-steppe bird community habitat (habitat model) • Change in movement (qualitative) • Change in mortality risk (qualitative)	Potential for Project interaction; addresses the broader suite of bird species potentially affected in grassland/shrub-steppe habitats; represents an important habitat type affected by the Project (*i.e.*, native grasslands in the southern interior region of BC); various species (at risk and common) are addressed.
Mature/old forest birds	• Baseline information: breeding bird density, diversity and richness by route segment and Natural Region or Ecoprovince; incidental field observations; literature/published research • Change in area (ha) of mature/old forest bird community habitat (habitat model) • Change in movement (qualitative) • Change in mortality risk (qualitative)	Potential for Project interaction; addresses the broader suite of bird species potentially affected in mature/old forest habitats; represents an important habitat type affected by the Project; various species (at risk and common) are addressed.

TABLE 7.2.10-1 Cont'd

Wildlife Indicators	Measurement Endpoints	Rationale for Indicator Selection
Early seral forest birds	• Baseline information: breeding bird density, diversity and richness by route segment and Natural Region or Ecoprovince; incidental field observations; literature/published research • Change in area (ha) of early seral forest bird community habitat (habitat model) • Change in movement (qualitative) • Change in mortality risk (qualitative)	Potential for Project interaction; addresses the broader suite of bird species potentially affected in early seral forest habitats; represents an important habitat type affected by the Project; various species (at risk and common) are addressed.
Riparian and wetland birds	• Baseline information: breeding bird density, diversity and richness by route segment and Natural Region or Ecoprovince for riparian habitats; wetland productivity (indicated breeding pairs, density, diversity and richness) for wetlands surveyed; trumpeter swan brood count (in Alberta); incidental field observations; literature/published research; wetland function • Change in area (ha) of riparian and wetland bird community nesting habitat • Change in area (ha) of cavity nesting wetland bird community nesting habitat • Change in movement (qualitative) • Change in mortality risk (qualitative)	Potential for Project interaction; addresses the broader suite of riparian and wetland bird species potentially affected; represents important habitat types affected by the Project; various species (at risk and common) are addressed.
Wood warblers	• Baseline information: breeding bird density by route segment and Natural Region or Ecoprovince (relative abundance); incidental field observations; literature/published research • Change in area (ha) of suitable nesting habitat for black-throated green warbler (habitat model) • Change in area (ha) of suitable nesting habitat for Cape May warbler (habitat model) • Change in movement (qualitative) • Change in mortality risk (qualitative)	Potential for Project interaction; addresses the community of bird species (in particular warblers) potentially affected in mature spruce-dominant and mixedwood forests along the corridor in Alberta; conservation/management concern in Alberta; environmental indicators (sensitive to disturbance).
Short-eared owl	• Baseline information: presence/not detected by habitat type surveyed; incidental field observations; literature/published research • Change in area (ha) of suitable nesting habitat (habitat model) • Change in movement (qualitative) • Change in mortality risk (qualitative)	Potential for Project interaction; conservation status; indicative of potential effects on species relying on open habitats in grassland and forested regions over the length of the proposed corridor.
Rusty blackbird	• Baseline information: density by broad habitat type (relative abundance) if sufficient detections; incidental field observations; literature/published research • Change in area (ha) of suitable nesting habitat (habitat model) • Change in movement (qualitative) • Change in mortality risk (qualitative)	Potential for Project interaction (primarily in Alberta); conservation status; environmental indicator (sensitive to disturbance); indicative of potential effects on species relying on treed wetland and riparian habitats.
Flammulated owl	• Baseline information: incidental field observations; literature/published research • Change in area (ha) of suitable nesting habitat (habitat model) • Change in movement (qualitative) • Change in mortality risk (qualitative)	Potential for Project interaction; conservation status; environmental indicator (sensitive to disturbance); indicative of potential effects on species relying on Douglas-fir and ponderosa pine forest habitats in the southern interior region of BC.
Lewis's woodpecker	• Baseline information: literature/published research • Change in area (ha) of suitable nesting habitat (habitat model) • Change in movement (qualitative) • Change in mortality risk (qualitative)	Potential for Project interaction; conservation status; environmental indicator (sensitive to disturbance); indicative of potential effects on species relying on ponderosa pine and deciduous forest habitats in the southern interior region of BC.
Williamson's sapsucker	• Baseline information: literature/published research • Change in area (ha) of suitable nesting habitat (habitat model) • Change in movement (qualitative) • Change in mortality risk (qualitative)	Potential for Project interaction; conservation status; environmental indicator (sensitive to disturbance); indicative of potential effects on species relying on mixed deciduous Douglas-fir and ponderosa pine forest habitats in the southern interior region of BC.

TABLE 7.2.10-1 Cont'd

Wildlife Indicators	Measurement Endpoints	Rationale for Indicator Selection
Western screech-owl	• Baseline information: incidental field observations; literature/published research • Change in area (ha) of suitable nesting habitat for *kennicotti* and *macfarlanei* ssp. (habitat models) • Change in movement (qualitative) • Change in mortality risk (qualitative)	Potential for Project interaction; conservation status; environmental indicator (sensitive to disturbance); indicative of potential effects on species relying on old/mature deciduous and mixedwood forest habitats in the interior and coastal regions of BC.
Great blue heron	• Baseline information: number counted from wetland and aerial surveys; incidental field observations; literature/published research • Change in habitat (qualitative) • Change in movement (qualitative) • Change in mortality risk (qualitative)	Potential for Project interaction; conservation status; environmental indicator (sensitive to disturbance).
Spotted owl	• Baseline information: presence/not detected and number counted from spotted owl surveys; literature/published research • Change in area (ha) of suitable nesting habitat (habitat model) • Change in movement (qualitative) • Change in mortality risk (qualitative)	Potential for Project interaction (proposed corridor intersects Wildlife Habitat Area); conservation status; high regulator/public profile and concern; environmental indicator (sensitive to disturbance).
Bald eagle	• Baseline information: incidental field observations (visual, stick nests); literature/published research • Change in habitat (qualitative) • Change in movement (qualitative) • Change in mortality risk (qualitative)	Potential for Project interaction; cultural importance.
Common nighthawk	• Baseline information: presence/not detected by locations sampled; literature/published research • Change in area (ha) of suitable nesting habitat (habitat model) • Change in movement (qualitative) • Change in mortality risk (qualitative)	Potential for Project interaction; conservation status; species of interest for regulatory authorities.
Northern goshawk	• Baseline information: incidental field observations; literature/published research • Change in area (ha) of suitable nesting habitat for *laingi* ssp. (habitat model) • Change in movement (qualitative) • Change in mortality risk (qualitative)	Potential for Project interaction; conservation concern; environmental indicator (sensitive to disturbance); indicative of potential effects on species relying on mature/old forest.
Olive-sided flycatcher	• Baseline information: density by broad habitat type (relative abundance) if sufficient detections; incidental field observations; literature/published research • Change in area (ha) of suitable nesting habitat (habitat model) • Change in movement (qualitative) • Change in mortality risk (qualitative)	Potential for Project interaction; conservation status; indicative of potential effects on species relying on open forests with complex overstory characteristics, and species that use forest edges, openings and disturbed habitats.
Pond-dwelling amphibians	• Baseline information: presence/not detected and number counted in targeted wetland surveys; incidental field observations; literature/published research • Change in area (ha) of pond-dwelling amphibian breeding habitat (habitat model) • Change in area (ha) of suitable living habitat for western toad (habitat model) • Change in area (ha) of suitable living habitat for Great Basin spadefoot (habitat model) • Change in movement (qualitative) • Change in mortality risk (qualitative)	Potential for Project interaction; addresses the broader suite of pond-dwelling amphibian species potentially affected by the Project; represents an important habitat type affected by project; various species (at risk and common) are addressed; environmental indicator (sensitive to disturbance).
Stream-dwelling amphibians	• Baseline information: presence/not detected and number counted in targeted stream surveys; incidental field observations; literature/published research • Change in area (ha) of suitable living habitat for coastal tailed frog (habitat model) • Change in movement (qualitative) • Change in mortality risk (qualitative)	Potential for Project interaction; addresses the broader suite of stream-dwelling amphibian species potentially affected by the Project; represents an important habitat type affected by Project; various species (at risk and common) are addressed; environmental indicator (sensitive to disturbance).

TABLE 7.2.10-1 Cont'd

Wildlife Indicators	Measurement Endpoints	Rationale for Indicator Selection
Arid habitat snakes	• Baseline information: presence/not detected and number counted in targeted surveys for western rattlesnake hibernacula; incidental observations; literature/published research • Change in area (ha) of suitable rattlesnake living habitat (habitat model) • Change in movement (qualitative) • Change in mortality risk (qualitative)	Potential for Project interaction; addresses the broader suite of snake species potentially affected by the Project; conservation status; environmental indicator (sensitive to disturbance).

7.2.10.2 Spatial Boundaries

The spatial boundaries considered for the assessment of wildlife and wildlife habitat include:

- a Footprint Study area;
- a Wildlife LSA, defined generally as the area within a 1 km buffer of the centre of the proposed pipeline corridor and power lines, and within a 1 km buffer around the boundary of the proposed pump station and terminal facilities;
- a Wildlife RSA, defined generally as the area within a 15 km buffer of the centre of the proposed pipeline corridor and power lines, and within a 15 km buffer around the boundary of the proposed pump station and terminal facilities;
- a Grizzly Bear RSA, defined by the Grizzly Bear Population Units (GBPUs) traversed by the proposed pipeline corridor; and
- a Caribou RSA, defined by the Wells Gray and Groundhog caribou ranges and associated mountain caribou Ungulate Winter Range (UWR) and Wildlife Habitat Area (WHA).

The Project Footprint as defined in Section 7.1.3 is used in the characterization and determination of significance for potential Project effects on wildlife and wildlife habitat indicators. Because the Project is in early planning stages, assumptions were made to spatially delineate the Footprint used in the quantitative analysis of Project effects. The spatial Footprint was defined as a 45 m wide pipeline corridor (which would encompass the permanent right-of-way and likely temporary workspace), 50 m wide power line corridors, and the footprint of the proposed permanent facilities (based on available spatial information).

The Wildlife LSA encompasses the Project Footprint and extends beyond it to include the surrounding area where there is a reasonable potential for Project-specific effects to occur. The Wildlife LSA considers the wildlife species expected to interact with the Project, the effects pathways, and available information on wildlife sensitivity to disturbance (*e.g.*, zones of influence, setback distances). The Wildlife RSA encompasses the Project Footprint, Wildlife LSA and the broader surrounding area where there is potential for interaction with existing activities and reasonably foreseeable developments to have cumulative effects. Species-specific RSAs were delineated for grizzly bear and caribou to capture the biologically relevant spatial scale at which management for those species occurs. Spatial boundaries, including the Wildlife LSA, Wildlife RSA, Grizzly Bear RSA and Caribou RSA, are shown in Section 5.0 of this volume.

The spatial extents of the study areas represent a compromise between choosing a large area that would mask or dilute the effects of the Project, versus choosing a smaller area where the effects on the wildlife indicator under consideration may no longer be meaningful. There were no concerns with the spatial boundaries identified in consultation with provincial and federal regulatory authorities, local biologists, participants of ESA Workshops, and Aboriginal community representatives who participated in field studies for the Project.

Given the length of the proposed pipeline corridor and the variability in ecological systems encountered, many of the wildlife indicators occur only along discreet segments of the study areas. These segments and relevant project components are identified in Table 7.2.10-2. The Natural Subregions (Alberta) and Ecosections (BC) are illustrated in the Wildlife Technical Report of Volume 5C.

TABLE 7.2.10-2

PROJECT COMPONENTS AND ECOSYSTEM UNITS RELATIVE TO INDICATOR SPECIES DISTRIBUTION IN THE WILDLIFE LSA

Wildlife Indicator	Project Components	Ecosystem Units[1]
Grizzly bear	Edmonton to Hinton Hargreaves to Darfield Black Pines to Hope Temporary facilities	Alberta: LF; M BC: NPK; UFT; CAM; NSH; CAP; NIB; HOR; EPR
Woodland caribou	Hargreaves to Darfield Temporary facilities	BC: CAM; NSH
Moose	Edmonton to Hinton Hargreaves to Darfield Black Pines to Hope Temporary facilities Black Pines Pump Station and power line Kingsvale Pump Station and power line	Alberta: All Natural Subregions BC: NPK; UFT; CAM; NSH; CAP; North Thompson Upland; THB; GUU; NIB; HOR
Forest Furbearers	Edmonton to Hinton Hargreaves to Darfield Black Pines to Hope Hope to Burnaby Temporary facilities Black Pines Pump Station and power line Kingsvale Pump Station and power line	Alberta: DM; CM; LF; UF; M BC: All Ecosections
Coastal riparian small mammals	Black Pines to Hope Hope to Burnaby Burnaby to Westridge Temporary facilities Sumas Terminal Westridge Marine Terminal	BC: HOR; EPR; NWC; FRL
Bats	All components	All Natural Subregions and Ecosections
Grassland/shrub-steppe birds	Hargreaves to Darfield Black Pines to Hope Temporary facilities Black Pines Pump Station and power line	BC: North Thompson Upland; THB; GUU; NIB; HOR
Mature/old forest birds	All components	All Natural Subregions and Ecosections
Early seral forest birds	All components	All Natural Subregions and Ecosections
Riparian and wetland birds	All components	All Natural Subregions and Ecosections
Wood warblers	Edmonton to Hinton Temporary facilities	Alberta: DM; CM; LF; UF
Short-eared owl	Edmonton to Hinton Hargreaves to Darfield Black Pines to Hope Hope to Burnaby Burnaby to Westridge Temporary facilities Black Pines Pump Station and power line	Alberta: All Natural Subregions BC: THB; GUU; NIB; FRL
Rusty blackbird	Edmonton to Hinton Hargreaves to Darfield Black Pines to Hope Hope to Burnaby Temporary facilities Black Pines Pump Station and power line Kingsvale Pump Station and power line	Alberta: All Natural Subregions BC: NPK; UFT; CAM; NSH; CAP; North Thompson Upland; THB; GUU; NIB; HOR
Flammulated Owl	Black Pines to Hope Temporary facilities Black Pines Pump Station and power line Kingsvale Pump Station and power line	BC: North Thompson Upland; THB; GUU; NIB

TABLE 7.2.10-2 Cont'd

Wildlife Indicator	Project Components	Ecosystem Units[1]
Lewis's woodpecker	Black Pines to Hope Temporary facilities Black Pines Pump Station and power line Kingsvale Pump Station and power line	BC: North Thompson Upland; THB; GUU; NIB
Williamson's sapsucker	Black Pines to Hope Temporary facilities Black Pines Pump Station and power line Kingsvale Pump Station and power line	BC: THB; GUU; NIB; HOR
Western screech-owl *kennicotti* ssp.	Hope to Burnaby Burnaby to Westridge Temporary facilities Sumas Terminal Westridge Marine Terminal	BC: NWC; FRL
Western screech-owl *macfarlanei* ssp.	Black Pines to Hope Temporary facilities Black Pines Pump Station and power line Kingsvale Pump Station and power line	BC: North Thompson Upland; THB; GUU; NIB
Great blue heron	All components	All Natural Subregions and Ecosections
Spotted owl	Black Pines to Hope Temporary facilities	BC: HOR; EPR; NWC
Bald eagle	All components	All Natural Subregions and Ecosections
Common nighthawk	All components	All Natural Subregions and Ecosections
Northern goshawk *laingi* ssp.	Hope to Burnaby Burnaby to Westridge Temporary facilities Sumas Terminal Westridge Marine Terminal	BC: HOR; EPR; NWC; FRL
Olive-sided flycatcher	All components	All Natural Subregions and Ecosections
Pond-dwelling amphibians	All components	All Natural Subregions and Ecosections
Stream-dwelling amphibians	Black Pines to Hope Hope to Burnaby Temporary facilities Sumas Terminal	BC: HOR; EPR; NWC; FRL
Arid habitat snakes	Black Pines to Hope Temporary facilities	BC: THB

Note: 1 Ecosystem Units are defined by Natural Subregions in Alberta and Ecosections in BC. The Natural Subregions in Alberta include the Central Parkland (CP), Dry Mixedwood (DM), Central Mixedwood (CM), Lower Foothills (LF), Upper Foothills (UF) and Montane (M). The Ecosections in BC include Northern Park Ranges (NPK), Upper Fraser Trench (UFT), Cariboo Mountains (CAM), Northern Shuswap Highlands (NSH), Cariboo Plateau (CAP), North Thompson Upland, Thompson Basin (THB), Guichon Upland (GUU), Nicola Basin (NIB), Hozameen Range (HOR), Eastern Pacific Ranges (EPR), Northwestern Cascade Range (NWC) and Fraser Lowland (FRL).

7.2.10.3 Wildlife Assessment Approach Considerations

Comments received in consultation regarding the assessment approach, including spatial boundaries, indicator selection, field studies and proposed measurement endpoints, were considered in the development of the wildlife and wildlife habitat effects assessment. A summary of consultation related to wildlife and wildlife habitat is provided in Section 3.0. All comments and suggestions were considered, and many were incorporated in the development of the assessment approach for wildlife and wildlife habitat. In some cases, recommendations were considered, but scoped out of the assessment for various reasons. For example, several wildlife species were suggested for inclusion as indicators in the effects assessment but ultimately were not included. Scoping was necessary to narrow the suite of indicators assessed in order to focus the assessment and provide information in a concise manner. Species that were scoped out of the assessment may have had limited interaction with the terrestrial components of the Project or mitigation is expected to eliminate or reduce potential Project effects to negligible levels (*e.g.*, river otter, American badger), or the expected effects are similar to those addressed by another indicator.

In addition, recommendations regarding field survey protocols were generally adopted; however, modifications were required for some field surveys to ensure the surveys were appropriate for the scope of the Project, and in consideration of logistical limitations. Where warranted, pre-construction surveys may be completed to collect information needed to inform mitigation planning.

7.2.10.4 Ecological and Regulatory Context

The following subsections summarize the general ecological and regulatory context relevant to wildlife and wildlife habitat for each of the Project segments. Additional context is provided for the indicators used to assess wildlife and wildlife habitat in Sections 7.2.10.9 (mammals), 7.2.10.10 (birds), 7.2.10.11 (amphibians) and 7.2.10.12 (reptiles).

<u>Edmonton to Hinton Segment</u>

Wildlife indicators relevant to the Edmonton to Hinton Segment include grizzly bear, moose, forest furbearers, bats, mature/old forest birds, early seral forest birds, riparian and wetlands birds, wood warblers, short-eared owl, rusty blackbird, great blue heron, bald eagle, common nighthawk, olive-sided flycatcher and pond-dwelling amphibians (Table 7.2.10-2).

The Edmonton to Hinton Segment traverses a mosaic of land uses and habitat types, including suburban and rural areas, agricultural fields (*i.e.*, cultivation and hay fields), pasture and forest. Within areas dominated by agricultural land use, wildlife activity is typically concentrated in patches of residual forest, wetlands and grasslands (including tame pasture). Forested areas include deciduous, coniferous and mixedwood forests comprised of trembling aspen, white spruce, black spruce, jack pine, balsam fir and, less commonly, balsalm poplar and paper birch. Upland mixedwood forests have been subject to forest harvesting activities and are at various stages of regeneration. Two sections of the Edmonton to Hinton Segment cross wildfire burns that occurred within the last 40 years: RK 188.7 to RK 189.4 (burned in 2009); and RK 135.9 to RK 136.3 (burned in 2012) (AESRD 2013c). Terrain is generally level to gently undulating along the Edmonton to Hinton Segment, with moderate to steep slopes encountered at watercourse crossings (*i.e.*, the North Saskatchewan, Pembina, McLeod and Athabasca rivers) and gently to moderately undulating terrain within the Lower Foothills and Montane Natural Subregions. Most of the wetlands encountered along the proposed pipeline corridor within the Edmonton to Hinton Segment are surrounded by cultivation or tame pasture, with larger expanses of treed bogs and fens encountered towards the western portion of the segment. Detailed information on wetlands and wetland function is available in the Wetland Evaluation Technical Report of Volume 5C. The Edmonton to Hinton Segment parallels existing linear disturbances for approximately 233 km (68.7%) of its length. Habitat alteration as a result of urbanization, agriculture and resource extraction (*e.g.*, forestry, oil and gas activity) has altered the suitability and use of wildlife habitat within the Wildlife RSA. Clearing of vegetation, the creation of linear corridors, facilities and/or infrastructure, and sensory disturbance associated with development and resource use have affected the historical distribution and movement of wildlife.

The Edmonton to Hinton Segment intersects Key Wildlife and Biodiversity Zones associated with the North Saskatchewan and Athabasca rivers, Special Access Zones, Grizzly Bear Core and Secondary Areas, Sensitive Raptor Range for bald eagle, Sharp-tailed Grouse Range, and is located within 800 m of several trumpeter swan waterbodies (Table 4.1.3 in Wildlife Technical Report of Volume 5C). The proposed pipeline corridor is north of Wabamun Lake Provincial Park, and is separated from the park by Highway 16. Wabamun Lake provides year-round habitat for a variety of migrating, breeding and molting water birds (ATPR 2012a,b). at its nearest point (approximately RK 96.0), the Edmonton to Hinton Segment is approximately 200 m north of Wabuman Lake (Wildlife Technical Report of Volume 5C, Table 4.1.5). Protective Notations (PNTs) for fragmented land pattern, ungulate winter range, fish and wildlife resource management area, research site structure, habitat management area for a Foothills Model Forest study, and a habitat protection area for long-toed salamander are located within the proposed pipeline corridor (Wildlife Technical Report of Volume 5C).

Provincial management objectives and guidelines related to wildlife in the Wildlife LSA are set out by the Government of Alberta in the *Integrated Standards and Guidelines* for the Enhanced Approval Process (Government of Alberta 2013a). This document includes recommendations for setback distances and timing restrictions for sensitive species, and guidelines for working in sensitive areas. Where applicable, the recommendations in the *Integrated Standards and Guidelines* are incorporated in mitigation planning for the Project. In addition to the provincial objectives, the Edmonton to Hinton Segment crosses the following planning areas:

- Capital Region Land Use Plan (Capital Region Board 2009);
- Coal Branch Sub-Regional Integrated Resource Plan (Government of Alberta 1990);
- Edmonton Environmental Strategic Plan (City of Edmonton 2011);
- Edmonton Municipal Development Plan (City of Edmonton 2010);
- Edson Municipal Development Plan (Town of Edson 2006);
- Edson Urban Fringe Intermunicipal Development Plan (Yellowhead County 2007);
- Entwistle Area Structure Plan (Parkland County 2012);
- Hinton Municipal Development Plan (Town of Hinton 1998);
- Hinton Community Sustainability Plan (Citizens Advisory Group 2011);
- Lake Wabamun Management Plan (Yellowhead Regional Planning Commission 1985);
- Northern East Slopes Sustainability Resource and Environmental Management Strategy (Government of Alberta 2003);
- Parkland County Municipal Development Plan and Integrated Community Sustainability Plan (Parkland County 2007, 2011);
- Spruce Grove Municipal Development Plan (City of Spruce Grove 2010);
- Stony Plain Community Sustainability Plan (Town of Stony Plain 2007);
- Stony Plain Municipal Development Plan (Town of Stony Plain 2005);
- Strathcona County Municipal Development Plan (Strathcona County 2007);
- Wabamun Municipal Development Plan (Village of Wabamun 2010); and
- Yellowhead County Municipal Development Plan (Yellowhead County 2006).

These plans have identified objectives, goals and/or strategies related to wildlife, habitat, biodiversity and ecosystem integrity, which are summarized in Appendix E of the Wildlife Technical Report of Volume 5C. In general, these plans in relation to wildlife and wildlife habitat stress the importance of protecting rare and sensitive flora, fauna and habitat, reducing the impacts of development on the natural environment, enhancing biodiversity and restoring disturbed and ecologically degraded and/or damaged areas. There is a particular focus on ungulates (*e.g.*, elk, moose, deer, mountain goat, and bighorn sheep), furbearers, upland games birds, species of concern (*e.g.*, peregrine falcon, trumpeter swan and long-toed salamander) and non-game species of wildlife in the some of the resource plans.

Hargreaves to Darfield Segment

Wildlife indicators relevant to the Hargreaves to Darfield Segment include grizzly bear, woodland caribou, moose, forest furbearers, bats, grassland/shrub-steppe birds, mature/old forest birds, early seral forest birds, riparian and wetland birds, short-eared owl, rusty blackbird, great blue heron, bald eagle, common nighthawk, olive-sided flycatcher and pond-dwelling amphibians (Table 7.2.10-2).

The Hargreaves to Darfield Segment crosses a mosaic of land uses and habitat types, including suburban areas associated with cities and towns, agricultural fields, pasture and forested areas. Forested areas are generally comprised of Douglas-fir, Engelmann spruce, white spruce, lodgepole pine, and trembling aspen, with ponderosa pine encountered on warm, dry slopes towards the southern end of the Hargreaves to Darfield Segment. A number of cutblocks in various stages of regeneration are encountered along the proposed pipeline segment. There is also evidence of selective harvesting in many areas. Two sections of the Hargreaves to Darfield Segment cross wildfire burns that occurred within the last 40 years: RK 639.6 to RK 647.3 (burned in 1998); and RK 706.4 to RK 706.5 (burned in 2007) (BC MFLNRO 2013b). Much of the forested land along this segment is range tenure used for cattle grazing. Agricultural lands (*i.e.*, cultivated fields, hay and tame pasture), rural and suburban residential areas are traversed in the valley bottoms and in the vicinity of communities, including Avola, Clearwater and Little Fort. Terrain encountered along the proposed corridor varies from flat to gently undulating on wide valley bottoms, to moderately undulating hills and steeper slopes along some watercourses and narrow valleys. Wetlands within the corridor are generally associated with streams and oxbow lakes, with a number of marshes, fens and swamps. Detailed information on wetlands and wetland function is available in the Wetland Evaluation Technical Report of Volume 5C. The Hargreaves to Darfield Segment parallels existing linear disturbances (*i.e.*, the existing Trans Mountain pipeline right-of-way and Highway 5) for approximately 205.3 km (73.5%) of its length. Habitat alteration as a result of urbanization, agriculture, transportation and resource extraction (*e.g.*, forestry) has altered the suitability and use of wildlife habitat within the Wildlife RSA. Clearing of vegetation, the creation of linear corridors, facilities and/or infrastructure, and sensory disturbance associated with development and resource use have affected the historical distribution and movement of wildlife.

The Hargreaves to Darfield Segment intersects the Wells Gray and Groundhog caribou ranges and ungulate winter range (UWR) for mountain caribou (within the Wells Gray caribou range) (Wildlife Technical Report of Volume 5C). The BC *Oil and Gas Activities Act* (*BC OGAA*) states that operating areas should not be located in a designated UWR unless the operating area will not have a material adverse effect on the ability of the wildlife habitat within the UWR to provide for the survival, within the UWR, of the wildlife species for which the UWR was established. Within the intersected UWR, the proposed corridor parallels the existing TMPL right-of-way, Highway 5, and an existing railway. It is likely that caribou currently avoid habitat along the proposed pipeline corridor, given that woodland caribou have demonstrated avoidance of such disturbance features (Dyer *et. al.* 2001).

The proposed pipeline corridor is located within the Finn Creek and North Thompson River provincial parks, and is adjacent to Jackman Flats and Blue River Black Spruce provincial parks (Wildlife Technical Report of Volume 5C). Refer to Section 7.2.4.6 of Volume 5B for additional information regarding requirements associated with development within the parks.

The Hargreaves to Darfield Segment crosses the following planning areas:

- Blue River Official Community Plan (Thompson-Nicola Regional District 2011a);
- Avola Official Community Plan (Thompson-Nicola Regional District 2011d);
- District of Clearwater Official Community Plan (District of Clearwater 2012);
- Eight Peaks Winter Recreation Sustainable Resource Management Plan (BC Ministry of Sustainable Resource Management [MSRM] 2003);
- Kamloops Land and Resource Management Plan (BC Integrated Land Management Bureau [ILMB] 1995);
- Regional District of Fraser-Fort George Official Community Plan (Regional District of Fraser-Fort George 2013);
- Robson Valley Land and Resource Management Plan (BC ILMB 1999);
- Thompson-Nicola Regional Growth Strategy (Thompson-Nicola Regional District 2000);
- Valemount to Blue River Winter Recreation Sustainable Resource Management Plan (BC ILMB 2005); and

- Village of Valemount Official Community Plan (Village of Valemount 2006).

These plans have identified objectives, goals and/or strategies related to wildlife, habitat, biodiversity and ecosystem integrity, which are summarized in the Wildlife Technical Report of Volume 5C (Appendix E). In general, these plans in relation to wildlife and wildlife habitat stress the importance of promoting conservation and sustainability of watershed ecosystems, wetlands and riparian areas and protecting environmentally sensitive and unique natural areas. Some LRMPs/SRMPs are particularly focused on grizzly bears, ungulates (*e.g.*, caribou, mountain goat, moose, elk and deer) and waterfowl. Grizzly bear objectives include minimizing impacts on grizzly bear habitats and human/bear conflicts, and maintaining or enhancing habitat, population size, genetic variability and distribution. Objectives specific to caribou include avoiding displacement and disturbance of mountain caribou, particularly in core early and late winter habitat, and improving understanding of the behaviour and biology of caribou populations.

Black Pines to Hope Segment

Wildlife indicators relevant to the Black Pines to Hope Segment include grizzly bear, moose, forest furbearers, coastal riparian small mammals, bats, grassland/shrub-steppe birds, mature/old forest birds, early seral forest birds, riparian and wetland birds, short-eared owl, rusty blackbird, flammulated owl, Lewis's woodpecker, Williamson's sapsucker, western screech-owl, great blue heron, spotted owl, bald eagle, common nighthawk, olive-sided flycatcher, pond-dwelling amphibians, stream-dwelling amphibians, and arid habitat snakes (Table 7.2.10-2).

The Black Pines to Hope Segment traverses a mosaic of land uses and habitat types, including suburban areas and rural areas, agricultural fields (*i.e.*, cultivation, hay), pasture, grasslands and forests. Forested areas are generally dominated by Douglas-fir and ponderosa pine, with open, grassy understories, particularly in ponderosa pine stands. Areas of ponderosa pine forest also contain large open grassland areas interspersed with big sage brush. Selective forest harvest is common along this segment, as evidenced by old stumps on the forest floor and sporadic large veteran Douglas-fir trees. The grasslands north and south of Kamloops show signs of human disturbance in the form of trails, access roads and cattle grazing. The Black Pines to Hope Segment traverses several areas burned by wildfire within the last 40 years: RK 830.1 to RK 830.7 (burned in 1987); RK 826.5 to RK 826.6 (burned in 2008); and RK 826.3 to RK 826.7 (burned in 2009) (BC MFLNRO 2013b). Terrain along the proposed pipeline segment varies from flat to gently undulating in large valley bottoms, to moderately and steeply undulating hills through the grasslands and forested areas north and south of Kamloops. Steeper slopes are encountered along some watercourses and narrow valleys (*e.g.*, Coquihalla valley). Wetlands encountered by the Black Pines to Hope Segment and are generally associated with streams and oxbow lakes, with a number of shrubby/treed fens and bogs. Pipeline routing avoids wetlands to the extent feasible. The Ajax-Afton open pit mine is located from RK 853.5 to RK 858.5. The Black Pines to Hope Segment parallels existing linear disturbances (*i.e.*, the existing TMPL right-of-way and Highway 5) for approximately 129.3 km (55.8%) of its length. Habitat alteration as a result of urbanization, agriculture and resource extraction (*e.g.*, forestry, mining) has altered the suitability and use of wildlife habitat within the Wildlife RSA. Clearing of vegetation, the creation of linear corridors, facilities and/or infrastructure, and sensory disturbance associated with development and resource use have affected the historical distribution and movement of wildlife.

The Black Pines to Hope Segment intersects UWRs for mule deer and black-tailed deer, and a Wildlife Habitat Area (WHA) for spotted owl. The Kingsvale Pump Station is located adjacent to UWR for mule deer and the proposed pump station power line intersects a WHA for Williamson's sapsucker (Wildlife Technical Report of Volume 5C). The *BC OGAA* adopts the same policy for WHAs as UWRs (refer to Hargreaves to Darfield Segment above). The proposed pipeline corridor intersects the Sowaqua Spotted Owl WHA, which is classified as a Long-Term Owl Habitat Area (LTOHA).

The proposed pipeline corridor is located within Lac du Bois Grasslands Protected Area and the Coquihalla Summit Recreation Area, and is adjacent to the Coldwater River, Coquihalla River and Coquihalla Canyon provincial parks. It is also located within the Douglas Lake Plateau IBA (BC172) (Bird Studies Canada and Nature Canada 2013) and the DUC Level 3 Priority Landscape, Eastern Boreal Forest, which encompasses areas rich in wetlands, lakes, ponds, rivers, and streams and supports breeding, migrating, moulting, and staging waterfowl (DUC 2013).

The Blackpines to Hope Segment crosses the following planning areas:

- Hope Official Community Plan (District of Hope 2004);
- Kamloops KAMPLAN (City of Kamloops 2004);
- Kamloops Land and Resource Management Plan (BC ILMB 1995);
- Kamloops North Official Community Plan (Thompson-Nicola Regional District 2011b);
- Kamloops South Official Community Plan (Thompson-Nicola Regional District 2011c);
- Merritt Official Community Plan (City of Merritt 2011); and
- Thompson-Nicola Regional Growth Strategy (Thompson-Nicola Regional District 2000).

These plans have identified objectives, goals and/or strategies related to wildlife, habitat, biodiversity and ecosystem integrity, which are summarized in the Wildlife Technical Report of Volume 5C (Appendix E). In general, these plans in relation to wildlife and wildlife habitat stress the importance of promoting conservation and sustainability of watershed ecosystems, wetlands and riparian areas, and protecting environmentally sensitive and unique natural areas. The Kamloops LRMP in particular focuses on riparian management, ecosystem management, biodiversity, and maintaining or enhancing ungulate (*i.e.*, moose, deer) habitat requirements (*e.g.*, forage production, thermal and visual cover).

Hope to Burnaby Segment

Wildlife indicators relevant to the Hope to Burnaby Segment include forest furbearers, coastal riparian small mammals, bats, mature/old forest birds, early seral forest birds, riparian and wetland birds, short-eared owl, rusty blackbird, western screech-owl, great blue heron, bald eagle, common nighthawk, northern goshawk, olive-sided flycatcher, pond-dwelling amphibians, and stream-dwelling amphibians (Table 7.2.10-2).

Portions of the proposed Hope to Burnaby Segment, particularly west of RK 1048, have a high level of anthropogenic disturbance which is characterized by agricultural fields (cultivation, hay, tame pasture), and urban, residential and industrial complexes located within and in the vicinity of Chilliwack, Abbotsford, Langley and Burnaby. These areas are identified for the purposes of the assessment as the Lower Mainland Developed Area (LMDA). Within the LMDA, residual forest is dominated by western redcedar, western hemlock and Douglas-fir. East of the LMDA to Hope, forested areas are typically dominated by Douglas-fir, western hemlock and western redcedar, with open understories. Riparian areas are dominated by black cottonwood. Wetlands encountered along this segment are generally associated with streams and oxbow lakes, with a number of shrubby/treed fens and bogs. The Hope to Burnaby Segment follows south of the Fraser River and the terrain is generally flat with some undulating hills. The proposed Hope to Burnaby Segment parallels existing linear disturbances for approximately 93.4 km (68.6%) of its length. Habitat alteration as a result of urbanization, agriculture, resource extraction (*e.g.*, forestry) and industrial development has altered the suitability and use of wildlife habitat within the Wildlife RSA. Clearing of vegetation, the creation of linear corridors, facilities and/or infrastructure, and sensory disturbance associated with development and resource use have affected the historical distribution and movement of wildlife.

Throughout the Wildlife LSA and RSA along the Hope to Burnaby Segment, there are residual pockets of habitat for suitable various wildlife species. These residual habitat patches are of increasing importance, given the existing level of cumulative disturbance. The Hope to Burnaby Segment crosses the Cheam Lake Wetlands Regional Park from RK 1079.9 to RK 1080.0, and is adjacent to the southeast boundary of the park from RK 1080.1 to RK 1080.4 where the proposed corridor is located on private land and is separated from the park by a secondary road. Trans Mountain is currently investigating route alternatives to avoid the Cheam Lake Wetlands Regional Park (Section 4.0); however, for the purposes of this assessment, it is assumed the route will cross the park. The Cheam Lake Wetlands Regional Park protects 93 ha of marsh, lake and uplands, and is one of the most mineral-rich wetlands in the Fraser Valley (Fraser Valley Regional District 2008).

The Hope to Burnaby Segment will parallel the existing TMPL right-of-way through the segment of land that is leased by the Mountain View Conservation and Breeding Centre. The Mountain View Conservation and Breeding Centre is a non-profit organization that operates breed and return conservation programs in natural settings and enclosures for several rare and endangered species from BC and around the world (Mountain View Conservation and Breeding Centre 2013).

The Hope to Burnaby Segment transects the Sumas Mountain Interregional Park from RK 1115.2 to RK 1120.7. The area has been identified as having high biodiversity and supports species and ecosystems designated as at risk by the provincial and/or federal government (City of Abbotsford 2012). A portion of the proposed pipeline corridor in the Hope to Burnaby Segment is located along the southwest boundary of the Surrey Bend Regional Park from RK 1160.9 to RK 1164.3. The Surrey Bend Regional Park provides a mosaic of foreshore and upland habitats that support a variety of wildlife species and provides a habitat reservoir for many species.

The Hope to Burnaby Segment crosses the following planning areas:

- Abbotsford Community Sustainability Plan (City of Abbotsford 2013);
- Abbotsford Official Community Plan (City of Abbotsford 2005);
- Burnaby Environmentally Sensitive Areas Strategy (City of Burnaby 1994);
- Burnaby Official Community Plan (City of Burnaby 1998);
- Burnaby State of the Environment Report (City of Burnaby 1993);
- Chilliwack Official Community Plan (City of Chilliwack 1998);
- Coquitlam Official Community Plan (City of Coquitlam 2001a);
- Fraser River Estuary Management Plan (Fraser River Estuary Management Program 2003);
- Greater Vancouver Regional Growth Strategy (Metro Vancouver 2011b);
- Greater Vancouver Strategic Directions for Biodiversity Conservation (Biodiversity Conservation Strategy Partnership 2008);
- Hope Official Community Plan (District of Hope 2004);
- Sumas Mountain Environmental Management Study (City of Abbotsford 2012);
- Surrey Bend Regional Park Management Plan (Metro Vancouver and City of Surrey 2010);
- Surrey Ecosystem Management Study (City of Surrey 2011); and
- Surrey Official Community Plan (City of Surrey 1996).

These plans have identified objectives, goals and/or strategies related to wildlife, habitat, biodiversity and ecosystem integrity, which are summarized in Appendix E of the Wildlife Technical Report of Volume 5C. In general, these plans in relation to wildlife and wildlife habitat stress the importance of enhancing habitat and park lands, protecting core habitat areas, large natural areas, watercourses, wetlands, riparian areas, corridors, topographic areas, reservoirs and refuges, promoting biodiversity, and minimizing impacts on rare or unique vegetation, wildlife and wildlife habitat.

Burnaby to Westridge Segment

Wildlife indicators relevant to the Burnaby to Westridge Segment include coastal riparian small mammals, bats, mature/old forest birds, early seral forest birds, riparian and wetland birds, short-eared owl, rusty blackbird, western screech-owl, great blue heron, bald eagle, common nighthawk, northern goshawk, olive-sided flycatcher, and pond-dwelling amphibians (Table 7.2.10-2).

The Burnaby to Westridge Segment is located within the LMDA, and characterized by residential neighbourhoods and industrial complexes within the City of Burnaby. Residual forest is dominated by western red cedar, western hemlock and Douglas-fir. Habitat alteration as a result of urbanization, commercial and industrial development has altered the suitability and use of wildlife habitat within the Wildlife RSA. Clearing of vegetation, the creation of linear corridors, facilities and/or infrastructure, and sensory disturbance associated with development and resource use have affected the historical distribution and movement of wildlife.

The Burnaby to Westridge Segment is located within the English Bay and Burrard Inlet IBA (BC020) from RK 3.2 to RK 3.6, which includes the shores of Burrard Inlet and English Bay. The IBA was designated primarily to protect western grebe, Barrow's goldeneye, surf scoter and great blue heron (*fannini* subspecies). The area also provides nesting habitat for pelagic and double-crested cormorants, osprey and bald eagle, and purple martins are commonly found nesting in nest-boxes along the shores (Bird Studies Canada and Nature Canada 2013). The proposed pipeline corridor is also located within the DUC Priority 2 Landscape, BC Coastal Areas and Estuaries, which provides important migration and winter habitat that supports a wintering population of over one million waterfowl (DUC 2013). The Burnaby to Westridge Segment traverses the southwest boundary of the Burnaby Mountain Conservation Area from RK 0.6 to RK 2.0. The proposed pipeline corridor parallels the Burnaby Mountain Parkway along this stretch and is located within a forested area. The Burnaby Mountain Conservation Area is a forested mountain ecosystem that provides habitat for a variety of species, including blacktail deer, coyote, bald eagle, black bear and cougar (City of Burnaby 2013).

The Burnaby to Westridge Segment crosses the following planning areas:

- Burnaby Environmentally Sensitive Areas Strategy (City of Burnaby 1994);
- Burnaby Official Community Plan (City of Burnaby 1998);
- Burnaby State of the Environment Report (City of Burnaby 1993);
- Burrard Inlet Environmental Action Program and *Shoreline Development Guidelines* (Burrard Inlet Environmental Action Program 2002, 2005);
- Fraser River Estuary Management Program (Fraser River Estuary Management Program 2003);
- Greater Vancouver Regional Growth Strategy (Metro Vancouver 2011b); and
- Greater Vancouver Strategic Directions for Biodiversity Conservation (Biodiversity Conservation Strategy Partnership 2008).

These plans have identified objectives, goals and/or strategies related to wildlife, habitat, biodiversity and ecosystem integrity, which are summarized in Appendix E of the Wildlife Technical Report of Volume 5C. In general, these plans in relation to wildlife and wildlife habitat stress the importance of enhancing habitat and park lands, protecting core habitat areas, large natural areas, reservoirs and refuges, connecting habitat areas and enhancing and restoring biodiversity. Some of the plans focus primarily on marine environments (*e.g.*, shorelines, estuaries and inlets) and migratory birds.

7.2.10.5 Identified Potential Effects

The potential environmental effects associated with the construction and operations of the Project on wildlife and wildlife habitat were based on the results of a literature review, desktop analysis, field work, compiled ATK and information gathered during Aboriginal participation in field surveys, habitat modelling, as well as engagement with regulatory authorities, landowners and stakeholders (Section 3.0), and the professional experience of the assessment team.

Project construction and operations activities have the potential to directly and indirectly affect wildlife and wildlife habitat through alteration of vegetation, terrain and drainage, causing changes in wildlife habitat, movement and mortality risk. These effects mechanisms or "pathways" define the potential effects identified for the Project:

- change in habitat;
- change in movement; and
- increased mortality risk.

These three effects pathways reflect the concerns identified by Aboriginal communities through participation in wildlife field studies and through compilation of ATK. In general, Aboriginal communities have identified concerns about the impact of development, and cumulative effects of developments, on wildlife resources. Specific issues raised during Aboriginal participation in field studies included avoiding disturbance of important site-specific wildlife habitats such as nests, dens, mineral licks, ungulate foraging and calving areas, wetlands and watercourses. In addition, maintaining wildlife movement and access to important habitats (*i.e.,* connectivity) was identified by participants during the field studies (*e.g.,* keeping game trails open). Aboriginal communities raised concerns about sensory disturbance of wildlife during construction, and changes in habitat quality related to contamination (*e.g.*, spills, leaks, construction waste). Changes in access and the associated effects on predator-prey dynamics and human hunting is also a concern for Aboriginal communities. All of these concerns are considered and included in the assessment of changes in habitat, movement and mortality risk on the wildlife indicators. Community concerns regarding effects related to cultural and traditional land use, such as trapping and hunting, are addressed in Volume 5B.

Habitat Suitability and Effectiveness

Changes in habitat suitability and effectiveness for wildlife will result from the Project. Habitat loss and reduced habitat effectiveness can cause displacement of wildlife, and potentially result in the use of less suitable habitat, reduced foraging ability (Bird *et al.* 2004), increased energy expenditure (Jalkotzy *et al.* 1997) and lower reproductive success (Habib *et al.* 2007). The Project will have effects on wildlife habitat in general, and on site-specific habitat features such as mineral licks, nests and dens, ungulate forage and calving areas, wildlife trees, wetlands, watercourses and riparian areas (Wildlife Technical Report in Volume 5C). Avoidance of site-specific habitat features during construction was a recommendation shared by most Aboriginal communities during the wildlife field studies. Concerns related to disturbance of habitat for rare or sensitive species were communicated by Aboriginal communities, regulatory authorities, local biologists, and other stakeholders (*e.g.*, participants of ESA and Community Workshops). Given the importance of moose, deer and elk to maintaining a traditional lifestyle, changes in ungulate habitat are a primary concern for Aboriginal communities. Potential effects on wildlife habitat resulting from spills, leaks and contamination (*e.g.*, drilling fluid release) is also a concern for Aboriginal communities and other stakeholders.

Clearing activities during construction of the Project will alter habitat structure, and result in direct habitat loss or alteration. Operations of the Project will also require ongoing vegetation management, resulting in the maintenance of forest habitat in earlier seral stages (herbaceous and shrub stages) until the pipeline is abandoned and the disturbed areas are reclaimed. Clearing of the construction right-of-way and temporary workspace will reduce cover availability for wildlife and temporarily reduce forage availability. As cleared areas regenerate with early seral vegetation, forage availability will increase for some species (*e.g.*, browse for moose and deer; increased berry production for bears and some bird species). The *Guidelines for Evaluating, Avoiding and Mitigating Impacts of Major Development Projects on Wildlife in British Columbia* (Harper *et al.* 2001) identify pipeline projects as having a negative effect on vegetation and, therefore, wildlife habitat, due to complete removal or modification of the original vegetation pattern and subsequent change in ecosystem dynamics (*i.e.*, changes in microclimate, ground cover, soil compaction). The negative habitat effects for most wildlife species are considered within these guidelines to be minor unless a substantial portion or critical element of the habitat was rendered unsuitable by the development. Further, the creation of a small portion of young seral habitat, in most cases, is not expected to influence most wildlife populations, and may result in habitat enhancement effects for some species (Harper *et al.* 2001).

Indirect habitat loss or alteration occurs when habitat is available but the quality or effectiveness of the habitat is changed such that wildlife avoids the habitat or reduce their use of it. Reduced habitat effectiveness can occur as a result of fragmentation, creation of edges, or sensory disturbance (*e.g.*, noise, artificial light, proximity to facilities and infrastructure, human activity and traffic). Habitat fragmentation can cause habitat to become unsuitable for species with large territories or home ranges, alter predator-prey dynamics and allow for increased invasive or parasitic species abundance (*e.g.*, cowbird parasitism of songbird nests near forest edges). Changes in habitat suitability may also result from changes in vegetation communities due to increased light penetration at clearing edges that causes increased understory vegetation growth, or from changes in water quality (*e.g.*, sedimentation, deposition of airborne contaminants).

The three main components of habitat fragmentation are habitat loss, reduced habitat patch size and increased isolation of patches (Andrén 1994). Habitat fragmentation has the potential to alter species abundance and distribution over the landscape by affecting predation and brood parasitism, altering microclimate, decreasing food, and reducing ability of animals to move between habitat patches within a landscape (Swift and Hannon 2010). Short and long-term declines of various species of forest birds have been attributed to the reduction and fragmentation of forest cover (Lynch and Whigham 1984, Sekercioglu *et al.* 2002, Schmiegelow and Mönkkönen 2002), although the term fragmentation has been used inconsistently. Precise determination of the actual magnitude and significance of forest fragmentation is made difficult by virtue of the interaction between a given bird species and factors such as: residual patch size; dynamics, duration and nature of habitat loss (*e.g.*, agricultural, urban/industrial, fire, forestry); species specialization; and presence of parasitic or generalist predators (*e.g.*, brown-headed cowbird, crows) (Schmiegelow *et al.* 1997, Schmiegelow and Mönkkönen 2002). Since the effects of habitat loss, reduced patch size, and increased isolation of patches act cumulatively, it is difficult to disentangle their effects.

Sensory disturbance such as noise and light can reduce habitat effectiveness. Noise associated with anthropogenic activities can reduce the effectiveness of habitat for wildlife. Construction, maintenance activities and operations of the pipeline and associated facilities will result in elevated noise levels that may reduce habitat effectiveness for some species. Different species, and even individuals within a species, are expected to respond differently to noise disturbances. Various factors affect an animal's response to noise, such as noise level, frequency distribution, duration, number of events, rate of onset, level of existing ambient noise, time of year or day, animal activity and location, animal age and gender. Noise effects on wildlife can potentially include habitat loss through avoidance, increased energy expenditure, changes in normal behaviours (*e.g.*, feeding) and impaired communication between individuals.

The assessment of potential Project effects on habitat suitability and effectiveness is supported by quantification of predicted changes in effective habitat. Habitat models were used to identify habitat suitability within the Wildlife LSA, predict changes in habitat effectiveness as a result of the Project and other developments, support development of appropriate mitigation measures, and inform the evaluation of significance of Project effects on habitat. Model results do not represent actual wildlife use of habitats, but provide a characterization of habitats in the Wildlife LSA most likely to be used by a given indicator based on habitat variables that have been demonstrated or deemed likely to affect suitability and effectiveness. Some species may avoid or reduce habitat use in proximity to human disturbance even if suitable habitat features are present. This is considered indirect habitat disturbance, or a reduction in habitat effectiveness. The area of avoidance or reduced use in proximity to disturbance is often referred to as a zone of influence (ZOI), which varies depending on the species sensitivity, the type, intensity and duration of the disturbance, and the ability of the surrounding habitat to buffer the disturbance (*e.g.*, topography and vegetation). Suitability ratings were adjusted within ZOI relevant to the modelled species and disturbance type, where appropriate, such that the resultant habitat suitability rating decreases closer to anthropogenic disturbance. This puts the suitability ratings in context and equates to a habitat effectiveness rating. For ease of description, habitat rated moderate to high is referred to as ‘effective’ habitat in this assessment. Habitat models will be updated upon completion of Terrestrial Ecosystem Mapping for the Project in 2014, where warranted. The conclusions of the assessment are not expected to change substantially as a result.

By their nature, all habitat models are limited by the accuracy and resolution of the data input. The results of habitat models for this assessment are not expected to be exact characterizations of habitat effectiveness for every wildlife species potentially occurring in the Wildlife LSA, but are considered appropriate for assessing changes in habitat, evaluating the significance of these changes, and informing development of mitigation. The Wildlife Habitat Modelling and Species Accounts Technical Report in

Volume 5C provides further details on habitat modelling methods, including evaluation of model reliability and confidence.

Movement

Project construction and operations can alter wildlife movement by reducing habitat connectivity and creating barriers or filters to movement. A disturbance is considered a barrier when no movement occurs across it, or a filter if the rate of movement through the disturbance is less than it would be through intact habitat (Jalkotzy *et al.* 1997). Habitat fragmentation results when barriers to movement cause functional separation of habitats into smaller, isolated habitat patches (Andrén 1994, Jalkotzy *et al.* 1997). Species that have late age of first reproduction, low population densities, low reproductive rates, large home ranges, low fecundity, and move over large distances to disperse, find food and mate, display low resilience to habitat fragmentation (Dunne and Quinn 2009). Compiled ATK and TEK shared during field studies and engagement identified disruption of wildlife movement during construction as an important consideration for Project effects. In particular, Aboriginal communities advised that identified game trails be kept open during construction, and disturbance within riparian areas be avoided by implementing buffers to prevent barriers to wildlife movement that could block access to important habitats (*e.g.*, food and water sources) (Wildlife Technical Report of Volume 5C).

Wildlife movement patterns vary between species, with species-specific attributes such as size and life stage, and other factors such as time of day and season. Many species will alter their movements to avoid areas with high levels of human activity and development. However, some species may be less affected by anthropogenic disturbance and use established trails that are habitually used for movement, regardless of proximity to human activity and development. In some cases, linear developments have been shown to block, delay or deflect ungulate movements, potentially restricting or reducing access to some parts of their range (Harper *et al.* 2001). Studies on small mammal movements in forested habitat have concluded that pipeline rights-of-way may act as barriers or filters to movement of flying squirrels, red squirrels and marten (Marklevitz 2003). Changes in movement patterns can also occur since some wildlife species may be attracted to linear corridors as travel routes. For example, wolverines have been found to diverge from their line of travel under forest cover when linear corridors with compacted snow were encountered, in order to follow the linear corridors, which provided easier travel routes (Wright and Ernst 2004). Changes in movement patterns may also occur as some species are attracted to early seral vegetation in regenerating areas. Species that prefer edges and habitat generalists are most likely to use disturbed areas (Jalkotzy *et al.* 1997).

Mortality Risk

This subsection addresses the anticipated effects of Project construction and operations on wildlife mortality risk. Given the difficulty in quantifying the variables potentially affecting wildlife mortality risk, this issue was assessed qualitatively. Minor spills during construction are typically readily contained and cleaned up, and are not expected to affect wildlife mortality risk. Pipeline spill scenarios are addressed separately in Volume 7.

Compiled ATK and TEK and shared during field studies identified concerns related to wildlife mortality risk associated with traffic and construction equipment, new access for hunters, predation on the cleared pipeline right-of-way (changes in predator-prey dynamics), and increased human-wildlife conflicts.

The Project has potential to increase wildlife mortality risk during construction as a result of wildlife collisions with vehicles or equipment, loss or disruption of habitat (*e.g.*, nests, dens, overwintering sites) and sensory disturbance (*e.g.*, nest abandonment). As noted above, wildlife mortality risk may be affected during Project operations as a result of changes in predator/prey dynamics. Linear corridors can increase the risk of mortality for some species by attracting prey species to early seral vegetation establishing on the disturbance, improving access and increasing sight-lines, which may lead to increased predator efficiency. Studies have found that linear corridors are attractive to predators as easy travel routes (James 1999, Stuart-Smith *et al.* 1997, Thurber *et al.* 1994) and may affect predator-prey dynamics (Bergerud *et al.* 1984, Edmonds and Bloomfield 1984, Rohner and Kuzyk 2000). James (1999) found that wolves traveled 2.9 times faster on linear corridors. Higher rates of travel may increase the encounter rates between predators and their prey, resulting in more frequent kills. Wolf hunting behaviour is suggested to potentially change when landscapes are altered by industrial development, which may affect predation risk (Kuzyk 2002).

Similarly, linear corridors potentially affect wildlife mortality risk from trapping, hunting and poaching due to access development, since these activities are often associated with roads or other linear corridors that create access (Collister *et al.* 2003, Wiacek *et al.* 2002).

7.2.10.6 Mitigation Measures

Pipeline corridor and site selection is the primary mechanism for avoiding or reducing Project effects on wildlife. Criteria used throughout the corridor and site selection process are described in detail in Volume 4A. In particular, the following corridor and site selection criteria were selected in part to minimize Project effects on wildlife:

- where practical, follow existing linear disturbances (*i.e.,* pipeline, utility, seismic and road rights-of-way) to avoid or minimize fragmentation of habitat;
- use existing clearings (*i.e.,* shared workspace) to reduce the amount of new clearing and land disturbance required;
- avoid or reduce length traversing environmentally sensitive areas such as parks, protected areas, endangered or sensitive vegetation and wildlife habitat, and other environmentally sensitive areas, where practical;
- avoid, to the extent practical, areas of undisturbed native vegetation by maximizing the use of previously cleared lands or lands currently under industrial land use;
- use of existing access, to the extent feasible; and
- avoid, to the extent practical, known locations that provide site-specific habitat for wildlife species of concern or apply site-specific mitigation.

Mitigation measures for avoiding or reducing Project effects on wildlife are presented in Table 7.2.10-3. The recommended timing/least risk windows and setback distances presented in Table 7.2.10-3 are in place to reduce disturbance to wildlife during sensitive periods. Various circumstances that may be encountered during Project construction or operations have been considered and included in the recommended mitigation. In the event there are conflicts between the timing/least risk windows and the construction schedule (*i.e.*, once the final route alignment has been determined and the construction schedule has been finalized), Trans Mountain will consult with the appropriate regulatory authorities to develop appropriate mitigation. Pre-construction wildlife surveys may be conducted to collect information needed to inform mitigation planning.

The recommended mitigation measures provided in Table 7.2.10-3 were developed in accordance with industry and regulatory guidelines, including relevant recommendations in land use planning documents (Appendix E in the Wildlife Technical Report of Volume 5C), in addition to:

- *Environmental Protection and Management Guide* (BC OGC 2013);
- *Approved Ungulate Winter Ranges - Approved Objectives/General Wildlife Measures* (BC MOE 2013c);
- *Approved Wildlife Habitat Areas – Approved Orders/General Wildlife Measures* (BC MOE 2013d);
- *Guidelines for Raptor Conservation during Urban and Rural Land Development in British Columbia* (BC MOE 2013e);
- *Develop with Care 2012* (BC MOE 2012a);
- *Environmental Protection and Management Regulation* under the *Oil and Gas Activities Act* (BC Reg 200/2010);
- *Standards and Best Practices for Instream Works* (BC MWLAP 2004a);

- *Accounts and Measures for Managing Identified Wildlife* (BC MWLAP 2004b);
- *Best Management Practices for Amphibians and Reptiles in Urban and Rural Environments in British Columbia* (BC MWLAP 2004c);
- *Draft Gastropod Best Management Practices Guidebook, Oregon Forest snail and Other Land Snails at Risk in the Coastal Lowlands* (BC MOE 2007);
- *Best Management Practices Guidelines for Pacific Water Shrew in Urban and Rural Areas* (Craig *et al.* 2010);
- *Guidelines for Evaluating, Avoiding and Mitigating Impacts of Major Development Projects on Wildlife in British Columbia* (Harper *et al.* 2001);
- *Integrated Standards and Guidelines for the Enhanced Approval Process* (Government of Alberta 2013a);
- *Recommended Land Use Guidelines for Protections of Selected Wildlife Species and Habitat within Grassland and Parkland Natural Regions of Alberta* (ASRD 2011a);
- Wildlife Sensitivity Maps, ASRD Digital Spatial Data Layers (AESRD 2013d);
- *Incidental Take of Migratory Birds in Canada* (Environment Canada 2013e);
- *Environmental Assessment Best Practice Guide for Wildlife at Risk in Canada* (Canadian CWS 2004);
- *Petroleum Industry Activity Guidelines for Wildlife Species at Risk in the Prairie and Northern Region* (Environment Canada 2011a);
- relevant recovery planning documents (BC MOE 2013f); and
- *Canadian Council on Animal Care species-specific recommendations on: amphibians and reptiles* (Canadian Council on Animal Care n.d.).

TABLE 7.2.10-3

RECOMMENDED MITIGATION FOR WILDLIFE AND WILDLIFE HABITAT

Concern	Province/Location	Recommended Mitigation[1]
Habitat Loss/Alteration	Alberta/BC	• Avoid activity during sensitive time periods for wildlife species to the extent feasible. • Share workspace with the adjacent existing TMPL right-of-way or other existing rights-of-way where practical to reduce the construction right-of-way-width. • Do not clear timber, stumps, brush or other vegetation beyond the marked construction right-of-way boundary. • Where grading is not required, cut/mow/walk down shrubs and small diameter deciduous trees at ground level to facilitate rapid regeneration. • Use natural recovery as the preferred method of reclamation on level terrain and at wetlands unless otherwise requested by the regulator and where bio-engineering (*e.g.*, shrub staking/planting) will be conducted. • Plant native tree seedlings and/or shrubs at select locations to be determined in the field by the Environmental Inspector, in consultation with the Wildlife Resource Specialist. • Avoid the use of pesticides (except for herbicides to control invasive plants or noxious weeds; only use as spot treatments and outside the migratory bird breeding season) (BC MOE 2012a). • Reduce the width of grubbing near watercourses, wetlands and through other wet areas to facilitate the restoration of shrub communities. • Reduce disturbance at riparian areas, and where practical, extend the riparian buffer by implementing trenchless pipeline crossing techniques, or cut/mow/walk down shrubs and small diameter deciduous trees at ground level to facilitate rapid regeneration. • Limit vegetation control along the right-of-way and allow natural regeneration during the operations phase to the extent feasible. • Conduct pre-construction surveys to identify site-specific habitat features (*e.g.*, mineral licks) and implement the appropriate setbacks and/or timing windows.

TABLE 7.2.10-3 Cont'd

Concern	Province/Location	Recommended Mitigation[1]
Access and Line-of-Sight Management	Alberta/BC	• Implement the measures included in the Traffic and Access Control Management Plan prepared for the Project (Appendix C of the Pipeline EPP). • Implement measures to reduce access (human and predator) along the right-of-way following construction. Measures may include but are not limited to planting tree seedlings and/or shrubs in select locations to facilitate rapid regeneration of natural vegetation, and blocking access entry points by mounding, rollback, boulder barriers, earth berms or locked gates. The locations of access control measures along the right-of-way will be determined in consideration of consultation with provincial regulatory authorities. • Where rollback and coarse woody debris are needed for access management, erosion control and habitat enhancement, ensure that a sufficient supply is set aside for this purpose during final clean-up. • Consider the following at the proposed crossing of roads, railways, other pipelines or watercourses: extend the length of an HDD or bored crossings where this crossing technique has been proposed to leave a vegetated screen and/or narrow the right-of-way width if feasible. • Use existing roads to access the pipeline right-of-way. Deactivate and reclaim any temporary roads that are no longer needed with native vegetation. Implement measures to reduce access (human and predator) along these temporary roads, as required. • Install educational signs as needed at selected locations.
Barriers to Wildlife Movement	Alberta/BC	• Conduct work as expeditiously as practical (*i.e.,* interval between front-end work activities such as grading and back-end activities such as clean-up) to reduce the length and duration of the open trench and to reduce potential barriers and hazards to wildlife. • Locate gaps in pipe to allow wildlife movement in places that also facilitate construction such as at slope changes, crossings (*i.e.,* watercourse, road, pipeline right-of-way, railway) and bends. The locations of the gaps should coincide with gaps in spoil, slash piles and snow windrows. The locations can be determined in the field by the Environmental Inspector. • Restore habitat connectivity by redistributing large-diameter slash (rollback) over select locations on the pipeline right-of-way (*e.g.*, where high levels of coarse woody debris occur prior to construction), to provide cover and facilitate movement of wildlife (*e.g.*, furbearers). Specific locations are to be determined in the field by the Environmental Inspector and Wildlife Resource Specialist in discussion with provincial regulatory authorities.
Wildlife Disturbance and Attraction of Wildlife During Construction	Alberta/BC	• Schedule clearing and construction activities to avoid sensitive wildlife timing windows wherever feasible. • Minimize traffic and prohibit recreational use of all-terrain vehicles or snowmobiles by construction personnel on the pipeline right-of-way and at facilities. • Prohibit personnel from having pets on the pipeline right-of-way and at facilities. • Prohibit personnel from feeding or harassing wildlife. • Obey speed limits along access roads and the right-of-way. • Ensure that food waste and industrial waste are disposed of properly. • Report any issues related to wildlife encountered during construction and operations to the Environmental Inspector, who will report it to the appropriate regulatory authorities. • Implement the measures in the Wildlife Conflict Management Plan to prevent human/wildlife conflict and wildlife mortality (Appendix C of the Pipeline and Facilities EPPs).
Sensory Disturbance	Alberta/BC	• Use low lighting and/or task lighting (*e.g.,* downturned shaded fixtures to prevent sky-lighting or bird disorientation), and a higher lumen/watt ratio at all new facilities or facility expansions. • Comply with appropriate regulatory requirements related to noise during construction and operations of facilities to minimize disturbance related to noise.
Migratory Birds	Alberta/BC	• In Alberta, schedule clearing and construction activities outside of the migratory bird restricted activity period (RAP) of May 7 to August 20. Wetlands attractive to migratory birds should not be cleared/disturbed from April 20 to August 25 (Gregoire pers. comm.). In the event clearing or construction activities are scheduled during the migratory bird RAP, follow the measures for conducting migratory bird nest sweeps described below. • In BC, schedule clearing and construction activities outside the migratory bird breeding season of March 15 to August 15 (Wilson pers. comm.). In the event clearing or construction activities are scheduled during the migratory bird breeding season, follow measures for conducting migratory bird nest sweeps described below.

TABLE 7.2.10-3 Cont'd

Concern	Province/Location	Recommended Mitigation[1]
Migratory Birds (cont'd)	Alberta/BC	• In simple habitat types where active nests are easier to locate (*i.e.,* previously cleared areas and open areas with sparse vegetation and few trees), a nest sweep may be completed within 7 days of activity that is scheduled to occur within the migratory bird RAP. Use non-intrusive methods to conduct an area search for evidence of nesting (*e.g.,* presence of singing birds, territorial males, alarm calls, distraction displays). In the event an active nest is found, it will be subject to site-specific mitigation measures (*i.e.,* clearly marked protective buffer around the nest and/or non-intrusive monitoring). • In complex habitats where active nests are more difficult to find (*e.g.,* forests), it is recommended that pre-clearing be conducted. If this is not feasible and activity is scheduled to occur within the migratory bird RAP, contact Environment Canada prior to activity to discuss the area to be cleared. Use non-intrusive methods to conduct an area search for evidence of nesting (*e.g.,* presence of singing birds, territorial males, alarm calls, distraction displays). In the event an active nest is found, it will be subject to site-specific mitigation measures (*i.e.,* clearly marked protective buffer around the nest and/or non-intrusive monitoring). • In BC, in the event that an active Williamson's sapsucker or Lewis's woodpecker nest tree is found within or adjacent to the Project Footprint, consult with BC MFLNRO to discuss practical options and mitigation strategies. • Consider implementing the following bird conservation strategies: for Lewis's woodpecker, retain cavity-bearing trees and snags as nesting habitat, initiate nest box programs in areas lacking cavities/snags, restore/expand riparian buffers (minimum 30 m and >300 m for at least 10% of stream length) where nests are found; for American white pelican, double-crested cormorant and Western grebe establish undisturbed buffer zones (100 m) around breeding colonies; for rusty blackbird maintain unharvested buffers of contiguous forest around bogs used for breeding; and for barn swallow avoid the use of pesticides to maintain invertebrate species (Environment Canada 2013f).
Key Wildlife and Biodiversity Zone	Alberta • North Saskatchewan River: RK 32.7 to RK 34.1 for approximately 1.4 km • North Saskatchewan River: RK 36.7 to RK 37.1 for approximately 0.4 km • Athabasca River: various locations between RK 307.4 to RK 311.6 for approximately 3.8 km	• Schedule clearing, construction and clean-up activities outside the timing restriction of January 15 to April 30. All activities within 100 m of existing arterial all-weather roads can be initiated at any time provided ground conditions are favourable and may continue until adverse ground conditions are encountered (Government of Alberta 2013a). Consult with AESRD if construction activity is scheduled within this period to to discuss practical options and mitigation strategies. • Conduct work as expeditiously as practical (*i.e.,* interval between front-end work activities such as grading and back-end activities such as clean-up) to reduce the length and duration of the open trench and to reduce potential barriers and hazards to wildlife.
Special Access Zone	Alberta • RK 286.8 to RK 292.6 (approximately 5.8 km) • RK 329.0 to RK 339.4 (approximately 10.4 km) • Hinton Pump Station	• Use existing roads to access the pipeline right-of-way and the Hinton Pump Station where practical. If new access is required, construct to minimal disturbance standards (Class V), unless the new access is less than 100 m to an existing arterial all-weather road, in which case, the new access can be developed using Class III to Class V roads (all-weather or dry tertiary; frozen; minimal disturbance) (Government of Alberta 2013a). If new access, which is attached to the existing arterial all-weather access road, is greater than 100 m in distance from the arterial all-weather access road, then access control is required to restrict unauthorized traffic at all stages of construction, operation, deactivation and reclamation of the road. The access control will be placed within 100 m distance from the start of the new access (Government of Alberta 2013a). • Avoid creating access routes as loops and design to dead-end (Government of Alberta 2013a). • Consult with AESRD on the use of rollback along the pipeline right-of-way within this zone. • Revegetate any areas that were cleared (pipeline right-of-way, roads, facilities) with species compatible to the adjacent vegetation type. Do not seed with species that are palatable to wildlife (*i.e.*, legumes) (Government of Alberta 2013a).

TABLE 7.2.10-3 Cont'd

Concern	Province/Location	Recommended Mitigation[1]
Grizzly Bear Zone	Alberta • RK 297.2 to RK 339.4 (approximately 42.2 km) • Hinton Pump Station	• Apply measures noted for Special Access Zones to limit new access. • All workers will receive Bear Awareness Training (Government of Alberta 2013a). • Coordinate access and new clearing requirements with other industrial users in the area to minimize human activity within grizzly bear habitat (Government of Alberta 2013a). • Delimb coniferous trees and leave limbs on-site, where practical, to provide a seed source (Government of Alberta 2013a). • Prohibit construction personnel from feeding or harassing wildlife. Dispose of food wastes and industrial waste properly. • Utilize multi-passenger vehicles for the transport of crews to and from the job sites, to the extent practicable, to reduce traffic during construction. • Follow the *Bear-Human Conflict Management Plan for Camps* provided in the *Integrated Standards and Guidelines* if a camp is located within grizzly bear habitat (Government of Alberta 2013a). • In the event an active grizzly bear den is found, contact AESRD to discuss mitigation strategies. Recommended setbacks are 750 m for high disturbance activities (*i.e.*, conventional pipelines) and 500 m for medium disturbance activities (*i.e.*, conventional pipeline parallel to a linear corridor) from October 1 to April 30 (Government of Alberta 2013a).
Trumpeter Swan Waterbodies/Watercourses	Alberta • Unnamed Lake (locally referred to as Lacy's Lake) at SW 22-53-18 W5M: approximately 400 m north of RK 242 • Annabel Lake at 34-52-19 W5M: approximately 700 m south of RK 254 • Unnamed waterbody at W 5-53-19 W5M: approximately 200 m north of RK 258	• Schedule clearing, construction and clean-up activities outside the timing restriction of April 1 to September 30 within 800 m of a trumpeter swan waterbody/watercourse. In the event activity is scheduled during this period and a breeding pair (with cygnets) is nesting on the waterbody, consult with AESRD to discuss practical options and mitigation strategies. • Avoid direct aerial overflights over identified trumpeter swan waterbodies/watercourses that have a breeding pair (with cygnets) from April 1 to September 30 (*e.g.*, low-level flights over the nest, circling the nest) (Government of Alberta 2013a).
Sensitive Raptor Range - Bald Eagle	Alberta • RK 0.0 to RK 68.8 (approximately 68.8 km) • Edmonton Terminal	• Recommended setbacks from bald eagle nests include: for high disturbance activities (*i.e.,* conventional pipeline), a 1,000 m setback is recommended year-round; for medium disturbance activities (*i.e.,* conventional pipeline parallel to a linear corridor), a 1,000 m setback is recommended from March 15 to July 15 and a 100 m setback is recommended from July 16 to March 14 (Government of Alberta 2013a). • In the event an active bald eagle nest is found, consult with AESRD to discuss practical options and mitigation strategies.
Sharp-Tailed Grouse Lek	Alberta • In Alberta, a provincially identified sharp-tailed grouse range occurs from RK 0.0 to RK 68.8 (approximately 68.8 km) BC	• In Alberta, implement a 500 m setback in the event an active sharp-tailed grouse lek is identified. Use noise reduction equipment to muffle or otherwise control noise so that operational noise does not exceed 49 decibels measured at 10 m from the source to the 500 m setback (Government of Alberta 2013a). In the event an active sharp-tailed grouse lek is found, consult with AESRD to discuss practical options and mitigation strategies. • In BC, avoid activity in the area of identified sharp-tailed grouse leks from April 1 to May 31 (Surgenor pers. comm.). Activities are not recommended within 400 m of a sharp-tailed grouse lek between April 1 and May 31 (BC MWLAP 2004b). In the event an active sharp-tailed grouse lek is identified, consult with BC MFLNRO to discuss practical options and mitigation strategies.
Protective Notations (PNT)	Alberta • PNT 980061 at NW 13-53-6 W5M (approximately RK 118.1 to RK 118.9) • PNT 870456 at NW 22-53-10 W5M (approximately RK 161.0 to RK 161.8)	• Consult with AESRD in regards to activity in PNT 980061 (Fragmented Land Pattern) and 980160 (Research Site Structure). • Maintain tree cover and minimize new clearing requirements in PNTs 870456 (Ungulate Winter Range) and 780290 (Fish and Wildlife Resource Management Area) by paralleling the existing TMPL right-of-way (Hobson pers. comm.). • Routing has avoided the long-toed salamander breeding ponds by 100 m in PNT 020232 (Rare and Endangered Species Habitat Protection Area for long-toed salamander). Traffic should be reduced within the area of the ponds in spring and early fall to reduce mortality during salamander breeding and dispersal periods (Wilkinson pers. comm.).

TABLE 7.2.10-3 Cont'd

Concern	Province/Location	Recommended Mitigation[1]

Mountain Caribou Range
 	
Includes Ungulate Winter Range U-3-004 (Modified Harvest Zone) for the Wells Gray Caribou Range
	BC
	• Wells Gray Caribou Range (various locations for approximately 30.7 km from RK 550.1 to RK 602.6; includes 4.3 km within UWR U-3-004)
	• Groundhog Caribou Range (various locations for approximately 10.3 km from RK 629.8 to RK 649.4)
		• Align route to parallel existing corridors (existing TMPL right-of-way, Highway 5, existing power line) to the extent feasible to reduce habitat disturbance.
		• Work with the appropriate regulatory authorities for deviation from the General Wildlife Measures set out in the Order for Wells Gray caribou Ungulate Winter Range (U-3-004).
		• Avoid activity in early to mid-winter within caribou range (*i.e.*, November 1 to January 15) (Surgenor pers. comm.), to the extent feasible.
		• Implement line-of-sight breaks every 500 m along segments not sharing a right-of-way boundary with another linear corridor such as a road or power line. Line-of-sight measures may include: bends in the right-of-way; doglegs at intersections with access roads; woody debris or earth berms; tree or shrub planting to create vegetation screens across the right-of-way; avoiding clearing on the right-of-way (*e.g.*, HDD or bored crossings of watercourses, roads or other rights-of-way).
		• Avoid creating early seral habitat that will provide forage for moose (*e.g.*, do not plant willow or red osier dogwood) (Surgenor pers. comm.).
		• Avoid creation of new access within caribou range where feasible. Use existing roads/linear corridors for access whenever practical (BC OGC 2013). Where practicable, avoid building roads within 100 m of an existing trail (Kamloops LRMP Mountain Caribou Subcommittee 2006).
		• Deactivate and reclaim all temporary construction access within caribou range (Kamloops LRMP Mountain Caribou Subcommittee 2006).
		• Coordinate any new access with all users and consider caribou management issues (*i.e.,* seasonal use of the road) (Kamloops LRMP Mountain Caribou Subcommittee 2006).
		• Minimize winter road use and, where feasible, coordinate with other activities such as winter logging (Kamloops LRMP Mountain Caribou Subcommittee 2006).
		• Conduct work expeditiously to maintain a tight construction spread (*i.e.,* interval between front-end work activities such as grading and back-end activities such as clean-up) to reduce the duration of the open trench and to reduce potential barriers and hazards to wildlife.
		• Locate gaps in pipe to facilitate wildlife movement in places that also facilitate construction such as at slope changes, crossings (*i.e.,* watercourse, road, pipeline right-of-way, railway) and bends. The locations of the gaps should coincide with gaps in spoil, slash piles and snow windrows. The locations can be determined in the field by the Environmental Inspector.
		• Where segments of the right-of-way require rollback for access management or erosion control, ensure sufficient timber is set aside for this purpose during final clean-up.
		• Implement minimum surface disturbance construction techniques that will facilitate natural revegetation in areas where grading or blasting is not required in areas of upland deciduous and mixedwood forests and in graminoid and shrub-dominated wetland communities.
		  – Minimize the width of the pipeline right-of-way to the extent practical by utilizing shared workspace, avoiding clearing large diameter trees on the edge of the right-of-way; minimizing extra temporary workspace (*e.g.*, place log decks, storage areas, other temporary construction areas outside of UWR U-3-004).
		  – Maintain root layer integrity on the right-of-way by clearing vegetation above ground level and restricting grubbing to the trench width.
		  – Protect travel and work surfaces by packing snow (during winter) to protect soils and vegetation where practical.
		• Avoid using seed mixtures that will attract other ungulates (deer, moose) during reclamation (Hoekstra pers. comm.).
		• Implement measures to reduce access (human and predator) along the pipeline right-of-way following construction. Measures include using woody debris as rollback, mounding, planting trees and/or shrubs for visual screens, and rock piles or berms across the right-of-way. The locations of access control measures along the pipeline right-of-way will be determined in consideration of consultation with provincial regulatory authorities.
		• Consider the following at the proposed crossing of roads, other pipelines or watercourses: extend the length of HDD or bored crossings where this crossing method has been proposed to leave a vegetated screen for line-of-sight and/or narrow the right-of-way width if feasible.
		• Monitor the effectiveness of access control measures and reclamation during post-construction environmental monitoring. Implement remedial measures if warranted. Schedule remedial work outside of the period of early to mid-winter when caribou are more likely to be in the area.

TABLE 7.2.10-3 Cont'd

Concern	Province/Location	Recommended Mitigation[1]
Mountain Caribou Range Includes Ungulate Winter Range U-3-004 (Modified Harvest Zone) for the Wells Gray Caribou Range (cont'd)	See above	• Limit vegetation control along the right-of-way and allow natural regeneration during the operations phase to the extent feasible. • Limit operational access along the pipeline right-of-way within caribou range. • Report any sightings of caribou during construction and operations to Trans Mountain's Lead Environmental Inspector or Environmental Inspector(s).
Ungulate Winter Range for Mule Deer (U-3-003)	BC • Various locations for approximately 36.7 km from RK 891.6 to RK 969.6 • Kingsvale Pump Station (expansion) • Kingsvale Power Line (6.2 km)	• A timing window does not apply to this UWR (Surgenor pers. comm.). • For the proposed Kingsvale power line and pipeline right-of-way, minimize the right-of-way width to the extent practical by utilizing shared workspace, avoid clearing large diameter trees on the edge of the right-of-way; minimizing extra temporary workspace (*e.g.*, placing log decks, storage areas, other temporary construction areas outside of the UWR). Maintain root layer integrity on the right-of-way by clearing vegetation above ground level and restricting grubbing to the trench, to the extent practical. Avoid creation of new access. Use existing roads/linear corridors for access wherever practical. Deactivate and reclaim all temporary access. Implement measures to reduce access (human and predator). Measures include using woody debris as rollback, and planting trees and/or shrubs at select locations. • Work with the appropriate regulatory authorities for deviation from the General Wildlife Measures set out in the Ungulate Winter Range Order.
Ungulate Winter Range for Mule Deer and Columbian Black-Tailed Deer (U-2-006)	BC • Approximate 1.3 km segment from RK 1029.6 to RK 1030.9	• Work with the appropriate regulatory authorities to discuss the General Wildlife Measures set out in the Ungulate Winter Range Order. The measures may not be applicable to exploration, development and production activities when these activities have been authorized by the *Pipeline Act*.
Wildlife Habitat Area for Williamson's Sapsucker (3-143)	BC • Kingsvale Power Line (952 m)	• Conduct a survey to confirm status and presence of nest trees along the proposed Kingsvale power line right-of-way. In the event an active nest tree is found, consult with BC MFLNRO to discuss practical options and mitigation strategies. • Schedule clearing and construction activities outside the breeding season of March 15 to August 31 to the extent feasible (BC MOE 2012b). • During operations, retain coarse woody debris and snags (if not deemed a hazard) on the power line right-of-way (to provide foraging habitat) where practical (BC MOE 2012b). • Avoid creation of new access, where feasible. Use existing roads/linear corridors for access wherever practical. Deactivate and reclaim all temporary access. • Avoid the use of pesticides (except for herbicides to control invasive plants or noxious weeds; only use as spot treatments and outside the breeding season of March 15 to August 31 (BC MOE 2012b). • Work with the appropriate regulatory authorities for deviation from the General Wildlife Measures set out in the Wildlife Habitat Area Order.
Sowaqua Spotted Owl WHA 2-498 (Long-Term Owl Habitat Area)	BC • Various locations for approximately 10.4 km from RK 1022.9 to RK 1038.2	• Align route to parallel existing corridors (*i.e.*, existing TMPL right-of-way, Highway 5) to the extent feasible to reduce habitat disturbance. • Do not clear timber, stumps, brush or other vegetation beyond the marked construction right-of-way boundaries. • Minimize the width of the pipeline right-of-way to the extent practical by utilizing shared workspace, avoid clearing large diameter trees on the edge of the right-of-way; minimizing extra temporary workspace (*e.g.*, placing log decks, storage areas, other temporary construction areas outside the Sowaqua Spotted Owl WHA). • Avoid clearing large wildlife trees/veteran trees and snags where feasible. Retain slow decaying tree species (*e.g.,* cedar) where feasible (Blackburn *et al.* 2009). • Place large coarse woody debris (diameters greater than 50 cm in dry ecosystems and 75 cm in wet ecosystems). Utilize the largest coarse woody debris available where this is not available. Avoid breaking coarse woody debris into sections smaller than 10 m where feasible (Blackburn *et al.* 2009). • Avoid creation of new access, where feasible. Use existing roads/linear corridors for access whenever practical. Deactivate and reclaim all temporary construction access. • Do not use pesticides within the Sowaqua Spotted Owl WHA (BC MOE 2011a). • Use natural regeneration strategies in harvest openings (Blackburn *et al.* 2009). • Prepare a detailed Mitigation Plan in consultation with BC MFLNRO's Spotted Owl Recovery Coordinator. • Work with the appropriate regulatory authorities for deviation from the General Wildlife Measures set out in the Wildlife Habitat Area Order.

TABLE 7.2.10-3 Cont'd

Concern	Province/Location	Recommended Mitigation[1]
Important Bird Area	BC Douglas Lake Plateau (BC172) • RK 850.6 to RK 865.4 (14.8 km) • RK 885.8 to RK 888.8 (3.0 km) • RK 897.6.0 to RK 898.2 (0.7 km) • Kamloops Pump Station BC English Bay and Burrard Inlet (BC020) • RK 1183.2 to RK 1183.6 (400 m) • Westridge Marine Terminal	• Schedule clearing and construction activities outside the migratory bird breeding season of March 15 to August 15 (Wilson pers. comm.). In the event clearing or construction activities are scheduled during the migratory bird breeding season, follow measures for conducting migratory bird nest sweeps described below. • In simple habitat types where active nests are easier to locate (*i.e.,* previously cleared areas and open areas with sparse vegetation and few trees), a nest sweep may be completed within 7 days of activity that is scheduled to occur within the migratory bird RAP. Use non-intrusive methods to conduct an area search for evidence of nesting (*e.g.,* presence of singing birds, territorial males, alarm calls, distraction displays). In the event an active nest is found, it will be subject to site-specific mitigation measures (*i.e.,* clearly marked protective buffer around the nest and/or non-intrusive monitoring). • In complex habitats where active nests are more difficult to find (*e.g.,* forests), it is recommended that pre-clearing be conducted. If this is not feasible and activity is scheduled to occur within the migratory bird RAP, contact Environment Canada prior to activity to discuss the area to be cleared. Use non-intrusive methods to conduct an area search for evidence of nesting (*e.g.,* presence of singing birds, territorial males, alarm calls, distraction displays). In the event an active nest is found, it will be subject to site-specific mitigation measures (*i.e.,* clearly marked protective buffer around the nest and/or non-intrusive monitoring). • Conduct species specific surveys to identify important wildlife features for species known to occur in the Important Bird Area (*e.g.*, Douglas Lake Plateau: sharp-tailed grouse leks, burrowing owl burrows, Lewis's woodpecker or Williamson's sapsucker nest; English Bay and Burrard Inlet: bald eagle nests, great blue heron colonies). In the event these are found, consult with BC MFLNRO to discuss practical options and mitigation strategies.
Raptor Nest	Alberta/BC	• Schedule clearing and construction activities outside of sensitive time periods for raptors (provided below) to the extent feasible. In the event clearing is scheduled within these periods, in areas of suitable habitat, conduct raptor nest searches prior to clearing to locate active raptor nests. In the event an active raptor nest is discovered, consult with the appropriate regulatory authorities to discuss practical options and mitigation strategies. • In Alberta, implement the appropriate setback in the event an active nest of a sensitive raptor is found (*i.e.,* ferruginous hawk, bald eagle, golden eagle, prairie falcon, peregrine falcon). For high disturbance activities (*i.e.*, conventional pipeline), a 1,000 m setback is recommended year-round. For medium disturbance activities (*i.e.,* conventional pipeline parallel to a linear corridor), a 1,000 m setback is recommended from March 15 to July 15 and a 100 m setback is recommended from July 16 to March 14 (Government of Alberta 2013a). All other raptor nests (*e.g.*, red-tailed hawk) have a recommended 100 m setback when they are active (Government of Alberta 2013a). • In BC, eagle, peregrine falcon, gyrfalcon, osprey and burrowing owl nests are protected year-round by the BC *Wildlife Act* and may not be cleared. The *Guidelines for Raptor Conservation* (BC MOE 2013e) provides information on sensitive breeding and nesting time periods and buffers for raptor nests according to their tolerance to human disturbance. These buffers range from 50 m to 500 m depending on the surrounding land use and species. During the breeding season, an additional 100 m "quiet" buffer is recommended. Clearly mark the appropriate buffers with fencing to prevent access to the nest. • In BC, barn owl nests have the following recommended setbacks: 200 m (undeveloped) and 100 m (rural). During the breeding season, an additional 100 m "quiet" buffer is recommended (BC MOE 2013e). • If construction is unavoidable within the recommended year-round and breeding buffers, a Nest Management Plan addressing various mitigation (including nest monitoring during the breeding period) is recommended. • If construction activities require the removal of a raptor nest that is protected year-round under the BC *Wildlife Act* (*i.e.*, eagle, peregrine falcon, gyrfalcon, osprey and burrowing owl), Trans Mountain will work with the appropriate regulatory authorities to develop a Nest Removal Management and Compensation Plan. Upon confirmation the nest is inactive, nest removal should occur during the least risk window of August through December. When a nest is removed the installation of a replacement structure (*i.e.*, a platform on a pole or transplanted tree) should be erected in nearby suitable habitat (BC MOE 2013e).

TABLE 7.2.10-3 Cont'd

Concern	Province/Location	Recommended Mitigation[1]
Great Blue Heron Nesting Colony	Alberta/BC	• Schedule clearing and construction activities outside of sensitive time periods for great blue heron (provided below), to the extent feasible. In the event clearing is scheduled within these periods, in areas of suitable habitat, conduct nest searches during the breeding season and prior to clearing to locate nesting colonies. In the event an active colony is discovered, discuss appropriate mitigation strategies with regulatory authorities, which may include establishing protective buffers during sensitive periods. • In Alberta, activities are not recommended within 1,000 m with the exception of Low and Medium impact activities (*i.e.*, conventional pipeline along existing linear disturbances) that may occur up to 100 m from a colony when construction occurs from September 1 and February 28 (Government of Alberta 2013a). • In BC, great blue heron nests are protected year-round under the BC *Wildlife Act*. The following are the recommended setbacks: 300 m (undeveloped), 200 m (rural), 60 m (urban) and a 200 m "quiet" buffer during the breeding season from the outer perimeter of all nesting trees. The least risk window is from September 1 to February 15 (BC MOE 2012a).
Stream-Dwelling Amphibian – Coastal Tailed Frog and Pacific Giant Salamander	BC • Coastal tailed frog: RK 965.8 to RK 1117 • Pacific giant salamander: RK 1067 to RK 1090	• Maintain a 30 m setback distance (core buffer) from streams identified as coastal tailed frog habitat, where disturbance is to be avoided, to the extent feasible. Minimize disturbance within an additional 20 m buffer extending beyond the core buffer (BC MOE 2012a), where feasible. • Maintain a 50 m setback distance (core buffer) from streams identified as Pacific giant salamander habitat, where disturbance is to be avoided, to the extent feasible. Minimize disturbance within an additional 30 m buffer extending beyond the core buffer (BC MOE 2012a), where feasible. • Place large coarse woody debris on the pipeline right-of-way after construction, from either the 30 m setback boundary of the streambank to 100 m distance from suitable (*i.e.,* known or likely to be occupied) streams for coastal tailed frog and Pacific giant salamander (BC MWLAP 2004b). • If a trenched stream crossing method is necessary, implement the following measures: – Use existing access to facilitate construction, where feasible. If no existing access is available, limit instream crossings to one vehicular/equipment crossing to install an appropriate temporary crossing to facilitate construction. Remove crossings following construction. – Limit riparian disturbance to the maximum extent feasible within 50 m of coastal tailed frog streams. Clear only the minimum workspace necessary to facilitate construction. Use hand clearing methods within 50 m of the stream. – Where slopes exceed 60%, riparian avoidance buffers should extend beyond the top of the ravine. – Clearly mark and/or fence off riparian buffers prior to clearing and construction. – Install and maintain appropriate erosion control measures to prevent sedimentation during and following construction. – Maintain stream flows throughout construction. – Following construction, reclaim disturbed riparian areas using best available techniques to encourage rapid regeneration of native riparian vegetation. Monitor and implement remedial measures, if warranted, to ensure riparian restoration is adequate. • Conduct an amphibian salvage prior to clearing and construction activities at known coastal tailed frog and Pacific giant salamander breeding locations. Adhere to the Best Management Practices for Amphibian and Reptile Salvages in BC (EDI Environmental Dynamics *et al. in prep*). Note that coastal tailed frog and Pacific giant salamander use the same stream year-round, therefore, this mitigation is applicable year-round. In the event that coastal tailed frogs and/or Pacific giant salamanders are identified on the pipeline right-of-way during construction, the following mitigation is recommended: – remove the frogs/salamanders to the closest suitable upstream habitat, if it is safe to do so; – ensure frogs/salamanders are not held for longer than necessary to move them to the closest suitable habitat; – ensure frogs/salamanders are not held for more than two to four hours under any circumstances; and – frogs/salamanders must be captured, held, transported and released humanely. • Use sediment control measures from *Standards and Best Practices for Instream Works* (BC MWLAP 2004a). • Review opportunities to enhance the habitat by planting/allowing native vegetation growth that provides a protective buffer along streams, and maintain stream habitat complexity (*i.e.*, a natural meandering channel with stabilized banks, and step-pool morphologies) (BC MWLAP 2004b).

TABLE 7.2.10-3 Cont'd

Concern	Province/Location	Recommended Mitigation[1]
Amphibian Breeding Pond	Alberta/BC	• Schedule clearing and construction activities outside of the breeding and seasonal migration periods for amphibians, where feasible. In Alberta, this is generally mid-April to mid-June (Government of Alberta 2013a). In BC, this will vary depending on pipeline segment and can be from mid-April to mid-June (Hargreaves to Hope) and from February to late-July or August (Hope to Westridge) (Wind pers. comm.). • In Alberta, in the event that a western toad breeding pond is found, a year-round 100 m setback distance is recommended (Government of Alberta 2013a), while Environment Canada recommends a year-round 400 m federal setback distance for western toad breeding ponds and wintering sites (Environment Canada 2011a). • In Alberta, in the event a long-toed salamander breeding pond is found, a year-round 200 m setback distance (where new-cut is required) and a 100 m setback distance (when paralleling existing linear disturbance) is recommended (Government of Alberta 2013a). In reference to the long-toed salamander breeding pond at NW 33-49-26 W5M (RK 339.3) located approximately 30 m north of the Hinton Pump Station, AESRD will be consulted to discuss mitigation for both the proposed expansion of the pump station, as well as pipeline construction. For activity in the summer (breeding season), mitigation may include exclusion fencing, onsite monitors and relocation if warranted. • In BC, protect identified amphibian breeding ponds by implementing appropriate buffers (150 m undeveloped; 100 m rural; 30 m urban) (BC MOE 2012a). • If the proposed pipeline right-of-way is located within the recommended setback distance of an amphibian breeding pond, consult with the appropriate regulatory authorities to discuss practical options and mitigation strategies. • Apply standard wetland construction and reclamation mitigation (*e.g.*, minimal disturbance, recontouring, reclamation, monitoring and remedial measures) to support habitat reclamation as needed. • Use snow packing and mats to avoid excessive soil compaction in the proximity of wetlands and watercourses. • Maintain natural hydrology of streams and wetlands during clearing, construction and clean-up activities. • Install fencing around wetlands for clearing and construction activities scheduled during the amphibian breeding period (spring), where warranted, to protect important habitat (BC MWLAP 2004b). • Install fencing along construction workspace near identified breeding ponds to prevent dispersing amphibians from entering the construction zone and limit vehicular activity in spring and early fall to reduce effects during the breeding and dispersal periods (Wilkinson pers. comm.). All fencing installed during clearing and construction activities should be removed once they are no longer necessary to prevent barriers to amphibian movement following construction. • Reclaim borrow pits and avoid creating small artificial ponds by avoiding construction during wet conditions that would create excessive soil rutting; grade ruts in construction access and on the right-of-way where rutting cannot be avoided. • Do not mow/brush vegetation within wetland riparian (fringe) areas during operation. • Conduct an amphibian salvage prior to clearing and construction activities at known amphibian breeding pond locations. Ensure the appropriate permit is obtained. In BC, adhere to the *Best Management Practices for Amphibian and Reptile Salvages in BC* (EDI Environmental Dynamics *et al. in prep*).
Pacific Water Shrew	BC • RK 1064 to 1179; • Burnaby to Westridge (RK 0 to RK 3.6)	• Where feasible, implement the following measures where Pacific water shrew are identified: a 100 m buffer from the Pacific water shrew habitat should be established and clearly marked and fenced off to prevent access; replant native vegetation (shrubs and trees) within 30 m of the stream or wetland to replace any cleared vegetation; and where replanting is not feasible, coarse woody debris should be placed within 30 m of the stream or wetland to provide cover and foraging habitat (Craig *et al.* 2010). • If Pacific water shrew are identified, a capture and release may be required to temporarily/permanently relocate individual shrews.

TABLE 7.2.10-3 Cont'd

Concern	Province/Location	Recommended Mitigation[1]
Oregon Forestsnail	BC • RK 1043.7 to RK 1179; • Burnaby to Westridge (RK 0 to RK 3.6)	• Avoid clearing during spring-early summer (March-June) when snails are most active on the surface and depositing eggs (BC MOE 2007). If clearing or construction occurs in spring, conduct a pre-construction survey in areas with high habitat suitability (*e.g.*, patches of stinging nettle, dense herbaceous vegetation with fringecup or other moisture-loving plants, riparian areas, or other suitable moist sites) in late March or early April to the end of June prior to vegetation clearing (BC MOE 2007). • If a snail is found, move it off the construction footprint. Install barrier fencing at the time of the survey to deflect movements of snails away from the construction footprint. Maintain the fencing until construction activities are complete (BC MOE 2007). • Restore riparian zones and natural drainage patterns as soon as practical after construction (BC MOE 2007). • Retain big leaf maples, especially large diameter trees, wherever feasible (BC MOE 2007). • Restrict heavy machinery and vehicles to the construction footprint (BC MOE 2007). • Clean machinery and boots prior to use to avoid introducing non-native species (BC MOE 2007). • Avoid compaction of soil, disturbance of herbaceous plants and removal of coarse woody debris (BC MOE 2007), to the extent practical. • Manage construction waste and pollutants to prevent contamination of snail habitat (BC MOE 2007). • During operations, retain coarse woody debris on the pipeline right-of-way, including large-diameter downed logs; limit vegetation control (mowing) to leave undisturbed patches of stinging nettle and other herbaceous vegetation where concentrations of snails or patches of high-quality habitat occur (BC MOE 2007). • If clearing of the right-of-way is needed for operations, use hand clearing methods and mechanical clearing rather than herbicides (BC MOE 2007).
Reptiles	BC	• In the event an active snake hibernacula is identified, implement a 150 m buffer (BC MOE 2012a), and avoid activity during the period of April 15 to September 30 (BC MWLAP 2004b), to the extent feasible. • Consult with BC MFLNRO to determine the location and need for additional site-specific mitigation measures (*e.g.*, exclusion fencing for the open trench or along vehicle travel lanes) at identified locations (*e.g.*, Lac du Bois Road) where there is high potential for encountering snakes (Grasslands Conservation Council of British Columbia 2009). • All workers will receive education prior to commencing work, which will include best practices for avoiding snakes and appropriate protocols in the event a snake is detected at the work site. Refer to the Wildlife Conflict Management Plan in Appendix C of the Pipeline EPP.
Bats	Alberta/BC	• In Alberta, roosts and hibernation sites of northern long-eared bats have a year round 300 m setback from high disturbance activities; 100 m setback from medium disturbance activities and a 50 m setback from low disturbance activities. (Government of Alberta 2013a). • In BC, protect bat roosts from disturbance by humans and other sensory disturbances (BC MOE 2012a). Implement a 125 m buffer from bat hibernacula (from October 1 to April 30 or maternity roost (from May 1 to August 31) (BC MWLAP 2004b). Consult with BC MFLNRO where disturbance of a hibernacula or maternity roost is unavoidable to discuss practical options and mitigation strategies. • Do not blast, remove rock or talus, or construct new roads in the area surrounding a hibernacula or maternity roost unless there is no other practical option. Consult with BC MFLNRO to discuss alternate mitigation (BC MWLAP 2004b). • Schedule blasting that may occur within 1 km of Keen's long-eared myotis maternity roosts and hibernacula, to occur outside the period from October 1 to May 31 (BC MWLAP 2004b). Consider applying this best practice to other bat species.
Mammal Dens	Alberta/BC	• Contact provincial regulatory authorities to discuss the appropriate mitigation in the event an active bear den is discovered on or near the work site. Mitigation may include establishing protective buffers, monitoring the den and/or modifying the construction schedule to avoid activity until the den is inactive. • In Alberta, in the event an active mammal den is found, a 100 m setback is recommended (Government of Alberta 2013a). A setback of 750 m for high disturbance activities (*i.e.*, conventional pipelines) and 500 m for medium disturbance activities (*i.e.*, conventional pipeline parallel to a linear corridor) from October 1 to April 30, is recommended in the event an active grizzly bear den is discovered (Government of Alberta 2013). • In BC, a setback of 50 m from active bear dens is recommended BC (BC OGC 2013).

TABLE 7.2.10-3 Cont'd

Concern	Province/Location	Recommended Mitigation[1]
Mineral Licks	Alberta/BC	• Implement a 100 m setback in the event a mineral lick is identified (Government of Alberta 2013a, BC OGC 2013). In the event that shifting/narrowing the pipeline right-of-way is not feasible to maintain the minimum setback from a mineral lick, consult with AESRD or BC MFLNRO to discuss practical options and mitigation strategies. • Maintain the integrity of trails to mineral licks and do not isolate from nearby escape cover (*e.g.*, dense forest) (BC MWLAP 2004b). • Avoid activities (*i.e.*, clearing, construction, helicopter overflights) near mineral licks during critical periods (May to November) (BC MWLAP 2004b), to the extent feasible. • Deactivate access roads as soon as practical (BC MWLAP 2004b). • Leave a gap in set-up pipe within the area of the mineral lick to allow wildlife to access the mineral lick. The locations of the gaps in strung pipe should coincide with gaps in strippings, spoil, snow and rollback windrows.
Beaver Dams/Lodges	Alberta/BC	• Notify DFO 14 days prior to beaver dam removal and ensure that the removals are conducted in accordance with conditions of DFO's Alberta Operational Statement for Beaver Dam Removal (DFO 2007a). • In BC, in the event that beaver dams or lodges will be disturbed, submit a notification to the appropriate regional Habitat Officer of the BC MFLNRO at least 45 days prior to beaver dam removal, as per Section 40 of the *Water Regulation*. Following this notification, obtain a Ministry of Natural Resource Operations Wildlife Sundry Permit to remove a beaver dam. Standards and best practices for beaver dam removal identified in the BC *Standards and Best Practices for Instream Works* (BC MWLAP 2004a) will be applied.
Species with Special Conservation Status	Alberta/BC	• In the event that a species with special conservation status is observed during construction, the appropriate regulatory authorities will be contacted to determine if additional mitigation measures are warranted. • Implement the Wildlife Species of Concern Discovery Contingency Plan in the event that wildlife species of concern are identified during construction.

Note: 1 Detailed mitigation measures are outlined in the Pipeline EPP (Volume 6B), Facilities EPP (Volume 6C) and Westridge Marine Terminal EPP (Volume 6D).

7.2.10.7 Potential Residual Effects

For each of the wildlife indicators, the identified potential effects associated with the construction and operations of the Project are:

- change in habitat;
- change in movement; and
- increased mortality risk.

The mitigation measures identified in Table 7.2.10-3 are expected to reduce the potential residual effects of the Project on wildlife and wildlife habitat. However, given the nature of the Project, effects on wildlife and wildlife habitat cannot be completely avoided or alleviated with mitigation. As a result, residual environmental effects are predicted. The combined suite of potential effects of the Project on wildlife habitat, movement and mortality risk constitute the potential residual effect for each indicator (Table 7.2.10-4). This approach was determined to be the most appropriate method of evaluating Project effects, since wildlife populations and individuals would potentially experience influences of all three effects pathways. Evaluation of the combined residual effect results in a realistic representation of the expected Project effects to the indicators for wildlife and wildlife habitat.

TABLE 7.2.10-4

POTENTIAL EFFECTS, MITIGATION MEASURES AND RESIDUAL EFFECTS OF PROJECT CONSTRUCTION AND OPERATIONS ON WILDLIFE AND WILDLIFE HABITAT

Potential Effect	Project Component(s)	Spatial Boundary[1]	Key Recommendations/Mitigation Measures[2]	Potential Residual Effect(s)
1. Wildlife Indicator – Grizzly Bear				
1.1 Change in habitat	Edmonton to Hinton Hargreaves to Darfield Black Pines to Hope Temporary Facilities	LSA	• Refer to Table 7.2.10-3: habitat loss/alteration, wildlife disturbance and attraction of wildlife during construction, grizzly bear zone, mammal dens, species with special conservation status.	• Combined Project effects on grizzly bear resulting from habitat loss or alteration, changes in movement and increased mortality risk.
1.2 Change in movement		LSA	• Refer to Table 7.2.10-3: habitat loss/alteration, access and line-of-sight management, barriers to wildlife movement, wildlife disturbance and attraction of wildlife during construction, grizzly bear zone.	
1.3 Increased mortality risk		RSA	• Refer to Table 7.2.10-3: habitat loss/alteration, access and line-of-sight management, disturbance and attraction of wildlife during construction, special access zone, grizzly bear zone, mammal dens, species with special conservation status.	
2. Wildlife Indicator – Woodland Caribou				
2.1 Change in habitat	Hargreaves to Darfield Temporary Facilities	LSA	• Refer to Table 7.2.10-3: habitat loss/alteration, access and line-of-sight management, disturbance and attraction of wildlife during construction; mountain caribou range, species with special conservation status.	• Combined Project effects on woodland caribou resulting from habitat loss or alteration, changes in movement and increased mortality risk.
2.2 Change in movement		LSA	• Refer to Table 7.2.10-3: habitat loss/alteration, access and line-of-sight management, barriers to wildlife movement, wildlife disturbance and attraction of wildlife during construction, mountain caribou range.	
2.3 Increased mortality risk		RSA	• Refer to Table 7.2.10-3: habitat loss/alteration, access and line-of-sight management, disturbance and attraction of wildlife during construction, mountain caribou range, species with special conservation status.	
3. Wildlife Indicator – Moose				
3.1 Change in habitat	Edmonton to Hinton Hargreaves to Darfield Black Pines to Hope Temporary Facilities Black Pines Pump Station Power line Kingsvale Pump Station Power line	LSA	• Refer to Table 7.2.10-3: habitat loss/alteration, wildlife disturbance and attraction of wildlife during construction, key wildlife and biodiversity zone, protective notations, moose winter range, mineral licks.	• Combined Project effects on moose resulting from habitat loss or alteration, changes in movement and increased mortality risk.
3.2 Change in movement		LSA	• Refer to Table 7.2.10-3: habitat loss/alteration, access and line-of-sight management, barriers to wildlife movement, wildlife disturbance and attraction of wildlife during construction, key wildlife and biodiversity zone, protective notations, moose winter range, mineral licks.	
3.3 Increased mortality risk		RSA	• Refer to Table 7.2.10-3: habitat loss/alteration, access and line-of-sight management, disturbance and attraction of wildlife during construction, key wildlife and biodiversity zone, protective notations, moose winter range.	
4. Wildlife Indicator – Forest Furbearers				
4.1 Change in habitat	Edmonton to Hinton Hargreaves to Darfield Black Pines to Hope Hope to Burnaby Temporary Facilities Black Pines Pump Station Power line Kingsvale Pump Station Power line	LSA	• Refer to Table 7.2.10-3: habitat loss/alteration, access and line-of-sight management, disturbance and attraction of wildlife during construction, mammal dens, species with special conservation status.	• Combined Project effects on forest furbearers resulting from habitat loss or alteration, changes in movement and increased mortality risk.
4.2 Change in movement		LSA	• Refer to Table 7.2.10-3: habitat loss/alteration, access and line-of-sight management, barriers to wildlife movement, wildlife disturbance and attraction of wildlife during construction, mammal dens.	
4.3 Increased mortality risk		RSA	• Refer to Table 7.2.10-3: habitat loss/alteration, access and line-of-sight management, disturbance and attraction of wildlife during construction, mammal dens, species with special conservation status.	

TABLE 7.2.10-4 Cont'd

Potential Effect	Project Component(s)	Spatial Boundary[1]	Key Recommendations/Mitigation Measures[2]	Potential Residual Effect(s)
5. Wildlife Indicator – Coastal Riparian Small Mammals				
5.1 Change in habitat	Black Pines to Hope Hope to Burnaby Burnaby to Westridge Temporary Facilities Sumas Terminal Westridge Marine Terminal	LSA	• Refer to Table 7.2.10-3: habitat loss/alteration, access and line-of-sight management, disturbance and attraction of wildlife during construction, Pacific water shrew, mammal dens, species with special conservation status.	• Combined Project effects on coastal riparian small mammals resulting from habitat loss or alteration, changes in movement and increased mortality risk.
5.2 Change in movement		LSA	• Refer to Table 7.2.10-3: habitat loss/alteration, access and line-of-sight management, barriers to wildlife movement, wildlife disturbance and attraction of wildlife during construction, mammal dens.	
5.3 Increased mortality risk		LSA	• Refer to Table 7.2.10-3: habitat loss/alteration, access and line-of-sight management, disturbance and attraction of wildlife during construction, Pacific water shrew, mammal dens, species with special conservation status.	
6. Wildlife Indicator – Bats				
6.1 Change in habitat	All	LSA	• Refer to Table 7.2.10-3: habitat loss/alteration, disturbance and attraction of wildlife during construction, bats, species with special conservation status.	• Combined Project effects on bats resulting from habitat loss or alteration, changes in movement and increased mortality risk.
6.2 Change in movement		LSA	• Refer to Table 7.2.10-3: habitat loss/alteration, access and line-of-sight management, wildlife disturbance and attraction of wildlife during construction, bats.	
6.3 Increased mortality risk		LSA	• Refer to Table 7.2.10-3: habitat loss/alteration, disturbance and attraction of wildlife during construction, bats, species with special conservation status.	
7. Wildlife Indicator – Grassland/Shrub-steppe Birds				
7.1 Change in habitat	Hargreaves to Darfield Black Pines to Hope Temporary Facilities Black Pines Pump Station Power line	LSA	• Refer to Table 7.2.10-3: habitat loss/alteration, disturbance and attraction of wildlife during construction, migratory birds, important bird area, sharp-tailed grouse range, sharp-tailed grouse lek, species with special conservation status.	• Combined Project effects on grassland/shrub-steppe birds resulting from habitat loss or alteration, changes in movement and increased mortality risk.
7.2 Change in movement		LSA	• Refer to Table 7.2.10-3: habitat loss/alteration, access and line-of-sight management, wildlife disturbance and attraction of wildlife during construction, migratory birds, important bird area, sharp-tailed grouse range, sharp-tailed grouse lek.	
7.3 Increased mortality risk		LSA	• Refer to Table 7.2.10-3: habitat loss/alteration, disturbance and attraction of wildlife during construction, migratory birds, Important bird area sharp-tailed grouse range, sharp-tailed grouse lek, species with special conservation status.	
8. Wildlife Indicator – Mature/Old Forest Birds				
8.1 Change in habitat	All	LSA	• Refer to Table 7.2.10-3: habitat loss/alteration, disturbance and attraction of wildlife during construction, migratory birds, raptor/owl nest species with special conservation status.	• Combined Project effects on mature/old forest birds resulting from habitat loss or alteration, changes in movement and increased mortality risk.
8.2 Change in movement		LSA	• Refer to Table 7.2.10-3: habitat loss/alteration, access and line-of-sight management, wildlife disturbance and attraction of wildlife during construction, migratory birds, raptor/owl nest.	
8.3 Increased mortality risk		LSA	• Refer to Table 7.2.10-3: habitat loss/alteration, disturbance and attraction of wildlife during construction, migratory birds, raptor/owl nest, species with special conservation status.	
9. Wildlife Indicator – Early Seral Forest Birds				
9.1 Change in habitat	All	LSA	• Refer to Table 7.2.10-3: habitat loss/alteration, disturbance and attraction of wildlife during construction, migratory birds, species with special conservation status.	• Combined Project effects on early seral forest birds resulting from habitat loss or alteration, changes in movement and increased mortality risk.
9.2 Change in movement		LSA	• Refer to Table 7.2.10-3: habitat loss/alteration, access and line-of-sight management, wildlife disturbance and attraction of wildlife during construction, migratory birds.	
9.3 Increased mortality risk		LSA	• Refer to Table 7.2.10-3: habitat loss/alteration, disturbance and attraction of wildlife during construction, migratory birds, species with special conservation status.	

TABLE 7.2.10-4 Cont'd

Potential Effect	Project Component(s)	Spatial Boundary[1]	Key Recommendations/Mitigation Measures[2]	Potential Residual Effect(s)
10. Wildlife Indicator – Riparian and Wetland Birds				
10.1 Change in habitat	All	LSA	• Refer to Table 7.2.10-3: habitat loss/alteration, disturbance and attraction of wildlife during construction, migratory birds, important bird area, trumpeter swan waterbodies/watercourses, species with special conservation status.	• Combined Project effects on riparian and wetland birds resulting from habitat loss or alteration, changes in movement and increased mortality risk.
10.2 Change in movement		LSA	• Refer to Table 7.2.10-3: habitat loss/alteration, access and line-of-sight management, wildlife disturbance and attraction of wildlife during construction, migratory birds, important bird area, trumpeter swan waterbodies/watercourses.	
10.3 Increased mortality risk		LSA	• Refer to Table 7.2.10-3: habitat loss/alteration, disturbance and attraction of wildlife during construction, migratory birds, important bird area, trumpeter swan waterbodies/watercourses, species with special conservation status.	
11. Wildlife Indicator – Wood Warblers				
11.1 Change in habitat	Edmonton to Hinton Temporary Facilities	LSA	• Refer to Table 7.2.10-3: habitat loss/alteration, disturbance and attraction of wildlife during construction, migratory birds, species with special conservation status.	• Combined Project effects on wood warblers resulting from habitat loss or alteration, changes in movement and increased mortality risk.
11.2 Change in movement		LSA	• Refer to Table 7.2.10-3: habitat loss/alteration, access and line-of-sight management, wildlife disturbance and attraction of wildlife during construction, migratory birds.	
11.3 Increased mortality risk		LSA	• Refer to Table 7.2.10-3: habitat loss/alteration, disturbance and attraction of wildlife during construction, migratory birds, species with special conservation status.	
12. Wildlife Indicator – Short-eared Owl				
12.1 Change in habitat	Edmonton to Hinton Hargreaves to Darfield Black Pines to Hope Hope to Burnaby Burnaby to Westridge Temporary Facilities Black Pines Pump Station Power line	LSA	• Refer to Table 7.2.10-3: habitat loss/alteration, disturbance and attraction of wildlife during construction, migratory birds, raptor nest, species with special conservation status.	• Combined Project effects on short-eared owl resulting from habitat loss or alteration, changes in movement and increased mortality risk.
12.2 Change in movement		LSA	• Refer to Table 7.2.10-3: habitat loss/alteration, access and line-of-sight management, wildlife disturbance and attraction of wildlife during construction, migratory birds, raptor nest.	
12.3 Increased mortality risk		LSA	• Refer to Table 7.2.10-3: habitat loss/alteration, disturbance and attraction of wildlife during construction, migratory birds, raptor nest, species with special conservation status.	
13. Wildlife Indicator – Rusty Blackbird				
13.1 Change in habitat	Edmonton to Hinton Hargreaves to Darfield Black Pines to Hope Hope to Burnaby Temporary Facilities Black Pines Pump Station Power line Kingsvale Pump Station Power line	LSA	• Refer to Table 7.2.10-3: habitat loss/alteration, disturbance and attraction of wildlife during construction, migratory birds, species with special conservation status.	• Combined Project effects on rusty blackbird resulting from habitat loss or alteration, changes in movement and increased mortality risk.
13.2 Change in movement		LSA	• Refer to Table 7.2.10-3: habitat loss/alteration, access and line-of-sight management, wildlife disturbance and attraction of wildlife during construction, migratory birds.	
13.3 Increased mortality risk		LSA	• Refer to Table 7.2.10-3: habitat loss/alteration, disturbance and attraction of wildlife during construction, migratory birds, species with special conservation status.	
14. Wildlife Indicator – Flammulated Owl				
14.1 Change in habitat	Black Pines to Hope Temporary Facilities Black Pines Pump Station Power line Kingsvale Pump Station Power line	LSA	• Refer to Table 7.2.10-3: habitat loss/alteration, disturbance and attraction of wildlife during construction, migratory birds, important bird area, raptor nest, species with special conservation status.	• Combined Project effects on flammulated owl resulting from habitat loss or alteration, changes in movement and increased mortality risk.
14.2 Change in movement		LSA	• Refer to Table 7.2.10-3: habitat loss/alteration, access and line-of-sight management, wildlife disturbance and attraction of wildlife during construction, migratory birds, important bird area, raptor nest.	

TABLE 7.2.10-4 Cont'd

Potential Effect	Project Component(s)	Spatial Boundary[1]	Key Recommendations/Mitigation Measures[2]	Potential Residual Effect(s)
14.3 Increased mortality risk		LSA	• Refer to Table 7.2.10-3: habitat loss/alteration, disturbance and attraction of wildlife during construction, migratory birds, important bird area, raptor nest, species with special conservation status.	
15. Wildlife Indicator – Lewis's Woodpecker				
15.1 Change in habitat	Black Pines to Hope Temporary Facilities Black Pines Pump Station Power line Kingsvale Pump Station Power line	LSA	• Refer to Table 7.2.10-3: habitat loss/alteration, disturbance and attraction of wildlife during construction, migratory birds, important bird area, species with special conservation status.	• Combined Project effects on Lewis's woodpecker resulting from habitat loss or alteration, changes in movement and increased mortality risk.
15.2 Change in movement		LSA	• Refer to Table 7.2.10-3: habitat loss/alteration, access and line-of-sight management, wildlife disturbance and attraction of wildlife during construction, migratory birds, important bird area.	
15.3 Increased mortality risk		LSA	• Refer to Table 7.2.10-3: habitat loss/alteration, disturbance and attraction of wildlife during construction, migratory birds, important bird area, species with special conservation status.	
16. Wildlife Indicator – Williamson's Sapsucker				
16.1 Change in habitat	Black Pines to Hope Temporary Facilities Black Pines Pump Station Power line Kingsvale Pump Station Power line	LSA	• Refer to Table 7.2.10-3: habitat loss/alteration, disturbance and attraction of wildlife during construction, migratory birds, species with special conservation status.	• Combined Project effects on Williamson's sapsucker resulting from habitat loss or alteration, changes in movement and increased mortality risk.
16.2 Change in movement		LSA	• Refer to Table 7.2.10-3: habitat loss/alteration, access and line-of-sight management, wildlife disturbance and attraction of wildlife during construction, migratory birds.	
16.3 Increased mortality risk		LSA	• Refer to Table 7.2.10-3: habitat loss/alteration, disturbance and attraction of wildlife during construction, migratory birds, species with special conservation status.	
17. Wildlife Indicator – Western Screech-owl				
17.1 Change in habitat	Black Pines to Hope Hope to Burnaby Burnaby to Westridge Temporary Facilities Black Pines Pump Station Power line Kingsvale Pump Station Power line Sumas Terminal Westridge Marine Terminal	LSA	• Refer to Table 7.2.10-3: habitat loss/alteration, disturbance and attraction of wildlife during construction, migratory birds, raptor nest, species with special conservation status.	• Combined Project effects on western screech-owl resulting from habitat loss or alteration, changes in movement and increased mortality risk.
17.2 Change in movement		LSA	• Refer to Table 7.2.10-3: habitat loss/alteration, access and line-of-sight management, wildlife disturbance and attraction of wildlife during construction, migratory birds, raptor nest.	
17.3 Increased mortality risk		LSA	• Refer to Table 7.2.10-3: habitat loss/alteration, disturbance and attraction of wildlife during construction, migratory birds, raptor nest, species with special conservation status.	
18. Wildlife Indicator – Great Blue Heron				
18.1 Change in habitat	All	LSA	• Refer to Table 7.2.10-3: habitat loss/alteration, disturbance and attraction of wildlife during construction, migratory birds, important bird area, great blue heron nesting colony, species with special conservation status.	• Combined Project effects on great blue heron resulting from habitat loss or alteration, changes in movement and increased mortality risk.
18.2 Change in movement		LSA	• Refer to Table 7.2.10-3: habitat loss/alteration, access and line-of-sight management, wildlife disturbance and attraction of wildlife during construction, migratory birds, important bird area, great blue heron nesting colony.	
18.3 Increased mortality risk		LSA	• Refer to Table 7.2.10-3: habitat loss/alteration, disturbance and attraction of wildlife during construction, migratory birds, important bird area, great blue heron nesting colony, species with special conservation status.	

TABLE 7.2.10-4 Cont'd

Potential Effect	Project Component(s)	Spatial Boundary[1]	Key Recommendations/Mitigation Measures[2]	Potential Residual Effect(s)
19. Wildlife Indicator – Spotted Owl				
19.1 Change in habitat	Black Pines to Hope Temporary Facilities	LSA	• Refer to Table 7.2.10-3: habitat loss/alteration, disturbance and attraction of wildlife during construction, migratory birds, Sowaqua spotted owl WHA, raptor nest, species with special conservation status.	• Combined Project effects on spotted owl resulting from habitat loss or alteration, changes in movement and increased mortality risk.
19.2 Change in movement		LSA	• Refer to Table 7.2.10-3: habitat loss/alteration, access and line-of-sight management, wildlife disturbance and attraction of wildlife during construction, migratory birds, Sowaqua spotted owl WHA, raptor nest.	
19.3 Increased mortality risk		LSA	• Refer to Table 7.2.10-3: habitat loss/alteration, disturbance and attraction of wildlife during construction, migratory birds, Sowaqua spotted owl WHA, raptor nest, species with special conservation status.	
20. Wildlife Indicator – Bald Eagle				
20.1 Change in habitat	All	LSA	• Refer to Table 7.2.10-3: habitat loss/alteration, disturbance and attraction of wildlife during construction, migratory birds, sensitive raptor range, raptor nest, species with special conservation status.	• Combined Project effects on bald eagle resulting from habitat loss or alteration, changes in movement and increased mortality risk.
20.2 Change in movement		LSA	• Refer to Table 7.2.10-3: habitat loss/alteration, access and line-of-sight management, wildlife disturbance and attraction of wildlife during construction, migratory birds, sensitive raptor range, raptor nest.	
20.3 Increased mortality risk		LSA	• Refer to Table 7.2.10-3: habitat loss/alteration, disturbance and attraction of wildlife during construction, migratory birds, sensitive raptor range, raptor nest, species with special conservation status.	
21. Wildlife Indicator – Common Nighthawk				
21.1 Change in habitat	All	LSA	• Refer to Table 7.2.10-3: habitat loss/alteration, disturbance and attraction of wildlife during construction, migratory birds, species with special conservation status.	• Combined Project effects on common nighthawk resulting from habitat loss or alteration, changes in movement and increased mortality risk.
21.2 Change in movement		LSA	• Refer to Table 7.2.10-3: habitat loss/alteration, access and line-of-sight management, wildlife disturbance and attraction of wildlife during construction, migratory birds.	
21.3 Increased mortality risk		LSA	• Refer to Table 7.2.10-3: habitat loss/alteration, disturbance and attraction of wildlife during construction, migratory birds, species with special conservation status.	
22. Wildlife Indicator – Northern Goshawk *laingi* ssp.				
22.1 Change in habitat	Hope to Burnaby Burnaby to Westridge Temporary Facilities Sumas Terminal Westridge Marine Terminal	LSA	• Refer to Table 7.2.10-3: habitat loss/alteration, disturbance and attraction of wildlife during construction, migratory birds, raptor/owl nest, species with special conservation status.	• Combined Project effects on northern goshawk resulting from habitat loss or alteration, changes in movement and increased mortality risk.
22.2 Change in movement		LSA	• Refer to Table 7.2.10-3: habitat loss/alteration, access and line-of-sight management, wildlife disturbance and attraction of wildlife during construction, migratory birds, raptor/owl nest.	
22.3 Increased mortality risk		LSA	• Refer to Table 7.2.10-3: habitat loss/alteration, disturbance and attraction of wildlife during construction, migratory birds, raptor nest, species with special conservation status.	
23. Wildlife Indicator – Olive-sided Flycatcher				
23.1 Change in habitat	All	LSA	• Refer to Table 7.2.10-3: habitat loss/alteration, disturbance and attraction of wildlife during construction, migratory birds, species with special conservation status.	• Combined Project effects on olive-sided flycatcher resulting from habitat loss or alteration, changes in movement and increased mortality risk.
23.2 Change in movement		LSA	• Refer to Table 7.2.10-3: habitat loss/alteration, access and line-of-sight management, wildlife disturbance and attraction of wildlife during construction, migratory birds.	
23.3 Increased mortality risk		LSA	• Refer to Table 7.2.10-3: habitat loss/alteration, disturbance and attraction of wildlife during construction, migratory birds, species with special conservation status.	

TABLE 7.2.10-4 Cont'd

Potential Effect	Project Component(s)	Spatial Boundary[1]	Key Recommendations/Mitigation Measures[2]	Potential Residual Effect(s)
24. Wildlife Indicator – Pond-dwelling Amphibians				
24.1 Change in habitat	All	LSA	• Refer to Table 7.2.10-3: habitat loss/alteration, access and line-of-sight management, disturbance and attraction of wildlife during construction, amphibian breeding pond, species with special conservation status.	• Combined Project effects on pond-dwelling amphibians resulting from habitat loss or alteration, changes in movement and increased mortality risk.
24.2 Change in movement		LSA	• Refer to Table 7.2.10-3: habitat loss/alteration, access and line-of-sight management, wildlife disturbance and attraction of wildlife during construction, amphibian breeding pond.	
24.3 Increased mortality risk		RSA	• Refer to Table 7.2.10-3: habitat loss/alteration, disturbance and attraction of wildlife during construction, amphibian breeding pond, species with special conservation status.	
25. Wildlife Indicator – Stream-dwelling Amphibians				
25.1 Change in habitat	Black Pines to Hope Hope to Burnaby Temporary Facilities Sumas Terminal	LSA	• Refer to Table 7.2.10-3: habitat loss/alteration, access and line-of-sight management, disturbance and attraction of wildlife during construction, stream dwelling amphibians, species with special conservation status.	• Combined Project effects on stream-dwelling amphibians resulting from habitat loss or alteration, changes in movement and increased mortality risk.
25.2 Change in movement		LSA	• Refer to Table 7.2.10-3: habitat loss/alteration, access and line-of-sight management, wildlife disturbance and attraction of wildlife during construction, stream dwelling amphibians.	
25.3 Increased mortality risk		LSA	• Refer to Table 7.2.10-3: habitat loss/alteration, disturbance and attraction of wildlife during construction, stream dwelling amphibians, species with special conservation status.	
26. Wildlife Indicator – Arid Habitat Snakes				
26.1 Change in habitat	Black Pines to Hope Temporary Facilities	LSA	• Refer to Table 7.2.10-3: habitat loss/alteration, access and line-of-sight management, disturbance and attraction of wildlife during construction, reptiles, species with special conservation status.	• Combined Project effects on arid habitat snakes resulting from habitat loss or alteration, changes in movement and increased mortality risk.
26.2 Change in movement		LSA	• Refer to Table 7.2.10-3: habitat loss/alteration, access and line-of-sight management, wildlife disturbance and attraction of wildlife during construction, reptiles.	
26.3 Increased mortality risk		RSA	• Refer to Table 7.2.10-3: habitat loss/alteration, disturbance and attraction of wildlife during construction, reptiles, species with special conservation status.	

Notes: 1 Refer to Section 7.2.10.2 for an explanation of spatial boundaries relevant to each indicator.
2 Refer to Table 7.2.10-3 for complete recommendations and mitigation.

7.2.10.8 Significance Evaluation Approach for Wildlife and Wildlife Habitat

All assessment criteria were considered for each residual effect. Where appropriate, the key or most influential assessment criteria used to determine the significance of each residual effect are noted (*e.g.,* magnitude, reversibility, probability). The significance determinations incorporate professional judgment, which allows integration of all of the effects criteria ratings to provide relevant significance conclusions that are sensitive to context and facilitate decision-making (Lawrence 2007).

Quantitative metrics (*e.g.,* change in area of suitable habitat) and accepted biological thresholds or standards (*e.g.,* road density for grizzly bear) are incorporated into the characterization of magnitude for each residual effect, where available. The sensitivity of the indicator (*e.g.,* indicated by conservation status, population trend and sensitivity to disturbance), where relevant, was considered in the determination of magnitude when biological thresholds or standards were not available, such as in the assessment of movement and mortality risk for most wildlife indicators. In the absence of biological thresholds or standards, the magnitude evaluation also considered relevant land use planning objectives and strategies, and previous environmental assessments reviewed and approved under provincial and federal environmental regulatory processes, where appropriate. These sources provide useful information on social values and risk tolerance, which are an essential component of significance determination.

7.2.10.9 Significance Evaluation of Potential Residual Effects on Mammal Indicators

The mammal indicators for the Project include grizzly bear, woodland caribou, moose, forest furbearers, coastal riparian small mammals and bats (Table 7.2.10-1). Pipeline and facility construction and operations activities have the potential to affect mammals by causing changes in habitat, movement and mortality risk. Detailed species accounts (including species lists for the community indicators) are described in the Wildlife Habitat Modelling and Species Accounts Technical Report of Volume 5C.

Relevant regulatory guidelines, information identified during Aboriginal participation and ecological context were considered in the characterization of potential residual effects for the mammal indicators. A summary of regulatory guidelines is provided in Section 7.2.10.4.

The compilation of ATK, including the collection of TEK through Aboriginal field participation and engagement provided valuable information on mammals along the proposed pipeline corridor, and identified concerns and potential effects of the Project. Consultation and engagement details regarding wildlife, ATK and TEK are provided in the Wildlife Technical Report of Volume 5C, and this information is included and considered throughout the effects assessment on mammal indicators.

Information on the ecological context for each mammal indicator (*e.g.*, species status, population trends, known threats, best management practices and conservation strategies) is provided in Table 7.2.10-5. The purpose of providing ecological context for each indicator is to provide an indication of the resilience of each indicator to disturbance effects.

TABLE 7.2.10-5

ECOLOGICAL CONTEXT SUMMARY FOR MAMMAL INDICATORS

Mammal Indicator	Ecological Context
Grizzly Bear	• Grizzly bears are Blue-listed in BC and have a Conservation Framework Priority rating of 2 (BC CDC 2013). Grizzly bears are designated as at Risk in Alberta and are listed as Threatened under the Alberta *Wildlife Act* and *Wildlife Regulation* (AESRD 2012a, ASRD 2011b). The western population of grizzly bears is federally listed as a species of Special Concern under COSEWIC due to extensive range and population reductions influenced by habitat development and fragmentation, and human-related conflicts and mortality (Ross 2002). Grizzly bear are also listed under Schedule 3 of *SARA* (Environment Canada 2013c). • The Project intersects two Bear Management Areas (also referred to as Grizzly Bear Population Units [GBPUs]) in Alberta: Grande Cache and Yellowhead (AESRD 2013d, ASRD 2008). The Project intersects three viable GBPUs in BC, including the Columbia-Shuswap, Wells Gray and Robson, and one threatened GBPU, the North Cascades (BC MFLNRO 2012b). The total population within the two GBPUs in Alberta is estimated at 395 individuals (ASRD ACA 2010) and the total population within the three viable GBPUs in BC is estimated at 1,197 individuals (BC MFLNRO 2012b). The BC MOE has identified objectives for the viable GBPUs in BC, including maintaining current population abundance and distribution, and providing sustainable harvest and viewing opportunities where appropriate (BC MFLNRO 2012b). The North Cascades GBPU has an estimated population of six individuals (BC MFLNRO 2012b). The management objective for threatened GBPUs in BC is population recovery to prevent range contraction and ensure long-term population viability (BC MFLNRO 2012b). • Cumulative effects of human development are identified as the greatest threat to grizzly bears (ASRD ACA 2010, BC MOE 2012c). • Grizzly bear is managed as a game animal in most viable GBPUs in BC. Hunting seasons are provided for Aboriginal communities, resident and, in some cases, non-resident hunters. Hunting seasons are closed in threatened population units and some viable GBPUs where known grizzly bear mortality has met or exceeded allowable limits established through the BC MOE's Grizzly Bear Harvest Management Procedure. The viable GBPUs crossed by the Project are open for hunting (BC MOE 2012c). In Alberta the spring grizzly bear hunt was suspended in 2006 to allow for a better population assessment. The hunting suspension continued through 2012 and 2013 (Government of Alberta 2012). • Grizzly bear mortality is primarily related to direct human causes (ASRD 2008, Austin and Wrenshall 2004, Hamilton *et al.* 2004, Kansas 2002, McLellan 1990, Ross 2002). Bear-human conflicts can result in mortality as bears may be destroyed ("animal control") or relocated. Hunting and poaching, and collisions with vehicle/rail traffic are also key factors in grizzly bear mortality (BC MOE 2012c, Ross 2002). Within the viable GBPUs crossed by the Project, hunting is the primary cause of mortality for grizzly bears (BC MOE 2012c). • Disturbance from anthropogenic noise created by roads has been found to have a negative effect on habitat use by grizzly bears. Work by Mace *et al.* (1996) found that noise from road activity of more than 10 vehicles per day (*e.g.,* primary and secondary roads) negatively affects grizzly habitat occupancy up to 500 m into the forest from the disturbance. • Roads are demonstrated to affect grizzly bear habitat effectiveness, fragment habitat (*e.g.*, create barriers/filters to movement; alienate bears from suitable habitat) and increase mortality risk (Hamilton pers. comm.). at the regional scale (*i.e.*, GBPU), open road density higher than 0.6 km/km^2 is known to affect grizzly bear habitat use, and these effects are magnified when road density increases over approximately 1.0 km/km^2 (ASRD 2008, BC MOE 2012c, BC MWLAP 2004b). Motorized access density of 0.6 km/km^2 is adopted in this assessment as a biological threshold for a high magnitude effect. • The Robson Valley LRMP recommends maintaining or enhancing habitat and/or increase numbers, genetic variability and distribution of grizzly bears (BC ILMB 1999).

TABLE 7.2.10-5 Cont'd

Mammal Indicator	Ecological Context
Grizzly Bear (cont'd)	• Valemount to Blue River and Eight Peaks Winter Recreation SRMPs recommend incorporating measures into the design of winter activities and developments that minimize impacts on grizzly bear habitat and denning sites and bear human conflicts (BC ILMB 2005, BC MSRM 2003). • The Alberta Grizzly Bear Recovery Plan 2008-2013 has been implemented within Alberta in an attempt to reduce human-caused mortality of grizzly bears, improve knowledge about the population within Alberta, reduce the number of human-bear conflicts, improve and deliver education programs to the public (*i.e.*, Bear Smart), maintain quality habitat, and improve inter-jurisdictional cooperation (ASRD 2008). A hunting moratorium was also put in place in 2006 and additional conservation initiatives include increasing the maximum poaching fine, delineating Bear Management Areas (comparable to Grizzly Bear Population Units), DNA population censuses in certain Bear Management Areas, financial support for government staff biologists, implementation of the Bear Smart Community Program, and aversive conditioning of grizzly bears in high risk areas (ASRD 2008). The North Cascades Grizzly Bear Recovery Team was initiated to restore this population to viable status. Seven objectives of the Recovery Plan were established including: providing habitat of sufficient quality and quantity; preventing population fragmentation and maintain genetic diversity; increasing the total number of grizzly bears in the North Cascades; minimizing the potential for human/bear conflict; minimizing human-caused mortality of grizzly bears; increasing scientific and public knowledge and support for grizzly bear recovery; and facilitating interagency cooperation and management (North Cascades Grizzly Bear Recovery Team 2004). • Table 7.2.10-7 provides a summary of the predicted change in grizzly bear habitat as a result of the Project.
Woodland Caribou	• The Wells Gray and Groundhog caribou herds are mountain ecotype woodland caribou, within the Southern Mountain Designatable Unit (DU9). Mountain ecotype caribou are Red-listed, have a Conservation Framework Priority rating of 2 (BC CDC 2013), and are designated as Threatened under Schedule 1 of *SARA* and by COSEWIC (COSEWIC 2013, Environment Canada 2013c). • The proposed pipeline corridor traverses the Wells Gray caribou range for approximately 30.7 km, of which 22 km (71.7%) are parallel to existing linear disturbance and 8.7 km (28.3%) is new cut. The proposed pipeline corridor traverses the Groundhog caribou range for approximately 10.3 km, of which 9.1 km (88.3%) are contiguous with existing linear disturbance and 1.2 km (11.7%) is new cut. Table 7.2.10-7 provides a summary of the predicted change in disturbance within caribou ranges and the approved UWR encountered by the proposed pipeline corridor. • The proposed pipeline corridor intersects one approved Ungulate Winter Range (UWR) for caribou in the Wells Gray caribou range: u-3-004 (mountain caribou). Within u-3-004, the corridor is located in a modified harvest zone. No UWRs for caribou are encountered in the Groundhog caribou range. • The Wells Gray caribou herd was estimated at 422 individuals in 2006, which is an increase from the 2004 of 307 individuals (Hatter 2006, Seip *et al.* 2005) suggesting that the recovery probability for this herd remains high. The Groundhog caribou herd was estimated at 23 individuals in 2008, 30 individuals in 2006, 23 individuals in 2004 and 43 individuals in 1995 (Furk 2008, Hatter 2006, Seip *et al.* 2005). The herd is small and extremely isolated from other mountain caribou populations and a population viability analysis estimated a high probability of extinction of the Groundhog Caribou Herd within 30 years (Wittmer *et al.* 2010). • Mountain ecotype caribou are generally found at elevations of 1,500-2,100 m; however, this can vary with year, season, local population and individual (BC MWLAP 2004b). Seasonally, mountain ecotype caribou generally exhibit weak horizontal range shifts, but strong elevational shifts (Hatter *et al.* 2009) from valley bottoms and lower slopes in early winter, to alpine and sub-alpine habitats in late winter and low-elevation snow-free areas in spring (BC MWLAP 2004b, Mountain Caribou Technical Advisory Committee [MCTAC] 2002). Sub-alpine forests and alpine areas are used in summer. Parturient females move to exposed locations in high elevation alpine and sub-alpine areas to calve in spring and early summer. These sites offer refuge from most predators, but are often food-limited (BC MWLAP 2004b, MCTAC 2002). • The Robson Valley LRMP recommends protecting high elevation caribou winter range habitat and improving understanding of the behaviour and biology of caribou populations and the effects of resource development on caribou habitat (BC ILMB 1999). • The Kamloops LRMP recommends maintaining opportunities for mineral exploration and development while ensuring that these activities will be undertaken with sensitivity to caribou habitat (BC ILMB 1995). • Within the Kamloops LRMP, the North Thompson Caribou Special Resource Management Zone is divided into planning cells and corridors and outlines management goals which include to maintain the quantity of habitat required to support viable populations within the plan area, and to maintain connectivity with adjoining areas, and to maintain or improve the effectiveness and quality of suitable mountain caribou habitats within core winter planning cells. The proposed pipeline corridor traverses movement corridor areas which have objectives including facilitating caribou movement within and between seasonal habitats and between populations, maintaining the suitable habitat necessary for caribou movement within corridors, by maintaining a minimum 33% of the capable habitat area as suitable habitat to provide security without impeding caribou movement, maintaining the functionality of confirmed trails over time, and employing harvest and silviculture activities that retain caribou habitat attributes, or that are intended to accelerate the recovery of caribou habitat suitability. Other objectives that may be relevant to the Project include managing and coordinating access in and adjacent to core planning cells and corridors so that habitat effectiveness is not diminished, and minimizing the amount and density of roads within caribou movement corridors (Kamloops LRMP Mountain Caribou Subcommittee 2006).

TABLE 7.2.10-5 Cont'd

Mammal Indicator	Ecological Context
Woodland Caribou (cont'd)	• The BC government announced the Mountain Caribou Recovery Implementation Plan (MCRIP) in 2007, with the goal to stop the decline of mountain caribou populations by 2014 and recover the population to pre-1995 levels (2,500 animals) within 20 years (*i.e.*, 2027). Recovery objectives include: - protecting all high suitability early and late winter mountain caribou habitat from logging and road building (*e.g.*, increasing fully protected high-suitability winter habitat from 65% to 95%) to address caribou mortality associated with habitat loss and fragmentation; - managing winter backcountry recreational activities (*e.g.*, snowmobiling, heli-skiing, cat-skiing) through education, closures and moratoriums; - managing predator (wolf and cougar) populations; - managing primary prey populations (deer, moose) to re-balance the predator-prey system; - augmenting critically endangered herds through transplanting animals; and – monitoring and adaptive management (BC ILMB 2007). • The BC MOE is responsible for implementing the MCRIP and convened the Mountain Caribou Science Team, which identified several recommendations to achieve the MCRIP objectives and timelines, including: predator population control; augmentation of the South Purcell herd and all herds with fewer than 20 animals; and reduction in moose densities in mountain caribou range through management of hunting seasons and cow moose harvest allowances. The Science Team also recommended: minimizing forestry-related activities in core habitat; enforcement of recreation restrictions; and complete census of mountain caribou herds every 3 years (BC MOE 2009). • The Environmental Protection and Management Guide (BC OGC 2013) includes recommended guidelines for operations in caribou range in BC, including measures related to road construction, snow berms, speed limits, line-of-sight management, pipeline construction, reclamation and restoration, and stewardship. The intent of the recommendations is to limit activities within caribou UWRs that affect lichen forage availability, predator mobility and hunting efficiency, forage for other ungulate species, and fragmentation of habitat. • Consultation with the local BC MFLNRO wildlife biologist identified restriction of construction timing to late winter, spring, or summer, and early seral vegetation and ungulate (moose) management as key management objectives in the Project area (Surgenor pers. comm.). • Table 7.2.10-7 provides a summary of the predicted change in caribou habitat as a result of the Project.
Moose	• Moose are not listed provincially or federally (ASRD 2011b, BC CDC 2013, COSEWIC 2013, Environment Canada 2013c), and are considered to be of lowest (6) conservation priority in BC (BC CDC 2013). • The most recent (2011) estimate for BC's moose population is 145,000 to 235,000 (BC MFLNRO 2013c,d). BC MFLNRO surveys conducted in the Thompson and Okanagan Region during winter 2012/2013 indicate moderate moose densities and low bull to cow ratios in the Monte Hills south of Kamloops. In parts of the North Thompson, an approximate 60% decline in moose densities was documented and due to limited hunting in the areas it is suggested that wolf predation may be a factor. In response to these results, the BC MFLNRO is continuing regular engagement with stakeholders and First Nations supporting a radio-collaring initiative in the Thompson and Okanagan region to examine moose survival and habitat use (BC MFLNRO 2013c). • There is no provincial estimate for moose in Alberta, however, the species in common throughout most eco-regions, except for the prairie and parkland (Pattie and Fisher 1999). • Limiting factors for moose populations include food availability, weather, hunting, parasites/disease and predation (Gasaway *et al.* 1992, Keystone Wildlife Research Ltd. 2006). Predation, availability of food, climate, parasites and disease are the most important natural factors potentially limiting moose populations. Moose populations are considered more sensitive to overharvest and other sources of mortality than to habitat loss and fragmentation (Antoniuk *et al.* 2009). Hunting is often the primary limiting factor of moose populations in areas accessible to humans (Dussault *et al.* 2005). Predation by wolves is an important factor for moose mortality. Wolves are known to travel on roads during winter, but have been shown to avoid them in areas with high levels of human activity, likely due to increased mortality risk (Kunkel and Pletscher 2000). This may explain why moose predation by wolves in the Flathead River area in BC was lower in areas of high road densities (Kunkel and Pletscher 2000). • Linear features such as secondary roads and seismic lines are not considered an impediment to moose movement (Collister *et al.* 2003). Reduced use or avoidance of linear features such as roads, trails and seismic lines by moose has been documented in some regions (Collister *et al.* 2003, Ferguson and Keith 1985, Rolley and Keith 1980). However, moose have been shown to exhibit heavy use of forestry roads and cutblocks during winter in other regions, presumably due to better forage availability and lower wolf densities (Kunkel and Pletscher 2000, Serrouya and D'Eon 2002). • Levels of human activity (*e.g.*, noise, traffic) affect moose response to anthropogenic disturbance (Collister *et al.* 2003). Wasser *et al.* (2011) reported moose avoided linear features with no or unknown levels of human use and areas near primary roads; however, avoidance effects were not apparent for moose beyond several hundred metres of exploration roads. Sensory disturbance of moose can result in displacement to less suitable habitats. Although sensitive to human disturbance, moose will habituate to non-threatening and repetitive activities (Wiacek *et al.* 2002). • Stand-initiating disturbances such as fire and forest harvest can create high quality forage sources for moose, since the canopy is opened and forage production is increased. Optimal successional stages for moose forage in burned areas usually occur 10 to 30 years following fire (Nietfeld *et al.* 1985, Peek 2007) and 10 to 15 years following forest harvest (Collister *et al.* 2003). Moose may use recently burned areas less frequently than remnant forests, and browse shrubby vegetation within young burns near forest edges (*i.e.*, less than 100 m from forest edges) (Peek 2007). In the Southern Interior region of BC, moose require a mix of forest age classes that provides browse as well as mature forest with high canopy closure (*i.e.*, snow interception cover and thermal cover) (Wall *et al.* 2011).

TABLE 7.2.10-5 Cont'd

Mammal Indicator	Ecological Context
Moose (cont'd)	• The Robson Valley LRMP recommends maintaining or enhancing populations and habitat for moose and the Kamloops LRMP recommends maintaining thermal and visual cover for moose, and enhancing browse production (BC ILMB 1995, 1999). • The Coal Branch Sub-Regional Integrated Resource Plan along the Edmonton to Hinton Segment recommends ensuring that populations of moose are maintained or increased (Alberta Forestry, Lands and Wildlife [AFLW] 1990). • The proposed pipeline corridor traverses areas that the Kamloops LRMP has identified as areas of moose winter range. Objectives for these areas include: maintaining thermal and visual cover for moose, and enhancing browse production; and maintaining suitable forest cover attributes with respect to thermal cover and forage production (BC Ministry of Agriculture and Lands 2006). Within these areas, it is recommended that construction not occur from December 1 to March 15 (Surgenor pers. comm.). • Table 7.2.10-7 provides a summary of the predicted change in moose habitat as a result of the Project.
Forest furbearers	• The assessment of forest furbearers focused on marten, fisher and wolverine, as these representative species are considered environmental indicators (*i.e.*, sensitive to change), have human (subsistence, cultural) and conservation importance, and have potential to interact with the Project. • Marten is not a species of conservation concern provincially or federally (ASRD 2011b, BC CDC 2013, COSEWIC 2013, Environment Canada 2013c). Marten populations are considered to be Apparently Secure to Secure in BC and Secure in Alberta (ASRD 2011b, BC Conservation Framework 2013) and are Yellow-listed in BC (BC CDC 2013). Fisher and wolverine are Blue-listed species in BC and have Conservation Framework Priority ratings of 2 (BC CDC 2013). Fisher are designated as Sensitive in Alberta (ASRD 2011b), and have no federal designation under COSEWIC or *SARA*. Wolverine are designated as May Be at Risk in Alberta (ASRD 2011b), and are federally listed as a species of Special Concern by COSEWIC given a low intrinsic rate of population growth coupled with trapping and habitat loss and fragmentation (COSEWIC 2003a). Wolverine are also listed under Schedule 3 of *SARA* (Environment Canada 2013c). • Population density estimates for marten across North America range from 0.4 to 2.4 animals/km^2 (Hatler *et al.* 2003a). Population density estimates for the Project area are not known; however, in the Selkirk Mountains of southeastern BC, marten density is estimated to be 0.33 animals/km^2 (Mowat and Paetkau 2002). Marten abundance may experience dramatic annual fluctuations due to changes in prey availability (Hatler *et al.* 2003a). • Fishers occur in low densities throughout much of their range in BC, which has been found to vary between ecological regions of BC based on habitat quality (Weir *et al.* 2011). For example, a study in the Williston Sub-Boreal Spruce BGC of BC estimated an average density of 8.8 fishers/1,000 km^2 (Weir and Corbould 2006), whereas a study by Weir *et al.* (2011) using the same methods in the boreal mixed-wood forests found almost double the density (16.3 fishers/1,000 km^2). • The population estimate for fishers in BC is estimated at 3,800 individuals (BC CDC 2013). Fisher population trends in BC are difficult to determine due to the lack of inventory information. Primary threats to fisher populations in BC are likely anthropogenic and occur through changes to habitats from development of forested lands (*i.e.*, logging, hydro-electric development, and land clearing) and changes in survival rates caused by trapping (BC MWLAP 2004b, Weir 2003). Fishers are particularly sensitive to intensive forest harvesting practices that occur quickly and cover large areas (*e.g.*, mountain pine beetle salvage harvests) (Weir and Almuedo 2010). Recent research in north-central BC estimated that harvesting 250 ha of forest in a 50 km^2 area (*i.e.*, a female home range) within a 12 year span reduces the likelihood of the area supporting a resident fisher by 50% (Weir and Almuedo 2010). Based on rates of habitat loss within areas known to support fisher, it is estimated that populations are declining annually by 20-30%; however, long-term population declines based on habitat loss are estimated at 25-50% (BC CDC 2013). • Wolverine occur at low densities throughout most of BC (BC MWLAP 2004b) and are expected to be most abundant in the interior mountain regions (Lofroth and Krebs 2007). Wolverines are more likely to occur in topographically rugged terrain and areas where industrial activity and habitat alteration is low (Fisher *et al.* 2013). • Marten, fisher and wolverine are managed as a fur-bearing species in Alberta and BC. Fisher and wolverine are categorized as a Class 2 species for fur harvest management in BC, which identifies them as sensitive to harvest (Hatler *et al.* 2003b). The harvest season for fisher was closed province wide due to concerns about the sustainability of the population from 1990 to 1992 (BC CDC 2013), however, harvest of fishers through incidental kills remained basically unchanged (Weir and Courbold 2000 in BC CDC 2013). Based on modelling of wolverine populations and harvest records from 1985 to 2004, harvest of wolverine at the provincial scale was sustainable (Lofroth and Ott 2007). • In Alberta, the fisher population status is unknown and distribution is uncertain (AESRD 2013d). Provincial fur production records in Alberta indicate the number of fisher harvested over four seasons from 2007 to 2011 ranged from 1,143 to 1,344 over the 2007/08 to 2010/11 seasons, with a large increase to 2,095 during the 2011/12 season (Government of Alberta 2013). • The wolverine is not common in Alberta and is found in the northern half of the province and along the Rocky Mountains (Petersen 1997) with wildlife management units bordering Jasper National Park reporting some of the highest harvest densities in Alberta (Alberta Conservation Association 2011). The number of wolverine harvested over five seasons from 2007 to 2012 have been slowly increasing from 26 in 2007-2008 to 41 in 2011-2012, with the highest number (54) produced in 2010-2011 (Government of Alberta 2013). • Limited distribution, low reproductive rates and large home ranges suggest fisher populations have a low resiliency or ability to recover from a reduction in numbers (BC MWLAP 2004b). Wolverine populations have low resiliency to population perturbation (*e.g.*, fur trapping) because of their low densities, large home range sizes, and relatively low reproductive rate (BC MWLAP 2004b). • Marten may move to lower elevations in winter when snowpack is high in mountainous coastal areas (Banfield 1974, Buskirk 1983, Steventon and Major 1982). Commonly reported refuge sites include ground burrows, rock piles and crevices, downed logs, stumps, snags, brush or slash piles and squirrel middens (Bull and Heater 2000, Buskirk 1984, Ruggiero *et al.* 1998, Steventon and Major 1982).

TABLE 7.2.10-5 Cont'd

Mammal Indicator	Ecological Context
Forest furbearers (cont'd)	• Marten and fisher habitat typically includes a mosaic of forest communities and seral stages, often with a relatively high proportion of mid- to late-seral forests (Bowman and Robitaille 1997, Buskirk and Powell 1994, Raley *et al.* 2012), including those that are deciduous-dominated (Poole *et al.* 2004). Fishers have been described as "area sensitive", meaning the frequency of fisher occurrence increases with increased size of late-successional forest stands, and they are less prevalent in forested landscapes with high levels of fragmentation (Powell and Zielinski 1994). Marten are often referred to as old-growth dependent and in northern boreal forests are closely associated with late successional coniferous stands, especially those dominated by spruce and fir, which have a complex coarse woody debris structure (Buskirk and Powell 1994, Slough 1989). • Coarse woody debris is an important ecological element for marten and fisher. Marten use coarse woody debris for thermal insulation and access to subnivean prey in winter, denning in spring, and for hunting and protection from predators all year (Buskirk and Powell 1994, Buskirk and Ruggiero 1994, Sherburne and Bissonette 1994, Taylor and Buskirk 1994, Thompson and Colgan 1994, Thompson and Harestad 1994). Complex forest structure provides security cover, microclimates for thermoregulation and potentially abundant prey for fisher (Raley *et. al.* 2012). • Open areas (*e.g.*, non-forested areas, large forest openings, open hardwood forests, recent clear-cuts, grasslands and areas above the timberline) and young seral stage forests are low-value habitat for marten and fisher and are typically avoided or used infrequently (Buskirk and Ruggiero 1994, Cheveau *et al.* 2013, Poole *et al.* 2004, Powell and Zielinski 1994, Soutière 1979, Spencer *et al.* 1983). However, fishers may occasionally use managed forests with little overhead cover and recently clear-cut areas, particularly in summer when shrubs and saplings may provide sufficient cover. These areas are generally avoided in winter when there is little cover and higher snow depths (Powell and Zielinski 1994). Marten will cross forestry roads and small clearings (Buskirk 1984, Buskirk and Ruggerio 1994) and in some situations, marten have been observed crossing relatively large non-forested openings (*e.g.*, 300 m); however, these movements were attributed to home range shifts or dispersion, rather than being typical of movements within a home range (Buskirk 1984). • Recommendations in the Identified Wildlife Species Account and status report for fisher include maintaining sufficient suitable habitat (*i.e.*, 30-45% mature and old forest with shrub cover, coniferous canopy cover, sub-hygric or wetter moisture regime, patches of large declining trees [especially black cottonwood] and greater than average amounts of coarse woody debris) and maximizing landscape connectivity using corridors of mature and old seral forests centered on stream systems (BC MWLAP 2004b, Weir 2003). Maintaining a 100 m riparian area buffer at ecologically relevant places along streams to help maintain landscape connectivity is also recommended for fisher (BC MWLAP 2004b). • The Identified Wildlife Species Account for wolverine suggests that the cumulative impacts of trapping, habitat alteration, forest harvesting, and forest access on wolverine populations is not well understood (Banci 1994 in BC MWLAP 2004b). The large-scale conversion of mature and old forest structural stages into early structural stage habitats is a major threat to wolverine habitat (BC MWLAP 2004b). Recommendations include creating refugia, planning development to occur on one side of a watershed at a time, minimizing road access, maintaining seasonal foraging areas, maintaining and minimizing disturbance to suitable denning sites, and retaining suitable movement and dispersal corridors (BC MWLAP 2004b). • Provincial recovery actions identified for fisher and wolverine under the BC Conservation Framework include monitoring population trends, compiling a status report, planning, reviewing resource use, habitat protection and restoration, and private land stewardship (BC CDC 2013). There are currently no federal recovery plans for marten, fisher or wolverine (Environment Canada 2013c), and no provincial recovery plans for these furbearers in Alberta (Government of Alberta 2013a). • The Coal Branch Sub-Regional Integrated Resource Plan along the Edmonton to Hinton Segment recommends maintaining viable, abundant and diverse populations of furbearers, and maintaining a mosaic of habitat types (AFLW 1990). • Table 7.2.10-7 provides a summary of the predicted change in marten and fisher habitat as a result of the Project.
Coastal riparian small mammals	• There are several small mammal species with conservation status designations of concern, which have potential to occur within the Lower Mainland region of BC, overlapping the Wildlife LSA (AESRD 2012a, ASRD 2011b, BC CDC 2013, COSEWIC 2013, Environment Canada 2013c): - Pacific water shrew (Endangered under Schedule 1 of *SARA* and by COSEWIC; Red-listed in BC; Conservation Framework Priority 1); - mountain beaver (Special Concern under Schedule 1 of *SARA* and by COSEWIC; Blue-listed in BC; Conservation Framework Priority 1 [*rainier* spp.] and 2 [*rufa* spp.]); - Olympic shrew (Red-listed in BC; Conservation Framework Priority 1); - Townsend's mole (Endangered under Schedule 1 of *SARA* and by COSEWIC; Red-listed in BC; Conservation Framework Priority 1); and - Trowbridge's shrew (Blue-listed in BC; Conservation Framework Priority 2). • The coastal riparian small mammal indicator is defined to include Pacific water shrew and mountain beaver specifically, but also addresses the broader community of small mammals that rely, at least for some life requisites, on riparian habitats in the coastal region of BC. • Population estimates are not available for Pacific water shrew but it is considered a rare species and important habitat continues to be lost to urban and agricultural developments and forestry (BC MWLAP 2004b, COSEWIC 2006d). They are restricted to the southwest corner of BC and can generally be found within 50 m of slow-moving streams and marshes (McComb and Anthony 1993, Whitaker and Maser 1976, Zuleta and Galindo-Leal 1994), and have been considered by some as a wetland-dependant species (Gomez and Anthony 1998). • Population estimates of mountain beaver are not well known because search effort had not been intensive with its range, but is likely > 10,000 mature animals in BC. A minimum of 1,500 mountain beaver dens have been identified in BC (COSEWIC 2012d). Primary threats to mountain beavers include climate change, habitat loss due to urban and agricultural development and habitat loss and soil compaction from forestry activities (COSEWIC 2012d).

TABLE 7.2.10-5 Cont'd

Mammal Indicator	Ecological Context
Coastal riparian small mammals (cont'd)	• The proposed pipeline corridor crosses proposed critical habitat for Pacific water shrew (Environment Canada 2013d). A proposed recovery strategy for Pacific water shrew has been completed, but has not yet been posted on the Species at Risk Public Registry for public consultation. The proposed pipeline corridor also crosses early candidate critical habitat for Townsend's mole, for which a recovery strategy has not yet been completed (Environment Canada 2013d). The Wildlife Technical Report in Volume 5C provides additional information regarding proposed and candidate critical habitats. • Pacific water shrew has been reported in the Surrey Bend Regional Park (BC CDC 2013). The Surrey Bend Management Plan guiding principal is to protect and enhance sensitive ecosystems and important habitats for wildlife and vegetation, including bog, marsh, and riparian forest areas (Metro Vancouver and City of Surrey 2010). • The goal of the *Recovery strategy for the Pacific water shrew* (*Sorex bendirii*) *in BC* is to maintain the current population of Pacific water shrew with no further loss of local populations and restore this species back to its historical range where suitable habitat still exists or can be restored (Pacific Water Shrew Recovery Team 2009). This goal will be achieved through seven objectives including: protecting all known extant locations; restoring historical and important potential habitat; preventing habitat fragmentation and maintaining connectivity; preventing inadvertent loss of unknown populations through surveys, modeling, and mapping; addressing immediate threats and mitigating direct mortality; evaluating implemented protective measures and recovery activities; and increasing our understanding of important habitat, life history, population dynamics, habitat use, and threats to the population. • The goal of the *Management plan for the Mountain Beaver (*Aplodontia rufa*) in BC* is to maintain the current distribution of all subpopulations in BC and maintain or improving the current abundance of each subpopulation (BC MOE 2013g). This goal will be achieved through three objectives including: protecting and/or maintaining habitat within the occupied range; assessing and mitigating the impacts of ongoing threats, particularly timber harvest/silviculture and residential urban development and road building; and addressing identified key knowledge gaps including population abundance, location of suitable habitat, and population viability. • A 100 m buffer from suitable Pacific water shrew habitat is recommended (Craig *et al.* 2010). The *Develop with Care Guidelines* (BC MOE 2012a) recommend a minimum 50 m buffer around mountain beaver colonies, tunnels and burrows. The *BC Coast Region Species and Ecosystems of Concern* suggest that a minimum, permanent 500 m buffer be established from mountain beaver burrows with structurally intact habitat features, and 100 m around water features (Zivet and Lindgren 2012). • Table 7.2.10-7 provides a summary of the predicted change in Pacific water shrew habitat capability and mountain beaver habitat suitability as a result of the Project.
Bats	• Bat species with potential to occur within the wildlife LSA include 13 species including the following species of conservation concern (AESRD 2012a, ASRD 2011b, BC CDC 2013, COSEWIC 2013, Environment Canada 2013c): - Townsend's big-eared bat (Blue-listed in BC; Conservation Framework Priority 2); - spotted bat (Special Concern under Schedule 1 of *SARA* and by COSEWIC; Blue-listed in BC; Conservation Framework Priority 2); - silver-haired bat (Yellow-listed in BC; Conservation Framework Priority 2; Sensitive in Alberta); - western small-footed myotis (Blue-listed in BC; Conservation Framework Priority 3; Sensitive in Alberta; Special Concern by Alberta's Endangered Species Conservation Committee [ESCC]); - Keen's myotis (Blue-listed in BC, Conservation Framework Priority 1); - little brown myotis (Endangered by COSEWIC; Yellow-listed in BC; Secure in Alberta); - northern myotis (Endangered by COSEWIC; Blue-listed in BC; Conservation Framework Priority 2; May Be at Risk in Alberta); and - fringed myotis (Blue-listed in BC; Conservation Framework Priority 3). • There are currently no federal or provincial recovery strategies or conservation plans for the bat species potentially occurring along the proposed pipeline corridor. • There is limited information available regarding bat habitat, movement, population status, trends and threats. Known threats include wind energy facilities and white-nose syndrome (BC CDC 2013). The nearest bat population infected with white-nose syndrome in Canada is in northwestern Ontario. • Forest edges are often associated with elevated bat foraging activity, likely because they provide openings required by bats, provide movement corridors, or accumulate insects (Jantzen 2012, Morris *et al.* 2010). Clearings, meadows, wetlands and other openings provide foraging habitat for bat species that forage for insects in the open (*e.g.*, little brown bats). Clutter-adapted species (*e.g.*, northern myotis) forage in the understory of forests (Morris *et al.* 2010, Patriquin and Barclay 2003). • Tree-cavities are extensively used for roosting by several bat species, and may be used as hibernacula in warmer areas of the province (Kalcounis-Ruppell *et al.* 2005, Nagorsen and Brigham 1993). Suitable tree-cavity roosting habitat is most often associated with old mixed or deciduous forests containing large-diameter decaying trees, which have cavities, crevices or sloughing bark where bats can hide (Kalcounis-Ruppell *et al.* 2005). • Refer to Table 7.2.10-7 for a summary of the predicted change in tree-roosting bat habitat as a result of the Project. • Caves and mines as well as tall rock faces with deep fissures are likely the primary hibernation habitat for bats, which may also be used as roosting habitat during the summer (Lausen and Barclay 2006, Nagorsen and Brigham 1993). There are no caves or mines along the proposed pipeline corridor (Wildlife Technical Report of Volume 5C).

Construction and operations of the Project will create new forest clearing, increase the existing corridor width where existing linear disturbances are paralleled, potentially remove site-specific habitat features (*e.g.*, forage/browse, security/thermal, dens, roosts), and require ongoing clearing as part of vegetation management during operations. The Project Footprint, including the proposed pipeline right-of-way, power lines and temporary facilities, will be reclaimed following construction. Temporary construction workspace will be allowed to regenerate to natural vegetation communities. The permanent pipeline right-of-way (approximately 18 m wide) and power line rights-of-way will be periodically maintained to low vegetation heights over the life of the operating pipeline to facilitate monitoring and meet safety requirements. This will result in the long-term maintenance of forest habitat in earlier seral stages (herbaceous and shrub stages) within a portion of the Project Footprint. Some herbaceous and shrub-dominated vegetation communities (*e.g.*, grasslands, wetlands) are likely to regenerate following construction over the medium-term, while forest and some shrub habitats (*e.g.*, sage shrub-steppe) take longer to regenerate. During construction, sensory disturbance and resultant displacement of mammals from suitable habitat near the Footprint is a primary effect mechanism associated with a reduction in effective habitat and changes in movement patterns. Given the phased approach to construction, sensory disturbance associated with Project construction is expected to be relatively localized and of short-term duration. Sensory disturbance associated with noise and artificial light at the proposed facilities will be ongoing over the life of the operating pipeline, and will affect the effectiveness of habitat in proximity to those facilities, particularly for species that are sensitive to human disturbance. The proposed pipeline right-of-way and temporary facilities will be reclaimed following construction.

The Project will interact with mammal indicators via all three of the identified effects pathways, including changes in habitat, changes in movement and increased risk of mortality. Table 7.2.10-6 provides a summary of the significance evaluation of the potential residual environmental effects of the construction and operations of the Project on the mammal indicators. The rationale used to evaluate the significance of the residual environmental effects is provided below.

TABLE 7.2.10-6

SIGNIFICANCE EVALUATION OF POTENTIAL RESIDUAL EFFECTS OF PROJECT CONSTRUCTION AND OPERATIONS ON MAMMAL INDICATORS

	Potential Residual Effects	Impact Balance	Spatial Boundary[1]	Temporal Context: Duration	Temporal Context: Frequency	Temporal Context: Reversibility	Magnitude	Probability	Confidence	Significance[2]
1.	Wildlife Indicator – Grizzly Bear									
1(a)	Combined Project effects on grizzly bear resulting from habitat loss or alteration, changes in movement and increased mortality risk.	Negative	Grizzly Bear RSA	Short-term	Periodic	Long-term	Medium	High	Moderate	Not significant
2.	Wildlife Indicator – Woodland Caribou									
2(a)	Combined Project effects on woodland caribou resulting from habitat loss or alteration, changes in movement and increased mortality risk.	Negative	Caribou RSA	Short-term	Periodic	Long-term	Medium	High	High	Not significant
3.	Wildlife Indicator – Moose									
3(a)	Combined Project effects on moose resulting from habitat loss or alteration, changes in movement and increased mortality risk.	Negative	Wildlife RSA	Short-term	Periodic	Long-term	Low	High	Moderate	Not significant
4.	Wildlife Indicator – Forest Furbearers									
4(a)	Combined Project effects on forest furbearers resulting from habitat loss or alteration, changes in movement and increased mortality risk.	Negative	Wildlife RSA	Short-term	Periodic	Long-term	Low	High	Moderate	Not significant
5.	Wildlife Indicator – Coastal Riparian Small Mammals									
5(a)	Combined Project effects on coastal riparian small mammals resulting from habitat loss or alteration, changes in movement and increased mortality risk.	Negative	LSA	Short-term	Periodic	Long-term	Medium	High	Low	Not significant
6.	Wildlife Indicator – Bats									
6(a)	Combined Project effects on bats resulting from habitat loss or alteration, changes in movement and increased mortality risk.	Negative	LSA	Short-term	Periodic	Long-term	Low	High	Low	Not significant

Notes: 1 Refer to Section 7.2.10.2 for an explanation of spatial boundaries relevant to each indicator. LSA = Wildlife LSA.

2 Significant Residual Environmental Effect: defined as a high probability of occurrence of a permanent or long-term residual effect of high magnitude that cannot be technically or economically mitigated.

Change in Habitat

The Project will change the amount of available effective habitat for mammals. The likely mechanisms for changes in effective mammal habitat include vegetation clearing and sensory disturbance (*e.g.*, human activity and noise). Concerns were identified during Aboriginal participation regarding the potential effects of the Project on mammal habitat, in particular, direct disturbance of riparian areas and mature and old forests, fragmentation, ungulate forage, rut and calving areas, habitat features such as beaver lodges, dens, game trials and mineral licks, and habitat for species at risk (*e.g.,* caribou), as well as indirect disturbance such as noise (Wildlife Technical Report of Volume 5C).

Clearing for construction and operations (*i.e.*, monitoring) of the Project will cause long-term maintenance of forest habitat in earlier seral stages (*e.g.*, herbaceous and shrub). Grassland and most shrub communities are expected to regenerate relatively quickly (medium-term) following construction and restoration, although community composition may take longer than 10 years to return to pre-construction conditions in some locations (*i.e.*, long-term). This change in vegetation within the Footprint will affect habitat suitability (*i.e.*, ability of the habitat to provide necessary requisites such as thermal/protective cover, denning, forage) and effectiveness (*i.e.*, utility of otherwise suitable habitat that may be influenced by human disturbance).

Clearing of the Footprint will reduce cover availability for wildlife and temporarily reduce forage availability for most mammals, with the exception of bats. Forest edges are often associated with elevated bat foraging activity, likely because they provide openings that provide movement corridors or accumulate insects (Hein *et al.* 2009, Jantzen 2012, Morris *et al.* 2010). The Project will likely create foraging habitat for bat species that forage for insects in the open (*e.g.*, little brown bats), but reduce foraging habitat for clutter-adapted bat species (*e.g.*, northern myotis) that forage in the understory of forests (Morris *et al.* 2010, Patriquin and Barclay 2003).

As cleared areas regenerate with early seral vegetation, forage availability will increase for some species (*e.g.*, browse for moose and deer; forage for bears). One study of collared grizzly bears demonstrated that grizzlies use pipeline rights-of-way and other linear disturbances (*e.g.*, roads and seismic lines) more than would be expected based on habitat availability (McKay *et al.* 2013). The study found that bears use pipeline rights-of-way for foraging and for travel. Anting was the primary foraging activity of grizzly bears on pipeline rights-of-way, particularly during the summer months (July and August), while herbaceous foraging, root digging sites and berry feeding sites were relatively common, and evidence of carnivory (*e.g.*, moose kill) was uncommon (McKay *et al.* 2013).

Forest furbearers such as marten and fisher are typically associated with old forest structure, riparian areas and densely forested wetlands, although a variety of forested ages and types are used (Thompson *et al.* 2012). Habitat use is associated with availability of coarse woody debris, large wildlife trees (snags) and canopy cover (particularly in winter), although marten and fisher will forage in a wide range of structural stages (BC MWLAP 2004b, Thompson *et al.* 2012). Habitat for wolverine is not easily delineated as a set of vegetative parameters and is closely tied to the distribution and abundance of food, as well as suitable habitat/structures for denning (BC MWLAP 2004b, Petersen 1997). Most studies of wolverine habitat indicate they require a suite of habitat variables that occur at larger spatial scales (*e.g.*, landscapes, regions) (BC MWLAP 2004b). Loss of forest habitat resulting from human development, particularly clear-cut forest harvest, is one of the main long-term threats to fisher and marten populations in BC (Hatler *et al.* 2003a,b, Proulx *et al.* 2003 in BC MWLAP 2004b, Weir 2003). Effects of habitat alteration on fisher depend on the intensity and scale (*e.g.,* landscape scale versus stand scale) at which the changes occur (BC MWLAP 2004b). Clearing for Project construction will result in habitat alteration at the patch or feature-level habitat scale, and is unlikely to preclude marten or fisher use of the modified habitat with the Footprint and adjacent areas, although individuals may expend more energy to find resources. Habitat loss resulting from human development is also a threat to wolverine populations (COSEWIC 2003a). Human activity including roads, infrastructure and back-country recreation negatively influence wolverine habitat selection (Lofroth and Krebs 2007). Some types of human activities that alter forested habitats may not result in negative changes to wolverine habitat (COSEWIC 2003a). For example, forest harvest practices that create a landscape matrix of uneven aged forest stands can diversify the prey base and maintain or improve wolverine habitat (COSEWIC 2003a). Conversely, habitat alterations that have negative effects on prey populations have negative indirect effects on wolverine habitat (COSEWIC 2003a).

Potential adverse Project effects on bats are primarily limited to the direct removal or degradation of roosting and hibernation habitat. Caves and mines as well as tall rock faces with deep fissures are likely the primary hibernation habitat for bats, and may also be used as roosting habitat during the summer (Lausen and Barclay 2006, Nagorsen and Brigham 1993). There are no caves or mines along the Project corridor, and steep topography indicative of rock faces will be avoided whenever practical during final pipeline routing. Tree-cavities are also extensively used for roosting by several bat species, and may be used as hibernacula in warmer areas of BC (Kalcounis-Rüppell *et al.* 2005, Nagorsen and Brigham 1993). Suitable tree-cavity roosting habitat is most often associated with old mixed or deciduous forests containing large-diameter decaying trees, which contain cavities, crevices or sloughing bark where bats can hide (Kalcounis-Rüppell *et al.* 2005). Concerns were identified during Aboriginal participation regarding the loss of wildlife trees, which provide habitat for cavity nesting and denning species (Wildlife Technical Report of Volume 5C). Some bat species (*i.e., Lasiurus* spp.) roost in the foliage among the canopy of trees (Nagorsen and Brigham 1993), which is not a limited habitat feature in the Wildlife LSA. Considering the limited available information on bat response to disturbance, the loss of tree-cavity roosting habitat is assumed to be limited to the direct area of mature and old forest within the Footprint. Quantitative change in tree-roosting habitat for bats is summarized in Table 7.2.10-7.

Disturbances that fragment habitat may have larger impacts than the area of direct habitat disturbance, if suitable habitat patch sizes are reduced below threshold levels that make them ineffective for certain species. For example, Snyder and Bissonette (1987) found that the majority of marten detections were in habitat patches ≥ 15 ha. The proposed pipeline corridor parallels existing linear corridors and will avoid construction of new access (*i.e.*, use existing access) to the extent feasible to reduce fragmentation of habitat patches.

Many mammal species are sensitive to human disturbance, and exhibit reduced use or avoidance of habitat in proximity to certain disturbance types (*i.e.*, zone of influence). This is referred to as a reduction in habitat effectiveness. Disturbance from anthropogenic noise created by roads has been found to have a negative effect on habitat use by grizzly bears, reducing habitat occupancy up to 500 m from active roads (Mace *et al.* 1996). The reduction in habitat effectiveness for carnivores such as wolverine and bears is expected to be limited to the construction period (*i.e.*, short-term).

Long-term reduction in habitat effectiveness adjacent to linear features may occur as caribou have been shown to partially avoid habitats near rights-of-way (Dyer 1999, Oberg 2001). Dyer *et al.* 2001 demonstrated that boreal woodland caribou avoid habitat within 250 m of roads and seismic lines, and within 1,000 m of industrial facilities such as well sites. Within the Wells Gray caribou range, the proposed pipeline corridor parallels the existing TMPL right-of-way, Highway 5, and an existing railway. It is likely that caribou avoid habitat along the proposed pipeline corridor, given that woodland caribou have demonstrated avoidance of such disturbance features (Dyer *et. al.* 2001). Long-term reduction in habitat effectiveness may result from the Project in the Groundhog caribou range where the proposed pipeline corridor deviates from the existing TMPL right-of-way and Highway 5 (for approximately 6.1 km). As is the case for most of the proposed pipeline corridor, this portion of the proposed corridor is located in the lower valley. Late winter construction is recommended to reduce the potential reduction in habitat effectiveness for Groundhog caribou associated with sensory disturbance from construction activities, since caribou tend to stay at higher elevations during the winter (Surgenor pers. comm.).

Reduced use or avoidance by moose of linear features such as roads, trails and seismic lines has been documented (Antoniuk *et al.* 2009, Collister *et al.* 2003, Ferguson and Keith 1985, Rolley and Keith 1980). Levels of human activity (*e.g.*, noise, traffic) affect moose response to these types of anthropogenic disturbance (Collister *et al.* 2003). Wasser *et al.* (2011) reported moose avoided linear features with no or unknown levels of human use and areas near primary roads. Avoidance effects were not apparent for moose beyond several hundred metres of exploration roads (Wasser *et al.* 2011). Sensory disturbance of moose can result in displacement to less suitable habitats. Although sensitive to human disturbance, moose will habituate to non-threatening and repetitive activities (Wiacek *et al.* 2002).

Open areas and young seral stage forests are low-value habitat for marten and fisher (Buskirk and Ruggiero 1994, Clark *et al.* 1987, Poole *et al.* 2004, Weir and Corbould 2010), which have been shown to avoid sites that lack overhead cover (*e.g.*, clear-cuts, meadows, burns, and wetlands) (Cheveau *et al.* 2013). Cleared areas may be avoided by marten and fisher due to increased predation risk, limited escape cover (*i.e.*, trees), and lower prey encounter and capture rates (Hargis *et al.* 1999, Thompson and Colgan 1994, Weir and Corbould 2010).

Pacific water shrew is found in and around riparian areas, especially within 50 m of the water's edge (Zevit and Welstead 2012). The primary threat to Pacific water shrew is the destruction or degradation of habitat (Craig *et al.* 2010). Primary causes of habitat loss include the removal of riparian vegetation, inadequate riparian buffers, and the loss of streams and wetlands that are not protected during development. Additional causes of habitat degradation include altering riparian habitat, edge effects, effects from runoff on water quality and clarity, and encroachment of development (Craig *et al.* 2010, Zevit and Welstead 2012). Both Olympic and Trowbridge's shrews are closely associated with forested communities with a well-developed litter layer and ground cover of shrubs and herbaceous plants. Olympic shrew may be more associated with riparian zones in and around streams and wetlands, while Trowbridge's shrew prefers more upland areas. Known populations of these species tend to be scattered and are potentially susceptible to local extirpation from habitat loss and fragmentation (Zevit 2012). Pacific water shrew, and to a lesser extent Olympic shrew, are riparian-dependent species and, therefore, many of the mitigation measures recommended for the protection of fish habitat (Table 7.2.10-3) will aid in protecting habitat for these species. However, riparian buffers imposed to protect fish habitat are likely insufficient in protecting the complete range of foraging and refugia requirements for these shrew species (Zevit 2012).

Different species, and even individuals within a species, are expected to respond differently to noise disturbances. Various factors affect an animal's response to noise, such as noise level, frequency distribution, duration, number of events, rate of onset, level of existing ambient noise, time of year or day, animal activity and location, animal age and gender. Noise effects on wildlife can potentially include habitat loss through avoidance, increased energy expenditure, changes in normal behaviours (*e.g.*, feeding) and impaired communication between individuals. Noise arising from construction and maintenance activities will potentially cause sensory disturbance to mammals. Sensory disturbance can cause increased energy expenditure and displacement of wildlife in the vicinity of the rights-of-way, potentially resulting in use of less suitable habitat in adjacent areas. Woodland caribou exposed to simulated petroleum exploration noise are reported to move faster and cross habitat boundaries substantially more than control caribou. The increased movement of caribou may result in higher energy expenditure and movement to different habitat types that provide cover or escape terrain (Bradshaw *et al.* 1997). Dyer *et al.* (2001) found that woodland caribou showed a higher level of avoidance of roads, seismic lines and oil and gas facilities (well sites) during late winter and calving seasons when human activity was higher. Moose have also been documented to avoid industrial developments during periods of human activity. Morgantini (1982, 1984 in Jalkotzy *et al.* 1997) documented avoidance of pipeline rights-of-way by moose during the construction periods of two pipeline projects.

The magnitude of potential Project effects on mammal habitat is expected to be higher for sensitive species. For example, woodland caribou are a Threatened species with declining populations and demonstrated adverse responses to disturbed habitats. Caribou are less resilient to habitat disturbance than some mammals that are more adaptable to disturbance, such as coyote, black bear or moose. The Project crosses proposed critical habitat for Pacific water shrew (Endangered under Schedule 1 of *SARA* and by COSEWIC) and early candidate critical habitat for Townsend's mole (Endangered under Schedule 1 of *SARA* and by COSEWIC) as identified by Environment Canada (Environment Canada 2013d). Pacific water shrew is at the northern limit of its distribution and is restricted to the southwest corner of BC in an area of rapid development and habitat change (COSEWIC 2006d). Pacific water shrews require riparian and wetland habitat at low elevations and this habitat specificity may increase the potential effects of habitat loss and fragmentation by limiting movement among habitat fragments (Pacific Water Shrew Recovery Team 2009).

Table 7.2.10-7 and Figure 7.2.10-1 summarize the predicted change in effective habitat for mammal indicators in the Wildlife LSA. Direct disturbance of mammal habitat resulting from the Project will be reduced by implementing the measures listed in Table 7.2.10-3 related to habitat loss and alteration, such as pre-construction surveys to identify site-specific habitat features (*e.g.*, mineral licks) and implementing buffers to avoid disturbance, minimizing the area of new footprint, and reclaiming the disturbed footprint to natural vegetation. Grassland and shrub dominated habitats are likely to regenerate following construction and reclamation in the medium-term. However, in forested areas direct alteration of mammal habitat is expected to extend over the long-term.

Reduced habitat effectiveness for mammal indicators associated with sensory disturbance from construction activities or site-specific maintenance during operations are reversible in short-term, once activities are complete. The mitigation measures listed in Table 7.2.10-3 related to sensory disturbance, such as avoiding sensitive timing windows wherever feasible, minimizing traffic and prohibiting recreational use of snowmobiles and ATVs on the work site, will reduce potential indirect effects of the Project on mammal habitat.

TABLE 7.2.10-7

PREDICTED CHANGE IN HABITAT FOR MAMMAL INDICATORS IN THE WILDLIFE LSA

Wildlife Indicator	Habitat/Life Requisite	Habitat Suitability Rating	Existing Conditions (ha)	Project Conditions (ha)	Incremental Change (ha)[2]	% Change
Grizzly Bear	Spring Feeding	High	3.7	3.6	0.1 ↓	2.68 ↓
		Moderately High	1,048.2	1,039.0	9.3 ↓	0.88 ↓
		Moderate	7,334.7	7,262.2	72.5 ↓	0.99 ↓
		Low	13,052.0	13,332.8	280.8 ↑	2.15 ↑
		Very Low	16,340.0	16,302.8	37.2 ↓	0.23 ↓
		Nil	27,749.5	27,587.6	161.8 ↓	0.58 ↓
		Effective Habitat	8,386.7	8,304.8	81.8 ↓	0.98 ↓
	Fall Foraging	High	761.8	754.0	7.7 ↓	1.01 ↓
		Moderately High	7,792.5	7,731.4	61.1 ↓	0.78 ↓
		Moderate	13,377.6	13,197.6	180.0 ↓	1.35 ↓
		Low	14,078.5	13,939.1	139.4 ↓	0.99 ↓
		Very Low	3,386.5	3,948.2	561.7 ↑	16.59 ↑
		Nil	26,119.4	25,945.9	173.6 ↓	0.66 ↓
		Effective Habitat	21,931.8	21,683.0	248.8 ↓	1.13 ↓
Moose	Winter Feeding	High	5,987.3	5,965.7	21.6 ↓	0.36 ↓
		Moderately High	3,641.7	3,610.3	31.3 ↓	0.86 ↓
		Moderate	9,683.3	9,551.6	131.7 ↓	1.36 ↓
		Low	31,865.7	31,512.1	353.6 ↓	1.11 ↓
		Very Low	18,017.3	18,546.6	529.3 ↑	2.94 ↑
		Nil	66,535.0	65,535.9	0.9 ↑	<0.01 ↑
		Effective Habitat	19,312.2	19,127.6	184.6 ↓	0.96 ↓
	Security/Thermal (Winter)	High	12,538.8	12,398.0	140.8 ↓	1.12 ↓
		Moderately High	2,927.5	2,900.2	27.4 ↓	0.93 ↓
		Moderate	23,642.3	23,375.2	267.1 ↓	1.13 ↓
		Low	28,614.0	28,189.7	424.3 ↓	1.48 ↓
		Very Low	1,435.8	1,426.3	9.5 ↓	0.66 ↓
		Nil	67,079.7	67,938.3	858.5 ↑	1.28 ↑
		Effective Habitat	39,108.6	38,673.3	435.3 ↓	1.11 ↓
Marten (forest furbearers indicator)	Year-round Living	High	17,060.2	16,867.7	192.5 ↓	1.13 ↓
		Moderate	23,369.2	23,068.2	301.0 ↓	1.29 ↓
		Low	19,515.7	19,322.2	193.5 ↓	0.99 ↓
		Nil	64,368.25	65,055.3	687.0 ↑	1.07 ↑
		Effective Habitat	40,429.4	39,935.9	493.5 ↓	1.22 ↓
Fisher (forest furbearers indicator)	Natal Denning	High	2,642.6	2,629.3	13.3 ↓	0.50 ↓
		Moderate	8,199.2	8,150.0	49.2 ↓	0.60 ↓
		Low	19,781.5	19,623.3	158.2 ↓	0.80 ↓
		Nil	54,567.6	54,785.2	220.7 ↑	0.40 ↑
		Effective Habitat	10,841.8	10,779.3	62.5 ↓	0.58 ↓
Mountain beaver (coastal riparian small mammals indicator)	Living Year-round	High	575.3	571.8	3.5 ↓	0.60 ↓
		Moderate	44.9	44.5	0.5 ↓	1.04 ↓
		Low	463.0	462.2	0.8 ↓	0.16 ↓
		Nil	25,363.7	25,368.4	4.7 ↑	0.02 ↑
		Effective Habitat	620.2	616.3	3.9 ↓	0.64 ↓
Pacific water shrew[1] (coastal riparian small mammals indicator)	Living Year-round	High	456.8	453.1	3.7 ↓	0.80 ↓
		Moderate	1,890.0	1,877.7	12.3 ↓	0.65 ↓
		Low	669.5	685.4	15.9 ↑	2.38 ↑
		Nil	23,232.7	23,232.7	< 0.1 ↑	< 0.01 ↑
		Effective Habitat	2,346.7	2,330.8	15.9 ↓	0.68 ↓

TABLE 7.2.10-7 Cont'd

Wildlife Indicator	Habitat/Life Requisite	Habitat Suitability Rating	Existing Conditions (ha)	Project Conditions (ha)	Incremental Change (ha)[2]	% Change
Bats	Tree Cavity Roosting	High	30,269.4	29,973.0	296.4 ↓	0.98 ↓
		Moderate	1,886.9	1,834.1	52.8 ↓	2.80 ↓
		Low	32,484.9	32,117.9	367.0 ↓	1.13 ↓
		Nil	88,687.1	89,403.3	716.2 ↑	0.81 ↑
		Effective Habitat	32,156.3	31,807.1	349.2 ↓	1.09 ↓

Notes: 1 The provincial model applied to the Pacific water shrew provides habitat capability. Refer to the Wildlife Habitat Modelling and Species Accounts Technical Report of Volume 5C.

2 ↓ represents a decrease and ↑ represents an increase.

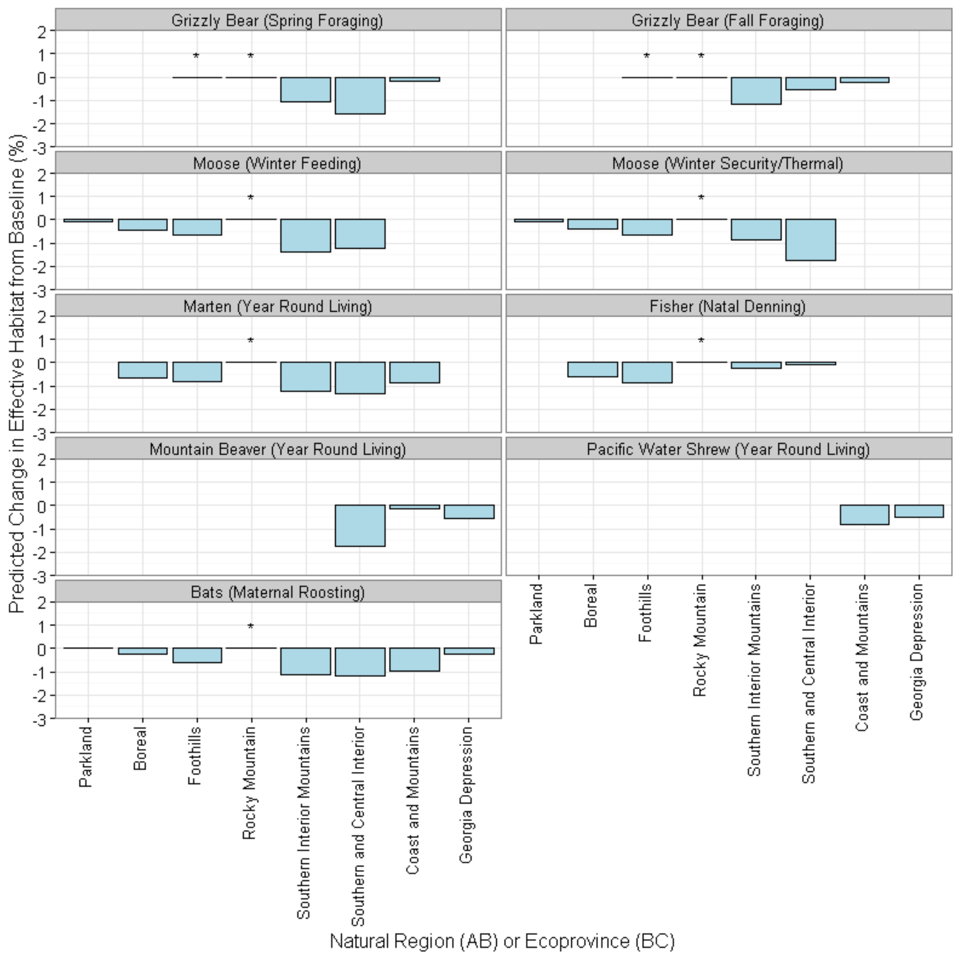

Figure 7.2.10-1 Predicted Change in Effective Habitat for Mammal Indicators
The change in effective habitat within the Wildlife LSA is presented as the percent change from baseline to Project conditions within each Natural Region in Alberta and Ecoprovince in BC. An asterisk (*) indicates spatial data are not available at the time of assessment to model the habitat within the identified Natural Region or Ecoprovince. Additional studies are planned to supplement the available data, which will be used to update habitat modelling, where needed.

Change in Movement

The Project may affect the movement of the mammal indicators. Physical barriers during construction (*e.g.*, pipe, soil, slash, and snow) may limit the movement of large mammals (*e.g.*, ungulates) (Morgantini 1985 in Hebblewhite 2008). Concerns identified during Aboriginal participation about potential effects of the Project included construction activities blocking game trails and restricting wildlife movement (Wildlife Technical Report of Volume 5C). However, this can be mitigated by leaving periodic openings in the strung pipe, soil and slash piles (Morgantini 1985 in Hebblewhite 2008). Most species are likely to move away from the Project area during construction (refer to sensory disturbance discussion above), but the displacement is expected to be short-term.

Changes in movement patterns during operations of the Project may occur in areas where new linear corridors are developed, and where the proposed pipeline is adjacent to existing linear corridors. The increased corridor width may cause an incremental barrier effect for some wildlife species. Aboriginal participants advised that clearing activities may alter the movement of wildlife (Wildlife Technical Report of Volume 5C). In some cases, linear developments have been shown to block, delay or deflect ungulate movements, potentially restricting or reducing access to some parts of their range (Harper *et al.* 2001). Studies on small mammal movements in the boreal forest have concluded that pipeline rights-of-way may act as barriers or filters to movement of flying squirrels, red squirrels and marten (Marklevitz 2003). Both marten and fisher typically do not venture into open areas without sufficient cover (Buskirk and Powell 1994, Powell and Zielinski 1994, Soutière 1979, Spencer *et al.* 1983). Collister *et al.* (2003) reviewed multiple studies on fisher habitat preference and dispersal, and concluded that fisher prefer large patches of contiguous forest habitat, avoid openings wider than 25 m and occur less frequently in stands less than 100 ha in size. Redistributing large-diameter slash (rollback) over select locations on the right-of-way (*e.g.*, where high levels of coarse woody debris occur prior to construction) is expected to reduce Project effects by providing cover and facilitating the movement of wildlife such as marten and fisher. Riparian areas may also provide important movement corridors for furbearers (Powell and Zielinski 1994) and small mammals that depend primarily on this habitat type (*e.g.*, Olympic shrew, Pacific water shrew) (Zivet 2012, Zivet and Welstead 2012). Trenchless watercourse crossings (where appropriate), measures to reduce riparian clearing during trenched watercourse crossings, and reclamation of disturbed riparian areas (Table 7.2.10-3) will reduce Project effects on mammal movement.

Research related to barrier effects of linear corridors on woodland caribou movement patterns is limited. One study found that seismic lines (which, like pipelines during operations, receive little human traffic or activity) do not create a barrier to caribou movement, although roads do (Dyer *et al.* 2002). Studies have concluded that pipelines do not create a movement barrier to boreal caribou (Carruthers and Jakimchuk 1987 in Dyer *et al.* 2002, Joint Pipeline Office 1999), except where they parallel roads with traffic (Curatolo and Murphy 1986 in Dyer *et al.* 2002). Dyer *et al.* (2002) suggest that roads and pipelines act in a synergistic fashion where they are parallel. Traffic levels, aversion to the physical barrier created by the forest opening along roads, and human predation are suggested by Dyer *et al.* (2002) as reasons why roads cause a barrier to caribou movement. Within the Wells Gray caribou range, the proposed pipeline corridor parallels the existing TMPL right-of-way, Highway 5, and an existing railway. Therefore, the corridor is likely already a barrier to caribou movement, given the conclusions of Dyer *et al.* (2002). The Project may create new movement barriers for caribou in the Groundhog caribou range where the Project deviates from the existing TMPL right-of-way and Highway 5 for approximately 6.1 km. The Project intersects one approved UWR for caribou in the Wells Gray caribou range (u-3-004). The General Wildlife Measures for this UWR (Table 7.2.10-3) are designed to maintain winter habitat for caribou. Caribou are likely to alter their movement to avoid the noise, activity and disturbance associated with construction activities. Project effects on caribou movement in the Wells Gray caribou range will occur during early to mid-winter, which corresponds to the period when caribou move from alpine and sub-alpine habitats to lower elevations in proximity to the proposed corridor and valley bottom (Surgenor pers. comm.).

Changes in movement patterns can also occur since some species may be attracted to the rights-of-way. The Footprint will create increased forage availability for some wildlife species once vegetation communities regenerate to early seral vegetation after reclamation (*e.g.*, grasses/shrubs and potential for greater berry productivity at clearing edges). This may attract some wildlife to the right-of-way and, therefore, affect their normal movement patterns. For example, moose have been shown to select habitat based on forage over security, often preferring early seral, shrub dominated habitats (Wasser *et al.* 2011) with lower densities of coniferous tree cover (Hebblewhite *et al.* 2010, Rempel *et al.* 1997, Schwartz and Franzmann 1991). Deer are also known to be attracted to recently cleared linear disturbances (Lyons and Jensen 1980) given the increased production of forage (Wallmo *et al.* 1972). Deer easily habituate to disturbance corridors, especially those with low human activity (Scott-Brown 1984). A study by Wasser *et al.* (2011) found positive selection by wolves for linear features and habitat with high suitability for deer. Rights-of-way may also provide travel routes for predators such as wolves (James 1999, Stuart-Smith *et al.* 1997, Thurber *et al.* 1994) and grizzly bears (McKay *et al.* 2013). James (1999) found that wolves traveled 2.9 times faster on linear corridors than through forest. McKay *et al.* (2013) found that collared grizzly bears tend to move faster on pipeline rights-of-way. Wolverines have also been found to diverge from their line of travel under forest cover when linear corridors with compacted snow were encountered, in order to follow the linear corridors, which provided easier travel routes (Wright and Ernst 2004). Bats have also been shown to use linear landscape features for movement, which provide navigational references and flight corridors for some bat species (Hein *et al.* 2009, Verboom and Huitema 1997).

Mitigation measures to reduce Project effects on mammal movement during construction and operations are described in Table 7.2.10-3. Limiting the length of open trench, maintaining periodic gaps in soil, slash, snow and pipe, where feasible, will limit barriers to mammal movement during construction. Redistributing large-diameter slash (coarse woody debris) over select locations on the right-of-way will contribute to maintaining habitat connectivity by reducing limitations to movement of furbearers (*e.g.*, marten, fisher) across the right-of-way.

Increased Mortality Risk

The Project may increase the risk of mortality for the mammal indicators. Potential mechanisms affecting mortality risk include clearing, blasting and vehicle collisions. In addition, linear corridors such as pipelines can increase the risk of mortality for some species by improving access, which can lead to increased predator numbers and efficiency, increased trapping, hunting and poaching, and human-wildlife conflicts. Concerns identified during Aboriginal participation about potential impacts of the Project on mortality risk included increased access for hunters and predators, increased line-of-sight altering predator-prey dynamics and potential pipeline spills and leaks. Participants raised concerns about caribou and caribou habitat, and reported that local caribou populations have been decreasing as the use of snowmobiles, industrial and urban development, overhunting and climate change have increased over time, and that large herds of caribou have not been seen in decades (Wildlife Technical Report of Volume 5C).

Linear corridors create improved access for predators such as wolves, which are known to travel along pipeline rights-of-way. Several studies have found that linear corridors are attractive to wolves as easy travel routes (James 1999, Stuart-Smith *et al.* 1997, Thurber *et al.* 1994) and may affect wolf-prey dynamics (Bergerud *et al.* 1984, Edmonds and Bloomfield 1984, Rohner and Kuzyk 2000). Wolves travel faster along linear disturbances (James 1999, McKenzie *et al.* 2012) and encounter rates between wolves and caribou have been shown to increase near linear features (Whittington *et al.* 2011). Linear corridors created by the proposed pipeline may increase wolf predation on ungulates (*e.g.*, moose, deer), since both prey (ungulates) and predators (wolves) will likely be attracted to revegetating linear corridors. Whittington *et al.* 2011 suggest that the influence of anthropogenic linear feature density on predation rates may be as important in mortality of ungulates (particularly caribou) as the density of predators. A recent study found that roads increased predation risk for mountain caribou, but early seral habitat and edge created by logging, power lines and wildfire did not (Apps *et al.* 2013). The study showed that with the exception of roads, early seral/edge habitats influence caribou predation risk less than habitat variables such as elevation, terrain conditions (*i.e.* complexity, slope), and variation in canopy cover (Apps *et al.* 2013). Vulnerability to predation for caribou increases as they move to lower elevations habitats that are selected by primarily prey (*i.e.*, moose and deer) regardless of habitat disturbance on the landscape. Vulnerability has also been shown to increase in rugged terrain and narrow valleys rather than wide valleys or plateau areas (Apps *et al.* 2013). This suggests that aside from roads, the functional response of predators to habitat changes on the landscape is less relevant than the population-level numerical response of predators to their primary prey (Apps *et al.* 2013). Aboriginal participants requested that willow be planted during reclamation at identified locations, in order to reduce line-of-sight for predators along the pipeline right-of-way (Wildlife Technical Report of Volume 5C). Willow planting can be a useful reclamation tool and will be implemented in select locations (*e.g.*, riparian area) outside of caribou range. Conifer seedling planting is an alternate measure that may be implemented to restore habitat, break line-of-sight and control access in selection locations. By planting shrubs and/or trees at select locations to restore woody vegetation cover and provide breaks in line-of-sight, and by redistributing coarse woody debris to limit predator mobility along the Footprint, the magnitude of residual effects associated with increased mammal mortality risk due to predation will be reduced. In addition, the creation of new linear corridors will be reduced by using existing access, and temporary access will be decommissioned and reclaimed following construction.

Linear corridors such as pipeline rights-of-way have the potential to increase mortality rates through hunting and trapping pressures by creating new access. Hunting is a major factor for grizzly bear mortalities in BC (McLellan *et al.* 2000). Road density thresholds related to grizzly bear mortality are discussed further in Section 8.0. Aboriginal participants noted that an increase in human presence and declines in the salmon population have also caused declines in the regional grizzly bear population (Wildlife Technical Report of Volume 5C). Hunting is also a key mortality factor for ungulates such as moose. Moose populations are considered more sensitive to overharvest and other sources of mortality than to habitat loss and fragmentation (Antoniuk *et al.* 2009). Aboriginal participants shared concerns regarding increased access for moose hunters (Wildlife Technical Report of Volume 5C). Trapping has been an important factor influencing fisher (Powell and Zielinski 1994, Weir 2003), marten (Buskirk *et al.* 2012, Hatler *et al.* 2003a) and wolverine (Lofroth and Ott 2007) populations. Fisher populations in eastern portions of their range have been found to have low to intermediate resiliency to trapping pressure, which means they generally have a moderate capability to recover from reduced population numbers (Banci and Proulx 1999 in Weir 2003). As noted above, new access for the Project will be minimized by using existing access wherever feasible, and temporary access will be decommissioned and reclaimed following construction. Mitigation to control access on the Footprint will be implemented (Table 7.2.10-3), including but not limited to planting tree seedlings and/or shrubs in select locations to facilitate rapid regeneration of natural vegetation and block sight-lines, and blocking access entry points by mounding, woody debris rollback, boulder barriers or earth berms. In addition to hunting and trapping pressure, increased human access increases the risk of human-bear conflicts that can result in animals being relocated or destroyed. Implementation of the Wildlife Conflict Management Plan (Table 7.2.10-3) is expected to prevent any direct bear mortalities associated with the construction and operations of the Project.

The Project also has the potential to affect the mortality risk of some mammal indicators through vegetation clearing. For example, the Project may result in the inadvertent felling of or disturbance to occupied fisher or marten natal dens (where parturition occurs) and maternal dens (where kits are raised). Fisher typically den in cavities in trees and logs (Powell and Zielinski 1994). Marten also typically den in cavities in trees and logs or in piles of debris, rock crevices, and underground burrows (Hatler *et al.* 2003a, Powell and Zielinski 1994, Thompson *et al.* 2012). Fisher parturition occurs in late winter, and natal dens may be occupied between February and May (Weir 2003, Powell and Zielinski 1994) after which kits are moved to maternal dens for the summer (Weir 2003). Marten parturition also occurs in late winter (Banfield 1974). Fishers and marten can be highly sensitive during the denning period. Fishers have been reported to move kits to different dens when disturbed (Powell and Zielinski 1994), however, availability of alternate den sites may be limiting (Powell *et al.* 1997). Therefore, disturbance during the denning period has potential to increase risk of mortality of kits. Similarly, disturbance of hibernation habitat (*e.g.*, bear dens, bat hibernacula) during winter construction has potential to increase mortality risk for hibernating mammals. The proposed mitigation regarding buffers for bat hibernacula, bat maternity roosts, and bear dens will help minimize mammal mortality from vegetation clearing (Table 7.2.10-3).

Vehicle traffic due to construction and operations of the Project may also increase the risk of mammal mortality due to vehicle collisions. With posting of low traffic speeds, signage and education of construction and operations contractors and employees, risk of mammal injury or mortality associated with vehicle collisions is not expected to increase substantially as a result of the Project.

Summary of Effects Characterization Rationale for Mammal Indicators

A summary of the rationale for the effects characterization for the mammal indicators is provided below. Environmental and/or regulatory standards used in the evaluation of magnitude are provided in Table 7.2.10-5 (ecological context for each mammal indicator) and Section 7.2.10.4 (regulatory guidelines). The criteria rating and rationale for duration, frequency, reversibility and probability are similar for all of the mammal indicators:

- Duration: short-term – the events causing effects are construction and operational activities (*e.g.*, monitoring, vegetation management and site-specific maintenance), the latter of which are limited to any 1 year during operations.
- Frequency: periodic – the events causing effects (*i.e.*, clearing of the Footprint, traffic and activity) will occur during construction and intermittently during operations for monitoring, vegetation control and maintenance.
- Reversibility: long-term – effects are reversible in the long-term following decommissioning and abandonment, once native vegetation regenerates over the Project Footprint.
- Probability: high – the Project will alter habitat, cause sensory disturbance and potentially increase mortality risk to affect the indicator.

The criteria rating and rational for spatial boundary, magnitude and confidence vary, and are provided below for each mammal indicator.

<u>Grizzly Bear</u>

- Spatial Boundary: Grizzly Bear RSA – habitat changes (*e.g.*, clearing) and alteration of movement (*e.g.*, avoidance of construction) will be limited to the Wildlife LSA; however, changes in mortality risk (*e.g.*, increased access, traffic) are assessed at the regional scale.
- Magnitude: medium – grizzly bear is a species of conservation concern provincially and federally, largely due to extensive range and population reductions influenced by habitat development and fragmentation, and human related conflicts and mortality. Clearing for Project construction and operation will create early seral habitat that will have a small increase in suitable foraging habitat for grizzly bear; however, mortality risk is known to be high for grizzly bears along linear corridors. The proposed mitigation measures, including development and implementation of a Wildlife Conflict Management Plan, and measures to reduce new access and control access where it cannot be avoided, are consistent with regional resource management objectives and strategies, and will reduce the magnitude of Project effects on grizzly bear to medium.
- Confidence: moderate – the assessment is based on a good understanding of cause-effect relationships and relevant data. Limitations and uncertainty associated with available data pertinent to the Project area reduce the confidence level to moderate.

<u>Woodland Caribou</u>

- Spatial Boundary: Caribou RSA – habitat changes (*e.g.*, clearing) and alteration of movement (*e.g.*, avoidance of construction) will be limited to the Wildlife LSA; however, changes in mortality risk (*e.g.*, increased access, traffic) are assessed at the regional scale.
- Magnitude: medium – Despite the relatively low value of the habitat within the proposed corridor for caribou (due to its low elevation location and existing disturbances), the Project is expected to improve habitat conditions for moose forage and for wolves (prey availability, ease of travel). Wolves have been documented using the existing TMPL right-of-way in the Caribou RSA. Wolves are suggested as a primary factor in the decline of mountain caribou in the Caribou RSA. Changes in moose-wolf-caribou interactions are likely the primary mechanism by which the Project will potentially affect caribou. Mitigation beyond standard measures is warranted to address the Project's residual effect on woodland caribou (*e.g.*, planting conifer seedlings in strategic locations within the Project Footprint, and potentially the existing TMPL right-of-way). Trans Mountain will work with provincial regulatory authorities, tenure holders and other stakeholders to identify opportunities to address potential residual Project effects on caribou habitat. Trans Mountain will work with regulatory authorities for the deviation from the General Wildlife Measures set out by the UWR Order, if required. Implementation of appropriate mitigation is expected to address the Project's residual effect and contribution to cumulative effects.
- Confidence: high – the assessment is based on a good understanding of cause-effect relationships and relevant data.

Moose

- Spatial Boundary: Wildlife RSA – habitat changes (*e.g.*, clearing) and alteration of movement (*e.g.*, avoidance of construction) will be limited to the Wildlife LSA; however, changes in mortality risk (*e.g.*, increased access, traffic) are assessed at the regional scale.

- Magnitude: low – moose are highly valued as a game species and for traditional and cultural purposes, but do not have conservation status designations of concern, either provincially or federally. Moose populations in Alberta are secure. Moose populations in BC appear to be generally stable, though recent declines have been observed. BC MFLNRO actively monitors and manages moose populations. Adverse residual effects of the Project on moose will be reduced through mitigation to use existing access wherever feasible, reclaim the disturbed Footprint to native vegetation, limit construction activities in winter range during winter and control access. These measures are consistent with regional resource management objectives and strategies, and will reduce the magnitude of Project effects on moose to low.

- Confidence: moderate – the assessment is based on a good understanding of cause-effect relationships and relevant data. Limitations and uncertainty associated with available data pertinent to the Project area reduce the confidence level to moderate.

Forest Furbearers

- Spatial Boundary: Wildlife RSA – habitat changes (*e.g.*, clearing), alteration of movement (*e.g.*, avoidance of construction and cleared Footprint) and direct mortality risk (*e.g.*, disturbance of natal den) are primarily limited to the Wildlife LSA. However, the study area is expanded to the Wildlife RSA to capture effects on mortality risk associated with increased access (*e.g.*, hunting pressure) and traffic (*e.g.*, collisions with construction traffic).

- Magnitude: low – there are species with special conservation concern within the forest fur-bearer indicator group (*e.g.*, fisher, wolverine). These species are managed as furbearers (*i.e.*, for harvest) in BC and Alberta. Habitat loss (forest clearing from human development) and trapping are primary threats to fur-bearer populations. Mitigation measures to reduce new access, reduce the area of disturbance (particularly in riparian areas), reclaim disturbed areas to natural vegetation, and distribute coarse woody debris over the Footprint, are expected to reduce the magnitude of residual Project effects on forest furbearers to low.

- Confidence: moderate – the assessment is based on a good understanding of cause-effect relationships and relevant data. Limitations and uncertainty associated with available data pertinent to the Project area reduce the confidence level to moderate.

Coastal Riparian Small Mammals

- Spatial Boundary: Wildlife LSA – habitat changes (*e.g.*, clearing), alteration of movement (*e.g.*, fragmentation) and direct mortality risk (*e.g.*, disturbance of nests/den) are primarily limited to the Wildlife LSA.

- Magnitude: medium – several coastal riparian small mammal species with conservation status of concern occur in the Wildlife LSA. The Project crosses proposed critical habitat for Pacific water shrew and early candidate critical habitat for Townsend's mole (Environment Canada 2013d). The proposed mitigation to reduce residual Project effects on riparian habitat for small mammals (*e.g.*, minimize the Footprint in riparian habitats, avoid disturbance of site-specific habitat features, avoid wildlife mortality and reclaim disturbed areas within the Project Footprint) are consistent with provincial regulatory guidelines. Consultation with Environment Canada regarding the Project's interaction with the proposed and candidate critical habitats, and an appropriate approach for mitigating effects, has been initiated and is ongoing. It is anticipated that, if warranted, an appropriate mitigation strategy will be developed to reduce the magnitude of residual Project effects on coastal riparian small mammals. With application of the mitigation measures, the residual effect of the Project on coastal riparian small mammals is concluded to be of medium magnitude.

- Confidence: low – the assessment is based on an incomplete understanding of cause-effect relationships (*i.e.*, limited research and literature is available). Data used to inform the effects assessment is primarily from outside the Project area. There are limitations and uncertainty associated with the data pertinent to the Project area.

<u>Bats</u>

- Spatial Boundary: Wildlife LSA – expected Project effects on bats are limited to the Wildlife LSA.
- Magnitude: low – several bat species with conservation status of concern occur in the Wildlife LSA. Known threats to bat populations are limited (*e.g.*, wind energy development, white-nose syndrome). Rock features that could potentially provide bat rock-roosting and hibernation habitat will be avoided where feasible during Project routing and siting. Direct habitat disturbance associated with clearing mature and old forests is likely the primary mechanism of Project interaction with bats. Direct habitat disturbance associated with clearing mature and old forests will be reduced by minimizing the Project Footprint, avoiding identified habitat features, and reclaiming the Footprint to natural vegetation, such that residual Project effects on bats are expected to be of low magnitude.
- Confidence: low – the assessment is based on a limited understanding of cause-effect relationships (*i.e.*, limited research and literature is available) and data from outside the Project area. There are limitations and uncertainty associated with the data pertinent to the Project area.

7.2.10.10 Significance Evaluation of Potential Residual Effects on Bird Indicators

The indicators selected to assess potential Project effects on birds includes a combination of habitat-based community indicators, species groups and individual species indicators, including grassland/shrub-steppe birds, mature/old forest birds, early seral forest birds, riparian and wetland birds, wood warblers, short-eared owl, rusty blackbird, flammulated owl, Lewis's woodpecker, Williamson's sapsucker, western screech-owl, great blue heron, spotted owl, bald eagle, common nighthawk, northern goshawk and olive-sided flycatcher. Detailed species accounts (including species lists for the community indicators) are described in the Wildlife Habitat Modelling and Species Accounts Technical Report of Volume 5C.

Relevant regulatory guidelines, information identified during Aboriginal participation in field studies, and ecological context was considered in the characterization of potential residual effects for the bird indicators. A summary of regulatory guidelines is provided in Section 7.2.10.4. In general, the planning documents relevant to the proposed pipeline corridor recommend conserving important bird habitat, particularly for species at risk or species of special management concern (Appendix E in Wildlife Technical Report of Volume 5C). In Alberta, the proposed pipeline corridor crosses Sensitive Raptor Range for bald eagle and sharp-tailed grouse range (AESRD 2013d). The proposed pipeline corridor is also in the vicinity of three identified trumpeter swan lakes (200 m, 400 m and 700 m from the proposed pipeline corridor) (AESRD 2013d). In BC, the proposed pipeline corridor intersects a LTOHA for spotted owl (WHA 2-498), proposed critical habitat for Williamson's sapsucker, and early candidate critical habitat for Lewis's woodpecker (Environment Canada 2013d). The Wildlife Technical Report in Volume 5C provides additional information regarding proposed and candidate critical habitats. Consultation with Environment Canada and BC MFLNRO regarding the Project's interaction with these sensitive habitat areas and an appropriate approach for mitigating effects has been initiated and is ongoing.

The compilation of ATK, including the collection of TEK through Aboriginal field participation, as well as the engagement process provided valuable information about wildlife along the proposed pipeline corridor, and identified concerns and potential effects of the Project. Engagement details regarding wildlife and Aboriginal participation in field studies are provided in the Wildlife Technical Report of Volume 5C, and this information is included and considered throughout the effects assessment for bird indicators. The Project crosses the Cheam Lake Wetlands Regional Park, which provides habitat for many bird species including great blue heron, bald eagle, and riparian and wetland bird species.

Information on the ecological context for each bird indicator (*e.g.,* species status, population trends, known threats, best management practices and conservation strategies) is provided in Table 7.2.10-8. The purpose of providing ecological context for each indicator is to provide an indication of the resilience of each indicator to disturbance effects.

TABLE 7.2.10-8

ECOLOGICAL CONTEXT SUMMARY FOR BIRD INDICATORS

Indicator	Ecological Context
Grassland/ shrub-steppe birds	• The grassland and shrub-steppe bird community indicator includes bird species known to inhabit BC's southern interior grassland/shrub-steppe communities. The indicator is defined to include 41 species (Wildlife Habitat Modelling and Species Accounts Technical Report of Volume 5C); including the following species of conservation concern (BC CDC 2013, COSEWIC 2013, Environment Canada 2013c): - barn swallow (Threatened by COSEWIC; Blue-listed in BC; Conservation Framework Priority 2); - bobolink (Threatened by COSEWIC; Blue-listed in BC; Conservation Framework Priority 2); - Brewer's sparrow, *breweri* ssp. (Red-listed in BC; Conservation Framework Priority 2); - burrowing owl (Endangered under Schedule 1 of *SARA* and by COSEWIC; Red-listed in BC; Conservation Framework Priority 2); - common nighthawk (Threatened under Schedule 1 of *SARA* and by COSEWIC); - horned lark, *merrilli* ssp. (Blue-listed in BC); - lark sparrow (Red-listed in BC; Conservation Framework Priority 2); - Le Conte's sparrow (Blue-listed in BC); - Lewis's woodpecker (Threatened under Schedule 1 of *SARA* and by COSEWIC; Red-listed in BC; Conservation Framework Priority 2); - long-billed curlew (Special Concern under Schedule 1 of *SARA* and by COSEWIC; Blue-listed in BC; Conservation Framework Priority 2); - prairie falcon (Red-listed in BC; Conservation Framework Priority 2); - sage thrasher (Endangered under Schedule 1 of *SARA* and by COSEWIC; Red-listed in BC; Conservation Framework Priority 1); - sharp-tailed grouse, *columbianus* ssp. (Blue-listed in BC; Conservation Framework Priority 2); - short-eared owl (Special Concern under Schedule 1 of *SARA* and by COSEWIC; Blue-listed in BC; Conservation Framework Priority 2); and - Swainson's hawk (Red-listed in BC; Conservation Framework Priority 2). • Grassland birds are in decline in every area of Canada where they have been studied (North American Bird Conservation Initiative 2012). • Despite the limited distribution of grassland ecosystems in BC, these habitats support a large number of the province's endemic bird species, and many of these species are grassland-obligates. The vast majority of grassland-associated birds nest on the ground (McCracken 2005), and this aspect of their ecology makes them more sensitive to anthropogenic activities than forest-dwelling birds (McCracken 2005). Based on their ground-nesting tendencies, incubating females and their offspring are also vulnerable to mammalian predators (McCracken 2005). Therefore, factors that increase the abundance or search efficiency of such predators are also expected to affect grassland bird abundance. During the summer, the diet of many grassland birds is dominated by insects, though some species like the horned lark are primarily granivorous (seed-eaters). • Grassland/shrub-steppe birds are associated with arid landscapes dominated by grasses; low shrubs (*e.g.*, big sagebrush) can be a major component of these ecosystems. Both migratory and non-migratory (*e.g.*, sharp-tailed grouse) species are included within the grassland/shrub-steppe bird community, and therefore, some species are present in the Wildlife LSA year-round. • Throughout North America, grassland and shrub-steppe associated birds have been suffering marked declines, and as a community, their rate of decline outpaces that of any other species guild. These declines are principally related to the loss of grassland ecosystems due to forest and dense shrub encroachment (from fire-suppression), agricultural development, industrial development, and conversion of grasslands for urban uses (Brennan and Kuvlesky 2005). • The Lac du Bois Grasslands area, specifically Lac du Bois Grasslands Protected Area, contains the greatest number of sharp-tailed grouse leks in the Thompson Basin, and provides winter habitat for sharp-tailed grouse. Sage thrasher has also been recorded in the Lac du Bois Grasslands Protected Area (Grasslands Conservation Council of British Columbia 2009). • The proposed pipeline corridor crosses burrowing owl range in the Thompson-Nicola region (BC CDC 2013). Re-introductions have occurred annually in several locations including Lac du Bois Grasslands Protected Area, Knutsford, Hamilton Commonage, and Quilchena. In the Lac du Bois Grasslands Protected Area, the proposed pipeline corridor is located approximately 1,400 m from the nearest burrowing owl re-introduction site (Grasslands Conservation Council of BC 2009). The program has not yet established a self-sustaining population. In 2005, 84 owls were released and they fledged 100 owlets. Approximately 15 owls returned from migration the following year (Environment Canada 2012). The current population of burrowing owls in the region is unknown; however, re-introduction programs continue (Burrowing Owl Conservation Society of BC 2009, Environment Canada 2012). The recovery goal in the Recovery Strategy for the Burrowing Owl (*athene cunicularia*) in Canada is to reverse the population decline in Canada and maintain a self-perpetuating, well-distributed population (*i.e.*, 800 pairs in 5 years) by improving knowledge of annual population changes; mitigating factors contributing to population declines and habitat loss; optimize nesting success and fledging rate; improve survival on Canadian breeding grounds; re-establish wild breeding populations; increase awareness and conservation (Environment Canada 2012). • The proposed pipeline corridor intersects long-billed curlew habitat in upland grassland habitats in BC. The goal of the *Management Plan for the Long-billed Curlew (Numenius americanus) in Canada* is to maintain or increase the recent breeding distribution of the long-billed curlew in Canada. This involves maintenance and improvement of habitat for breeding and migrating (Environment Canada 2013g).

TABLE 7.2.10-8 Cont'd

Indicator	Ecological Context
Grassland/ shrub-steppe birds (cont'd)	• Identified Wildlife Species Accounts for grassland/shrub-steppe bird community species, including the long-billed curlew, prairie falcon, Brewer's sparrow, grasshopper sparrow, sharp-tailed grouse, and sage thrasher, recommend the following provisions and management recommendations: protection of large areas of continuous dry shrub-steppe and sagebrush habitats; and maintain and maximize connectivity of suitable habitats (sagebrush habitats, aspen-dominated ravines). Common recommended general wildlife measures include: establishment of WHAs to protect and maintain suitable breeding, nesting and fledging/brood rearing habitat; minimization of disturbance in grassland and sagebrush habitats during breeding season; maintenance of adjacent riparian and forest habitats; and prevention of forest encroachment. Specific measures include avoiding road and trail development; limiting road use during critical times during the breeding season (April 1 to July 15); not using pesticides; avoiding concentrations of livestock during the breeding season; and maintaining large (>2 ha) patches of sagebrush by managing livestock impacts (BC MWLAP 2004b). • The *Guidelines for Raptor Conservation* recommend the following management guidelines for species, including Swainson's hawk, in grassland and shrub-steppe habitats: protect trees, snags, cliffs, or other roosting and perching structures; retain natural open habitats to provide security cover for both prey species and ground nesting raptors; avoid mowing of fields during the nesting season; and maintain undisturbed buffers of up to 500 m around nest sites (BC MOE 2013e). • Context for short-eared owl and Lewis's woodpecker are provided below. • Table 7.2.10-10 provides a summary of the predicted change in effective grassland/shrub-steppe bird habitat as a result of the Project.
Mature/old forest birds	• The mature/old forest bird community indicator includes bird species known to inhabit mature and old forests, and potentially occur in the Wildlife LSA. The indicator is defined to include 91 species (Wildlife Habitat Modelling and Species Accounts Technical Report of Volume 5C), including the following species of conservation concern (AESRD 2012a, ASRD 2011b, BC CDC 2013, COSEWIC 2013, Environment Canada 2013c): - Baltimore oriole (Sensitive in Alberta); - band-tailed pigeon (Special Concern under Schedule 1 of *SARA* and by COSEWIC; Blue-listed in BC; Conservation Framework Priority 2); - barred owl (Yellow-listed in BC; Sensitive in Alberta, Special Concern by Alberta's ESCC); - black-backed woodpecker (Yellow-listed in BC; Sensitive in Alberta); - black-throated green warbler (Sensitive in Alberta; Special Concern by Alberta's ESCC); - broad-winged hawk (Blue-listed in BC; Sensitive in Alberta); - brown creeper (Yellow-listed in BC; Conservation Framework Priority 1; Sensitive in Alberta); - Canada warbler (Threatened under Schedule 1 of *SARA* and by COSEWIC; Sensitive in Alberta); - Cape May warbler (Sensitive in Alberta; In Process [previously Special Concern] by Alberta's ESCC); - flammulated owl (Special Concern under Schedule 1 of *SARA* and by COSEWIC; Blue-listed in BC; Conservation Framework Priority 2); - great gray owl (Yellow-listed in BC; Sensitive in Alberta); - least flycatcher (Yellow-listed in BC; Sensitive in Alberta); - northern goshawk, *atricapillus* ssp. (Yellow-listed in BC; Conservation Framework Priority 3; Sensitive in Alberta); - northern goshawk, *laingi* ssp. (Threatened under Schedule 1 of *SARA* and by COSEWIC; Red-listed in BC; Conservation Framework Priority 1); - northern pygmy-owl (Yellow-listed in BC; Conservation Framework Priority 3; Sensitive in Alberta); - pileated woodpecker (Yellow-listed in BC; Sensitive in Alberta); - spotted owl (Endangered under Schedule 1 of *SARA* and by COSEWIC; Red-listed in BC; Conservation Framework Priority 2); - western screech-owl, *kennicotti* ssp. (Special Concern under Schedule 1 of *SARA*; Threatened by COSEWIC; Blue-listed in BC; Conservation Framework Priority 1); - western screech-owl, *macfarlanei* ssp. (Endangered under Schedule 1 of *SARA*; Threatened by COSEWIC; Red-listed in BC; Conservation Framework Priority 1); - western tanager (Yellow-listed in BC; Sensitive in Alberta); - western wood-pewee (Yellow-listed in BC; Conservation Framework Priority 2; Sensitive in Alberta); and - Williamson's sapsucker (Endangered under Schedule 1 of *SARA* and by COSEWIC; Blue-listed in BC; Conservation Framework Priority 2). • The mature/old forest birds includes species that are most commonly associated with mature, structurally complex forests, characterized by multi-storied canopies and well-developed understories. Waterhouse *et al.* (2003) suggest that representation of old-growth forest by BGC Zone, forest stand structure, and elevational gradient helps maintain bird diversity. • Context for wood warblers, flammulated owl, Williamson's sapsucker, western screech-owl, spotted owl and northern goshawk are provided below. • Table 7.2.10-10 provides a summary of the predicted change in effective mature/old forest bird habitat as a result of the Project.

TABLE 7.2.10-8 Cont'd

Indicator	Ecological Context
Early seral forest birds	• The early seral forest bird community indicator includes species that inhabit young forest habitats and potentially occur in the Wildlife LSA. The community indicator is defined to include 86 bird species (Wildlife Habitat Modelling and Species Accounts Technical Report of Volume 5C), including the following species of conservation concern (AESRD 2012a, ASRD 2011b, BC CDC 2013, COSEWIC 2013, Environment Canada 2013c): - Baltimore oriole (Sensitive in Alberta); - band-tailed pigeon (Special Concern under Schedule 1 of *SARA* and by COSEWIC; Blue-listed in BC; Conservation Framework Priority 2); - black-backed woodpecker (Yellow-listed in BC; Sensitive in Alberta); - Cape May warbler (Sensitive in Alberta; In Process [previously Special Concern] by Alberta's ESCC); - Clark's nutcracker (Yellow-listed in BC; Sensitive in Alberta); - least flycatcher (Yellow-listed in BC; Sensitive in Alberta); - northern pygmy-owl (Yellow-listed in BC; Conservation Framework Priority 3; Sensitive in Alberta); - olive-sided flycatcher (Threatened under Schedule 1 of *SARA* and by COSEWIC; Blue-listed in BC; Conservation Framework Priority 2; May Be at Risk in Alberta); - pileated woodpecker (Yellow-listed in BC; Sensitive in Alberta); - sooty grouse (Blue-listed in BC; Conservation Framework Priority 2); - western tanager (Yellow-listed in BC; Sensitive in Alberta); and - western wood-pewee (Yellow-listed in BC; Conservation Framework Priority 2; Sensitive in Alberta). • A similar group consisting of early seral forest breeding birds has been analysed by the North American Breeding Bird Survey (Breeding Bird Surveys); of the birds showing substantial population changes (increasing or decreasing) in North America, 77% (35/46) have been declining (Environment Canada 2013h). • Early seral forests are composed of young shade-intolerant trees and large shrubs that have attained dominance over other vegetation. Such forests are often characterized by their high stem density, broadleaf dominance, and lack of mature trees. In later stages of succession early seral stands undergo self-thinning and vertical structure can become evident (Resource Inventory Committee 1998). These stages of early seral cover support a variety and abundance of birds (Ellis *et al.* 2012). • A unique feature of early seral forests is that they are relatively short-lived under natural disturbance regimes (Bunnell 1995). Under contemporary forest management practices, the life-span of this successional stage is being further shortened and their overall structure is altered as well (Betts *et al.* 2010). In the conifer-dominated portions of the Pacific Northwest, early successional forests typically contain an abundant and long-lasting broadleaf component (Resource Inventory Committee 1998). • Most of the birds inhabiting young forests are leaf-gleaning insectivores (Ellis and Betts 2011). Since broadleaf species promote higher densities of arthropods than do conifers (Hagar 2007, Hammond and Miller 1998), early seral bird abundance increases as broadleaf species become more prolific (Ellis *et al.* 2012). There is also some recent evidence from the Pacific Northwest, that bird species diversity is higher on early seral sites with productivity (McWethy *et al.* 2009, Verschuyl *et al.* 2008). • Early successional forests are gradually being reduced in spatial extent due to intensive management for conifers, fire suppression, and public demand for old-growth forests (Kennedy and Spies 2005). A recent study suggests that the reductions in the extent of early seral forests may be responsible for declines seen in various bird species of the Pacific Northwest (Betts *et al.* 2010). • There currently are no recovery plans for the birds in this indicator (BC MOE 2013f). • Context for Cape May warbler and olive-sided flycatcher are provided below. • Table 7.2.10-10 provides a summary of the predicted change in effective early seral forest bird habitat as a result of the Project.
Riparian and wetland birds	• The riparian and wetland bird community indicator is defined to include 158 bird species, including 35 species of conservation concern. The riparian and wetland bird community includes but is not limited to waterfowl, grebes, pelicans, cormorants, herons, rails, gulls, flycatchers, songbirds and raptors, listed in detail in the Wildlife Habitat Modelling and Species Accounts Technical Report of Volume 5C. • Species in this indicator rely on wetlands, lakes, watercourses and the associated riparian areas. Aquatic habitats include watercourses, wetlands with varying amounts of emergent vegetation, swamps, bogs, fens, lakes and lake margins. Wetland surveys for the Project identified 638 wetlands (approximately 94.4 km and 570.4 ha) crossed by the proposed pipeline corridor, comprising approximately 9.6% of the length of the proposed corridor (Section 7.2.8.3). Wetlands crossed by the proposed corridor include 141 basin marshes, 67 riparian marshes, 4 lacustrine marshes, 7 slope marshes, 2 hummock marshes, 104 flat swamps, 78 riparian swamps, 2 discharge swamps, 6 slope swamps, 45 basin shallow open water, 19 riparian shallow open water, 13 basin fens, 26 horizontal fens, 13 riparian fens, 2 channel fens, 1 feather fens, 1 slope fen and 1 basin bog. • The primary threats to riparian and wetland birds including both species at risk (*e.g.,* Canada warbler, harlequin duck) and more common species (*e.g.,* spotted sandpiper, dippers) are habitat/wetland loss to development, urban expansion, and livestock degradation, as well as pollution and predation (COSEWIC 2008b). • The proposed pipeline corridor intersects potential yellow rail habitat on the Edmonton to Hinton Segment. Field surveys in 2013 did not detect any yellow rails (Wildlife Technical Report of Volume 5C). The goal of the *SARA* management plan for yellow rail is to protect and maintain the population and habitat of yellow rail in Canada. Recommended management measures include population monitoring and assessment, habitat conservation and management, and outreach (Environment Canada 2013j).

TABLE 7.2.10-8 Cont'd

Indicator	Ecological Context
Riparian and wetland birds (cont'd)	• In the Identified Wildlife Species Account for sandhill crane, management objectives include establishment of WHAs to maintain breeding habitats and recommended general wildlife measures. The proposed pipeline corridor does not encounter any WHAs for sandhill crane. The recommended general wildlife measures are maintenance of the structural integrity of emergent vegetation in and around nesting areas to provide cover and nesting habitat, maintenance vegetated screen around breeding wetlands, minimizing disturbance and access during the breeding season (April 1 to September 21), minimizing human access to important staging areas during the migratory period (April and September/October), and restoration of historical water regimes to wetland areas that have been drained (BC MWLAP 2004b). • Management guidelines for American bittern recommend the following measures in known breeding habitat (Gill 2007): establish a 30 m restricted zone around the wetland in which no forestry activities are permitted within the restricted zone, nor entry during the breeding season (March 1 to September 1) in order to prevent disturbing nesting birds; establish a management zone (200 m to 350 m) around the restricted zone to maintain seclusion of the wetland and minimize disturbance during the breeding season (March 1 to September 1, including harvest, salvage, hauling, and road construction); implement erosion and sediment controls in the management zone; do not use pesticides or herbicides; and do not remove beaver dams where flood areas are being used by American bitterns. • In the status report for trumpeter swans in Alberta, the recommended management strategies include a reintroduction program and implementation of land use legislation such as a 500 m buffer on identified trumpeter swan lakes that precludes long term development (roads, wells, pipelines) and flying restrictions over trumpeter swan lakes during breeding season (April 1 to September 30) (James 2000). Regulatory guidelines for disturbance activities near trumpeter swan nesting habitat in Alberta recommend a year-round disturbance setback distance of 500 m from the bead and shore of identified waterbodies and/or watercourses, and 800 m between April 1 and September 30 (Government of Alberta 2013a). • Recommendations from the BC *Develop with Care Guidelines* for riparian and wetlands habitats include: maintaining riparian vegetation cover including trees, shrubs, and ground cover, as well as emergent aquatic vegetation (*e.g.*, cattails, bulrushes) to reduce flow and wave energy, thereby reducing erosion of shorelines; maintaining the roots of shrubby vegetation such as willows, red-osier dogwood, and hardhack to stabilize banks and prevent bank erosion; avoiding filling or draining permanent or seasonally wet areas; buffering wetlands by 150 m in undeveloped areas, 100 m in rural areas, and 30 m in urban areas (BC MOE 2012a). • The goal of *Management Plan for Peale's Peregrine Falcon (Falco peregrines pealei) in BC* is to maintain the population at a minimum of 100 occupied aeries and to slowly increase the population to numbers that are closer to historical numbers found in the early twentieth century (Cooper 2007). This goal will be achieved through four objectives including: managing the subspecies in order to maintain a well-distributed minimum population of 100 occupied aeries throughout the current range in coastal BC; marinating habitat quality in order to promote and overall mean annual fledging rate of at least 1.5 young per breeding pair, maintaining colonial-nesting seabird populations at current or higher levels; and monitoring organochlorine pesticide contaminants in Peale's peregrine falcons (Cooper 2007). • Environment Canada recommends activities maintain a 100 m setback from the high water mark of wetlands or waterbodies containing a horned grebe nest from April 1 to August 31 (Environment Canada 2011a). In Alberta, a 500 m setback is recommended from April 15 to July 31 for horned grebe nests (Government of Alberta 2013a). Breeding horned grebe were detected along the Edmonton to Hinton Segment during field surveys in 2013 (Wildlife Technical Report of Volume 5C). • Context for bald eagle, black-throated green warbler, Canada warbler, Cape May warbler, common nighthawk, great blue heron, olive-sided flycatcher, rusty blackbird, short-eared owl. spotted owl, and western screech-owl are provided below. • Table 7.2.10-10 provides a summary of the predicted change in effective riparian and wetland bird habitat as a result of the Project.
Wood warblers	• Wood warblers are a group of passerine birds of the family Parulidae. The wood warblers indicator includes species with special conservation status and common species. Habitat models were developed specifically for Cape May warbler and black-throated green warbler, which occupy habitats along the Edmonton to Hinton Segment that may be especially sensitive to anthropogenic disturbances. Some common species included in the wood warblers indicator community are American redstart, blackpoll warbler, Connecticut warbler, MacGillivray's warbler, ovenbird and Wilson's warbler. The indicator community includes the following species of conservation concern (AESRD 2012a, ASRD 2011b, BC CDC 2013, COSEWIC 2013, Environment Canada 2013c): - black-throated green warbler (Sensitive in Alberta; Special Concern by Alberta's ESCC); - Cape May warbler (Sensitive in Alberta; In Process [previously Special Concern] by Alberta's ESCC); and - Canada Warbler (Threatened under Schedule 1 of *SARA* and by COSEWIC; Sensitive in Alberta). • The population of black-throated green warblers appears to be stable to slightly increasing across Canada, but within Alberta, observations of the species have declined (Environment Canada 2013h). Populations of Cape May warbler appear to be stable in Canada, with slight increases seen in Alberta (Environment Canada 2013h). Breeding Bird Survey data indicate a steady population decrease for Canada warbler from about 1970 to the present, with an overall loss of 70% of the population during that period (Environment Canada 2013h). • Warblers are present in Alberta from late May until late summer (August/September) (Campbell *et al.* 1990a). • Black-throated green warblers, Canada warblers and common yellowthroats primarily eat insects, including flies, spiders, caterpillars, beetles and bugs (BC MWLAP 2004b, COSEWIC 2008b). Berries and seeds are also foraged. The Cape May warbler is a spruce budworm specialist, foraging in the upper forest canopy (Morse 1978). • The species in the wood warblers indicator group are typically associated with spruce forests (Boreal Avian Modelling Project 2013). Nests are commonly built in coniferous trees or coarse woody debris, in stands with a well-developed understory that provides foraging habitat (Cooper *et al.* 1997a,b, Morse and Poole 2005, Norton 1999, 2001). Black-throated green warblers and Cape May warblers are generally associated with mature forest, while Canada warbler is found in a variety of stand ages, including shrubby riparian areas (Cooper *et al.* 1997a,b, COSEWIC 2008b, Norton 2001).

TABLE 7.2.10-8 Cont'd

Indicator	Ecological Context
Wood warblers (cont'd)	• Black-throated green warblers are found at highest densities in mixedwood forest with some white spruce, although pure white spruce stands and lowland forests are sometimes used (Norton 1999). Cape May warblers are found at their highest densities in pure white spruce stands, with mixed wood stands being used at lower densities. Cape May warblers rarely use lowland forest or deciduous forest (Norton 2001). Cape May warblers are rarely found in disturbed sites (Norton 2001). • Wood warblers are largely insectivorous and therefore experience population fluctuations in response to insect outbreaks (*e.g.*, spruce budworm) (Cooper *et al.* 1997a,b, COSEWIC 2008b, Norton 2001). • Habitat loss and fragmentation resulting from logging, industrial developments and the energy sector are believed to be among the most important limiting factors for wood warbler populations in Alberta (Norton 1999, 2001). • No specific management or recovery plans are available for these species in Alberta; however, habitat retention and fragmentation reduction guidelines are part of some forest management plans (Norton 1999, 2001). • Environment Canada recommends the following setback distance for disturbance activities in proximity to Canada warbler nests: from May 1 to July 31, 300 m setback from active nests for high disturbance activities 150 m for medium disturbance activities and 0-50 m for low disturbance activities (Environment Canada 2011a). • Table 7.2.10-10 provides a summary of the predicted change in effective wood warbler habitat as a result of the Project.
Short-eared owl	• Short-eared owl is listed as Special Concern on Schedule 1 of *SARA* and by COSEWIC (COSEWIC 2013, Environment Canada 2013c), are Blue-listed in BC and have a Conservation Framework Priority rating of 2 (BC CDC 2013), and are listed as May Be at Risk in Alberta (ASRD 2011b). • Short-eared owls are not adequately sampled by regular bird surveys, but the Breeding Bird Surveys (1970-2011) captures the wide population fluctuations characteristic of this species. Most recently, short-eared owls appear to be in a phase of abundance in Alberta (Environment Canada 2013h); however, national trends indicate an overall decline since 1970 (Environment Canada 2013h). In BC, there is inadequate data for a population estimate, however, the population appears to have declined steadily in both breeding and overwintering areas since 1960 (Campbell *et al*. 1990 as cited in BC MWLAP 2004b). • Short-eared owls are nomadic and their distribution and abundance is tied to that of small rodents (BC MWLAP 2004b). • Breeding season of short-eared owls in western Canada typically extends from March to June. In some cases, owls may re-nest if the first clutch is lost, which can extend the breeding period into July (COSEWIC 2008c). Nests are located on the ground in a shallow scrape and are generally in dry areas (Holt and Leasure 1993). Nest sites in BC tend to be located in shrubby, grassy fields adjacent to agricultural areas; use of airport fields, marshes, rangeland, sagebrush plains, bogs, and hayfields has also been documented (Campbell *et al*. 1990b, COSEWIC 2008c). Short-eared owls prefer densely vegetated grasslands, and grazed areas are avoided due to increases in nest predation at these sites (Fondell and Ball 2004). In Alberta, short-eared owls have frequently been found nesting in active cropland with grain stubble. Although these sites may be attractive for nesting, fledging success may be very low (COSEWIC 2008c, Houston 1997). In addition to using agricultural fields and grasslands, young reforested areas (<10 year old) also provide attractive nesting cover (Shaw 1995). • Short-eared owls are sensitive to disturbance, especially during the nesting period, and females have been reported to abandon nests after being flushed and harassed at their nest site (Leasure and Holt 1991). • The primary threat to the short-eared owl is loss of nesting habitat due to rapid urbanization, industrialization, intensive agriculture and human disturbance. Fragmentation of habitats may cause fluctuations in the population of their rodent prey base (COSEWIC 2008c, Demarchi *et al*. 2005). • The Identified Wildlife Species Account for the short-eared owl recommends establishment of WHAs around known breeding areas, minimizing human and livestock disturbance to active winter roosts and nest sites, and maintaining important structural features, such as mid-height to tall grasses with some low shrub cover for nesting (BC MWLAP 2004b). The proposed pipeline corridor does not encounter any WHAs for short-eared owl. • The *Best Management Practices for Raptor Conservation in BC* recommend: retention of undisturbed grasslands, old fields, pastures and natural forest openings; avoidance of mowing of fields during the nesting season; and minimizing disturbance and access to potential nesting areas (Demarchi *et al*. 2005). • The *Guidelines for Raptor Conservation* in BC recommend a 500 m buffer (in undeveloped areas), a 200 m buffer (in rural areas), or an approximately 50 m buffer (in urban areas) around raptor nests, with an additional 100 m quiet buffer during nesting season (BC MOE 2013e). • In Alberta, a 100 m setback is recommended from April 1 to July 15 for short-eared owl nests (Government of Alberta 2013a). • There is no recovery plan or strategy for short-eared owl (BC MOE 2013f, Environment Canada 2013c). • Table 7.2.10-10 provides a summary of the predicted change in effective short-eared owl habitat as a result of the Project.
Rusty blackbird	• Rusty blackbird is listed as Special Concern under Schedule 1 of *SARA* and by COSEWIC (COSEWIC 2013, Environment Canada 2013c), are Blue-listed in BC and have a Conservation Framework Priority rating of 2 (BC CDC 2013), and are listed as Sensitive in Alberta (ASRD 2011b). • The rusty blackbird is migratory and is present in Canada from early April to early October (COSEWIC 2006e).The population of rusty blackbird in Canada, which is about 70% of the global population, is estimated at 110,400 to 1.4 million individuals (COSEWIC 2006e). The estimates vary greatly, but include data from Breeding Birds Surveys and the Canadian Migration Monitoring Program. Long-term trend analyses based on Christmas Bird Counts (in the rusty blackbird winter range in the US) indicate that the rusty blackbird population has declined substantially over the last 40 years (COSEWIC 2006e). • Rusty blackbird habitat includes forest wetlands, such as slow moving streams, peat bogs, sedge meadows, marshes, swamps, beaver ponds and pasture edges. In winter, it occurs primarily in damp woodlands and cultivated fields. Females build the nests, which are typically placed in thickets of small conifers, deciduous shrubs or in dead trees, usually over or close to water (COSEWIC 2006e).

TABLE 7.2.10-8 Cont'd

Indicator	Ecological Context
Rusty blackbird (cont'd)	• Rusty blackbirds are highly specialized and, therefore, may have limited ability to adapt to even slight changes in habitat (Smithsonian 2012). Although the reasons for the species' decline are unclear and attributed largely to habitat degradation in wintering habitats, alteration or loss of wetlands in the forest breeding habitat is suspected to be a contributing factor (COSEWIC 2006e, Greenberg and Matsuoka 2010, Smithsonian 2012). Competition with dominant species such as red-winged blackbird, disease, pest control (in the wintering grounds in the US), and increased predation and inter-specific competition in fragmented habitats have also been suggested contributing factors for rusty blackbird declines (COSEWIC 2006e, Greenberg and Matsuoka 2010). • Environment Canada recommends the following species specific setback for rusty blackbird nests: from May 1 to July 31, a 300 m setback for high disturbance activities, a 150 m setback for medium disturbance activities and 0-50 m for low disturbance activities (Environment Canada 2011a). • There is no Identified Wildlife Species Account, recovery plan or strategy for rusty blackbird (BC MOE 2013f, BC MWLAP 2004b, Environment Canada 2013c). • Table 7.2.10-10 provides a summary of the predicted change in effective rusty blackbird habitat as a result of the Project.
Flammulated owl	• Flammulated owl is listed as Special Concern under Schedule 1 of *SARA* and by COSEWIC (COSEWIC 2013, Environment Canada 2013c), is Blue-listed in BC and has a Conservation Framework Priority rating of 2 (BC CDC 2013). • Population estimates and distribution are uncertain. A recent population estimate (2001) 1,200-2,000 owls across a range of 113,000 km² in BC (van Woundenberg 2001 as cited in COSEWIC 2010b). Local estimates of individuals include 337 owls were counted in the Kamloops Forest District (Booth and Merkens 1998); 26 owls in 1995 and 40 owls in 1996 at Wheeler Mountain (van Woudenberg and Christie 1997); and 24 owls in the Heffley Creek area in 2007 (Iredale and Ferguson 2007). Estimates of breeding pairs in 1999 were 100 pairs in the Okanagan Valley, 100-200 pairs in the Merritt Forest District, and >200 pairs in the Kamloops Forest District (van Woudenberg 1999). • There is no information regarding population trends for the province. Suitable habitat is declining due to harvesting of old-growth forest and firewood cutting, which may limit the population of flammulated owls (BC MWLAP 2004b). • Flammulated owls are associated with open ponderosa pine forest or Douglas-fir forest. Mature or old forest is important habitat for nesting, roosting and foraging. They are a secondary cavity nester and use either natural cavities or cavities excavated by pileated woodpeckers or northern flickers (Campbell *et al.* 1990b). Ponderosa pine appears to be selected over Douglas-fir for nesting, likely due to greater use by pileated woodpeckers and northern flickers (BC MWLAP 2004b). • Flammulated owls are insectivorous. Foraging occurs in flight and prey is either taken in tall grass or shrubs in forest openings or from the forest canopy (BC MWLAP 2004b). Openings used for foraging can be natural (*e.g.*, blowdown) or result from forest harvesting (van Woudenberg 1992), however, openings must be small (<1 ha) and adjacent to forest cover for security (BC MWLAP 2004b). Foraging generally occurs within 300 m of the nest (BC MWLAP 2004b). • Flammulated owls are present in BC during the breeding season from May to September (BC MWLAP 2004b). They will reuse the same tree or group of trees in subsequent years, but generally occupy different cavities. • Flammulated owls are habitat specialists, and the loss or degradation of old heterogeneous stands of Douglas-fir and ponderosa pine has potential to limit populations in BC. Suitable habitat has decreased substantially from historic levels as the result of forest harvesting, fire suppression, and, more recently, from mountain pine beetle infestation (COSEWIC 2010b). • The British Columbia Provincial Flammulated Owl Working Group (PFOWG) established the *Management Plan for the Flammulated Owl (Otus flammeolus) in British Columbia* in 2011 (PFOWG 2011). The goal of this management plan is to maintain stable or increasing populations of flammulated owl distributed throughout the species' present range. This goal will be achieved through five management objectives: 1) identify population, habitat, and distribution targets required to maintain viable populations; 2) initiate protection and/or management of priority breeding habitats; 3) investigate knowledge gaps related to cumulative impacts of medium impact, extreme severity, or unknown threats (*e.g.*, mountain pine beetle, fire and fire suppression, timber harvest); 4) investigate knowledge gaps related to range management; and 5) establish and implement a monitoring program for flammulated owl populations and habitat. • The Identified Wildlife Species Account (BC MWLAP 2004b) recommends four general measures for management of flammulated owls in BC: establish WHAs that area appropriately sized and structured; minimize disturbance during the breeding season (June 1 to August 31); maintain adequate foraging habitat for productivity; and ensure security cover from predators for both foraging adults and fledglings. The proposed pipeline corridor does not encounter any WHAs for flammulated owl. • Recommendations from the BC *Develop with Care Guidelines* for flammulated owl include protection of nesting, foraging and perching habitats and features, and establishment of buffers around nesting habitats (500 m in undeveloped areas, 200 m in rural areas, approximately 50 m in urban habitats, and an additional "quiet" buffer of 100 m during breeding season) (BC MOE 2012a). • The goal of the *Management Plan for the Flammulated Owl (Otus flammeolus) in Canada* (Environment Canada 2013j) is to maintain stable or increasing populations of flammulated owl throughout the species' range in BC. Specifically, the objectives of the plan are to quantify population, habitat and distribution targets required to maintain viable populations, protect and/or manage of priority breeding habitat, address knowledge gaps with regards to threats and management, and institute a monitoring program of owls and their habitat. • Table 7.2.10-10 provides a summary of the predicted change in effective flammulated owl habitat as a result of the Project.

TABLE 7.2.10-8 Cont'd

Indicator	Ecological Context
Lewis's woodpecker	• Lewis's woodpecker is listed as Threatened under Schedule 1 of *SARA* and by COSEWIC (COSEWIC 2013, Environment Canada 2013c), is Red-listed in BC and has a Conservation Framework Priority rating of 2 (BC CDC 2013). • The proposed pipeline corridor crosses early candidate critical habitat for Lewis's woodpecker, which is in the early stages of internal review (Environment Canada 2013d). The Wildlife Technical Report in Volume 5C provides additional information regarding candidate critical habitats. • The BC population was estimated at 600 breeding pairs in 1990 and 630-920 adults in 2007 (BC MWLAP 2004b, COSEWIC 2010c). The current population estimate is 315-460 pairs (Environment Canada 2011b). Lewis's woodpecker populations have declined in total numbers, extent of occurrence and area of occupancy. Population trends in the East Kootenay Trench show an estimated 22% decline in this species from 1997 to 2007 (COSEWIC 2010c). Breeding Bird Surveys show a general decline in sightings of this species in BC (Environment Canada 2013h). • Lewis's woodpeckers typically nest in open areas with low tree densities, and are generally found in three habitat types: open forest or shrub-steppe/grassland with scattered trees (especially ponderosa pine); riparian cottonwood forests adjacent to open areas; and burns (COSEWIC 2010c, Vierling *et al.* 2013). • Lewis's woodpeckers nest in the cavities of trees, especially within ponderosa pine, black cottonwood and Douglas-fir (BC MWLAP 2004b). Western larch, trembling aspen and paper birch may also be suitable for nesting, and utility poles have been used as nest sites when close to good foraging grounds (Cooper and Beauchesne 2000). Lewis's woodpeckers are weak cavity excavators; they can excavate their own nest cavity, but often use holes excavated by other woodpeckers or natural cavities (Cooper and Beauchesne 2000). Large diameter, decaying snags are often ideal for nest cavity excavation by Lewis's Woodpecker, and are important components of breeding habitat (BC MWLAP 2004b). The same cavity is often occupied in consecutive years (COSEWIC 2010c). • The Lewis's woodpecker has a wide ranging diet that changes throughout the year to take advantage of seasonally abundant food sources. A well developed ground cover or understory layer providing suitable foraging opportunities (insects, berries) is an important component of habitat suitability. Large open areas are required to provide enough space and visibility for aerial pursuit of flying insects (BC MWLAP 2004b). • Lewis's woodpeckers are migrants, present in BC from May to September (BC MWLAP 2004b). • The loss or degradation of suitable breeding habitat is believed to be a limiting factor for Lewis's Woodpecker in BC (COSEWIC 2010c). Habitat has been substantially reduced as a result of fire suppression (resulting in the growth of dense forest stands), removal of snags for safety reasons, intensifying agricultural practices, over grazing, urbanization, commercial forestry (especially the selective removal of ponderosa pine and the replanting of dense stands), harvesting trees for firewood, and industrial development (COSEWIC 2010c, Vierling *et al.* 2013). • In their 1998 status report, Cooper *et al.* (1998) recommend the following measures for management of Lewis's woodpecker in BC: management of ponderosa pine forests and riparian stands of black cottonwood to maintain an adequate abundance of soft snags; habitat enhancement including girdling of live, mature ponderosa pines or black cottonwoods to produce snags suitable for nesting, and managed burns to create open habitats; public education to raise awareness of the value of wildlife and wildlife habitat; habitat acquisition including purchasing lands to protect habitat; and a wildlife tree sign program. • The *Ecological Area Assessment for the Lac du Bois Grasslands Protected Area* identifies habitat potential for Lewis's woodpecker and recommends that large standing snags should be retained as wildlife trees for Lewis's woodpecker and other cavity nesting birds (Grasslands Conservation Council of British Columbia 2009). • The Identified Wildlife Species Account (BC MWLAP 2004b) recommends the following measures to protect and manage Lewis's woodpecker: establish WHAs to maintain suitable nesting habitat for multiple pairs; provide an adequate supply of large diameter live and dead wildlife trees suitable for foraging and nesting; maintain an open canopy; maintain the integrity of nesting habitat; and maintain adequate shrub cover. • The objective of the *Management Plan for Lewis's Woodpecker (Melanerpes lewis) in Canada* (Environment Canada 2011b) is to increase the breeding population of Lewis's Woodpeckers across their current range in Canada to approximately 600 pairs by 2040. The plan includes six strategies and conservation measures: secure breeding habitat around known nests; develop and implement strategies that will maintain the nests; manage Lewis's Woodpecker nest trees and foraging habitats on unsecured crown lands, private land, and Indian Reserve lands following best management practices; conserve migration stopover and overwintering habitat; assess the threats to Lewis's woodpecker; and conduct research and monitoring. The Management Plan recommends the following best management practices for forest management: maintain open forests (< 25% canopy closure) dominated by ponderosa pine, black cottonwood or Douglas-fir with some large snags and recruitment trees; retention of clusters of trees rather than uniformly distributed trees in salvaged or harvested stands; and retention of naturally vegetated linkages between riparian areas, open forest, and reserve areas. Habitat restoration best management practices include removal of conifer regeneration and encroachment, and creating nest trees and snags. Range use best management practices include management of the distribution and intensity of livestock grazing in suitable habitat and near known nests. Disturbance should avoid frequent or prolonged disturbance at nest sites during the breeding season (May to August) (Environment Canada 2011b). There is currently no federal recovery strategy for Lewis' woodpecker. • Table 7.2.10-10 provides a summary of the predicted change in effective Lewis's woodpecker habitat as a result of the Project.

TABLE 7.2.10-8 Cont'd

Indicator	Ecological Context
Williamson's sapsucker	• Williamson's sapsucker is listed as Endangered on Schedule 1 of *SARA* and by COSEWIC (COSEWIC 2013, Environment Canada 2013c) and is Blue-listed in BC (BC CDC 2013). The *thyroideus* ssp. occurs within the Wildlife LSA and RSA. • The proposed pipeline corridor intersects proposed critical habitat for Williamson's sapsucker (Environment Canada 2013d). The proposed recovery strategy for Williamson's sapsucker has not yet been posted on the Species at Risk Public Registry for public review and comment. The Wildlife Technical Report in Volume 5C provides additional information regarding proposed critical habitats. • Based on inventory data to 2007, the estimated Williamson's sapsucker population in BC is 460-1,000 breeding birds (BC MOE 2012b). There are no reliable trend data for the Canadian population, but in Oregon, where it has been assessed, this species has declined at an average rate of 3.3% per year from 1980 to 2003 (COSEWIC 2005). Williamson's sapsucker is considered an accidental species in Alberta. • The Williamson's sapsucker is found in mature coniferous or mixed deciduous mountain forests at mid to high elevations with large-diameter partially decaying trees as nest trees (Gyug *et al.* 2009). They are strongly associated with forests containing western larch where it occurs. They may also use spruce, Douglas-fir, lodgepole pine, ponderosa pine and trembling aspen as nest trees (BC MWLAP 2004b, Gyug *et al.* 2009). • Feeding sites may range up to 460 m from the nesting sites, but are typically less than 100 m from the nest tree (COSEWIC 2005; Gyug *et al.* 2009). Forage trees are typically live mature conifers (*e.g.*, Douglas-fir, ponderosa pine, western larch, lodgepole pine), but also include snags and aspen that contain abundant forage (especially ants) (Gyug *et al.* 2009, Gyug *et al.* 2012). • A migratory species, the Williamson's sapsucker is present in BC from April to July (BC MWLAP 2004b). • Habitat with suitable nest sites is believed to be the primary limiting factor for Williamson's sapsucker in Canada (COSEWIC 2005, Gyug *et al.* 2012). Large, partially decaying trees are necessary and they do not occupy isolated trees within openings or small remnant patches of aspen within non-forested habitat (COSEWIC 2005, Gyug *et al.* 2012). Nest productivity (*i.e.*, number fledged per nest) is reduced in open stands with low tree density; in particular, when tree density goes below 85 trees/ha in the breeding territory (Gyug *et al.* 2010). • Williamson's sapsuckers are generally tolerant of disturbance and often forage near or within forest openings (Gyug *et al.* 2012). The primary impact of human activities is likely through direct habitat loss and the removal of large dead or decaying trees. However, it was assumed that high levels of noise would reduce habitat quality by impeding intra-specific communication or predator detection (Gyug *et al.* 2012). • Loss of old forest as a result of short-rotation forestry and industrial development is a concern for management of Willamson's sapsucker habitat (COSEWIC 2005). • The Identified Wildlife Species Account for Williamson's sapsucker identifies the primary threats to Williamson's sapsucker as a small population size making the species vulnerable to extirpation, and habitat loss due to logging of mature or old western larch and Douglas-fir stands. The conservation and management goals recommended include maintenance of suitable nesting trees during industrial and forestry activities, and establishment of WHAs that area appropriately sized and structured (BC MWLAP 2004b). • The *Recovery Plan for the Williamson's Sapsucker* (Sphyrapicus thyroideus) *on Crown Lands in British Columbia* (BC MOE 2012b) was developed with the goal to ensure the persistence of Williamson's sapsucker in Canada by maintaining the population at or above the current abundance, distribution, and area of occupancy. To achieve this goal, habitat attributes will need to be identified and locations of suitable habitat described to facilitate management and mitigate habitat threats (BC MOE 2012b). • Table 7.2.10-10 provides a summary of the predicted change in effective Williamson's sapsucker habitat as a result of the Project.

Western screech-owl	• Separate habitat models were completed for the coastal and interior subspecies of western screech-owl (Wildlife Habitat Modelling and Species Accounts Technical Report of Volume 5C), however, the two subspecies are assessed as a single indicator (ASRD 2011b, BC CDC 2013, COSEWIC 2013, Environment Canada 2013c):
	  - *Megascops kennicotti kennicotti* (Special Concern under Schedule 1 of *SARA*; Threatened by COSEWIC; Blue-listed in BC; Conservation Framework Priority 1); and
	  - *M.k. macfarlanei* (Endangered under Schedule 1 of *SARA*; Threatened by COSEWIC; Red-listed in BC; Conservation Framework Priority 1).
	• It is estimated that 50-200 owls (*macfarlanei* ssp.) inhabit a range of 22,000 km² in the interior region of BC, mostly within the Okanagan and lower Similkameen valleys (COSEWIC 2002c, western screech-owl, *macfarlanei* ssp. Recovery Team 2008). The provincial population estimate for this subspecies is 350-500 individuals (COSEWIC 2012e).
	• There are approximately 3,000-10,000 owls (*kennicotti* ssp.) inhabiting the 50,000 km² area along the southern coast of BC and about 10 breeding pairs in the Greater Vancouver area (COSEWIC 2002c). More recent population surveys for the *kennicotti* ssp. estimate 1,500 to 3,000 individuals in BC (COSEWIC 2012e).
	• Data from the BC-Yukon Nocturnal Owl Survey on the central and south coast show a steep decline in western screech-owl detections between 2000 and 2009 (COSEWIC 2012e). Christmas Bird Count data from the south coast of BC similarly show a substantial population decline (COSEWIC 2012e).
	• Western screech-owls are non-migratory, territorial birds found in woodland habitats, generally at low elevation and near riparian habitat (BC MWLAP 2004b, Campbell *et al.* 1990b). Nests are located in secondary or natural tree cavities; nest boxes are sometimes used where provided (COSEWIC 2012e). Egg-laying occurs between March and May; the young stay in the nest as late as August before dispersing (BC MWLAP 2004b).

TABLE 7.2.10-8 Cont'd

Indicator	Ecological Context
Western screech-owl (cont'd)	• Western screech-owls prefer mature mixedwood or deciduous forests in close proximity to riparian habitat, likely due to the presence of large deciduous trees in these areas. Black cottonwood, trembling aspen and water birch are preferred species for nesting, due to a propensity for natural cavities. Coniferous trees are also used, especially when there are nesting cavities previously made by pileated woodpecker or northern flicker (Cannings and Davis 2007). • As a secondary cavity nester, the availability of suitable nesting trees is a limiting factor for nesting habitat since each breeding pair requires a minimum of two nest cavities (BC MWLAP 2004b, Cannings and Davis 2007). • Habitat loss through forestry activities (*i.e.*, timber harvesting and the removal of dead trees and snags that serve as potential nest cavity trees) is the primary threat to both subspecies of western screech-owl (BC MOE 2013h, COSEWIC 2012e). In the southern interior of BC, an estimated 50% of its habitat has already been lost and the majority of the remainder is degraded (BC MWLAP 2004b). • Additional threats to western screech-owl (*kennicotti* ssp.), especially on the southern part of Vancouver Island and the lower mainland, include urbanization and increased predation from newly established populations of barred owls (BC MOE 2013h, COSEWIC 2012e). • There is no Identified Wildlife Species Account available for western screech-owl (*kennicotti* ssp.) (BC MWLAP 2004b). The Identified Wildlife Species Account for western screech-owl (*macfarlanei* ssp.) recommends protecting habitat (BC MWLAP 2004b). The proposed pipeline corridor does not encounter any WHAs for western screech-owl. • The *Recovery Plan for the Western Screech-owl, kennicottii ssp. (Megascops kennicottii kennicottii) in British Columbia* (BC MOE 2013h) identifies the protection of breeding habitat, establishment and implementation of a monitoring program to assess trends in occupancy and habitat availability across the subspecies range, and assessment and mitigation of current threats as primary objectives. • The western screech-owl, *macfarlanei* ssp. Recovery Team was established with the goal of maintaining a viable, well-distributed population in secure habitat across its known range (Western Screech Owl, *macfarlanei* subspecies Recovery Team 2008). The objectives of the Recovery Team are to secure a minimum of 400 ha of nesting habitat and adjacent foraging habitat at priority sites and to address knowledge gaps of population size, distribution, demographics, viability, habitat requirements and distribution, genetics, and clarification of potential threats. • Recommendations from the BC *Develop with Care Guidelines* for western screech-owl include: protect nest sites with a buffer of at least 1.5 tree lengths in urban areas and 200 m in rural areas plus an additional 200 m buffer during the breeding season (March 15 to August 31); retain existing habitats and features; restore availability of nest cavities by replacing any that were damaged or lost with suitable nest boxes; and protect roost and perch sites (BC MOE 2012a). • The BC *Guidelines for Raptor Conservation* recommend a 500 m buffer around western screech-owl nests in undeveloped areas, and an additional 'quiet' 100 m buffer (*i.e.*, a total of 600 m) during the breeding season (February 17 to August 25) (BC MOE 2013e). • Table 7.2.10-10 provides a summary of the predicted change in effective western screech-owl habitat as a result of the Project.
Great blue heron	• The coastal and interior subspecies of great blue heron are included in this indicator, which is assessed at the species level. The status designations of the subspecies are (BC CDC 2013, COSEWIC 2013, Environment Canada 2013c): - *Ardea herodias fannini* (Special Concern under Schedule 1 of *SARA* and by COSEWIC; Blue-listed in BC; Conservation Framework Priority 1); and - *A. h. herodias* (Blue-listed in BC; Conservation Framework Priority 2; Sensitive in Alberta). • Population size has been difficult to estimate for great blue heron since colonies are not stable entities and are difficult to track in a standardized fashion (Gebauer and Moul 2001). The *fannini* ssp. in BC is currently estimated at 3,626 breeding adults, with an estimated 3,326 adults breeding in the Strait of Georgia and 300 breeding elsewhere on the coast (Gebauer and Moul 2001). The population size of the *herodias* ssp. in BC is not known, but probably ranges between 300 and 700 individuals (Gebauer and Moul 2001). • There is conflicting information regarding population trends for great blue heron in BC. The Christmas Bird Count shows declines over the last three generations, while the Coastal Waterbird Survey shows a five-year increase. Colony surveys suggest that there have been substantial declines in productivity and success since 1970 (COSEWIC 2008d). • Great blue herons require different habitats for nesting and for foraging. Foraging habitat must be within 10 km of nesting habitat. Important foraging habitats include estuaries, eelgrass beds, tidal flats, freshwater marshes and other wetlands, old fields, river and lake edges, and flooded fields (BC MOE 2012a, BC MWLAP 2004b). Inland fields are considered an important foraging habitat for both adults and juveniles in the lower Fraser Valley and on southern Vancouver Island (Gebauer and Moul 2001). Nesting habitats include contiguous forest, fragmented forest, and solitary trees The most common tree species used for breeding on the coast are red alder, black cottonwood, bigleaf maple, lodgepole pine, Sitka spruce and Douglas-fir (Gebauer and Moul 2001). In the southeastern interior, black cottonwood comprises 54% of nest trees with coniferous species (Douglas-fir, western white pine, hybrid white spruce , ponderosa pine, western redcedar and western hemlock) accounting for the remaining 46% (BC MWLAP 2004b). • Great blue herons are sensitive to disturbance, which can result in nest and/or colony abandonment (BC MWLAP 2004b, COSEWIC 2008d). • Direct threats to great blue heron populations in BC include human disturbance, mortality from predators (*e.g.*, bald eagles) and humans, limited food supply, and stochastic weather events, including high rainfall events and wind storms (BC MWLAP 2004b).

TABLE 7.2.10-8 Cont'd

Indicator	Ecological Context
Great blue heron (cont'd)	• The Status of the Great Blue Heron in British Columbia report recommends the following measures to manage and protect the populations in BC: buffer zones; barriers to disturbance such as fences, ditches, other watercourses, and dense forests; seasonal windows of activity (activities that may negatively affect herons should be avoided between mid-February and early August on the coast and between March and August in the interior); establishment of protected areas; timber harvest plans to protect future heron nesting sites; urban planning to include suitable habitats in designs for parks, greenbelts, and subdivisions; agricultural planning to include treed hedgerows for nesting and roosting adjacent to winter foraging fields and drainage ditches; and habitat enhancement (Gebauer and Moul 2001). • The Identified Wildlife Species Account for great blue heron in BC identifies the following measures for management and recovery: establishment of WHAs to protect nesting sites; minimization of disturbance during the breeding season (February 15 to August 31) and between November 1 and March 31 for colonies that occupy areas year round; and maintenance of important structural elements for nesting and foraging (*i.e.*, suitable nest trees, non-fragmented forest around nest trees, wetland characteristics for foraging if applicable, roost trees, and ground barriers to exclude mammalian predators) (BC MWLAP 2004b). • Recommendations from the BC *Develop with Care Guidelines* for great blue herons include: protection of potential heron nesting habitats that occur within 3–4 km of known foraging areas; establishment of buffers around nesting areas (300 m in undeveloped areas, 200 m in rural areas, and 60 m in urban areas) including an additional "quiet" buffer of 200 m during breeding season; and timing of construction in the Least Risk Window of September 1 to February 15 (new disturbances should be avoided between February 15 and August 31 when herons are nesting) (BC MOE 2012a). • In Alberta, it is recommended that activities not occur within 1,000 m of great blue heron nesting colony (Government of Alberta 2013a). • Table 7.2.10-10 provides a summary of the predicted change in effective great blue heron habitat as a result of the Project.
Spotted owl	• Spotted owl is Endangered under Schedule 1 of *SARA* and by COSEWIC (COSEWIC 2013, Environment Canada 2013c), is Red-listed in BC and has a Conservation Framework Priority rating of 2 (BC CDC 2013). • The proposed pipeline corridor crosses the Sowaqua Spotted Owl WHA (2-498) for spotted owl, which is identified as a Long-term Owl Habitat Area (LTOHA). • The population of spotted owls in BC was estimated to be about 500 pairs prior to European settlement (Blackburn *et al.* 2002), and has been steadily declining from less than 30 pairs (60 birds) in 2002 to 19 birds at 14 sites in 2007 (Blackburn and Godwin 2004a, COSEWIC 2008e, Hausleitner 2006, Hobbs 2005). • The spotted owl is associated with a variety of forest types but is generally found in mature to old growth forests dominated by coniferous tree species (COSEWIC 2008e). The requirements for all life requisites (foraging, roosting and nesting) are met in these habitats. • Habitat requirements include structural diversity (structural deformities, snags, broken tops of trees), multiple canopy layers with open spaces for flying, moderate to high canopy cover, and large amounts of large coarse woody debris on the forest floor (Blackburn and Godwin 2004a). High suitability habitat is more likely to be used for nesting, while low suitability habitat may only be used for foraging or roosting. • Spotted owls require very specific structural habitat features for nesting. The spotted owl does not create its own nesting cavities or platforms but uses cavities excavated by other birds (*e.g.* pileated woodpecker), platforms constructed by other birds (*e.g.*, northern goshawk), natural cavities, or accumulations of debris that form nesting platforms (Blackburn and Godwin 2004a). Spotted owl nests average approximately 50 cm in diameter; therefore, large diameter trees with large branches, snags, or cavities are required. These trees are generally found in mature and old growth forests with a mean tree age >140 years. • Home range size varies throughout the year, from a small area surrounding the nest in breeding season to several thousand hectares in the winter (Forsman *et al.* 1984). • The spotted owl is vulnerable to extirpation in BC due to its small population size and low densities. The primary threats facing the spotted owl are habitat loss and fragmentation, and increased competition with the barred owl, likely as the result of habitat fragmentation (Blackburn and Godwin 2004b, Dugger *et al.* 2011, Kelly *et al.* 2003). The small population size combined with habitat fragmentation may limit the connectivity of the spotted owl population in BC by reducing recruitment of dispersing juvenile owls, increasing the number of sites occupied by a single owl (rather than pairs), and increasing the distance between breeding pairs (COSEWIC 2008e). The amount and distribution of suitable habitat can further affect reproductive success since spotted owls show site fidelity to breeding habitats (COSEWIC 2008e). • The reproductive success of northern spotted owls has been shown to decrease within 100 m of noisy roads in northern California (Hayward *et al.* 2011). Nesting success did not decrease near quiet roads in northern California; however, northern spotted owls are known to avoid nesting within 100 m for a forest edge (Johnson 1993) and California spotted owls show a positive selection for the amount of interior forest habitat (>100 m from an edge) (Chatfield 2005). Due to competition with barred owls, a negative response to forest edge is likely to occur in BC. • The goal of the *Spotted Owl Management Plan* (1997) was to achieve a reasonable level of probability that populations would stabilize, and possibly improve over the long-term, without substantial short-term impacts on timber supply or forest industry employment (Spotted Owl Management Inter-Agency Team 1997). As a part of the Spotted Owl Management Plan, 21 special resource management zones were established. In the 5 years following this document, the population of spotted owls continued to decrease dramatically. In 2004, additional habitat protection was afforded to known spotted owl occurrences in the form of WHAs (Spotted Owl Best Management Practices Working Group 2009). • The goal of the *Recovery Strategy for the Northern Spotted Owl (Strix occidentalis caurina) in British Columbia* is to down-list the spotted owl from Endangered status by establishing a stable or increasing, self-sustaining population distributed throughout the species' natural range (Chutter *et al.* 2004). This recovery strategy was reviewed and adopted by the BC provincial government in 2006.

TABLE 7.2.10-8 Cont'd

Indicator	Ecological Context
Spotted owl (cont'd)	• Following the recovery strategy, the Spotted Owl Population Enhancement Team (SOPET) was formed in 2006. The team produced a Five-year Action Plan, with a primary goal of facilitating the recovery of the spotted owl population in BC through population enhancement. The plan included establishment of a captive breeding and reintroduction program for spotted owls within BC. As part of this, predator and competitor control programs were also proposed (SOPET 2007). • In 2009, the previous management plans were revisited and revised. The resultant document, *Best Management Practices for Managing Spotted Owl Habitat* (Spotted Owl Best Management Practices Working Group 2009), aims to recover and sustain the spotted owl population and protect spotted owl habitat by establishing WHAs (LTOHAs and Managed Future Habitat Areas). One LTOHA for spotted owls is intersected by the proposed pipeline corridor (WHA 2-498). The management goal in a LTOHA is to achieve 100% suitable spotted owl habitat conditions by conserving the existing spotted owl habitats and creating additional spotted owl habitats. A no-net-loss policy is in place in the LTOHAs and management recommendations include limited clearing, retention of large trees and prioritizing regeneration of vegetation and trees in clearings (Spotted Owl Best Management Practices Working Group 2009). • Table 7.2.10-10 provides a summary of the predicted change in effective spotted owl habitat as a result of the Project.
Bald eagle	• Bald eagle is Yellow-listed in BC (BC CDC 2013) and is listed as Sensitive in Alberta (ASRD 2011b). The species is designated Not at Risk by COSEWIC (COSEWIC 2007). • Aboriginal participants reported that the bald eagle is a species of high cultural value. The bald eagle represents many things, including luck, womanhood, wisdom and protection; and bald eagle bones and feathers have many ceremonial uses. Primary concerns identified during Aboriginal participation in field studies for the Project were disturbance or destruction of bald eagles' nests during construction (Wildlife Technical Report of Volume 5C). • The global population of bald eagles was estimated to be 70,500 birds in 1980. Of this total, approximately 30,000 bald eagles occurred in Canada with 28,500 in BC (Gerrard 1983 cited in Blood and Anweiler 1994). Since the 1970s, observations of this species have been increasing steadily throughout its Canadian range (Environment Canada 2013h). • In the Pacific Northwest, the population of bald eagles increased four-fold in the last 30 years (Elliott *et al.* 2011). • The bald eagle nests earlier in the year than other birds in the same area and it tends to be territorial during the breeding season (Blood and Anweiler 1994). The nesting densities of bald eagles vary by region and are generally highest where food abundance is highest (Blood and Anweiler 1994). • In BC, most of bald eagle nests have been found in old growth ponderosa pine, Douglas-fir, Sitka spruce and western hemlock trees within 1.6 km of a large waterbody (Blood and Anweiler 1994). Nests are often used for several years and there may be alternate nest sites within a single territory. Nest site selection appears to be dependent on structural characteristics of the tree (*e.g.*, tallest tree in area, clear flight path to nearby water, view of surrounding area, proximity to food source) rather than tree species (Blood and Anweiler 1994). • The seasonal movements of the bald eagle are complex and vary by geographic region, weather, food availability, individual birds (Blood and Anweiler 1994). Some bald eagles migrate, while other populations occur year-round in BC (Blood and Anweiler 1994). • Ice-free waterbodies, including rivers, are the most important habitat requirement for bald eagles wintering in BC, and population sizes will fluctuate regionally and seasonally, based on the availability of prey. Bald eagles use the entire coastline during the winter, focusing largely on fish spawning rivers, and estuaries and mudflats with wintering waterfowl (Blood and Anweiler 1994). In addition to foraging habitat, bald eagles also require adequate perching and roosting habitat in proximity to waterbodies throughout the winter. Roosting and perching habitat includes snags, deciduous or spindly coniferous trees, pilings, log booms, or unvegetated ground. • The primary threats to bald eagles are shooting mortality, pesticide contamination, and habitat loss (Blood and Anweiler 1994). The 1994 report on the status of the bald eagle in BC identifies inventory, protection and research as necessary for bald eagle protection and management, and recommends the following measures: a province-wide nest tree inventory; protective buffering around nest trees, key forage resources, and habitats; province-wide elimination of lead shot; discontinued use of some pesticides; movement of ungulate carcasses away from road edges; modified design of power lines; reduced use of leg-hold traps and snares; increased support of rehabilitation programs; and research to fill knowledge gaps in eagle ecology, mortality and tolerance to human disturbance (Blood and Anweiler 1994). • There is no Identified Wildlife Species Account available for bald eagle (BC MWLAP 2004b). • Recommendations from the BC *Develop with Care Guidelines* for bald eagles include: management and restoration of raptor habitat and features including feeding, roosting, and perching sites; preserve good foraging sites include shorelines, estuaries, wetlands, shrubby areas, old fields, hedgerows, and riparian areas; establishment of buffers around nesting areas (200 m in undeveloped areas, 100 m in rural areas, and approximately 50 m in urban areas) including an additional "quiet" buffer of 100 m during breeding season; and timing of construction within the Least Risk Window of September 1 to December 31 (BC MOE 2012a). • The proposed pipeline corridor crosses Sensitive Raptor Range for bald eagle along the Edmonton to Hinton Segment. In Alberta, a year-round 1,000 m buffer is recommended for bald eagle nests (Government of Alberta 2013a). • Table 7.2.10-10 provides a summary of the predicted change in effective bald eagle habitat as a result of the Project.

TABLE 7.2.10-8 Cont'd

Indicator	Ecological Context
Common nighthawk	• Common nighthawk is listed as Threatened under Schedule 1 of *SARA* and by COSEWIC (COSEWIC 2013, Environment Canada 2013c), is Yellow-listed in BC and has a Conservation Framework Priority rating of 2 (BC CDC 2013) and is listed as Sensitive in Alberta (ASRD 2011b). • Based on Breeding Bird Surveys, the population estimate of common nighthawks in Canada is 400,000 individuals (COSEWIC 2007a). Between 1976 and 2011, this species has been declining on a national scale at an average annual rate of 3.81% (Environment Canada 2013h). In BC, the species has experienced an average annual decline of 2.52% from 1970 to 2011 in BC (Environment Canada 2013h). • Common nighthawks breed in a variety of open habitat types, including sand dunes and beaches, recent burns and logged areas, forest clearings, prairies, pastures, bogs, marshes, lakeshores, gravel roads, river banks, rock barrens and outcrops, railways, quarries, urban parks, airports, mines (COSEWIC 2007a), clear-cuts and burns (Poulin *et al.* 2011), and open ponderosa pine forests (Campbell *et al.* 1990b). Although common nighthawks may use urban areas, natural sites are preferred (Brigham 1989). • Non-vegetated sites with bare ground or rock are markedly preferred for nesting (Allen and Peters 2012, Lohnes 2010). In urban areas, gravel rooftops can provide attractive nesting habitat, although high sun exposure at these sites has been associated with nestling mortality (COSEWIC 2007a). When nesting in natural habitats, young nighthawks seek refuge from the sun and heat in nearby vegetation (Lohnes 2010). • Common nighthawks are limited by the availability of suitable nesting habitat. Habitat loss has resulted from forest fire suppression, changes to forest harvesting practices, reforestation efforts, and intensive agricultural practices. All of these changes result in fewer open areas suitable for common nighthawk nesting (COSEWIC 2007a). A general decline in insect populations due to pesticide use, particularly in urban environments, may be responsible for the decline in some common nighthawk populations (COSEWIC 2007a, Nebel *et al.* 2010, Poulin *et al.* 1996). • Environment Canada recommends the following species-specific setback for common nighthawk: from May 1 to August 31, a 200 m setback for high disturbance activities, 100 m setback for medium disturbance activities, and 0-50 m for low disturbance activities (Environment Canada 2011a). • There is no Identified Wildlife Species Account available for common nighthawk (BC MWLAP 2004b). There is currently no recovery plan or strategy for common nighthawk (BC MOE 2013f, Environment Canada 2013c). • Table 7.2.10-10 provides a summary of the predicted change in effective common nighthawk habitat as a result of the Project.
Northern goshawk	• Northern goshawk *laingi* spp., is listed as Threatened under Schedule 1 of *SARA* and by COSEWIC (COSEWIC 2013, Environment Canada 2013c) is Red-listed in BC and has a Conservation Framework Priority rating of 1 (BC CDC 2013). • It is difficult to determine population size or trends for northern goshawk as the species breeds at low densities and can be difficult to detect (Northern Goshawk Recovery Team [NGRT] 2008). The Breeding Bird Survey results are insufficient to estimate population trends for northern goshawk species (Environment Canada 2013h). Nevertheless, goshawks are believed to be declining in Canada due to the loss of mature forests which they require for nesting and foraging (Cooper and Stevens 2000). In BC, the *laingi* ssp. is believed to number <1,000 individuals (COSEWIC 2000). • Northern goshawk nest sites occur in a wide variety of forest types, including deciduous, coniferous and mixed forests. Northern goshawks require mature to old growth (>80 years old) forest (BC MFLNRO and MOE 2013, Coopers and Stevens 2000, Penteriani 2002). Preferred habitats have an open understory, which provides necessary space for foraging, flying and access to nests (Mahon 2009, Penteriani 2002, Schaffer *et al.* 1999). The home range of the northern goshawk includes nest areas (fine-scale), post fledging areas, and foraging areas (larger scale) (Reynolds *et al.* 1992). In BC, most northern goshawks are residents and overwinter close to a foraging home range, which includes the nest site (Stuart-Smith *et al.* 2012). • The primary threat facing northern goshawks is the loss of mature forest habitat for nesting and foraging (Cooper and Stevens 2000, Stuart-Smith *et al.* 2012). Loss of mature forest results in fewer suitable nesting sites and reductions in prey diversity and availability (NGRT 2008). Forest fragmentation has the potential to adversely affect northern goshawk populations as exposure to cold and rain can cause nestling mortality increases (Squires and Reynolds 1997). Dense canopy in the nest stands can maintain a mild and stable microclimate (Schaffer 1998, Schaffer *et al.* 1999). Northern goshawks may alter their behaviour to avoid forest clearings and industrial and forestry disturbances (Coopers and Stevens 2000), which potentially alters their dispersal and may lead to genetic isolation. Additional known and perceived threats include introduced species, depredation and competition, climate change, and disease (NGRT 2008). • Recommendations from the BC *Develop with Care Guidelines* for northern goshawk include: conserve habitat and habitat connectivity; minimize disturbance around known breeding territories; and protect nest sites (BC MOE 2012a). • The long-term goal of the *Recovery Strategy and Management Plan for the Northern Goshawk, laingi subspecies (Accipiter gentilis laingi) in British Columbia* and management plan for *A. g. laingi* in BC is to ensure viable populations of northern goshawk, *laingi* ssp. persist in each conservation region in BC (NGRT 2008, BC MFLNRO and MOE 2013). The objectives set forth in the 2008 BC Recovery Strategy are to manage, conserve, and recover habitat that meets the needs of the northern goshawk, *laingi* ssp. through its annual cycle; and to conserve and recover well-distributed and viable populations within coastal BC (NGRT 2008). The proposed pipeline corridor crosses the South Coast Northern Goshawk (*laingi* ssp.) Recovery Region (NGRT 2008). The South Coast region contains an estimated 106-116 *A. g. laingi* breeding pairs (NGRT 2008). • The BC *Guidelines for Raptor Conservation* recommend a 500 m buffer around northern goshawk nests in undeveloped areas, and an additional ‘quiet’ buffer (to be determined by a professional biologist) during the breeding season (BC MOE 2013e). The breeding season for northern goshawk is May 7 to August 21(BC MOE 2013e). • Table 7.2.10-10 provides a summary of the predicted change in effective northern goshawk habitat as a result of the Project.

TABLE 7.2.10-8 Cont'd

Indicator	Ecological Context
Olive-sided flycatcher	• The olive-sided flycatcher is Threatened under Schedule 1 of *SARA* and by COSEWIC (COSEWIC 2013, Environment Canada 2013c), is Blue-listed in BC and has a Conservation Framework Priority rating of 2 (BC CDC 2013) and is listed as May Be at Risk in Alberta (ASRD 2011b). • There are approximately 450,000 breeding olive-sided flycatchers within Canada (COSEWIC 2007b). Nationally, observations of olive-sided flycatcher have been declining at an average annual rate of 3.22% (Environment Canada 2013h). Observations of olive-sided flycatchers have been declining in Alberta, but it is not clear if this represents a decline in populations. BC's population appears to be declining at an average annual rate of 3.23% (Environment Canada 2013h). • Olive-sided flycatchers are migratory and present in their Canadian range from late April to September (Campbell *et al.* 1997). • Olive-sided flycatchers are found in coniferous-dominated and mixedwood forest of a variety of forest age classes, but are most often found in fragmented forest habitat with abundant edges (either natural or man-made), mature coniferous forests (especially patches adjacent to water), and burned sites (Campbell *et al.* 1997, COSEWIC 2007b, Wright 1997). They are also found in open woodlands, deciduous woodlands, swamps, floodplain forests, and along steep mountain slopes (Campbell *et al.* 1997, COSEWIC 2007b). • In Alberta, olive-sided flycatchers are most abundant in shrubby and wetland-fringe habitats (Alberta Biodiversity Monitoring Institute 2012). They require access to living trees and snags that are higher than the surrounding vegetation to use as perches, likely because they enhance territory maintenance, mate attraction, and prey detection (Campbell *et al.* 1997, COSEWIC 2007b). On average, foraging trees are 1.4 times taller than the surrounding canopy and are preferentially on steeper slopes (Wright 1997). • Olive-sided flycatchers are considered an early post-fire dependent species. Forest management practices and other human-caused forest disturbances provide additional nesting habitat for this species, but these areas may be ecological sinks as reproductive success is comparatively low on harvested sites than in natural openings (Robertson and Hutto 2007). • The primary threats to olive-sided flycatchers are habitat loss and change, and potentially reduction in insect prey, due to pesticide use (COSEWIC 2007b). • A 2002 study (Waterhouse *et al.* 2003) suggests that representation of old-growth forest by biogeoclimatic zone, forest stand structure, and elevational gradient helps maintain bird diversity. • Environment Canada recommends the following species-specific setback for olive-sided Flycatcher: from May 1 to August 31, a 300 m setback for high disturbance activities, a 150 m setback for medium disturbance activities, and 0-50 m for low disturbance activities (Environment Canada 2011a). • There is no Identified Wildlife Species Account or recovery strategy available for olive-sided flycatcher (BC MOE 2013f, BC MWLAP 2004b). • Table 7.2.10-10 provides a summary of the predicted change in effective olive-sided flycatcher habitat as a result of the Project.

Construction and operations of the proposed pipeline corridor will create new forest clearing, increase the existing corridor width where existing rights-of-way are paralleled, remove potential nesting and perch trees, and require ongoing clearing as part of vegetation management during operations. Although the Footprint will be reclaimed following construction and temporary workspace will be allowed to regenerate to natural vegetation communities, the permanent pipeline right-of-way (18 m wide) will require ongoing clearing during operations to meet safety and regulatory requirements for monitoring. This will result in the long-term maintenance of forest habitat to earlier seral stages (herbaceous and shrub stages). Some disturbed grassland/shrubland and wetland habitats will likely regenerate following reclamation in the medium-term. Sagebrush habitat is expected to regenerate to grassland habitat in the medium-term, and will progress to a sagebrush community over the long-term. Given the planned phased approach to Project construction, sensory disturbance associated with Project construction and reclamation is expected to be relatively localized and of short-term duration. Birds may also experience Project effects related to changes in movement and increased mortality risk during construction (*e.g.*, clearing, sensory disturbance) and operations (*e.g.*, predation risk, reluctance to move across wide openings). The significance evaluation of potential residual effects of Project construction and operations on the bird indicators is summarized in Table 7.2.10-9. The rationale used to evaluate the significance of the residual environmental effects is provided below.

TABLE 7.2.10-9

SIGNIFICANCE EVALUATION OF POTENTIAL RESIDUAL EFFECTS OF PROJECT CONSTRUCTION AND OPERATIONS ON BIRD INDICATORS

Potential Residual Effects	Impact Balance	Spatial Boundary[1]	Temporal Context			Magnitude	Probability	Confidence	Significance[2]
			Duration	Frequency	Reversibility				
7. Wildlife Indicator – Grassland/Shrub-steppe Birds									
7(a) Combined Project effects on grassland/shrub-steppe birds resulting from habitat loss or alteration, changes in movement and increased mortality risk.	Negative	LSA	Short-term	Periodic	Long-term	Low	High	Moderate	Not significant
8. Wildlife Indicator – Mature/Old Forest Birds									
8(a) Combined Project effects on mature/old forest birds resulting from habitat loss or alteration, changes in movement and increased mortality risk.	Negative	LSA	Short-term	Periodic	Long-term	Medium	High	Moderate	Not significant
9. Wildlife Indicator – Early Seral Forest Birds									
9(a) Combined Project effects on early seral forest birds resulting from habitat loss or alteration, changes in movement and increased mortality risk.	Negative	LSA	Short-term	Periodic	Long-term	Low	High	Moderate	Not significant
10. Wildlife Indicator – Riparian and Wetland Birds									
10(a) Combined Project effects on riparian and wetland birds resulting from habitat loss or alteration, changes in movement and increased mortality risk.	Negative	LSA	Short-term	Periodic	Long-term	Low	High	Moderate	Not significant
11. Wildlife Indicator – Wood Warblers									
11(a) Combined Project effects on wood warblers resulting from habitat loss or alteration, changes in movement and increased mortality risk.	Negative	LSA	Short-term	Periodic	Long-term	Low	High	Moderate	Not significant
12. Wildlife Indicator – Short-eared Owl									
12(a) Combined Project effects on short-eared owl resulting from habitat loss or alteration, changes in movement and increased mortality risk.	Negative	LSA	Short-term	Periodic	Long-term	Low	High	Moderate	Not significant
13. Wildlife Indicator – Rusty Blackbird									
13(a) Combined Project effects on rusty blackbird resulting from habitat loss or alteration, changes in movement and increased mortality risk.	Negative	LSA	Short-term	Periodic	Long-term	Low	High	Moderate	Not significant
14. Wildlife Indicator – Flammulated Owl									
14(a) Combined Project effects on flammulated owl resulting from habitat loss or alteration, changes in movement and increased mortality risk.	Negative	LSA	Short-term	Periodic	Long-term	Low	High	Moderate	Not significant
15. Wildlife Indicator – Lewis's Woodpecker									
15(a) Combined Project effects on Lewis's woodpecker resulting from habitat loss or alteration, changes in movement and increased mortality risk.	Negative	LSA	Short-term	Periodic	Long-term	Medium	High	Moderate	Not significant
16. Wildlife Indicator – Williamson's Sapsucker									
16(a) Combined Project effects on Williamson's sapsucker resulting from habitat loss or alteration, changes in movement and increased mortality risk.	Negative	LSA	Short-term	Periodic	Long-term	Medium	High	Moderate	Not significant
17. Wildlife Indicator – Western Screech-owl									
17(a) Combined Project effects on western screech-owl resulting from habitat loss or alteration, changes in movement and increased mortality risk.	Negative	LSA	Short-term	Periodic	Long-term	Low	High	Moderate	Not significant
18. Wildlife Indicator – Great Blue Heron									
18(a) Combined Project effects on great blue heron resulting from habitat loss or alteration, changes in movement and increased mortality risk.	Negative	LSA	Short-term	Periodic	Long-term	Low	High	Moderate	Not significant
19. Wildlife Indicator – Spotted Owl									
19(a) Combined Project effects on spotted owl resulting from habitat loss or alteration, changes in movement and increased mortality risk.	Negative	LSA	Short-term	Periodic	Long-term	Medium	High	Moderate	Not significant

TABLE 7.2.10-9 Cont'd

Potential Residual Effects	Impact Balance	Spatial Boundary[1]	Temporal Context: Duration	Frequency	Reversibility	Magnitude	Probability	Confidence	Significance[2]
20. Wildlife Indicator – Bald Eagle									
20(a) Combined Project effects on bald eagle resulting from habitat loss or alteration, changes in movement and increased mortality risk.	Negative	LSA	Short-term	Periodic	Long-term	Low	High	Moderate	Not significant
21. Wildlife Indicator – Common Nighthawk									
21(a) Combined Project effects on common nighthawk resulting from habitat loss or alteration, changes in movement and increased mortality risk.	Negative	LSA	Short-term	Periodic	Long-term	Low	High	Moderate	Not significant
22. Wildlife Indicator – Northern Goshawk									
22(a) Combined Project effects on northern goshawk resulting from habitat loss or alteration, changes in movement and increased mortality risk.	Negative	LSA	Short-term	Periodic	Long-term	Low	High	Moderate	Not significant
23. Wildlife Indicator – Olive-sided Flycatcher									
23(a) Combined Project effects on olive-sided flycatcher resulting from habitat loss or alteration, changes in movement and increased mortality risk.	Negative	LSA	Short-term	Periodic	Long-term	Low	High	Moderate	Not significant

Notes: 1 LSA = Wildlife LSA.

2 Significant Residual Environmental Effect: a high probability of occurrence of a permanent or long-term residual effect of high magnitude that cannot be technically or economically mitigated.

Change in Habitat

The Project will change the area of available effective habitat for birds. Possible mechanisms for changing effective bird habitat include vegetation clearing, anthropogenic noise and artificial night-time light. Aboriginal participants shared concern about potential effects of the Project on bird habitat, in particular, direct disturbance of nesting trees along large watercourses for raptors (*e.g.*, bald eagle), clearing of nesting habitat for ground nesting birds (*e.g.*, grouse), disturbance of wetland and riparian habitat for ducks and geese, and removal of cavity trees and wildlife trees used by cavity nesting birds. Details of information identified during Aboriginal participation in field studies are provided in the Wildlife Technical Report of Volume 5C.

As a result of vegetation clearing for the Project, earlier seral stages (herbaceous and shrub stages) will replace previously forested areas along the pipeline right-of-way until disturbed areas regenerate following abandonment in the long-term. Grassland/shrub-steppe habitats and wetlands will be revegetated with native vegetation or allowed to revegetate naturally following Project construction.

The wetland assessment estimates approximately 570.4 ha of wetland habitat is encountered by the proposed pipeline corridor, of which 236.2 ha have High Functional Condition, 175.3 ha have High-Moderate Functional Condition, 28.7 ha have Low-Moderate Functional Condition and 0.1 ha have Low Functional Condition (refer to Section 7.2.8 for definitions of wetland functional condition). These estimates reflect the total area of wetlands crossed by the 150 m wide proposed pipeline corridor; however, the expected Footprint will be approximately 45 m wide on average. Therefore, it is anticipated that the area of wetland disturbance will be substantially lower than estimated for the corridor. Monitoring of past projects of similar scope and ecological characteristics have demonstrated that with implementation of appropriate mitigation, wetlands are resilient to pipeline construction disturbance, and habitat function can be restored in the medium to long-term. Additional information and supporting documentation is provided in Section 7.2.8.6.

Vegetation clearing for the Project will directly decrease available bird habitat by removing potential nesting and perch trees and temporarily removing grassland/shrub-steppe and wetland vegetation. The openings created by the Project may also increase bird habitat for forest habitat species that use open spaces for hunting (*e.g.*, northern goshawk) and for habitat generalists (*e.g.*, band-tailed pigeon) or grassland/shrub-steppe specialists (*e.g.*, common nighthawk) (Jalkotzy *et al.* 1997).

As habitat loss increases, the remaining habitat becomes increasingly fragmented or the habitat patches are increasingly isolated, which may compound the effects of habitat loss (Swift and Hannon 2010). Habitat fragmentation occurs when habitat loss results in the remaining habitat becoming increasingly fragmented and/or habitat patches are increasingly isolated (Swift and Hannon 2010). Numerous scientific studies suggest that habitat availability is the primary habitat variable determining species occurrence, distribution and abundance, and that the spatial arrangement of habitat (*i.e.*, fragmentation) has comparatively very little effect on population variables unless the level of habitat loss is very high (Andrén 1994, Cunningham and Johnson 2011, Fahrig 1997, Flather and Bevers 2002, Forman and Collinge 1997, Lichstein *et al.* 2002, Rich *et al.* 1994, Schmiegelow and Mönkkönen 2002, Swift and Hannon 2010, Trzcinski *et al.* 1999). Nonetheless, short and long-term declines of various species of forest birds have been attributed to the reduction and fragmentation of forest cover (Lynch and Whigham 1984, Schmiegelow and Mönkkönen 2002, Sekercioglu *et al.* 2002). Precise determination of the actual magnitude and significance of forest fragmentation is made difficult by virtue of the interaction between a given bird species and factors such as: residual patch size, dynamics, duration and nature of loss (*e.g.*, differences in disturbance between agricultural, urban, industrial, mineral, fire and forestry disturbances); species specialization; and presence of parasitic or generalist predators (*e.g.*, brown-headed cowbird, crows) (Schmiegelow *et al.* 1997, Schmiegelow and Mönkkönen 2002). Habitat fragmentation has been identified as a potential mechanism contributing to population declines for many of the bird indicators including rusty blackbird, spotted owl and northern goshawk (COSEWIC 2006e, COSEWIC 2008e, Greenberg and Matsuoka 2010, NGRT 2008).

Edge effects are the biotic and abiotic conditions that result from the interaction between two adjacent ecosystems separated by an abrupt transition (*i.e.*, the edge) (Murcia 1995). Disturbance-related edge effects occur when changes in the amount of available habitat due to a disturbance extend into a zone of influence immediately adjacent to the disturbed area. Disturbance-related edge effects will occur adjacent to the direct footprint of the Project. New edge effects will be minimal where the proposed pipeline corridor parallels existing linear disturbances. Edge effects can have negative impacts on wildlife. However, there is evidence to suggest that edge effects resulting from oil and gas linear corridors have a minimal effect on birds. A study by Machtans (2006) on seismic lines and boreal forest songbirds found that most birds were able to incorporate seismic lines into their territories, resulting in no change in bird abundance, average location and size of territories. Similarly, a study of edge effects on breeding songbirds south of Grande Prairie, Alberta concluded that species richness and abundance did not differ between edge habitats along pipeline rights-of-way and forested control areas (Fleming and Schmiegelow 2002). It is important to note, however, that Fleming and Schmiegelow (2002) did not differentiate between interior forest specialists and more generalist species. Other potential consequences of increased forest fragmentation and subsequent edge effects on songbirds and owls include increased nest predation (BC MOE 2013h, Vergara 2011) and exposure to the elements (light, temperature, and moisture) (Cadenasso *et al.* 1997).

To minimize vegetation clearing and reduce the fragmentation and isolation of habitat patches, the proposed pipeline corridor parallels existing corridors for approximately 89% (881 km) of its length and incorporates existing disturbances where practical (*e.g.*, shared workspace on adjacent disturbance). The final routing will be aligned to avoid wetlands to the extent feasible. The proposed mitigation measures (Table 7.2.10-3) are expected to reduce residual Project effects on bird habitat by minimizing the area of new disturbance and reclamation of disturbed habitat. The proposed watercourse and wetland crossings will be designed to limit disturbance to wetlands and stream channels, and prevent to erosion and sedimentation, which can adversely affect the invertebrate food supply for birds that forage in streams and wetlands (*e.g.*, dippers, ducks, thrushes, rusty blackbird). Application of sediment control measures from Standards and Best Practices for Instream Works (BC MWLAP 2004a) will prevent siltation in streams and wetlands that provide valuable invertebrate food sources for birds.

The proposed pipeline corridor is within the Sowaqua Spotted Owl WHA (2-498) for approximately 11.5 km. There is a no-net-loss policy for spotted owl habitat in the Sowaqua Spotted Owl WHA. The Project will affect the long-term management goal of the WHA, since clearing for Project construction will result in habitat loss and fragmentation. Consultation with BC MFLNRO regarding the Project's interaction with the WHA and an appropriate approach for mitigating effects has been initiated and is ongoing. A mitigation plan will be developed in consultation with BC MFLNRO, which is anticipated to include measures to avoid, mitigate, restore and offset adverse effects on spotted owl habitat.

The proposed pipeline corridor intersects proposed critical habitat for Williamson's sapsucker and early candidate critical habitat for Lewis's woodpecker (Environment Canada 2013d). Consultation with Environment Canada and BC MFLNRO regarding the Project's interaction with these sensitive habitat areas and an appropriate approach for mitigating effects has been initiated and is ongoing.

High levels of chronic industrial noise have been shown to have a negative effect on birds. Bird species richness, diversity and densities have been demonstrated to be substantially lower in proximity to noisy facilities and roadways compared to less noisy habitats (Bayne *et al.* 2008, Kaseloo 2005, Rheindt 2003). Results of several studies on effects of traffic noise on bird populations suggest that sound levels above 50 dBA can be considered potentially deleterious to some, but not all, bird species (Kasaloo 2005). Bayne *et al.* (2008) demonstrated that noise associated with facilities in boreal Alberta reduced abundance of one third of the songbird species detected, when compared to quiet sites. High levels of ambient noise can also affect mate attraction, pair bonding and territory defense by impairing communication between birds (Brumm 2004, Swaddle and Page 2007). Habib *et al.* (2007) found that chronic industrial noise (*e.g.*, arising from facilities) affected pairing success and age structure of ovenbirds in boreal forests of Alberta. Breeding success of passerines is also reduced in areas near noisy facilities in boreal Alberta (Bayne *et al.* 2008). Brumm (2004) demonstrated that birds in noisier territories sang more loudly than birds at less noisy locations, presumably to mitigate impairment of communication between individuals. High levels of ambient noise can affect mate attraction, pair bonding and territory defense by impairing communication between birds (Brumm 2004, Swaddle and Page 2007). Metabolic costs of increasing song amplitude do not appear to be high, but increased detection by predators may contribute to the costs of increased song amplitude (Brumm 2004). Furthermore, although birds may be able to adapt their song somewhat by increasing amplitude, Rheindt (2003) suggests that most birds are unlikely to have had sufficient time to modify their frequency range to adapt to an increasingly noisy environment. To minimize anthropogenic noise during construction, noise equipment on machinery will be in good working order.

Table 7.2.10-10 and Figures 7.2.10-2 and 7.2.10-3 summarize the predicted change in effective habitat for bird indicators in the Wildlife LSA. Direct disturbance of bird habitat resulting from the Project will be reduced by implementing the measures listed in Table 7.2.10-3 related to habitat loss and alteration, such as pre-construction surveys to identify site-specific habitat features (*e.g.*, nests) and implementing buffers to avoid disturbance, minimizing the area of new footprint, and reclaiming the disturbed footprint to natural vegetation. Grassland and some shrub-dominated habitats (*e.g.*, shrubby wetlands and riparian areas) are likely to regenerate in the medium-term following construction. Residual Project effects on sagebrush grasslands (*e.g.*, shrub-steppe) and forested habitats are predicted to extend over the long-term.

TABLE 7.2.10-10

PREDICTED CHANGE IN HABITAT FOR BIRD INDICATORS IN THE WILDLIFE LSA

Key Indicator	Habitat/Life Requisite[1] – Season of Use[2]	Habitat Suitability Rating	Existing Conditions (ha)	Project Conditions (ha)	Incremental Change (ha)[3]	% Change
Grassland/ Shrub-steppe Birds	Nesting - Growing	High	467.6	458.7	8.9 ↓	1.90 ↓
		Moderate	1,036.7	1,047.4	10.6 ↑	1.02 ↑
		Low	104.6	102.9	1.7 ↓	1.66 ↓
		Nil	2,694.8	2,694.8	< 0.1 ↑	< 0.01 ↑
		Effective Habitat	1,504.3	1,506.1	1.7 ↑	0.12 ↑
Mature/Old Forest Birds	Nesting - Growing	High	1,989.9	1,981.8	8.1 ↓	0.41 ↓
		Moderate	17,800.7	17,585.4	215.3 ↓	1.21 ↓
		Low	46,534.7	46,028.6	506.1 ↓	1.09 ↓
		Nil	86,659.6	87,389.1	729.5 ↑	0.84 ↑
		Effective Habitat	19,790.6	19,567.2	223.4 ↓	1.13 ↓

TABLE 7.2.10-10

Key Indicator	Habitat/Life Requisite[1] – Season of Use[2]	Habitat Suitability Rating	Existing Conditions (ha)	Project Conditions (ha)	Incremental Change (ha)[3]	% Change
Early Seral Forest Birds	Nesting - Growing	High	8,058.0	8,033.3	24.6 ↓	0.31 ↓
		Moderate	21,015.5	20,785.9	229.6 ↓	1.09 ↓
		Low	57,793.8	57,052.0	741.8 ↓	1.28 ↓
		Nil	65,829.1	66,825.1	996.0 ↑	1.51 ↑
		Effective Habitat	29,073.5	28,819.3	254.2 ↓	0.87 ↓
Riparian and Wetland Birds	Nesting - Growing	High	14,086.5	13,948.2	138.4 ↓	0.98 ↓
		Moderate	8,228.1	8,122.1	106.0 ↓	1.29 ↓
		Low	13,056.5	13,300.9	244.4 ↑	1.87 ↑
		Nil	2,333.1	2,333.1	< 0.1 ↓	< 0.01 ↓
		Effective Habitat	22,314.6	22,070.2	244.4 ↓	1.10 ↓
Cavity Nesting Wetland Birds (Riparian and Wetland Birds indicator)	Nesting - Growing	High	1,881.4	1,870.3	11.1 ↓	0.59 ↓
		Moderate	19,120.4	18,824.2	296.2 ↓	1.55 ↓
		Low	74,679.1	73,782.6	896.5 ↓	1.20 ↓
		Nil	20,146.4	21,350.2	1,203.9 ↑	5.97 ↑
		Effective Habitat	21,001.8	20,694.5	307.3 ↓	1.46 ↓
Black-throated Green Warbler (Wood Warblers indicator)	Nesting - Growing	High	0	0	0	0
		Moderately High	0	0	0	0
		Moderate	672.1	667.4	-4.6 ↓	-0.69 ↓
		Low	1,541.3	1,533.7	-7.6 ↓	-0.49 ↓
		Very Low	7,881.1	7,822.2	-58.9 ↓	-0.75 ↓
		Nil	25,454.4	25,525.5	71.1 ↑	0.28 ↑
		Effective Habitat	672.1	667.4	-4.6 ↓	-0.69 ↓
Cape May Warbler (Wood Warblers indicator)	Nesting - Growing	High	0	0	0	0
		Moderately High	0	0	0	0
		Moderate	0	0	0	0
		Low	1,329.5	1,321.3	8.2 ↓	0.62 ↓
		Very Low	6,299.4	6,249.5	49.9 ↓	0.79 ↓
		Nil	27,920.0	27,978.1	58.1 ↑	0.21 ↑
		Effective Habitat	0	0	0	0
Short-eared owl	Nesting - Growing	High	5,276.7	5,195.5	81.2 ↓	1.54 ↓
		Moderate	13,022.9	13,184.7	161.7 ↑	1.24 ↑
		Low	26,503.5	26,500.1	3.4 ↓	0.01 ↓
		Nil	47,481.3	47,404.1	77.2 ↓	0.16 ↓
		Effective Habitat	18,299.6	18,380.2	80.6 ↑	0.44 ↑
Rusty blackbird	Nesting - Growing	High	3,572.7	3,554.7	18.0 ↓	0.50 ↓
		Moderate	22,963.7	22,717.0	246.7 ↓	1.07 ↓
		Low	16,288.6	16,085.6	203.1 ↓	1.25 ↓
		Nil	86,116.5	86,634.3	467.8 ↑	0.54 ↑
		Effective Habitat	26,536.4	26,271.7	264.7	1.00 ↓
Flammulated Owl	Nesting - Growing	High	394.9	392.7	2.1 ↓	0.54 ↓
		Moderate	2,267.9	2,236.9	31.0 ↓	1.37 ↓
		Low	1,225.4	1,201.0	24.4 ↓	1.99 ↓
		Nil	35,200.7	35,258.2	57.5 ↑	0.16 ↑
		Effective Habitat	2,662.8	2,629.7	33.1 ↓	1.24 ↓
Lewis's Woodpecker	Nesting - Growing	High	78.3	76.7	1.6 ↓	2.02 ↓
		Moderately High	2,612.7	2,569.9	42.8 ↓	1.64 ↓
		Moderate	1,752.1	1,725.2	26.9 ↓	1.54 ↓
		Low	3,601.6	3,549.3	52.3 ↓	1.45 ↓
		Very Low	14,878.9	14,640.3	238.6 ↓	1.60 ↓
		Nil	12,602.7	12,964.9	362.2 ↑	2.87 ↑
		Effective Habitat	4443.1	4371.8	71.3 ↓	1.60 ↓

TABLE 7.2.10-10

Key Indicator	Habitat/Life Requisite[1] – Season of Use[2]	Habitat Suitability Rating	Existing Conditions (ha)	Project Conditions (ha)	Incremental Change (ha)[3]	% Change
Williamson's sapsucker	Nesting - Growing	High	0	0	0	0
		Moderately High	0	0	0	0
		Moderate	243.3	238.8	-4.5 ↓	-1.83 ↓
		Low	2,138.5	2,036.8	-101.7 ↓	-4.76 ↓
		Very Low	2,965.3	2,903.6	-61.7 ↓	-2.08 ↓
		Nil	2,317.8	2,485.7	167.9 ↑	7.24 ↑
		Effective Habitat	243.3	238.8	-4.5 ↓	-1.83 ↓
Western screech-owl (coastal)	Nesting - Growing	High	2,308.4	2,300.7	7.6 ↓	0.33 ↓
		Moderate	3,029.5	3,003.1	26.4 ↓	0.87 ↓
		Low	2,858.0	2,830.7	27.2 ↓	0.95 ↓
		Nil	18,025.9	18,087.2	61.3 ↑	0.34 ↑
		Effective Habitat	5,337.9	5,303.9	34.0 ↓	0.64 ↓
Western screech-owl (interior)	Nesting - Growing	High	1,056.8	1,052.2	4.6 ↓	0.43 ↓
		Moderate	3,496.4	3,451.3	45.1 ↓	1.29 ↓
		Low	9,208.0	9,063.6	144.3 ↓	1.57 ↓
		Nil	21,677.7	27,871.6	194.0 ↑	0.89 ↑
		Effective Habitat	4,553.2	4,503.5	49.6 ↓	1.09 ↓
Spotted owl	Nesting - Growing	High	798.2	798.2	< 0.1 ↓	< 0.01 ↓
		Moderately High	1,022.8	1,024.7	1.9 ↑	0.19 ↑
		Moderate	1,451.9	1,446.4	5.5 ↓	0.38 ↓
		Low	1,117.6	1,119.8	2.2 ↑	0.20 ↑
		Very Low	407.9	420.0	12.1 ↑	2.97 ↑
		Nil	18,239.5	18,228.7	10.8 ↓	0.06 ↓
		Effective Habitat	3,272.8	3,269.3	3.5 ↓	0.11 ↓
Common nighthawk	Nesting - Growing	High	16,275.1	16,165.6	109.5 ↓	0.67 ↓
		Moderate	15,090.3	15,222.8	132.5 ↑	0.88 ↑
		Low	68,831.9	68,806.3	25.6 ↓	0.04 ↓
		Nil	53,160.8	53,163.3	2.6 ↑	< 0.01 ↑
		Effective Habitat	31,365.4	31,388.4	23.0 ↑	0.07 ↑
Northern goshawk (coastal)	Nesting - Growing	High	71.7	68.5	3.2 ↓	4.49 ↓
		Moderate	597.1	594.6	2.5 ↓	0.42 ↓
		Low	1,004.5	1,002.0	2.6 ↓	0.26 ↓
		Nil	26,871.2	26,879.5	8.3 ↑	0.03 ↑
		Effective Habitat	668.8	663.1	5.7 ↓	0.85 ↓
Olive-sided flycatcher	Nesting - Growing	High	2,157.0	2,139.1	17.9 ↓	0.83 ↓
		Moderately High	6,889.8	6,831.4	58.3 ↓	0.85 ↓
		Moderate	11,714.9	11,568.1	146.8 ↓	1.25 ↓
		Low	24,656.8	24,433.7	223.1 ↓	0.90 ↓
		Very Low	18,127.1	17,966.2	160.9 ↓	0.89 ↓
		Nil	59,198.4	59,805.3	607.0 ↑	1.03 ↑
		Effective Habitat	20,761.6	20,538.6	223.0 ↓	1.07 ↓

Notes:
1. The nesting life requisite is defined as habitat that is used for nesting and rearing young. It also includes foraging habitat for species that defend territories which include both foraging and nesting habitat (*e.g.*, most songbirds).
2. The growing season generally includes spring, summer and fall. It includes cases where the life requisite habitat is important throughout most of the year, seasonal habitat use can only be roughly differentiated, or the indicator is not present during the winter, as in many migratory bird species.
3. ↓ represents a decrease and ↑ represents an increase.

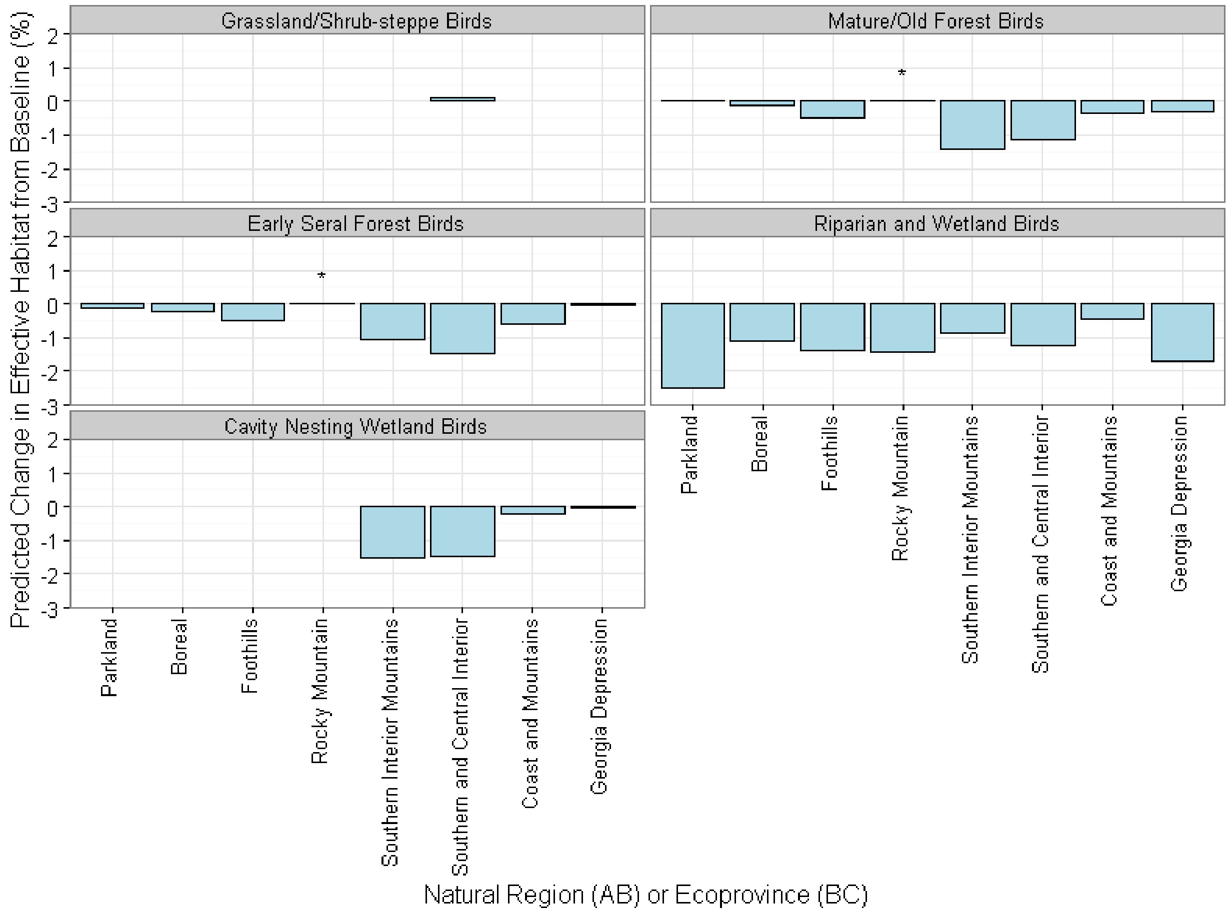

Figure 7.2.10-2 Predicted Change in Effective Habitat for Bird Community Indicators
The change in effective habitat within the Wildlife LSA is presented as the percent change from baseline to Project conditions within each Natural Region in Alberta and Ecoprovince in BC.

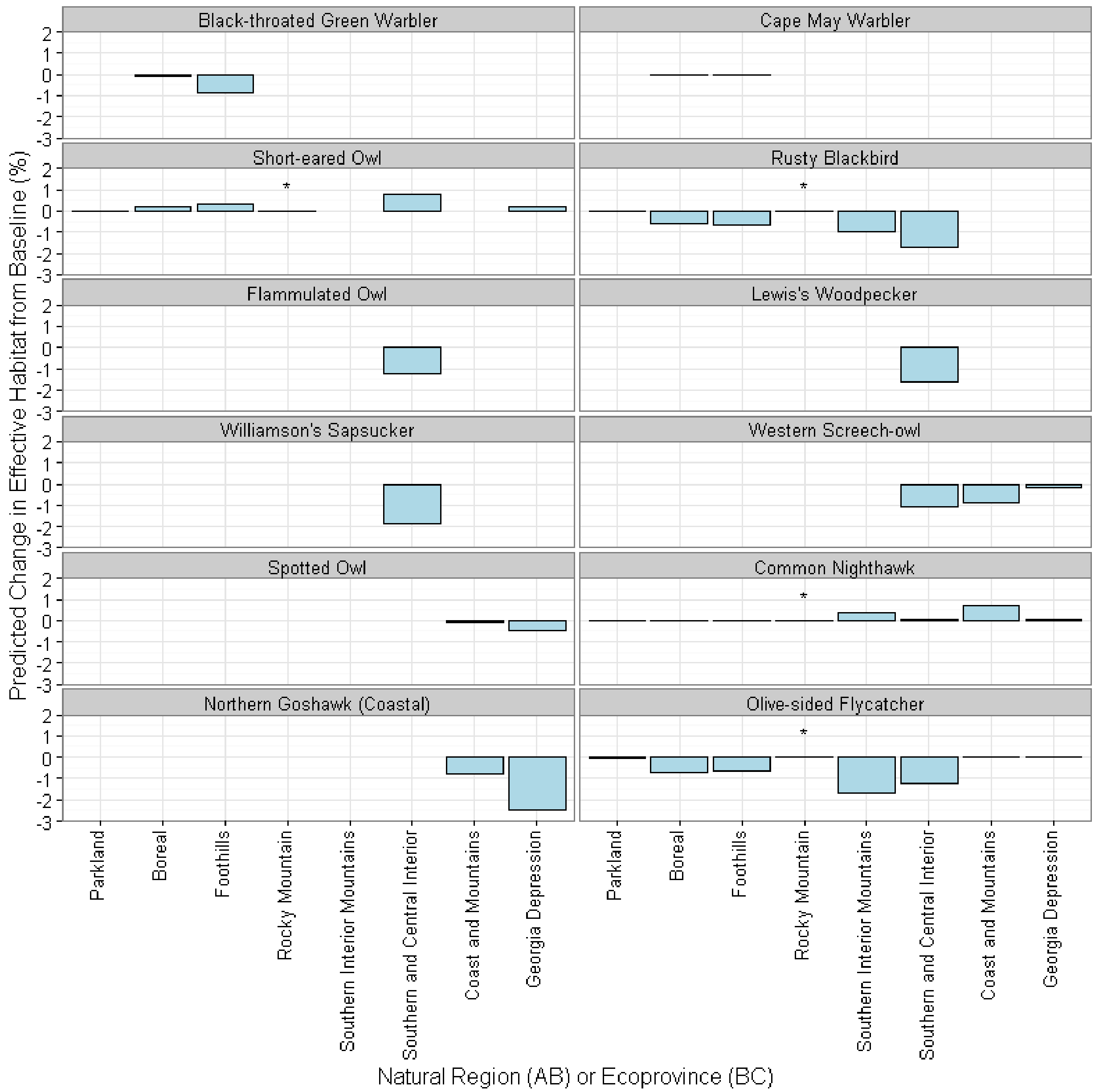

Figure 7.2.10-3 Predicted Change in Effective Habitat for Bird Indicators

The change in effective habitat within the Wildlife LSA is presented as the percent change from baseline to Project conditions within each Natural Region in Alberta and Ecoprovince in BC. Both the interior and coastal western screech-owl are provided in the results at the species level, but can be distinguished by the Ecoprovince (*i.e.*, interior subspecies occurs within the Southern and Central Interior Ecoprovince; coastal subspecies occurs within the Coast and Mountains, and Georgia Depression Ecoprovince).

Change in Movement

The Project will require new clearing, create new linear disturbance and increase the width of existing linear disturbance features. The Footprint may act as a filter or barrier for movement of some bird species. Forest gaps have been shown to affect movements of forest birds (Bayne *et al.* 2005, Desrochers and Hannon 1997, Fleming and Schmiegelow 2002) and owls (COSEWIC 2008e). Wider corridor widths increase barrier effects on bird movements more than narrower corridors (Desrochers and Hannon 1997), and parallel forest openings can cause a cumulative barrier effect at the landscape scale for some species (Bélisle and St. Clair 2001). Desrochers and Hannon (1997) found that gaps less than 30 m in width had little effect on bird movements, though wider gaps constrained movement for specific species. Residual forest patches, or detours, may facilitate bird movements across gaps (Desrochers and Hannon 1997, St. Clair *et al.* 1998).

Changes in movement patterns may also occur as some species are attracted to early seral vegetation. Species that prefer edges and habitat generalists are most likely to use disturbed areas (Jalkotzy *et al.* 1997). Species that use open spaces for hunting (*e.g.*, northern goshawk), foraging (*e.g.*, sandhill crane) or nesting (*e.g.*, grassland/shrub-steppe birds, short-eared owl, common nighthawk) may also benefit.

With the proposed mitigation (*e.g.*, sharing workspace with the adjacent right-of-way to reduce the construction right-of-way-width, minimum disturbance construction, where feasible, reduce grubbing near watercourses, wetlands, and other wet areas to facilitate the restoration of deciduous tree and shrub communities), forest openings resulting from the Project and other existing disturbances are expected to result in filters, but not complete barriers to movement of some bird species.

Increase Mortality Risk

Vegetation clearing, human activity (including traffic and equipment operations) and artificial lighting have potential to affect bird mortality risk. Birds are particularly vulnerable during the nesting stage. Bird mortality during construction may occur if nests are encountered during vegetation clearing for construction of the Project. Construction activities also have potential to increase bird mortality risk by disrupting bird nesting and breeding behaviour to an extent that causes nest failure or abandonment of the breeding area. Most bird species are sensitive to human disturbance in proximity to nest sites and often have physiological or behavioural responses (Antoniuk and Ainsle 2003) that may result in population effects such as nest desertion, reduced parental care of young, decreased feeding efficiency and increased dispersal distances of young (Hill *et al.* 1997, Jalkotzy *et al.* 1997, Richardson and Miller 1997). 'Flushing' is a common short-term response of birds to disturbance, where birds temporarily leaving the nest or perch site in response to unfamiliar noises, pedestrian approach or traffic (*e.g.*, vehicle, boat, aircraft, ATV) (Antoniuk and Ainsle 2003).

Declines of various species of birds have been attributed to the reduction and fragmentation of forest cover (Lynch and Whigham 1984, Sekercioglu *et al*. 2002, Schmiegelow and Mönkkönen 2002). Increased risk of nest predation resulting from edges in forested landscapes is a potential issue for some breeding birds, particularly ground nesters (Flaspohler *et al.* 2001). Numerous studies in forested landscapes have found no evidence of increased nest predation due to either forestry (Bayne and Hobson 1997, Cotterill and Hannon 1999, Ibarzabal and Desrochers 2001, Schmiegelow and Mönkkönen 2002) or roads (Ortega and Capen 1999). Regional differences in predator communities can also influence the potential effects of fragmentation on nest predation (Chalfoun *et al.* 2002). A study by Cavitt and Martin (2002) found that forest fragmentation was related to an increase in nest predation east of the Rocky Mountains (in the US), but that nest predation decreased with fragmentation west of the Rocky Mountains.

Artificial night-time light sources attract songbirds that migrate at night and can increase bird mortality risk from collisions, excessive energy expenditure and predation (Jones and Francis 2003, Poot *et al.* 2008). Light pollution from the Project facilities will be reduced by using directional or shielded lighting, where practical. Aboriginal participants identified potential effects of the Project on mortality risk through physical (*e.g.*, riparian vegetation clearing) and sensory disturbance (*e.g.*, noise) of nests and nesting habitat during construction for several bird species including bald eagle, hawks, geese and ducks (Wildlife Technical Report of Volume 5C).

The proposed mitigation (Table 7.2.10-3) is expected to reduce the residual effects of the Project on increased bird mortality risk. Where practical, clearing and construction activities will be scheduled outside the migratory bird nesting period of March 15 to August 15 in BC (Wilson pers. comm.) and the migratory bird restricted activity period (RAP) of May 7 to August 20 in Alberta (Gregoire pers. comm.). Otherwise, potential effects of clearing and construction on bird mortality risk during the nesting period will be mitigated by conducting non-intrusive area searches for evidence of nesting (*e.g.*, presence of singing birds, territorial males, alarm calls, distraction displays). Any active nests will be subject to site-specific mitigation measures.

Summary of Effects Characterization Rationale for Bird Indicators

A summary of the rationale for the effects characterization for the bird indicators is provided below. Environmental and/or regulatory standards considered in the evaluation of magnitude are provided in Table 7.2.10-8 (ecological context bird indicators) and Section 7.2.10.4 (regulatory guidelines). The criteria rating and rationale for spatial boundary, duration, frequency, reversibility, probability and confidence are similar for all of the bird indicators:

- Spatial Boundary: Wildlife LSA – changes to habitat, movement and mortality risk may extend beyond the cleared construction right-of-way (Footprint) into the Wildlife LSA (*e.g.*, edge effects or sensory disturbances).
- Duration: short-term – the events causing effects (*i.e.*, vegetation removal during construction or site-specific maintenance events; vegetation control during operations) occur during the construction phase or will be completed in less than 1 year during operations.
- Frequency: periodic – the events causing effects (*i.e.*, clearing, traffic and activity) occur during construction and intermittently during operations for monitoring, vegetation control and maintenance.
- Reversibility: long-term – effects are reversible in the long-term following decommissioning and abandonment, once native vegetation regenerates over the Project Footprint.

Re-establishment of herbaceous and shrub vegetation on the disturbed Footprint is expected to occur in the short to medium-term following reclamation; however, residual effects on treed wetland habitats and adjacent terrestrial western toad habitats will extend over the long-term. The reversibility of combined Project effects on western toad (*i.e.*, change in habitat, movement and mortality risk) is constrained by the long-term timeline for reclamation of treed habitats (*i.e.*, greater than 10 years following Project construction).

- Probability: high – the Project will alter habitat, cause sensory disturbance and increase mortality risk to affect the indicator.
- Confidence: moderate – the assessment is based on a good understanding of cause-effect relationships and relevant data. Limitations and uncertainty associated with available data pertinent to the Project area reduce the confidence level to moderate.

The criteria ratings and rationale for magnitude vary and are provided below for each bird indicator.

Grassland/Shrub-steppe Birds

- Magnitude: low – several grassland/shrub-steppe bird species with conservation status of concern occur in the Wildlife LSA. The proposed mitigation (*e.g.*, minimizing the Project Footprint, avoiding active nests, and reclaiming the Footprint to natural vegetation) is expected to reduce the magnitude of residual Project effects on the grassland/shrub-steppe bird community to low.

Mature/Old Growth Forest Birds

- Magnitude: medium – several mature/old forest bird species with conservation status of concern occur in the Wildlife LSA. The proposed mitigation (*e.g.,* minimizing the Project Footprint, avoiding active nests, and reclaiming the Footprint to natural vegetation) is expected to reduce the magnitude of residual Project effects to low for most species in the mature/old forest bird community. Additional mitigation will be applied to reduce the magnitude of residual effects on particularly sensitive species/habitats (*e.g.,* refer to spotted owl assessment rationale below). Given the sensitivity of some species in the mature/old forest bird community, the magnitude of residual effects is concluded to be medium.

Early Seral Forest Birds

- Magnitude: low – several early seral forest bird species with conservation status of concern occur in the Wildlife LSA. The proposed mitigation (*e.g.,* minimizing the Project Footprint, avoiding active nests, and reclaiming the Footprint to natural vegetation) is expected to reduce the magnitude of residual Project effects on the early seral forest bird community to low.

Riparian and Wetland Birds

- Magnitude: low – a number of riparian and wetland bird species with conservation status of concern occur in the Wildlife LSA. The proposed mitigation (*e.g.,* minimizing the Project Footprint, avoiding active nests, and reclaiming the Footprint to natural vegetation) is expected to reduce the magnitude of residual Project effects on the riparian and wetland bird community to low.

Wood Warblers

- Magnitude: low – the wood warbler indicator group includes species of conservation concern. The proposed mitigation (*e.g.,* minimizing the Project Footprint, avoiding active nests, and reclaiming the Footprint to natural vegetation) is expected to reduce the magnitude of residual Project effects on wood warblers to low.

Short-eared Owl

- Magnitude: low – short-eared owls are designated as Special Concern under Schedule 1 of *SARA* and by COSEWIC, May Be at Risk in Alberta and Blue-listed in BC. Short-eared owls are sensitive to disturbance, particularly sensory disturbance during the nesting period. The proposed mitigation (*e.g.,* minimizing the Footprint, avoiding active nests, and reclaiming the Footprint to natural vegetation) is expected to reduce the magnitude of residual Project effects to low.

Rusty Blackbird

- Magnitude: low – rusty blackbird is designated as Special Concern under Schedule 1 of *SARA* and by COSEWIC and is Blue-listed in BC. The proposed mitigation (*e.g.,* minimizing the Project Footprint, avoiding active nests, and reclaiming the Footprint to natural vegetation) is expected to reduce the magnitude of residual Project effects to low.

Flammulated Owl

- Magnitude: low – flammulated owl is designated as Special Concern under Schedule 1 of *SARA* and by COSEWIC and is Blue-listed in BC. The proposed mitigation (*e.g.,* minimizing the Project Footprint, avoiding active nests, and reclaiming the Footprint to natural vegetation) is expected to reduce the magnitude of residual Project effects to low.

Lewis's Woodpecker

- Magnitude: medium - Lewis's woodpecker is designated as Threatened under Schedule 1 of *SARA* and by COSEWIC and is Red-listed in BC. Lewis's woodpecker populations have declined in total numbers, extent of occurrence and area of occupancy. The loss or degradation of suitable breeding habitat is believed to be a limiting factor for Lewis's woodpecker in BC. Small population size and low density makes the species particularly sensitive to disturbance and habitat loss. The proposed pipeline corridor intersects early candidate critical habitat for Lewis's woodpecker. Consultation with Environment Canada and BC MFLNRO regarding the Project's interaction with candidate critical habitat areas and an appropriate approach for mitigating effects has been initiated and is ongoing. With application of appropriate mitigation, the residual effects on Lewis's woodpecker are concluded to be medium magnitude.

Williamson's Sapsucker

- Magnitude: medium – Williamson's sapsucker is designated as Endangered under Schedule 1 of *SARA* and by COSEWIC and is Blue-listed in BC. Primary threats to Williamson's sapsucker include its small population size making the species vulnerable to extirpation, and habitat loss due to logging of mature or old western larch and Douglas-fir stands. Williamson's sapsuckers are generally tolerant of disturbance and often forage near or within forest openings. The Project intersects proposed critical habitat for Williamson's sapsucker. Consultation with Environment Canada and BC MFLNRO regarding the Project's interaction with proposed critical habitat and an appropriate approach for mitigating effects has been initiated and is ongoing. With application of appropriate mitigation, the residual effects on Williamson's sapsucker are concluded to be medium magnitude.

Western Screech-owl

- Magnitude: low – the interior (*macfarlanei*) subspecies of western screech-owl is designated as Endangered under Schedule 1 of *SARA*, Threatened by COSEWIC and is Red-listed in BC. The coastal (*kennicotti*) subspecies is designated as Special Concern under Schedule 1 of *SARA*, Threatened by COSEWIC, and is Blue-listed in BC. The species has undergone substantial decline across its range in BC. Small population size and low density makes the species particularly sensitive to disturbance and habitat loss. Habitat loss from forestry activities is the primary threat to both subspecies of western screech-owl. The proposed mitigation (*e.g.,* minimizing the Project Footprint, avoiding active nests, and reclaiming the Footprint to natural vegetation) is expected to reduce the magnitude of residual Project effects to low.

Great Blue Heron

- Magnitude: low – both subspecies of great blue heron are Blue-listed in BC. *A. g. fannini* is Special Concern under Schedule 1 of *SARA* and by COSEWIC. Proposed mitigation includes alignment of the final Project route to avoid known heron nesting colonies, applying appropriate minimum disturbance buffers, and scheduling clearing and construction outside sensitive time periods. With implementation of mitigation, the residual Project effects on great blue heron are expected to be of low magnitude.

Spotted Owl

- Magnitude: medium – spotted owl is Endangered under Schedule 1 of *SARA* and by COSEWIC and is Red-listed in BC. The population has experienced substantial declines and the species is vulnerable to extinction due to small densities, habitat loss and barred owl competition. There is a no-net-loss policy for spotted owl habitat in the Sowaqua Spotted Owl WHA (2-498) crossed by the proposed pipeline corridor. Construction of the Project in this WHA is inconsistent with the long-term management goal of the WHA, since clearing will result in habitat loss and fragmentation. Consultation with BC MFLNRO regarding the Project's interaction with the WHA and an appropriate approach for mitigating effects has been initiated and is ongoing. A mitigation plan will be developed in consultation with BC MFLNRO, which is anticipated to include measures to avoid, mitigate, restore and offset adverse effects on spotted owl habitat. With application of the appropriate measures, the magnitude of residual Project effects on spotted owl is concluded to be medium.

Bald Eagle

- Magnitude: low – bald eagle is listed as Sensitive in Alberta and the proposed pipeline corridor traverses Sensitive Raptor Range for bald eagle along the Edmonton to Hinton Segment. Bald eagle is not a species of conservation concern in BC, as populations have been increasing in numbers, often in areas with substantial human development. Bald eagles have high cultural value for Aboriginal communities. The proposed mitigation (*e.g.,* minimizing the Project Footprint, avoiding active nests, scheduling activities outside of sensitive periods) is expected to reduce the magnitude of residual Project effects to low.

Common Nighthawk

- Magnitude: low – common nighthawk is Threatened under Schedule 1 of *SARA* and by COSEWIC, Sensitive in Alberta, and Yellow-listed in BC. The proposed mitigation (*e.g.,* minimizing the Project

Footprint, avoiding active nests, and reclaiming the Footprint to natural vegetation) is expected to reduce the magnitude of residual Project effects to low.

Northern Goshawk

- Magnitude: low – coastal northern goshawk (*laingi* ssp.) is Threatened under Schedule 1 of *SARA* and by COSEWIC and is Red-listed in BC. Goshawks are considered sensitive to habitat disturbance. The proposed mitigation (*e.g.,* minimizing the Project Footprint, avoiding active nests, scheduling activities outside of sensitive periods, and reclaiming the Footprint to natural vegetation) is expected to reduce the magnitude of residual Project effects to low.

Olive-sided Flycatcher

- Magnitude: low – olive-sided flycatcher is Threatened on Schedule 1 of *SARA* and by COSEWIC, May Be at Risk in Alberta, and Blue-listed in BC. The proposed mitigation (*e.g.,* minimizing the Project Footprint, avoiding active nests, and reclaiming the Footprint to natural vegetation) is expected to reduce the magnitude of residual Project effects to low.

7.2.10.11 Significance Evaluation of Potential Residual Effects on Amphibian Indicators

Two habitat-based community indicators were selected to assess potential Project effects on amphibians: pond-dwelling amphibians; and stream dwelling amphibians (Section 7.2.10.1). Project construction and operations activities have the potential to affect amphibians by causing changes in habitat, movement and mortality risk. Detailed species accounts are described in the Wildlife Habitat Modelling and Species Accounts Technical Report of Volume 5C.

Relevant regulatory guidelines, information identified during Aboriginal participation in field studies, and ecological context was considered in the characterization of potential residual effects for the amphibian indicators. A summary of ecological and regulatory context is provided in Section 7.2.10.4. In general, regulatory and planning objectives relevant to amphibians include conserving wildlife habitat, particularly for species at risk, and maintaining biodiversity. Measures to identify, protect, buffer, and restore wetlands and riparian habitat are recommended in LRMPs, SRMPs and Protective Notation (PNT) along the proposed pipeline corridor. Consultation details regarding wildlife and Aboriginal participation in the wildlife field studies are provided in the Wildlife Technical Report of Volume 5C. Additional consultation information is summarized in Section 3.0.

Information on the ecological context for each amphibian indicator (*e.g.,* species status, population trends, known threats, best management practices and conservation strategies) is provided in Table 7.2.10-11. The purpose of the ecological context is to provide an indication of the resilience of each indicator to disturbance effects.

TABLE 7.2.10-11

ECOLOGICAL CONTEXT SUMMARY FOR AMPHIBIAN INDICATORS

Species	Ecological Context
Pond-dwelling amphibians	• The pond-dwelling amphibians indicator includes 14 species of amphibians that use wetland habitats for one or more life requisites (Wildlife Habitat Modelling and Species Accounts Technical Report of Volume 5C), including the following species with conservation status of concern (AESRD 2012a, ASRD 2011b, BC CDC 2013, COSEWIC 2013, Environment Canada 2013c): - Canadian toad (May Be at Risk in Alberta); - Columbia spotted frog (Yellow-listed in BC, Conservation Framework Priority 2; Sensitive in Alberta); - Great Basin spadefoot (Threatened under Schedule 1 of *SARA* and by COSEWIC; Blue-listed in BC; Conservation Framework Priority 1); - northern leopard frog (Endangered under Schedule 1 of *SARA* and by COSEWIC; at Risk in Alberta); - northern red-legged frog (Special Concern under Schedule 1 of *SARA*; Blue-listed in BC, Conservation Framework Priority 1); - Oregon spotted frog (Endangered under Schedule 1 of *SARA* and by COSEWIC, Red-listed in BC, Conservation Framework Priority 1); - tiger salamander (Special Concern by COSEWIC, Secure in Alberta); - long-toed salamander (Yellow-listed in BC; Sensitive in Alberta; Special Concern by Alberta's ESCC); and - western toad (Special Concern under Schedule 1 of *SARA* and by COSEWIC; Blue-listed in BC; Conservation Framework Priority 2; Sensitive in Alberta). • The Oregon spotted frog is restricted to the lower mainland of BC. The population of Oregon spotted frogs in BC declined by approximately 17% between 1997 and 2010 (COSEWIC 2011c). • No population estimate is available for northern red-legged frogs in BC. The species is locally common in some surveyed areas, but suitable habitats are largely under-surveyed (COSEWIC 2002d). Northern red-legged frogs are presumed to be declining due to habitat conversion and an increasing number of bullfrogs in suitable habitats (COSEWIC 2002d). • Western toad is widespread and locally common in a variety of habitats in BC; however, no long-term data sets or abundance estimates are available for this species (COSEWIC 2002e). Western toad juveniles experience high mortality rates and populations can fluctuate in response to climatic conditions. It is presumed that in southern BC western toad have experienced widespread declines and extirpations (COSEWIC 2002e). In Alberta, western toads are locally common (COSEWIC 2002e). • Although there is no accurate count of Great Basin spadefoots, there are an estimated 5,000 to 10,000 individuals in Canada's population (COSEWIC 2007c). There are currently insufficient data to assess population trends for Great Basin spadefoot in Canada; however, the amount of habitat loss suggests that the species is likely experiencing declines. Annual fluctuations in population numbers due to varying water levels and recruitment success increases the species vulnerability to local extirpation (COSEWIC 2007c). • Records of Columbia spotted frog observations suggest that their populations in BC are declining in areas where they were formerly abundant (Ovaska and Govindarajulu 2010). The population size and trend of Columbia spotted frog in Alberta is uncertain; however, they are known to occur at low density and their distribution is discontinuous (James 1998). • Well connected aquatic and terrestrial habitats are required by pond-dwelling amphibians to complete all stages of their life cycle (BC MWLAP 2004c). Some common species that may be encountered by the Project are boreal chorus frogs, Pacific tree frogs, wood frogs, northwestern salamanders and rough-skinned newts (Wildlife Habitat Modelling and Species Accounts Technical Report of Volume 5C). • Amphibian breeding occurs in various natural and artificial aquatic habitats, including permanent and ephemeral ponds, slow streams, shallow margins of lakes, marshes, swamps, bogs, ditches, road ruts and borrow pits (COSEWIC 2002e, 2007c, 2011a, Stevens *et al.* 2006a,b, Wind and Dupuis 2002). Emergent vegetation is preferred by northern red-legged frogs and northern leopard frogs, while Oregon spotted frogs and spadefoots prefer lower amounts of emergent vegetation (BC MWLAP 2004b, COSEWIC 2002d, 2011a, Wagner 1997). • Oregon spotted frogs, Columbia spotted frogs and northern leopard frogs overwinter in ponds that include springs, seeps and low-flow channels that do not freeze. Frogs may bury themselves into silty soil or vegetation to hibernate (BC MOE 2013i, COSEWIC 2011c, Wagner 1997). • Outside of the breeding season, pond-dwelling amphibians can be found in a variety of habitats including wetlands, forests, meadows, riparian areas and muskeg (Matsuda *et al.* 2006, Ovaska and Govindarajulu 2010). Terrestrial adult amphibians (*e.g.*, northern red-legged frogs, western toads, wood frogs, long-toed salamanders and newts) use mature, moist forested habitats with adequate leaf litter and cover objects (*e.g.*, fallen logs, coarse woody debris) for thermal and security cover year round (COSEWIC 2002d,e, BC MOE 2013i, Russell and Bauer 2000). Great Basin spadefoots require terrestrial habitats for underground retreat year-round, including grasslands, shrub-steppe and open forest with loose, friable soils that can be easily burrowed into (BC MWLAP 2004b). Northern leopard frogs, Canadian toads, chorus frogs, and tiger salamanders can be found in a variety of terrestrial habitats outside of breeding season, including grasslands, meadows and open forests (BC MOE 2013i, Russell and Bauer 2000). • Outside of the breeding season, pond-dwelling amphibians can be found in a variety of habitats including wetlands, forests, meadows, riparian areas and muskeg (Matsuda *et al.* 2006, Ovaska and Govindarajulu 2010). Terrestrial adult amphibians (*e.g.*, northern red-legged frogs, western toads, wood frogs, long-toed salamanders and newts) use mature, moist forested habitats with adequate leaf litter and cover objects (*e.g.*, fallen logs, coarse woody debris) for thermal and security cover year round (COSEWIC 2002d,e, BC MOE 2013i, Russell and Bauer 2000). Great Basin spadefoots require terrestrial habitats for underground retreat year-round, including grasslands, shrub-steppe and open forest with loose, friable soils that can be easily burrowed into (BC MWLAP 2004b). Northern leopard frogs, Canadian toads, chorus frogs, and tiger salamanders can be found in a variety of terrestrial habitats outside of breeding season, including grasslands, meadows and open forests (BC MOE 2013i, Russell and Bauer 2000). • Browne *et al.* (2009) suggest landscape variables are more influential to western toad relative abundance than quality of breeding habitat. Even if breeding habitat remains intact, loss or degradation of key terrestrial habitat can potentially result in detrimental impacts to western toad populations (Browne and Paszkowski 2010).

TABLE 7.2.10-11 Cont'd

Species	Ecological Context
Pond-dwelling amphibians (cont'd)	• Disturbed habitats are potentially population sinks for breeding pond-dwelling amphibians (Gyug 1999, Stevens *et al.* 2006a), and research has found that western toads do not use anthropogenic disturbance for hibernating (Browne and Paszkowski 2010). • Primary threats to pond-dwelling amphibians include habitat loss and fragmentation due to agricultural and urban expansion, habitat degradation (including pollution), barriers to movement, water-table changes, road mortality, and predation and competition from non-native species (BC MWLAP 2004c, COSEWIC 2011c). • Disease outbreak or parasite infection (*i.e.*, chytrid fungus, *Aeromonas* bacteria, *Saprolegnia* fungus, trematode infections, *Batrachochytrium dendrobatidis*) have caused population collapses in the US; chytrid fungus has been detected in frogs and toads in southern BC (Deguise and Richardson 2009). Disease and parasites could result in rapid extirpations, or local extinctions, of toad populations in BC (Wind and Dupuis 2002). • Best management practices for pond-dwelling amphibians include preserving wetlands, maintaining natural hydrology, maintaining sufficient terrestrial habitat (and access to it) for amphibians to complete all life history phases, mitigating road mortality and reducing the spread of introduced species (BC MWLAP 2004c). • The *Western Toad Working Report* (Davis 2002) identifies research and management priorities for western toad in BC as long-term monitoring, reducing mortality of adult toads, and study of dispersal patterns and habitat selection. Currently there are no provincial or federal recovery strategies or management plans for western toad (BC MOE 2013f, Environment Canada 2013c). In Alberta, the *Best Management Guidelines for the Enhanced Approval Process* recommends a year-round 100 m buffer around wetlands that provide breeding habitat for western toad for all levels of disturbance (Government of Alberta 2013a). In BC, there is a recommended a minimum 30 m setback distance for western toad breeding ponds (BC MOE 2012a). • The goal of the *Recovery Strategy for the Oregon spotted frog (*Rana pretiosa*) in British Columbia* is to maintain and restore extant populations, expand these populations where feasible, and to establish new self-sustaining population. The recovery objectives for the Oregon spotted frog are to: protect and restore habitat at known occupied locations in the lower mainland of BC and at additional occupied sites if found or established; reduce mortality of all life stages; inventory potentially suitable habitat; monitor population status to determine effectiveness of protection and habitat enhancement; and address knowledge gaps in the life-history, population ecology, threats, and habitat requirements of the species (Canadian Oregon Spotted Frog Recovery Team [COSFRT] 2012). • The objective of the *Management Plan for the Northern Leopard Frog (*Lithobates pipiens*), Western Boreal/Prairie Populations, in Canada* (Environment Canada 2013k) is to maintain and increase the western boreal/prairie populations of the species. The proposed pipeline corridor intersects potentially suitable habitat for northern leopard frogs between Edmonton and Edson. Threats to the species and its habitat should be identified, reduced or eliminated, where possible, through population monitoring, habitat conservation, stewardship, research, and reintroduction of the species (Environment Canada 2013k). In Alberta, the *Integrated Standards and Guidelines – Enhanced Approval Process* (Government of Alberta 2013a) recommends a year-round 100 m setback for northern leopard frog breeding ponds. • The goal of the *Recovery Strategy for Great Basin spadefoot (*Spea intermontana*) in British Columbia* (BC Southern Interior Reptile and Amphibian Recovery Team [SIRART] 2008a) is to ensure that there is sufficient, secure habitat distributed throughout the historic range to maintain self-sustaining populations of Great Basin spadefoot in BC. The objectives of the strategy are to secure known, wetland, breeding and terrestrial habitats throughout the historic range; increase knowledge on the distribution, habitat requirements, population processes, terrestrial movements, threats, population viability, and important habitats; and increase understanding by stakeholders. • The *Ecological Area Assessment for the Lac du Bois Grasslands Protected Area* identifies habitat potential for Great Basin spadefoots in Batchelor Lake and in other alkaline ponds in the Lac du Bois Grasslands Protected Area, and recommends protection of these ponds by fencing and signage (Grasslands Conservation Council of British Columbia 2009). • A year-round 200 m setback is recommended for high disturbance activities and 100 m for medium disturbance activities from long-toed salamander breeding ponds (Government of Alberta 2013a). The proposed pipeline corridor intersects a PNT identified as a Rare and Endangered Species Habitat Protection Area for long-toed salamander along the Edmonton to Hinton Segment (Wildlife Technical Report of Volume 5C). The proposed pipeline corridor is located more than 200 m from the identified ponds. Recommended mitigation in the PNT includes restriction of vehicular activity in spring and early fall to reduce effects during the breeding and dispersal periods (Wilkinson pers. comm.). There is also a known long-toed salamander breeding pond located at the Hinton Pump Station. The pond is located within 200 m of the existing disturbances. • Currently there are no provincial or federal recovery strategies or management plans for Canadian toad (BC MOE 2013f, Environment Canada 2013c). In Alberta, the *Integrated Standards and Guidelines – Enhanced Approval Process* recommend a year-round 100 m setback for Canadian toad breeding ponds (Government of Alberta 2013a). The distribution of Canada toads along the proposed pipeline corridor is limited, potentially occurring between Edmonton and Spruce Grove. In this area, suitable habitat is limited due to existing development and land use. • Table 7.2.10-13 provides a summary of the predicted change in effective pond-dwelling amphibian habitat as a result of the Project. Refer to Table 7.2.10-8 and Section 7.2.8 for information on wetland function, including habitat function.

TABLE 7.2.10-11 Cont'd

Species	Ecological Context
Stream-dwelling amphibians	• The stream-dwelling amphibians indicator includes the following species (Wildlife Habitat Modelling and Species Accounts Technical Report of Volume 5C) (BC CDC 2013, COSEWIC 2013, Environment Canada 2013c): - coastal tailed frog (Special Concern under Schedule 1 of *SARA* and by COSEWIC; Blue-listed in BC; Conservation Framework Priority 1); and - Pacific giant salamander (Threatened under Schedule 1 of *SARA* and by COSEWIC; Red-listed in BC; Conservation Framework Priority 1). • While coastal tailed frogs are moderately widespread and can be common locally, there is very limited information available regarding population size and densities in BC (BC MWLAP 2004b, COSEWIC 2011d). Matsuda and Richardson (2005) surveyed clear-cut and mature second growth forests near Chilliwack, BC and found approximately 60 adults/ha. • A rough estimate of Pacific giant salamanders suggested approximately 20,000 adults in BC, however, the cryptic nature of the species results in a large error associated with the estimate (Pacific Giant Salamander Recovery Team [PGSRT] 2010). The known range of the Pacific giant salamander has not changed substantially in recent history; however, land use practices may be reducing high quality habitats within the species' range (PGSRT 2010). • Aquatic and terrestrial habitats are required for different life stages for both coastal tailed frog and Pacific giant salamander (BC MWLAP 2004b, COSEWIC 2011d). Streams with step-pool morphology adjacent to old forest with abundant understory are preferred habitat for this species (BC MWLAP 2004b). Year-round streamflow is critical for tadpole survival as they spend up to 4 to 6 years instream before morphing into adult form (BC MOE 2012a). • The proposed pipeline corridor crosses early candidate critical habitat for Pacific giant salamander (Environment Canada 2013d), for which a federal recovery strategy has not yet been completed. The Wildlife Technical Report in Volume 5C provides additional information regarding candidate critical habitats. • Preferred breeding streams for both stream-dwelling amphibian species are cool, fish-free, boulder-rich mountain streams that are ice-free in winter (Matsuda *et al.* 2006). They prefer moist, old and mature forest habitat, although maturing forests are also suitable (Matsuda *et al.* 2006, COSEWIC 2011d). They are often found in forests with dense herb and fern cover, although they are not associated with any particular plant species or communities (COSEWIC 2011d). • During terrestrial life phases, coastal tailed frog and Pacific giant salamander juveniles and adults inhabit both the breeding stream and wet, forested habitats close to the streams. Adequate cover objects (*i.e.*, coarse woody debris) must be present on the stream banks and in the surrounding forest for shelter. Individuals may be found up to 50 m from the stream bank (BC MWLAP 2004b, COSEWIC 2011d). Pacific giant salamander adults may be terrestrial or can exhibit facultative neoteny (aquatic adults). Pacific giant salamander neotenes live in streams, and can sometimes occur in larger waterbodies at lower elevations (BC MWLAP 2004b). • Coastal tailed frogs sometimes use instream and terrestrial habitats within clear-cut areas. Clear-cuts can cause stream siltation and alter hydrological regimes, which can negatively impact tailed frog breeding success (Dupuis and Steventon 1999, Wahbe *et al.* 2004). There is some evidence that the density of coastal tailed frog tadpoles is greater in streams running through clear-cuts, which may be linked to increased primary productivity in clear-cuts (Wahbe *et al.* 2004). • Primary threats to stream-dwelling amphibians include habitat loss and degradation (including erosion, siltation, changes in stream flow and structure, removal of riparian vegetation), barriers to movement, predation, and disease (BC MWLAP 2004b, COSEWIC 2011d). • Best management practices for stream-dwelling amphibians include maintaining moist forested habitat with abundant coarse woody debris along streams (at least 30 m extending from both stream banks), avoiding siltation of stream habitats, avoid altering stream-flow patterns, and maintaining abundant in-stream cover (BC MWLAP 2004c). • BC MOE recommends a 30-50 m setback distance for stream-dwelling amphibian breeding streams, and an additional 20-30 m buffer within which disturbance should be minimized (BC MOE 2012a). Where slopes exceed 60%, recommended riparian avoidance buffers extend beyond the top of the ravine (BC MOE 2012a). • The goal of the Recovery Strategy for the Pacific giant salamander (*Dicamptodon tenebrosus*) in British Columbia (PGSRT 2010) is to ensure a well-connected, viable, and self-sustaining population within secure habitat. The short-term objectives are to secure known populations, prevent fragmentation, inventory for unidentified populations, and restore historical populations. • Table 7.2.10-13 provides a summary of the predicted change in effective coastal tailed frog habitat as a result of the Project.

Construction and operations of the Project will create new forest clearing, increase the existing corridor width where existing rights-of-way are paralleled, remove potential site-specific habitat features (*e.g.*, coarse woody debris, small mammal burrows used as daily retreats or for hibernation), and require ongoing clearing as part of vegetation management during operations. The Project will interact with amphibian indicators via all three of the identified effects pathways, including changes in habitat, changes in movement and increased risk of mortality. Table 7.2.10-12 provides a summary of the significance evaluation of the potential residual effects of the construction and operations of the proposed Project on the amphibian indicators. The rationale used to evaluate the significance of the residual environmental effects is provided below.

TABLE 7.2.10-12

SIGNIFICANCE EVALUATION OF POTENTIAL RESIDUAL EFFECTS OF PROJECT CONSTRUCTION AND OPERATIONS ON AMPHIBIAN INDICATORS

Potential Residual Effects	Impact Balance	Spatial Boundary[1]	Temporal Context: Duration	Temporal Context: Frequency	Temporal Context: Reversibility	Magnitude	Probability	Confidence	Significance[2]
24. Wildlife Indicator – Pond-dwelling Amphibians									
24(a) Combined Project effects on pond-dwelling amphibians resulting from habitat loss or alteration, changes in movement and increased mortality risk.	Negative	LSA	Short-term	Periodic	Long-term	Medium	High	Low	Not significant
25. Wildlife Indicator – Stream-dwelling Amphibians									
25(a) Combined Project effects on stream-dwelling amphibians resulting from habitat loss or alteration, changes in movement and increased mortality risk.	Negative	LSA	Short-term	Periodic	Long-term	Medium	High	Moderate	Not significant

Notes: 1 LSA = Wildlife LSA.

2 Significant Residual Environmental Effect: a high probability of occurrence of a permanent or long-term residual effect of high magnitude that cannot be technically or economically mitigated.

Change in Habitat

The Project will change the area of available effective habitat for amphibians. Possible mechanisms for changing effective amphibian habitat include site clearing (wetland and terrestrial habitats), watercourse crossings and soil handling (including trenching). Aboriginal participants raised concerns about potential effects of the Project on amphibian habitat, in particular, direct disturbance, contamination and loss of wetland or stream habitat during construction and operations of the Project (Wildlife Technical Report of Volume 5C).

Vegetation clearing for the Project will disturb both wetland and terrestrial amphibian habitat. Amphibian abundance is often lower in cleared areas and second-growth stands than in mature forests due to changes in micro-climate (Wind 1999). Clearing of wetland and riparian vegetation around ponds and streams can affect the temperatures that amphibians are exposed to both in aquatic and terrestrial habitats (Newton and Cole 2013, Semlitsch *et al.* 2008). Variation in temperatures in breeding ponds and streams can affect the breeding success, tadpole development and survival, and immunity to disease for amphibians (Lucas and Reynolds 1967, Raffel *et al.* 2006). Temperature and moisture variation caused by vegetation and tree clearing in the terrestrial habitat surrounding breeding ponds and streams can affect the dispersal and survival of juvenile and adult amphibians (Naughton *et al.* 2000, Semlitsch *et al.* 2009, Walston and Mullin 2008).

Standard best practices for protecting pond-dwelling amphibian habitat include a recommended set-back distance from breeding ponds (BC MOE 2012a, BC MWLAP 2004c, Government of Alberta 2013a). However, a study by Browne and Paszowski (2010) demonstrated that wetland-based buffers are not sufficient or realistic for protecting some pond-dwelling amphibian (*e.g.*, western toad) hibernation sites, since individuals can move long distances from breeding ponds to hibernation sites. Maintenance of stream structure, complexity and condition, as well as maintenance of riparian habitat buffers are standard best practices for protecting stream-dwelling amphibians. BC MOE (2012a) recommends disturbance buffers and trenchless crossing methods, where possible, to protect suitable amphibian breeding streams. Stream-dwelling amphibians generally remain closer to breeding habitat during terrestrial life stages than do pond-dwelling amphibians. The proposed mitigation measures to reduce disturbance and facilitate restoration of amphibian breeding and terrestrial habitat include minimizing the area of disturbance (including implementing riparian protection buffers to the extent practical), implementing minimal disturbance construction in key habitats, controlling erosion and sedimentation, maintaining streamflow during crossing construction, and reclamation of disturbed habitat to natural vegetation communities (Table 7.2.10-3).

The Project is predicted to change the availability of amphibian habitat in the wildlife LSA (Table 7.2.10-13 and Figure 7.2.10-4). The western toad and Great Basin spadefoot have specific terrestrial habitat requirements and therefore the habitat change was quantified in addition to habitat change for the pond-dwelling amphibian community indicator. The coastal tailed frog range is substantially larger than the Pacific giant salamander and, therefore, the quantification of habitat change for this species will encompass that of the other species in the stream-dwelling amphibians community indicator.

TABLE 7.2.10-13

PREDICTED CHANGE IN HABITAT FOR AMPHIBIAN INDICATORS IN THE WILDLIFE LSA

Wildlife Indicator	Habitat/Life Requisite	Habitat Suitability Rating	Existing Conditions (ha)	Project Conditions (ha)	Incremental Change (ha)[1]	% Change
Pond-dwelling amphibians	Reproductive habitat	High	8,019.8	7,934.5	85.3 ↓	1.06 ↓
		Moderate	2,189.0	2,153.4	35.6 ↓	1.63 ↓
		Low	5,685.9	5,806.9	121.0 ↑	2.13 ↑
		Nil	1,300.0	1,300.0	< 0.1 ↓	< 0.01 ↓
		Effective Habitat	10,208.9	10,087.9	121.0 ↓	1.18 ↓
Western toad (pond-dwelling amphibians indicator)	Year-round living habitat	High	23,699.9	23,528.8	171.1 ↓	0.72 ↓
		Moderate	77,577.3	77,183.1	394.1 ↓	0.51 ↓
		Low	17,648.7	18,149.1	500.4 ↑	2.84 ↑
		Nil	33,510.2	33,575.0	64.8 ↑	0.19 ↑
		Effective Habitat	101,277.1	100,711.9	565.2 ↓	0.56 ↓
Great Basin spadefoot (pond-dwelling amphibians indicator)	Year-round living habitat	High	639.4	631.9	7.5 ↓	1.17 ↓
		Moderate	2,347.9	2,324.7	23.2 ↓	0.99 ↓
		Low	2,323.3	2,274.2	49.2 ↓	2.12 ↓
		Nil	22,725.7	22,805.6	79.8 ↑	0.35 ↑
		Effective Habitat	2,987.2	2,956.5	30.7 ↓	1.03 ↓
Coastal tailed frog	Year-round living habitat	High	1,523.5	1,500.4	23.1 ↓	1.52 ↓
		Moderately High	1,105.1	1,089.4	15.7 ↓	1.42 ↓
		Moderate	5,269.3	5,187.0	82.3 ↓	1.56 ↓
		Low	4,068.1	3,977.8	90.3 ↓	2.22 ↓
		Very Low	1,675.0	1,886.5	211.5 ↑	12.62 ↑
		Nil	29,191.1	29,191.1	< 0.1 ↓	< 0.01 ↓
		Effective Habitat	7,898.0	7,776.8	121.2 ↓	1.53 ↓

Note: 1 ↓ represents a decrease and ↑ represents an increase.

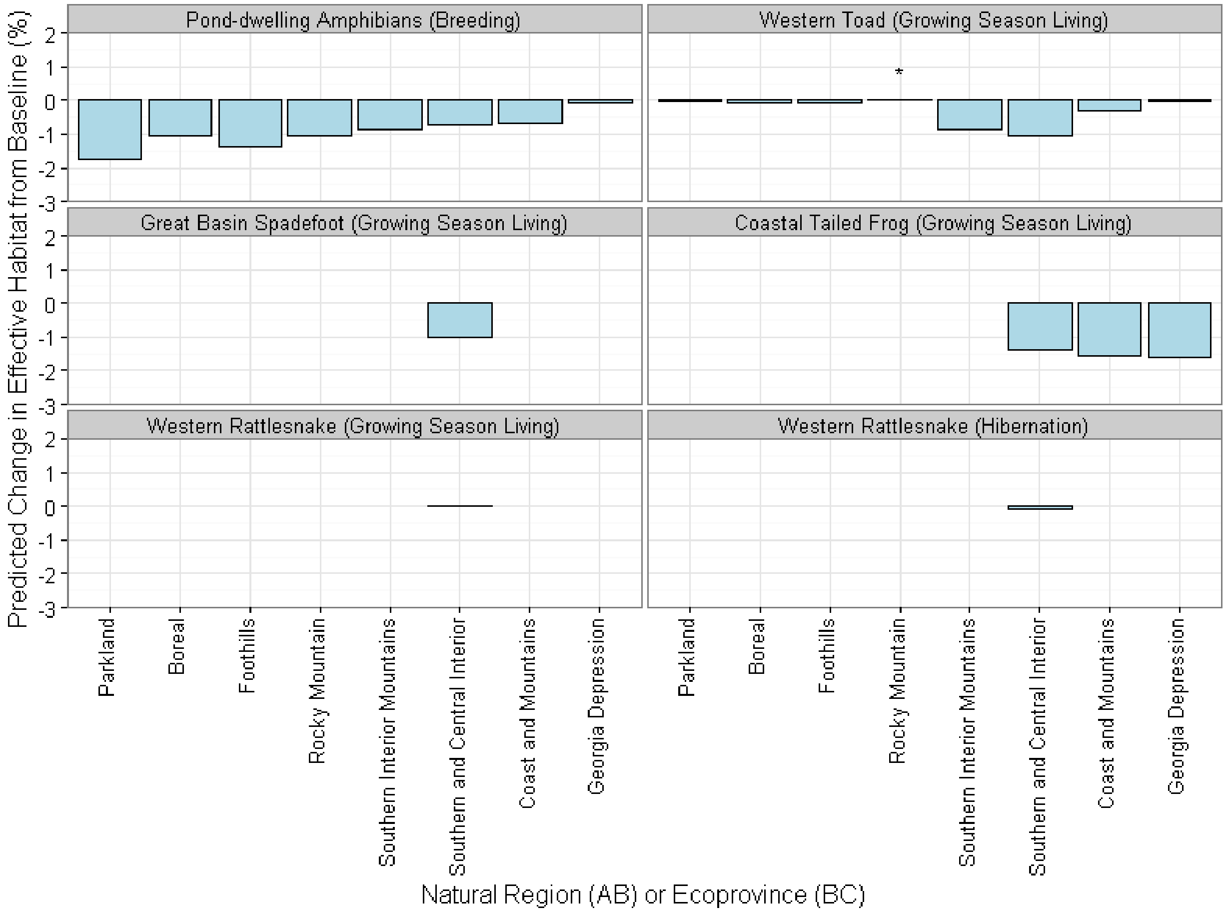

Figure 7.2.10-4 Predicted Change in Effective Habitat for Amphibian and Reptile Indicators
The change in effective habitat within the Wildlife LSA is presented as the percent change from baseline to Project conditions within each Natural Region in Alberta and Ecoprovince in BC.

Change in Movement

Construction of the Project may create barriers to amphibian movement (*e.g.,* spoil piles, brush piles, traffic, strung pipe, open trench), depending on the location of the final Project alignment relative to breeding and upland habitats, and the season of construction. The extent of amphibian movement across the landscape varies between species. Pond-dwelling amphibians may stay in or near the same waterbody during their lifetime, or may migrate seasonally, sometimes for extended distances. Habitat connectivity and movement can be affected by anthropogenic disturbances such as low fences (*e.g.*, sediment or snow fences), soil berms, ditches, deep ruts, roads, or high-impact development (*e.g.*, industrial, commercial, urban, residential areas). The following summarizes typical movement patterns of pond- and stream-dwelling amphibian species that may interact with the Project.

- Oregon spotted frogs may move several hundred metres between breeding and winter habitats (COSFRT 2012). Oregon spotted frogs require connected aquatic habitat for annual movements (COSFRT 2012).

- Great Basin spadefoots utilize habitats in proximity to breeding areas. Maximum dispersal distances from breeding ponds may be as large as 370 m (Garner 2012). Spadefoots move overland.

- A study by Browne and Paszkowski (2010) found that radio tracked western toads in boreal forests of north-central Alberta travelled a distance, on average, of about 1 km between breeding and hibernation sites. Non-breeding western toad habitat is typically within 2 km of breeding areas, but distances of up to 7 km along watercourses have been recorded (Davis 2002). Western toads move overland by climbing and crawling (Wind and Dupuis 2002).

- Seasonal movement by Columbia spotted frogs varies by individual. Some individuals complete their entire life cycle in or near the same lake or pond, while others use different water bodies for breeding, summer feeding and overwintering (James 1998). Male Columbia spotted frogs in Idaho remained within 200 m of breeding ponds, while female frogs moved up to 1 km from breeding ponds to summer habitats (Pilliod *et al.* 2002). In Oregon, Bull and Hayes (2001) measured movements of 15 m to 560 m by some frogs, while approximately half of the frogs remained in the breeding ponds year-round.

- Wood frogs, long-toed salamanders, northwestern salamanders and roughskin newts migrate between breeding ponds and non-breeding terrestrial habitats. Wood frogs travelled an average of 1.2 km away from their ponds, and have been recorded migrating up to 2.5 km away from their ponds (Berven and Grudzien 1990). Female wood frogs generally travel longer distances than males (Regosin *et al.* 2003). Long-toed salamanders migrate seasonally and generally return to the same breeding ponds (Beneski *et al.* 1986), dispersing up to 1.2 km (Funk and Dunlap 1999 in Smith and Green 2005). Roughskin newts may migrate up to several hundred metres, often during or after seasonal rains; males migrate earlier than females (NatureServe 2012).

- Stream-dwelling amphibians typically move within the immediate riparian zone (less than 5 m from the stream) (Matsuda and Richardson 1999). However, both Pacific giant salamanders and coastal tailed frogs have been detected several hundred metres from streams under moist conditions (Ascaphus Consulting 2003, BC MWLAP 2004b). In a study by Wahbe *et al.* (2000), newly emerged juvenile tailed frogs were detected up to 100 m from natal streams.

Application of the proposed mitigation measures (Table 7.2.10-3) is expected to reduce the magnitude of potential residual effects of Project construction and operations on amphibian movement. Leaving periodic gaps in windrows (*i.e.*, grubbing piles, topsoil/root zone material, grade spoil, rollback, strung pipe), avoiding grubbing in shrubby wetlands, and moving any amphibians that are observed on the construction right-of-way will facilitate amphibian movement during Project construction. If warranted, sedimentation fences may be used during construction to redirect amphibian movement away from the construction site. Silt fences used to prevent amphibians from accessing the active construction site, as well as for erosion control, will be removed once they are no longer necessary to prevent barriers to amphibian movement following construction. Recontouring disturbed surface soils to remove deep ruts will also prevent barriers to movement.

Increased Mortality Risk

The Project will increase the risk of amphibian mortality. Possible mechanisms for increasing the risk of amphibian mortality include heavy machinery and vehicle traffic, predation risk, creation of artificial ponds and reduced water quality (*e.g.*, sedimentation). Site clearing, watercourse crossings and vehicle traffic (Beasley 2006, Davis 2002, Wind and Dupuis 2002) will potentially increase mortality risk for pond-dwelling amphibians during construction and operations (*e.g.*, site-specific maintenance activities). Aboriginal participants shared concern about potential effects of the Project on amphibian mortality risk due to increased traffic on roads accessing the work site, and from habitat contamination associated with potential pipeline spills and leaks (Wildlife Technical Report of Volume 5C). The proposed mitigation measures listed in Table 7.2.10-3 (*e.g.*, conducting an amphibian salvage at breeding locations if amphibians are present during construction; moving any amphibians observed on the construction right-of-way or in the trench; using sediment fencing or other measures to redirect dispersing amphibians away from the construction site; minimizing grubbing in shrubby wetland areas to avoid creating pitfall traps) will reduce the potential residual effect of the Project on amphibian mortality risk associated with amphibians moving into and/or becoming trapped in the work site.

Amphibian species that will potentially interact with the Project are not freeze-tolerant, and require thermally stable retreat habitat to overwinter. Suitable hibernation habitats include abandoned small mammal burrows, cover objects or soil (provided soil texture is loose enough to allow burrowing below the depth of frost). The immobility of ground-hibernating animals increases their vulnerability to soil disturbance during the winter (COSEWIC 2002d,e, 2007c). Great Basin spadefoots rely on underground retreats year-round. Soil compaction due to machinery and vehicles can decrease amphibians' ability to burrow into the soil and, therefore, potentially increase mortality due to desiccation or predation (COSEWIC 2007c, Garner 2012). Proposed mitigation measures listed in Table 7.2.10-3 (*e.g.*, conducting an amphibian salvage at known sensitive amphibian species breeding locations if construction is scheduled during the amphibian breeding season; moving any amphibians observed on the construction right-of-way; implementing measures such as packing snow or using mats to avoid excessive soil compaction on the Footprint, particularly in proximity to wetlands and watercourses) are expected to reduce the potential residual effect of the Project on amphibian mortality risk as a result of hibernation habitat disturbance.

Construction activities have potential to create artificial ponds, which can increase amphibian mortality risk. Borrow pits, road ditches, vehicle ruts, and grubbing can create small areas of ponded water. Under coniferous tree cover, pools of such small size would typically be too cold during spring for amphibian breeding, but in open conditions they are sufficiently warm and, therefore, can be attractive breeding sites for pond-dwelling amphibians (*e.g.*, western toads and Oregon spotted frogs) (Gyug 1999, Stevens *et al.* 2006a,b). Artificial ponds often have unfavourable environments for developing embryos and larvae because they dry out too quickly, or have nutrient-limited conditions that limit primary production and available algal food resources for developing larvae (Gyug 1999, Stevens *et al.* 2006a). As a result, artificial ponds can be population sinks for pond-dwelling amphibians (COSFRT 2012, Gyug 1999, Stevens *et al.* 2006a). The proposed mitigation measures listed in Table 7.2.10-3 (*e.g.*, reclaim borrow pits; avoid construction during wet conditions that will create excessive soil rutting, and/or grade ruts in construction access and within the Footprint where rutting cannot be avoided; reduce grubbing in wetlands, riparian areas and wet areas to the extent practical) are expected to avoid creating small pools that are unsuitable for amphibian breeding, and reduce the potential residual Project effect on amphibian mortality risk.

Amphibians are sensitive to water contamination (BC MWLAP 2004c). They can be adversely affected by the high conductivity of water in breeding ponds, which is often related to total dissolved solids, organic or mineral particles, disturbance, or runoff with high sediment levels (Browne *et al.* 2009). Mitigation measures that limit disturbance to wetlands, stream channels and riparian areas, and prevent erosion and sedimentation, are expected to reduce residual Project effects on water quality, and associated amphibian mortality risk. The Emergency Response Plan, which will include prevention, containment and clean-up measures, is expected to alleviate any potential effects on amphibian mortality risk associated with exposure to contaminants (*e.g.*, leaks, spills or chemical release).

During construction and operations, the Footprint may increase amphibian mortality risk, since, like other small animals, amphibians are susceptible to predation in open and unvegetated areas (Gyug 1999, Wind and Dupuis 2002). Oregon spotted frogs and red-legged frogs experience increased predation at various life stages in disturbed areas due to predatory species such as bull frog, raccoon and striped skunk, which are well-adapted to human disturbance (COSFRT 2012). Implementation of the Waste Management Program will reduce the potential for attracting species that may depredate amphibians (*e.g.*, ravens, racoons). Measures to reduce the Footprint, use minimum disturbance construction techniques and reclaim the Footprint to natural vegetation communities will further reduce the residual effect of Project clearing on predation risk for amphibians.

Summary of Effects Characterization Rationale for Amphibian Indicators

A summary of the rationale for the effects characterization for the amphibian indicators is provided below. Environmental and/or regulatory standards considered in the evaluation of magnitude are provided in Table 7.2.10-11 (ecological context for amphibian indicators) and Section 7.2.10.3 (regulatory guidelines). The criteria rating and rationale for spatial boundary, duration, frequency, reversibility and probability are similar for all of the amphibian indicators.

- Spatial Boundary: Wildlife LSA – changes in habitat, movement and mortality risk for the amphibian indicators will primarily be focused on the Footprint, but may extend into the Wildlife LSA.

- Duration: short-term – the events causing effects (*i.e.*, clearing and soil handling, vehicle watercourse crossing installation and removal, instream pipeline installation, construction-related barriers to amphibian dispersal, heavy machinery and vehicle traffic) occur during the construction phase or will be completed in less than 1 year during operations (*i.e.*, site-specific maintenance events).

- Frequency: periodic – the events causing effects (*i.e.*, construction and site-specific maintenance events during operations) will occur intermittently but repeatedly over the assessment period.

- Reversibility: long-term – changes in aquatic habitats resulting from Project construction (*i.e.* water crossings) or sediment introduction (erosion, run-off), are expected to be alleviated in the short to medium-term with application of appropriate mitigation and reclamation measures. Changes in instream habitat, movement barriers and mortality risk are primarily limited to the construction period (*i.e.*, reversible in the short-term). Re-establishment of graminoid and shrub dominated wetland, riparian and upland vegetation on the disturbed Footprint is expected to occur in the short to medium-term following reclamation; however, residual effects on treed wetland and riparian habitats and adjacent terrestrial amphibian habitats will extend over the long-term. Effects are reversible in the long-term following decommissioning and abandonment, once native vegetation regenerates over the Project Footprint.

- Probability: high – the Project will alter habitat and increase mortality risk to affect the indicator.

The criteria rating and rational for magnitude and confidence vary, and are provided below for each bird indicator.

Pond-dwelling Amphibians

- Magnitude: medium – several pond-dwelling amphibian species with conservation status of concern occur in the Wildlife LSA. The proposed corridor traverses suitable habitat for the Oregon spotted frog and Great basin spadefoot, both of which are of conservation concern and have limited geographic ranges within BC, which may make them particularly sensitive to disturbance. The proposed mitigation measures are consistent with the available guidelines and regulatory recommendations, and are expected to reduce the residual effects of the Project on pond-dwelling amphibians to medium magnitude.

- Confidence: low – the assessment is based on a good understanding of cause-effect relationships for habitat and movement effects, and relevant data. Limitations and uncertainty associated with available data pertinent to the Project area, and the potential extent of disturbance to hibernating amphibians during winter construction, reduce the confidence level to low. Supplemental field surveys will be conducted to collect additional information on amphibian occurrence along the final pipeline alignment, which will inform the development of mitigation and increase prediction confidence.

Stream-dwelling Amphibians

- Magnitude: medium – coastal tailed frog and Pacific giant salamander are species of conservation concern. Coastal tailed frogs were observed in streams surveyed along the proposed pipeline corridor. The proposed pipeline corridor traverses early candidate critical habitat for Pacific giant salamanders. There were no confirmed detections of Pacific giant salamander during field surveys for the Project. The proposed mitigation measures are consistent with the available guidelines and regulatory recommendations to reduce riparian and instream habitat loss, and reclaim disturbed habitats. Consultation with Environment Canada regarding the Project's interaction with the candidate critical habitat and an appropriate approach for mitigating effects has been initiated and is ongoing. It is anticipated that, if warranted, an appropriate mitigation strategy (in addition to the measures recommended in Section 7.2.10.6) will be developed to reduce the magnitude of residual Project effects on stream-dwelling amphibians to medium magnitude.

- Confidence: moderate – the assessment is based on a good understanding of cause-effect relationships and relevant data. Limitations and uncertainty associated with available data pertinent to the Project area reduce the confidence level to moderate.

7.2.10.12 Significance Evaluation of Potential Residual Effects on Reptile Indicator

Arid habitat snakes were selected as a habitat-based community indicator for the assessment of potential Project effects on reptiles. The arid habitat snake community includes western rattlesnake, Great Basin gopher snake, yellow-bellied racer, rubber boa and garter snakes. Given the suite of snake species with conservation status of concern (species at risk are typically sensitive to change and good environmental indicators) in arid habitats, particularly the dry southern interior region of BC, as well as the high value (identified in consultation; refer to Section 3.0) and sensitivity of grassland habitats in this region, this reptile indicator is expected to provide a conservative estimate of the potential Project effects on reptiles. For similar reasons, western rattlesnake was identified as a suitable species to model change in habitat. Project construction and operational activities have the potential to affect arid habitat snakes by causing changes in habitat effectiveness, movement and mortality risk. A detailed species account for western rattlesnake is described in the Wildlife Habitat Modelling and Species Accounts Technical Report of Volume 5C.

Relevant regulatory guidelines, information identified during Aboriginal participation and ecological context were considered in the characterization of potential residual effects for arid habitat snakes. A summary of regulatory guidelines is provided in Section 7.2.10.4. In general, regional planning guidelines have little or no information specific to snakes or other reptile species. Planning objectives relevant to reptiles include conserving wildlife habitat, particularly for species at risk, and maintaining biodiversity. The Kamloops LRMP (BC ILMB 1995) aims to maintain viable populations of all species by ensuring habitat needs are met, and to restore species that are endangered or threatened by human activities. This goal may be accomplished by maintaining and/or enhancing a diversity of viable grassland ecosystems. The Ecological Area Assessment for the Lac du Bois Grasslands Protected Area identifies Batchelor Hills and the Lac du Bois Gateway areas as high value core habitat for arid habitat snakes. Wildlife objectives include maintenance of habitat integrity and connectivity, creating buffers between protected areas and development, and mortality prevention (Grasslands Conservation Council of British Columbia 2009).

The compilation of ATK, including the collection of TEK through Aboriginal field participation and engagement, provided valuable information about wildlife along the proposed pipeline corridor. No concerns regarding the potential effects of the Project on reptiles were identified. Consultation and engagement details regarding wildlife, ATK and TEK are provided in the Wildlife Technical Report of Volume 5C, and this information is included and considered throughout the effects assessment for arid habitat snakes. Consultation with BC MFLNRO and local biologist identified existing information available about reptiles habitat and recommended the area from RK 837 to RK 842 as suitable habitat for arid habitat snakes and surveys.

Information on the ecological context for this indicator (*e.g.,* species status, population trends, known threats, best management practices and conservation strategies) is provided in Table 7.2.10-14. The purpose of including the ecological context is to provide an indication of the resilience of the indicator to disturbance effects.

TABLE 7.2.10-14

ECOLOGICAL CONTEXT SUMMARY FOR THE REPTILE INDICATOR

Reptile Indicator	Ecological Context
Arid Habitat Snakes	• The arid habitat snakes indicator includes the following species (Wildlife Habitat Modelling and Species Accounts Technical Report of Volume 5C) (ASRD 2011b, BC CDC 2013, COSEWIC 2013, Environment Canada 2013c): - western rattlesnake (Threatened under Schedule 1 of the *SARA* and by COSEWIC; Blue-listed in BC; Conservation Framework Priority 2); - gopher snake, *deserticola* ssp. (Threatened under Schedule 1 of *SARA* and by COSEWIC; Blue-listed in BC; Conservation Framework Priority 2); - yellow-bellied racer (Special Concern under Schedule 1 of *SARA* and by COSEWIC; Blue listed in BC; Conservation Framework Priority 2); - rubber boa (Special Concern under Schedule 1 of *SARA* and by COSEWIC; Yellow-listed in BC; Conservation Framework Priority 1); and - common and terrestrial gartersnakes (Yellow-listed in BC). • The number of snakes in BC is unknown. Due to their cryptic nature and mobility, accurate population estimates have not been possible (Racer Management Team Working Group [RMTWG] 2013, SIRART 2008b,c). • The population estimate for western rattlesnake in BC (extrapolated from counts at known den sites) is approximately 7,900 individuals (Hobbs 2013). This is likely inaccurate due to fluctuation in den counts and the likelihood of undiscovered dens. • Based on the slow reproductive rates, high mortality rates, habitat loss of up to 52% and known local extirpations, the populations of snakes in BC are likely declining (COSEWIC 2004a,b, SIRART 2008b,c). Snakes have discontiguous ranges in BC (COSEWIC 2004a,b), increasing vulnerability to local extirpation. • Arid habitat snakes are restricted to warm, dry habitats including grasslands, ponderosa pine and Douglas-fir forests. Well connected seasonal habitats are required to complete all aspects of the snakes' life history, including hibernating, mating, foraging, and egg-laying. • Dens located in rocky outcrops and talus slopes on south-facing slopes are used for hibernating. Rattlesnakes hibernate communally, at times with other snake species including gopher snakes and racers (Bertram *et al.* 2001, COSEWIC 2004b,c). Gopher snakes and racers also hibernate singly or in small non-specific groups (COSEWIC 2002f, Bertram 2004). • Open grassland and dry forest habitats as well as riparian areas are preferred by rattlesnakes, gopher snakes, and racers for foraging and mating during the active season (COSEWIC 2002f, 2004a,b). • Egg-laying habitat for gopher snakes and racers includes south-facing open areas, with adequate cover. This may include talus, rock fissures, coarse woody debris, abandoned rodent burrows or excavated chambers in sandy soil (BC MWLAP 2004b, Bertram 2004, COSEWIC 2002f). • Rubber boas potentially use a variety of habitats in the southern interior and south coast ecoprovinces, and may occur in the Project area from Black Pines to Westridge. Garter snakes likely occur along the length of the Project from Edmonton to Westridge, in forests, grasslands, riparian areas, wetlands and meadows encountered by the proposed pipeline corridor. • Since populations are seasonally concentrated at hibernating sites, arid snake species are particularly vulnerable to disturbance and local extirpation. Habitat loss and direct mortality due to road construction, utility development, agricultural expansion and urban expansion are the main threats to these species (SIRART 2008b,c). • Best management practices for arid habitat snakes include implementing disturbance buffers around known den sites, preserving important migration and foraging habitats, maintaining corridors for movement between summer and winter habitats, mitigating road mortality, and discouraging killing of snakes (BC MWLAP 2004c). • The goal of the provincial *Recovery Plan for the Gopher Snake deserticola ssp. (Pitophis catenifer deserticola) in British Columbia* (SIRART 2008b) is to maintain self-sustaining populations of the gopher snake, *deserticola* ssp. throughout its range. The specific objectives include: protecting habitat, including suitably connected sites with sufficient habitat for hibernation, egg laying, foraging, and seasonal movements; addressing road kill of snakes at identified sites; and increasing understanding and knowledge of gopher snake ecology and threats. • The goal of the *Management Plan for the Racer (Coluber constrictor) in British Columbia (RMTWG 2013)* is to maintain the current area of occupancy and distribution by protecting and conserving suitable habitat, reducing roadkill, and quantifying racer habitat needs, population demographics, and viability within all 5 population areas. • The goal of the *Recovery Strategy for the Western Rattlesnake (Crotalus oreganus) in British Columbia* (SIRART 2008c) is to maintain self-sustaining populations throughout the species' range. The objectives are to: protect and manage threats to habitat, consisting of suitably connected priority sites with sufficient habitat for hibernation, foraging, gestation, and seasonal movements; reduce road kill mortality of snakes; and develop a research program to increase knowledge of western rattlesnake distribution, population size and demography, habitat use, movements, and threats. • The Ecological Area Assessment for the Lac du Bois Grasslands Protected Area identifies Batchelor Hills and the Lac du Bois Gateway areas as high value core habitat for western rattlesnake and other snake species including the racer, gopher snake and rubber boa. There are three known den sites in the area, and telemetry studies have shown extensive active season movements. The Ecological Area Assessment recommends that wildlife fencing be considered if traffic increases on the Lac du Bois road and that signage be increased for motorized vehicle access control (Grasslands Conservation Council of British Columbia 2009). • Table 7.2.10-16 provides a summary of the predicted change in effective western rattlesnake habitat as a result of the Project.

Construction and operations of the Project will disrupt movement and increase mortality risk due to soil handling and trenching, increase the existing corridor width where existing rights-of-way are paralleled, remove habitat structural features including coarse woody debris and rocks that provide cover for both snakes and small mammal prey species, and increase traffic. The Project will result in the long-term conversion of shrubby sagebrush habitat to grassland. With appropriate construction and reclamation practices, disturbed grassland habitat within the Footprint is expected to regenerate in the short to medium-term following Project construction and reclamation.

The Project is predicted to interact with arid habitat snakes via all three of the identified effects pathways, including changes in habitat, changes in movement and increased risk of mortality. Table 7.2.10-15 provides a summary of the significance evaluation of the potential residual effects of the construction and operations of the proposed pipeline on arid habitat snakes. The rationale used to evaluate the significance of the residual environmental effects is provided below.

TABLE 7.2.10-15

SIGNIFICANCE EVALUATION OF POTENTIAL RESIDUAL EFFECTS OF PROJECT CONSTRUCTION AND OPERATIONS ON THE REPTILE INDICATOR

				Temporal Context						
	Potential Residual Effects	Impact Balance	Spatial Boundary[1]	Duration	Frequency	Reversibility	Magnitude	Probability	Confidence	Significance[2]
26.	Wildlife Indicator – Arid Habitat Snakes									
26(a)	Combined Project effects on arid habitat snakes resulting from habitat loss or alteration, changes in movement and increased mortality risk.	Negative	LSA	Short-term	Periodic	Long-term	Medium	High	Moderate	Not significant

Notes: 1 LSA = Wildlife LSA.

2 Significant Residual Environmental Effect: a high probability of occurrence of a permanent or long-term residual effect of high magnitude that cannot be technically or economically mitigated.

Change in Habitat

Project clearing and construction activities will disturb grassland, shrub-steppe and open forest habitat, and site-specific habitat features such as rocks, talus, outcrops and coarse woody debris that comprise suitable habitat components for arid habitat snakes. Disturbance of these habitats is predicted to reduce cover availability for arid habitat snakes as well as their prey species, and alter the availability of effective snake habitat within the Project Footprint. Due to the slow life history (*i.e.*, mature slowly, low reproductive rate) of snakes in temperate regions, they are not resilient to landscape changes (Waldron *et al.* 2013). Snakes are predominantly found under or near cover objects including coarse woody debris, rocks and woody vegetation, used for thermal and security cover (Bertram *et al.* 2001, Gomez 2007). Arid habitat snakes primarily prey on small mammals. Disturbed grassland areas have fewer prey species and at lower density, resulting in lower prey availability for snakes (Grant *et al.* 1982, LoBue and Darnell 1959). A study of western rattlesnakes in southern BC found that snakes in disturbed areas had lower body condition than snakes in undisturbed areas and, therefore, were likely to have lower reproductive rates and survival (Lomas 2013).

The Project is predicted to change the availability of western rattlesnake habitat in the Wildlife LSA (Table 7.2.10-16 and Figure 7.2.10-4). Results of habitat modelling indicate a small increase in effective living habitat for western rattlesnake as a result of the Project, which is a function of clearing of treed habitat in the dry interior region of BC. Of the species within the arid habitat snakes indicator community, the western rattlesnake has the most restricted distribution due to historical extirpation, and least variable habitat requirements of the species in the arid snake community. Therefore, the quantification of habitat change for western rattlesnake is expected to provide a precautionary indication of potential Project effects on arid habitat snakes. Standard best practices for protecting snakes include maintaining buffers of undisturbed native vegetation around breeding, foraging, egg-laying and hibernating habitats

(BC MWLAP 2004c). Application of the proposed mitigation (Table 7.2.10-3), including minimizing the area of disturbance, implementing minimal disturbance construction to the extent feasible, protecting site-specific habitat features habitat features of importance (*e.g.*, rock outcrops) where practical, and restoration of disturbed habitat, is expected to reduce the magnitude of potential residual effects of Project construction and operations on snake habitat.

TABLE 7.2.10-16

PREDICTED CHANGE IN HABITAT FOR WESTERN RATTLESNAKE IN THE WILDLIFE LSA

Wildlife Indicator	Habitat/Life Requisite	Habitat Suitability Rating	Existing Conditions (ha)	Project Conditions (ha)	Incremental Change (ha)[1]	% Change
Western rattlesnake (arid habitat snakes indicator)	Year-round living habitat	High	205.5	204.9	0.5 ↓	0.26 ↓
		Moderate	1048.1	1048.6	0.5 ↑	0.05 ↑
		Low	1438.6	1438.6	< 0.1 ↓	< 0.01 ↓
		Nil	775.9	775.9	< 0.1 ↓	< 0.01 ↓
		Effective Habitat	1253.5	1253.5	< 0.1 ↑	< 0.01 ↑
	Hibernating	High	48.5	48.5	< 0.1↓	0.04↓
		Moderate	50.4	50.3	0.1↓	0.16↓
		Low	0	0	0	0
		Nil	3,372.7	3,372.8	0.1↑	< 0.01↑
		Effective Habitat	98.9	98.8	0.1↓	0.10↓

Note: 1 ↓ represents a decrease and ↑ represents an increase.

Change in Movement

The Project may affect snake movement during construction. Soil and brush piles, traffic and movement of heavy machinery, strung pipe and the pipeline trench could create barriers to snake dispersal. The degree of changes in snake movement will depend on the location of construction activities relative to snake hibernacula and foraging habitats, and the season of construction.

The extent of snake movement across the landscape varies between species. Western rattlesnakes are philopatric (loyal to winter hibernacula), undergoing annual migrations between hibernacula and foraging habitats. These movements range from hundreds of metres to several kilometres (Gomez 2007, Gosling 2013). Gravid females do not migrate and move as little as 10-100 m during the active season (Macartney and Gregory 1988). Great Basin gopher snakes have been known to travel as far as 2.4 km from their hibernation site (Williams *et al.* 2012). The maximum dispersal distance between hibernacula by racers in Utah was measured at 1.8 km (Brown and Parker 1976).

Roads have been found to create barriers to snake dispersal (Jackson and Fahrig 2011, Shepard *et al.* 2008). All snake species experience immobilization (a defensive response where a snake freezes to avoid being detected by a threat) due to traffic. For gopher snakes and racers, the immobilization is momentary; however, for rattlesnakes, immobilization can be extended and may affect their overall dispersal success (Andrews and Gibbons 2005).

Brush and debris piles may create artificial cover features for snakes, which are often found under man-made cover objects (Bertram *et al.* 2001). This may affect natural dispersal patterns.

Increased Mortality Risk

The Project has potential to increase the risk of snake mortality as a result of heavy machinery and vehicle traffic, soil handling and trenching, predation risk, and persecution.

Road kill is a substantial source of mortality for snakes in BC (COSEWIC 2002f, 2003b, 2004a,b). Road mortalities can result in severe "depletion effects" on snake populations (Hobbs 2013, Jackson and Fahrig 2011). Mortality on roads also leads to road avoidance and potential genetic isolation of snake populations (Shepard *et al.* 2008).

Arid habitat snakes (*e.g.*, rattlesnake, gopher snake, racer, rubber boa) are ground-dwelling snakes, with limited climbing abilities (Bertram *et al.* 2001). Snakes that may enter the pipeline trench during construction would likely not be capable of getting out, putting the animal at risk of thermal stress, predation and mortality from equipment, backfilling or human-wildlife conflict.

The primary defense mechanisms against predation used by arid habitat snakes are crypsis (camouflage) and shelter under cover objects (Andrews and Gibbon 2005, COSEWIC 2002f, 2004a,b). Disturbance of snake habitats, including clearing of cover objects and vegetation, exposes snakes to predation by predator species such as hawks and coyotes. Immobilization due to vehicle traffic can increase exposure to predation, as snakes are likely to freeze in place without seeking a safe place to hide (Andrews and Gibbons 2005).

Active persecution of rattlesnakes is prevalent. Although individuals of the species are protected like other animals by the BC *Wildlife Act*, Sections 2(4), 26(2) and 75(1) of the Act provide for the killing of wildlife if a threat to person or property exists. Due to the venomous nature of the rattlesnake and its reputation, the perception of a threat is common and many snakes are killed in situations where the animal could have easily been avoided (Bertram *et al.* 2001, Charland *et al.* 1993). A primary strategy for defense by the gopher snake is to imitate the rattlesnake by shaking its tail and making a rattle noise in the throat. Unfortunately, this often leads humans to mistake harmless gopher snakes for venomous rattlesnakes and to kill the animal in perceived defense (Bertram *et al.* 2001).

Application of the proposed mitigation measures (Table 7.2.10-3), including implementing protective buffers around known hibernacula or breeding sites and scheduling construction activities in identified snake habitats outside the active period (*i.e.*, from April to October), is expected to reduce potential residual Project effects on snake mortality risk due to machinery, vehicles, open trench, and human-wildlife conflict (BC MWLAP 2004c). An education program will be mandatory for all construction staff, and will include measures to avoid snakes and appropriate protocols in the event that a snake is detected on the work site. This mitigation is expected to effectively prevent the killing of snakes that may be perceived as a threat.

Summary of Effects Characterization Rationale for Reptile Indicator

A summary of the rationale for the effects characterization for the arid habitat snakes indicator is provided below. Environmental and/or regulatory standards considered in the evaluation of magnitude are provided in Table 7.2.10-14 (ecological context for the arid habitat snakes indicator) and Section 7.2.10.4 (regulatory guidelines).

- Spatial Boundary: Wildlife LSA – habitat changes (*e.g.*, removal of cover) are expected to be primarily limited to the Project Footprint; changes (*e.g.*, barriers) to movement (*e.g.,* spoil piles, traffic) would likely extend to the Wildlife LSA; and changes in mortality risk (*e.g.*, traffic) are assessed at the regional scale.
- Duration: short-term – the events causing effects are construction and operational activities (*e.g.*, monitoring, vegetation management and site-specific maintenance).
- Frequency: periodic – the events causing effects (*i.e.*, clearing, traffic and activity) will occur during construction and intermittently during operations for monitoring, vegetation control and maintenance.
- Reversibility: long-term – the arid habitat snake community relies primarily on grassland, shrub-steppe and open forest habitats. Grassland habitats are expected to regenerate on the Project Footprint in the short to medium-term. Sagebrush and open forest habitats are expected regenerate in the long-term. Effects are reversible in the long-term following decommissioning and abandonment, once native vegetation regenerates over the Project Footprint.
- Magnitude: medium - the arid habitat snake community includes several species with both provincial and federal conservation status designations of concern. Snake populations in BC are assumed to be declining based on their slow reproductive rates, high mortality rates, habitat loss of up to 52%, and known local extirpations. The slow life history of snakes in the Wildlife LSA means they are not resilient to habitat change. The disconnected distribution of snakes in BC increases their vulnerability to local extirpation. The proposed mitigation to reduce Project effects on snake habitat, movement

and mortality risk are consistent with available best practices and conservation objectives, and are expected to reduce the residual effects of the Project on arid habitat snakes to medium.

- Probability: high – the Project will alter habitat and increase mortality risk to affect the indicator.
- Confidence: moderate – the assessment is based on a good understanding of cause-effect relationships and relevant data. Limitations and uncertainty associated with available data pertinent to the Project area reduce the confidence level to moderate.

7.2.10.13 Summary of Residual Effects Significance Determination for Wildlife and Wildlife Habitat

As discussed in Sections 7.2.10.9 to 7.2.10.12, there are no situations where there is a high probability of occurrence of a permanent or long-term residual environmental effect on wildlife and wildlife habitat indicators of high magnitude that cannot be technically or economically mitigated. Consequently, the residual environmental effects of Project construction and operations on wildlife and wildlife habitat indicators are concluded to be not significant.

7.2.11 Species at Risk

For the purpose of the assessment, species at risk are considered to include all federally-listed species of conservation concern (*i.e.*, COSEWIC or *SARA* Schedule 1 designation) (COSEWIC 2013, Environment Canada 2013c). Species identified as having the potential to occur along the proposed pipeline corridor and in the element-specific RSAs are based on previous field assessments and existing data.

This subsection discusses the species at risk that have been identified as likely to occur within each element-specific RSA. The list of federal species at risk includes 10 fish species within the Aquatics RSA, 8 vegetation species within the Vegetation RSA, and 57 wildlife species within the Wildlife RSA. Potential effects of the Project on these species are assessed through the use of indicators in Section 7.2.7 Fish and Fish Habitat, Section 7.2.9 Vegetation and Section 7.2.10 Wildlife and Wildlife Habitat.

In selecting the indicators for fish and fish habitat, vegetation and wildlife and wildlife habitat, preference was often given to species at risk. Species at risk are often sensitive to human disturbance and, as a result, are useful indicators since they provide a conservative indication of potential effects. For fish and fish habitat, species at risk identified as indicators include bull trout, Dolly Varden, Chinook salmon, coho salmon, and some populations of cutthroat trout. For vegetation, rare plant and lichen species were identified as an indicator.

For wildlife, species at risk identified as indicators for the Project include grizzly bear, woodland caribou, short-eared owl, rusty blackbird, flammulated owl, Lewis's woodpecker, Williamson's sapsucker, western screech-owl, great blue heron (*fannini* ssp.), spotted owl, common nighthawk, northern goshawk (*laingi* ssp.) and olive-sided flycatcher. In addition, many of the habitat-based communities and species groups identified as indicators included species at risk. In some cases, habitat models were developed for individual species at risk to support the assessment of these indicator communities or groups, including Pacific water shrew, western toad, Great Basin spadefoot, coastal tailed frog and western rattlesnake.

While prioritizing the selection of indicator species with conservation status, indicators were also required to reasonably represent a suite of species with similar habitat requirements, life history characteristics and most importantly, potential sensitivities to Project effects. An important consideration in selecting indicators was whether or not the indicator can be linked to a probable pathway of effect.

In cases where two or more species at risk with similar habitat requirements and life history characteristics were identified as potentially suitable indicators, the assessment considered: priority of conservation concern; the likelihood of the species to occur within the element-specific RSA; and the degree to which the species is considered to be sensitive to potential Project effects. For example, where provincially-listed species were identified with similar habitat requirements and life history characteristics to a federally-listed species, the federally-listed species was typically chosen as the indicator.

While acknowledged differences remain between species represented underneath the indicators (*e.g.*, seasonal timing in the area, preferred habitat, prey), the most important consideration remains the similarities or differences in how the potential effects of the Project manifest for a specific organism, and whether these are adequately captured by the assessment of the indicator.

Most importantly, while determinations of significance focus on the individual indicator species, mitigation is described in consideration of the broader taxonomic group or ecological guild, and will be applied to equally benefit all species at risk, not only the assessment indicators.

In summary, although not all species at risk are discussed explicitly under each indicator, potential Project effects were assessed in consideration of all species at risk. The indicators used to represent fish and fish habitat, vegetation and wildlife and wildlife habitat were carefully selected to ensure that the full range of potential Project effects on species at risk was addressed and mitigation measures to reduce these effects will apply to all species at risk, not just the indicators. Section 7.2.7 Fish and Fish Habitat, Section 7.2. Vegetation and Section 7.2.10 Wildlife and Wildlife Habitat provide the significance rationale for applicable indicator species. No significant adverse effect on species at risk has been identified as a result of the pipeline and facilities component of the Project.

7.2.12 Facilities Located Within Pipeline Right-of-Way

The elements interacting with pipeline facilities (*e.g.,* automated MLBVs) within the pipeline right-of-way and the associated potential residual effects on the environmental indicators are provided in Table 7.2.12-1. The evaluation of significance of the potential residual effects is as described in the applicable subsection of Section 7.2 for the construction and operations of the pipeline.

TABLE 7.2.12-1

POTENTIAL RESIDUAL EFFECTS ASSOCIATED WITH FACILITIES LOCATED WITHIN THE PROPOSED PIPELINE CORRIDOR

Element	Indicator	Potential Residual Effect(s)
Physical and Meteorological Environment	• N/A	• N/A
Soil and Soil Productivity	• Soil productivity	• Mixing of topsoil/root zone material and subsoil.
	• Soil degradation	• Compaction and rutting, surface erosion of topsoil/root zone material and pulverization of soil or sod.
Water Quality and Quantity	• Surface water quality	• Contamination of surface water due to a spill during construction.
	• Surface water quantity	• Localized alteration of natural drainage patterns.
Air Emissions	• CACs and VOCs	• Increase in air emissions during construction and site-specific maintenance activities.
GHG Emissions	• Emissions of CO2, CH4 and N2O • Effect on overall climate change	• Increase in GHG emissions during construction and site-specific maintenance activities. • Changes in environmental parameters (*e.g.*, increase in global average temperature)
Acoustic Environment	• Sound levels	• Increased sound levels at receptors.
Fish and Fish Habitat	• Riparian habitat	• The pipeline right-of-way crosses riparian habitat. The following potential residual effects have been identified if permanent facilities are located within riparian habitat in the pipeline right–of-way. • Riparian habitat loss or alteration due to construction activities. • Clearing of disturbance of riparian habitat during maintenance and operations.
Wetland Loss or Alteration	• Wetland function	• Loss or alteration of wetland habitat, hydrological and biogeochemical functions. • Reduction of wetland habitat, hydrological and biogeochemical functions in the event of a spill during construction.
Vegetation	• Vegetation communities of concern	• Incremental alteration of the composition of native vegetation. • Incremental alteration of grassland communities in the BG BGC Zone. • Grasslands located adjacent to the temporary facility in the BG BGC Zone may be indirectly affected by the Project. • Some disturbance or alteration of a rare ecological community, if avoidance is not practical and mitigation measures do not completely protect a site. • If rare ecological communities are located adjacent to the temporary facility they may be indirectly affected by changes in hydrology or light levels.

TABLE 7.2.12-1 Cont'd

Element	Indicator	Potential Residual Effect(s)
Vegetation (cont'd)	• Plant and lichen species of concern	• Some disturbance or alteration of a rare plant occurrence, if avoidance is not practical and mitigation measures do not completely protect a site. • If rare plant sub-populations are located adjacent to the temporary facility they may be affected by changes in hydrology or light levels. • Some disturbance or alteration of a rare lichen occurrence, if avoidance is not practical and mitigation measures do not completely protect a site. • If rare lichen sub-populations are located adjacent to the temporary facility they may be affected by changes in hydrology or light levels.
	• Presence of infestations of Provincial weed species and other invasive non-native species identified as a concern	• Weed introduction and spread.
Wildlife and Wildlife Habitat	• All indicator species	• Combined effects on wildlife resulting from habitat loss or alteration, changes in movement and increased mortality risk.
Species at Risk	Refer to fish and fish habitat, vegetation and wildlife and wildlife habitat rows of this table	

7.3 Effects Assessment - Temporary Facilities Construction and Operations

The following temporary facilities that are located beyond the pipeline construction right-of-way are required during the construction of the Project:

- temporary access roads and shoo-flies;
- staging and stockpile sites;
- equipment storage sites;
- construction office sites;
- construction camps, if needed;
- trenchless crossing work areas;
- borrow pits; and
- log decks.

This subsection considers the preparation of the temporary sites and installation of temporary facilities (*i.e.,* construction) as well as the use of the temporary facilities (*i.e.,* operations). Although the need for and the respective general location of some of these sites are the responsibility of the pipeline construction contractor, all temporary facility site locations will require the approval of Trans Mountain's Inspector(s). Temporary facilities will be located within previously disturbed areas within the proposed pipeline corridor, where possible. In the event that specific mitigation is warranted for site(s), the measures developed will be documented in the Pipeline EPP prior to construction. The level of mitigation measures applied will ensure that any adverse residual environmental effects associated with the temporary facilities are reduced to a level that is not significant.

Using the assessment methodology described in Section 7.1, the following subsections evaluate the potential environmental effects associated with the construction and operations of the temporary facilities located beyond the pipeline construction right-of-way. Temporary facilities such as stockpile and staging areas that are located within the construction right-of-way are evaluated in the applicable subsection of Section 7.2. Spatial boundaries for the assessment of temporary facilities are the same as in the applicable subsection of Section 7.2 unless otherwise noted.

Environmental elements potentially interacting with the construction and operations of the temporary construction camps and other temporary facilities include:

- physical elements such as physical and meteorological environment, soil and soil productivity, water quality and quantity, air emissions, GHG emissions and acoustic environment; and
- biological elements such as fish and fish habitat, wetland loss or alteration, vegetation, wildlife and wildlife habitat, and species at risk.

7.3.1 Physical and Meteorological Environment

Sections 7.2.1.1, 7.2.1.2 and 7.2.1.3 provide the assessment indicators, measurement endpoints, spatial boundaries and physical environment context for the assessment of potential effects of the proposed temporary facilities on the physical environment.

7.3.1.1 Potential Effects and Mitigation Measures

<u>Identified Potential Effects</u>

Potential effects associated with the construction and operations of temporary facilities such as access roads and borrow sites were based on the results of the literature review, desktop analysis and the professional experience of the assessment team.

A summary of mitigation measures provided in Table 7.3.1-1 was principally developed in accordance with Trans Mountain standards and industry and provincial regulatory guidelines as described in Section 7.2.1.4.

TABLE 7.3.1-1

POTENTIAL EFFECTS, MITIGATION MEASURES AND RESIDUAL EFFECTS OF CONSTRUCTION AND OPERATIONS OF TEMPORARY FACILITIES ON THE PHYSICAL ENVIRONMENT

Potential Effect	Temporary Facility Type	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
1. Physical Environment Indicator – Terrain Instability				
1.1 Terrain instability	Temporary Access Roads Borrow Sites	LSA	<u>Temporary Access Roads</u> • Develop/upgrade each access road only to the extent necessary to accommodate the intended construction traffic during the period of planned use [Section 9.0]. • Where warranted and requested by the appropriate regulatory authority or private landowner, implement measures to deactivate and reclaim the access road including: - recontour the road right-of-way and replace salvaged topsoil/root zone material; - install permanent erosion control structures such as cross ditches and berms; and - seed disturbed areas with an approved cover crop and/or grass mix and, where warranted, install biodegradable erosion control measures [Section 9.0]. <u>Borrow Sites</u> • Ensure the excavation of borrow material does not extend within 1 m (minimum) of a water table [Section 11.0]. • Grade slopes created during the development or operation of upland borrow sites to stable angles (approximately 1:3; rise over run) or as specified in the applicable Pit Development Plan (to be developed and provided under separate cover) or borrow site approval conditions [Section 11.0].	• Areas of terrain instability may occur as a result of construction activities.
2. Physical Environment Indicator – Topography				
2.1 Alteration of topography	Temporary Access Roads Borrow Sites	LSA	<u>Temporary Access Roads</u> • See recommended mitigation measures outlined in potential effect 1.1 of this table. <u>Borrow Sites</u> • See recommended mitigation measures outlined in potential effect 1.1 of this table.	• Topography may be altered at borrow sites and along temporary access roads at locations where cut slopes are too steep to be replaced to the pre-construction profile without creating areas of instability.
3. Physical Environment Indicator – Acid Generating and Metal Leaching Rock				
3.1 Acid generation or metal leaching	Borrow Sites	LSA	• See recommended mitigation measures outlined in Table 7.2.1-2 Physical Environment.	• Acidification/ contamination of the terrestrial and/or aquatic environment from ARD or metal leaching.

Notes: 1 LSA = Physical Environment LSA.
2 Detailed mitigation measures are outlined in the Pipeline EPP (Volume 6B).

7.3.1.2 Potential Residual Effects

The potential residual environmental effects on physical environment indicators associated with the construction and operations of temporary access roads and borrow sites (Table 7.3.1-1) are:

- areas of terrain instability may occur as a result of construction activities;

- topography may be altered at borrow sites and along temporary access roads at locations where cut slopes are too steep to be replaced to the pre-construction profile without creating areas of instability; and
- acidification/contamination of the terrestrial and/or aquatic environment from ARD or metal leaching.

7.3.1.3 Significance Evaluation of Potential Residual Effects

Table 7.3.1-2 provides a summary of the significance evaluation of the potential residual environmental effects of the construction and operations of temporary access roads and borrow sites on the physical environment. The rationale used to evaluate the significance of each of the residual environmental effects is provided below.

TABLE 7.3.1-2

SIGNIFICANCE EVALUATION OF POTENTIAL RESIDUAL EFFECTS OF CONSTRUCTION AND OPERATIONS OF TEMPORARY FACILITIES ON PHYSICAL ENVIRONMENT

				Temporal Context						
	Potential Residual Effects	Impact Balance	Spatial Boundary[1]	Duration	Frequency	Reversibility	Magnitude	Probability	Confidence	Significance[2]
1.	Physical Environment – Terrain Instability									
1(a)	Areas of terrain instability may occur as a result of construction activities.	Negative	LSA	Short-term	Isolated	Short to medium-term	Low	Low	High	Not significant
2.	Physical Environment Indicator – Topography									
2(a)	Topography may be altered at borrow sites and along temporary access roads at locations where cut slopes are too steep to be replaced to the pre-construction profile without creating areas of instability.	Negative	LSA	Short-term	Isolated	Permanent	Low to medium	High	High	Not significant
3.	Physical Environment Indicator – Acid Generating and Metal Leaching Rock									
3(a)	Acidification/contamination of the terrestrial and/or aquatic environment from ARD or metal leaching.	Negative	LSA	Short-term	Isolated	Short to medium-term	Low	Low	High	Not significant

Notes: 1 LSA = Physical Environment LSA.

2 Significant Residual Environmental Effect: A high probability of occurrence of a permanent or long-term residual effect of high magnitude that cannot be technically or economically mitigated.

The significance evaluation of the potential effects on terrain instability, topography and ARD or metal leaching rock indicators was determined to be the same for the construction and operations of temporary facilities as for pipeline construction and operations (Table 7.3.1-2, points 1[a], 2[a] and 3[a]). The exception is the probability of areas of terrain instability occurring as a result of construction activities, which for temporary facilities is considered to be low due to the limited extent of ground disturbance anticipated and since temporary facilities will be located on stable, previously disturbed areas, where possible. Table 7.2.1-3 and the accompanying discussion in Section 7.2.1.6 provide an evaluation of potential residual effects of temporary facilities and their significance on the applicable physical environment indicator.

7.3.1.4 Summary

As identified in Table 7.3.1-2, there are no situations where there is a high probability of occurrence of a permanent or long-term residual environmental effect on physical environment indicators of high magnitude that cannot be technically or economically mitigated. Consequently, it is concluded that the residual environmental effects of construction and operations of the temporary facilities on the physical environment will be not significant.

7.3.2 Soil and Soil Productivity

Sections 7.2.2.1, 7.2.2.2 and 7.2.2.3 provide the assessment indicators, measurement endpoints, spatial boundaries and soil context for the assessment of potential effects of the proposed temporary facilities on soil and soil productivity.

7.3.2.1 Potential Effects and Mitigation Measures

Identified Potential Effects

Potential effects associated with the construction and operations of the temporary construction camps and other temporary facilities on soil and soil productivity indicators are listed in Table 7.3.2-1. These interactions were based on the results of the literature review, desktop analysis and the professional experience of the assessment team.

A summary of mitigation measures provided in Table 7.3.2-1 was principally developed in accordance with Trans Mountain standards as well as industry and provincial regulatory guidelines as described in Section 7.2.2.4.

TABLE 7.3.2-1

POTENTIAL EFFECTS, MITIGATION MEASURES AND RESIDUAL EFFECTS OF CONSTRUCTION AND OPERATIONS OF TEMPORARY FACILITIES ON SOIL AND SOIL PRODUCTIVITY

Potential Effect	Temporary Facility Type	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
1. Soil Indicator – Soil Productivity				
1.1 Decreased topsoil/root zone material productivity during topsoil/root zone material salvaging	All	Footprint	• See recommended mitigation measures outlined in Table 7.2.2-2 Soil and Soil Productivity.	• Mixing of topsoil/root zone material and subsoil.
1.2 Decreased soil productivity from soil diseases (*i.e.,* clubroot disease and potato cyst nematode)	All	LSA	• See recommended mitigation measures outlined in Table 7.2.2-2 Soil and Soil Productivity.	• Clubroot disease introduction and spread. Potato nematode introduction and spread.
2. Soil Indicator – Soil Degradation				
2.1 Degradation of soil structure due to compaction and rutting	All	Footprint	• See recommended mitigation measures outlined in Table 7.2.2-2 Soil and Soil Productivity.	• Degradation of soil structure and impairment of rooting zone due to compaction and rutting.
2.2 Loss of topsoil/root zone material through wind and water erosion	All	Footprint	• See recommended mitigation measures outlined in Table 7.2.2-2 Soil and Soil Productivity.	• Surface erosion of topsoil/root zone material can be expected until a vegetative cover is established.
2.3 Degradation of soil structure due to pulverization of soil and sod	All	Footprint	• See recommended mitigation measures outlined in Table 7.2.2-2 Soil and Soil Productivity.	• Pulverization resulting in fugitive dust and loss of soil structure can be expected during dry conditions.
3. Soil Indicator – Soil Contamination				
3.1 Disturbance of previously contaminated soil	All	Footprint	• See recommended mitigation measures outlined in Table 7.2.2-2 Soil and Soil Productivity.	• No residual effect identified.
3.2 Soil contamination due to spot spills during construction	All	Footprint	• See recommended mitigation measures outlined in Table 7.2.2-2 Soil and Soil Productivity.	• No residual effect identified.

Notes: 1 LSA = Soils LSA.
2 Detailed mitigation measures are outlined in the Pipeline EPP (Volume 6B).

7.3.2.2 Potential Residual Effects

The potential residual environmental effects on soil and soil productivity indicators associated with the construction and operations of the temporary construction camps and other temporary facilities (Table 7.3.2-2) are:

- mixing of topsoil/root zone material and subsoil;
- clubroot disease and potato cyst nematode introduction and spread;
- degradation of soil structure and impairment of rooting zone due to compaction and rutting;
- surface erosion of topsoil/root zone material can be expected until a vegetative cover is established; and
- pulverization resulting in fugitive dust and loss of soil structure can be expected during dry conditions.

Some of the potential effects on element indicators associated with the construction and operations of temporary facilities are predicted to be eliminated through the implementation of mitigation measures (Table 7.3.2-2). The potential effects determined not to have a residual effect are disturbance of previously contaminated soil and soil contamination due to spot spills during construction.

7.3.2.3 Significance Evaluation of Potential Residual Effects

Table 7.3.2-2 provides a summary of the significance evaluation of the potential residual environmental effects of the construction and operations of the temporary construction camps and other temporary facilities on soil and soil productivity.

TABLE 7.3.2-2

SIGNIFICANCE EVALUATION OF POTENTIAL RESIDUAL EFFECTS OF CONSTRUCTION AND OPERATIONS OF TEMPORARY FACILITIES ON SOIL AND SOIL PRODUCTIVITY

Potential Residual Effects	Impact Balance	Spatial Boundary[1]	Temporal Context			Magnitude	Probability	Confidence	Significance[2]
			Duration	Frequency	Reversibility				
1. Soil Indicator – Soil Productivity									
1(a) Mixing of topsoil/root zone material and subsoil.	Negative	Footprint	Short-term	Isolated	Medium-term	Low	High	High	Not significant
1(b) Clubroot disease and potato cyst nematode introduction and spread.	Negative	LSA	Short-term	Accidental	Long-term	High	Low	Moderate	Not significant
2. Soil Indicator – Soil Degradation									
2(a) Degradation of soil structure and impairment of rooting zone due to compaction and rutting.	Negative	Footprint	Short-term	Isolated	Short to medium-term	Low	High	High	Not significant
2(b) Surface erosion of topsoil/root zone material can be expected until a vegetative cover is established.	Negative	Footprint	Short-term	Isolated	Medium-term	Low	High	High	Not significant
2(c) Pulverization resulting in fugitive dust and loss of soil structure can be expected during dry conditions.	Negative	Footprint	Short-term	Isolated	Short to medium-term	Low	Low to high	High	Not significant
2(d) Combined effects on the soil degradation indicator (2[a] to 2[c]).	Negative	Footprint	Short-term	Isolated	Short to medium-term	Low	High	High	Not significant

Notes: 1 LSA = Soil LSA.

2 Significant Residual Environmental Effect: A high probability of occurrence of a permanent or long-term residual effect of high magnitude that cannot be technically or economically mitigated.

The significance evaluation of the potential residual effects on the soil productivity indicator and soil degradation indicator (Table 7.3.2-2 points 1[a], 1[b] and 2[a] to 2[d]) was determined to be generally the same for the construction and operations of temporary facilities as for pipeline construction and operations. The exception is the frequency of the events causing soil degradation, which for temporary facilities is confined to the construction period of the Project (*i.e.,* isolated). Table 7.2.2-3 and the accompanying discussion in Section 7.2.2.6 provide an evaluation of potential residual effects of temporary facilities and their significance on the applicable soil and soil productivity indicator.

7.3.2.4 Summary

As identified in Table 7.3.2-2, there are no situations where there is a high probability of occurrence of a permanent or long-term residual environmental effect on soil and soil productivity indicators of high magnitude that cannot be technically or economically mitigated. Consequently, it is concluded that the residual environmental effects of construction and operations of the temporary facilities on soil and soil productivity will be not significant.

7.3.3 Water Quality and Quantity

Sections 7.2.3.1, 7.2.3.2 and 7.2.3.3 provide the assessment indicators, measurement endpoints, spatial boundaries and water quality and quantity context for the assessment of potential effects of the proposed temporary facilities on water quality and quantity.

7.3.3.1 Potential Effects and Mitigation Measures

Identified Potential Effects

Potential effects associated with the construction and operations of the temporary construction camps and other temporary facilities on the water quality and quantity indicators listed in Table 7.3.3-1 were based on the results of the literature review, desktop analysis and the professional experience of the assessment team. Note that no interactions between temporary facilities and groundwater indicators were predicted and, consequently, no potential effects were identified.

A summary of mitigation measures provided in Table 7.3.3-1 was principally developed in accordance with Trans Mountain standards and industry and provincial regulatory guidelines as described in Section 7.2.3.4.

TABLE 7.3.3-1

POTENTIAL EFFECTS, MITIGATION MEASURES AND RESIDUAL EFFECTS OF CONSTRUCTION AND OPERATIONS OF TEMPORARY FACILITIES ON WATER QUALITY AND QUANTITY

Potential Effect	Temporary Facility Type	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
1. Water Quality and Quantity Indicator – Surface Water Quality				
1.1 Possible contamination of surface water from access road runoff and grey water and sewage water discharge at temporary construction camps	Temporary AccessRoads Construction Camps	LSA	Temporary Access Roads • Do not use de-icer or salt for access road maintenance. Prevent sand used for maintenance purposes from entering watercourses by restricting sand application to access roads within 10 m of waterbodies [Section 9.0]. • Apply only water or non-toxic and non-persistent chemical products as approved to access roads for dust control [Section 9.0]. • Do not apply dust control chemicals to roads during windy conditions or within 300 m of a watercourse/wetland/lake [Section 9.0]. Construction Camps • Ensure that water withdrawal from surface water will not result in detrimental effects to the hydrologic regime [Section 10.0].	• No residual effect identified.

TABLE 7.3.3-1 Cont'd

Potential Effect	Temporary Facility Type	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
1.1 Possible contamination of surface water from access road runoff and grey water and sewage water discharge at temporary construction camps (cont'd)	See above	See above	• Process as required and dispose of sewage and grey water in accordance with provincial legislation and requirements [Section 10.0]. • Refer to the Water Withdrawal and Discharge Procedures Management Plan [Appendix C] for additional measures [Section 10.0]. • Follow reclamation measures outlined in the Reclamation Management Plan [Appendix C] for reclamation of sewage lagoons [Section 10.0]. <u>British Columbia</u> • Design and operate sewage facilities in accordance with the BC *Sewage Disposal Regulations* and the BC *Industrial Camp Regulations* under the *Public Health Act*. Sewage facilities in camps of more than 100 people are subject to requirements of a permit issued by the regional Health Authority [Section 10.0]. <u>Alberta</u> • Implement sewage treatment at temporary construction camps as outlined in the *Alberta Private Sewage Systems Standard of Practice* [Section 10.0].	• See above.
1.2 Suspended sediment in water column	Temporary Access Roads Borrow Sites	LSA	<u>Temporary Access Roads</u> • Align new access roads, where needed, to avoid, to the extent practical, watercourse crossings [Section 9.0]. • Align, if feasible, new access roads or extensions to existing access a minimum of 100 m from watercourses/wetlands/lakes [Section 9.0]. • Store mixtures of snow and soil in a manner that prevents sedimentation of watercourses/wetlands/lakes during spring breakup [Section 9.0]. • Install/implement drainage and erosion control measures (*e.g.,* check dams, sediment traps, culverts), as warranted, during the development of new access roads and upgrading of existing roads/trails [Section 9.0]. • Place armouring at both inflow and outflow ends of culverts, if warranted, to prevent erosion [Section 9.0]. • Provide sediment catch basins at the entrance to major culverts as deemed necessary by appropriate regulatory authorities [Section 9.0]. • Ensure ditches do not drain directly into a watercourse, unless limited by topography and approved by the appropriate regulatory authority. Install ditch blocks where required [Section 9.0]. • Apply geotechnical or bioengineering techniques, where warranted, to control chronic slumping problems that have the potential to contribute sediment to nearby watercourses to correct the problem [Section 9.0]. • Remove accumulated debris in a controlled and incremental manner to reduce the risk of flow surges, erosion and/or sedimentation of downstream areas [Section 9.0]. • Monitor and, if warranted, repair erosion control measures and/or implement supplemental erosion control measures, when the risk of erosion and sedimentation of a watercourse exists [Section 9.0].	• Reduction in surface water quality due to suspended sediment during construction and operations of temporary access roads and borrow sites.

TABLE 7.3.3-1 Cont'd

Potential Effect	Temporary Facility Type	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
1.2 Suspended sediment in water column (cont'd)	Temporary Access Roads Borrow Sites	LSA	• See also Section 7.2.3 Water Quality and Quantity for additional measures. Borrow Sites • Create retention ponds, where warranted, using the BC *Dam Safety Review Guidelines*, *Canadian Dam Safety Guidelines*, *Stormwater Management Guidelines* for the Province of Alberta, and *Aggregate Operators Best Management Practices Handbook for British Columbia* as a guide to hold sediment laden stormwater runoff until the sediment has settled [Section 11.0]. • Conduct discharge of water from retention ponds as outlined in the Water Withdrawal and Discharge Procedures Management Plan [Appendix C]. • Follow all approval conditions related to the withdrawal or discharge of water associated with the operation of borrow sites [Section 11.0]. • Discharge water from a settling pond, retention pond or other stormwater site onto the borrow site if feasible. Avoid discharging this water into a watercourse/wetland/lake without the approval of the Inspector(s) and acquisition of applicable approvals [Section 11.0]. • Follow water quality guidelines and additional measures for the discharge of water at borrow sites as outlined in the Water Quality Management Plan [Appendix C].	• See above.
1.3 Reduction of surface water quality due to small spill during construction	Temporary Access Roads Borrow Sites Other Temporary Sites	LSA	• See recommended mitigation measures outlined in Table 7.2.3-2 Water Quality and Quantity.	• Contamination of surface water due to a small spill during construction.
2. Water Quality and Quantity Indicator – Surface Water Quantity				
2.1 Localized alteration of natural surface drainage patterns during construction and operations of the temporary access roads, borrow sites and other temporary sites	Temporary access roads Borrow sites Other temporary sites	LSA	Temporary Access Roads • Ensure adequate drainage by maintaining the proper grade and installing culverts to allow for cross drainage. Outslope the crown of the road so that it is a minimum of 15 cm higher than the shoulders to allow the road surface to drain and dry [Section 9.0]. • Ensure that culverts of proper size, number and alignment are in place to handle peak run-off events for the period/duration the culverts will be in place and to reduce water movement along ditches and road surface [Section 9.0]. • Reduce alteration of natural drainage patterns by aligning culverts with the drainage and at angles other than right angles to the road [Section 9.0]. • Remove accumulated debris in a controlled and incremental manner to reduce the risk of flow surges [Section 9.0]. • Monitor the effectiveness of culverts in handling surface drainage across temporary access roads following installation [Section 9.0]. • Remove and reclaim new temporary access roads developed for the Project unless otherwise directed by the appropriate regulatory authority or landowner [Section 9.0]. Follow reclamation measures outlined in the Reclamation Management Plan [Appendix C].	• Localized alteration of natural surface drainage patterns.

TABLE 7.3.3-1 Cont'd

Potential Effect	Temporary Facility Type	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
2.1 Localized alteration of natural surface drainage patterns during construction and operations of the temporary access roads, borrow sites and other temporary sites (cont'd)	Temporary access roads Borrow sites Other temporary sites	LSA	<u>Borrow Sites</u> • Grade borrow sites, where feasible, to maintain natural surface drainage or drainage structures. Install/construct ditches or berms to provide surface drainage and direct stormwater around the borrow site [Section 11.0]. • Remove the dykes of settling and retention ponds, if present, and recontour the area. Remove or rip clay liners to restore natural drainage [Section 11.0]. • Seed and revegetate borrow sites to be restored in accordance with the respective Pit Development Plan (to be developed and provided under separate cover) and Reclamation Management Plan [Appendix C] [Section 11.0]. <u>Other Temporary Facilities</u> • Ensure that selected sites for temporary construction camps and staging areas are outside of applicable riparian buffers [Section 10.0]. • Ensure that selected sites for camps and staging areas are above the highest annual flood level (200-year flood), where practical [Section 10.0]. • Inspect all water conveyance installations (*e.g.,* ditches and culverts) and ensure they are functioning appropriately. Take appropriate action prior to and during the spring freshet to clear culverts blocked by ice or debris [Section 7.0]. • Maintain or, when the area is stabilized, remove drainage and erosion control devices and materials at all sites that are no longer in use [Section 7.0]. • Follow reclamation measures outlined in the Reclamation Management Plan [Appendix C] for reclamation of temporary construction sites [Section 10.0].	• See above.

Notes: 1 LSA = Water Quality and Quantity LSA.
2 Detailed mitigation measures are outlined in the Pipeline EPP (Volume 6B).

7.3.3.2 Potential Residual Effects

The potential residual environmental effects on water quality and quantity indicators associated with the construction and operations of the temporary construction camps and other temporary facilities (Table 7.3.3-1) are:

- reduction in surface water quality due to suspended sediment during construction and operations of temporary access roads and borrow sites;
- contamination of surface water due to a small spill during construction; and
- localized alteration of natural surface drainage patterns.

Some of the potential effects on water quality and quantity indicators associated with the construction and operations of temporary facilities are predicted to be eliminated through the implementation of mitigation measures (Table 7.3.3-1). The potential effects determined not to have a residual effect are contamination of surface water from access road runoff and grey water and sewage water discharge at temporary construction camps.

7.3.3.3 Significance Evaluation of Potential Residual Effects

Table 7.3.3-2 provides a summary of the significance evaluation of the potential residual environmental effects of the construction and operations of temporary construction camps and other temporary facilities on water quality and quantity indicators.

TABLE 7.3.3-2

SIGNIFICANCE EVALUATION OF POTENTIAL RESIDUAL EFFECTS OF CONSTRUCTION AND OPERATIONS OF TEMPORARY FACILITIES ON WATER QUALITY AND QUANTITY

	Potential Residual Effects	Impact Balance	Spatial Boundary[1]	Temporal Context			Magnitude	Probability	Confidence	Significance[2]
				Duration	Frequency	Reversibility				
1.	Water Quality and Quantity Indicator – Surface Water Quality									
1(a)	Reduction in surface water quality due to suspended sediment during construction and operations of temporary access roads and borrow sites.	Negative	LSA	Immediate to short-term	Isolated	Immediate to short-term	Low	High	High	Not significant
1(b)	Contamination of surface water due to a small spill during construction.	Negative	LSA	Immediate	Accidental	Short to medium-term	Low to high	Low	Moderate	Not significant
2.	Water Quality and Quantity Indicator – Surface Water Quantity									
2(a)	Localized alteration of natural surface drainage patterns.	Negative	LSA	Short-term	Isolated	Short to medium-term	Low to medium	High	High	Not significant

Notes: 1 LSA = Water Quality and Quantity LSA.

2 Significant Residual Environmental Effect: A high probability of occurrence of a permanent or long-term residual effect of high magnitude that cannot be technically or economically mitigated.

The significance evaluation of the potential residual effects on the surface water quality indicator and the surface water quantity indicator (Table 7.3.3-2, point 1[a], 1[b] and 2[a]) was determined to be generally the same for the construction and operations of temporary facilities as for pipeline construction and operations. The exception is the frequency of events causing reduced surface water quality and localized alteration of drainage patterns, which for temporary facilities is confined to the construction period of the Project (*i.e.,* isolated). Table 7.2.3-3 and the accompanying discussion in Section 7.2.3.6 provide an evaluation of potential residual effects of temporary facilities and their significance on the applicable water quality and quantity indicator.

7.3.3.4 Summary

As identified in Table 7.3.3-2, there are no situations where there is a high probability of occurrence of a permanent or long-term residual environmental effect on water quality and quantity indicators of high magnitude that cannot be technically or economically mitigated. Consequently, it is concluded that the residual environmental effects of construction and operations of the temporary facilities on water quality and quantity will be not significant.

7.3.4 Air Emissions

Sections 7.2.4.1 and 7.2.4.2 provide the assessment indicator, measurement endpoints and spatial boundaries for the assessment of potential effects of the proposed temporary facilities on air emissions.

7.3.4.1 Project Associated Air Emissions

During the construction of temporary facilities, site preparation, operation of vehicles and equipment, and other construction activities will result in air emissions. It is assumed that no burning of slash will be required for the construction of temporary facilities. During operation of the temporary facilities, air emissions are caused by transportation and activities associated with the residence of workers (*e.g.,* space heating and electricity use in construction camps). All air emissions associated with construction and operation of temporary facilities will be intermittent and limited in duration to the construction phase of the Project.

Information on construction and operations activities for temporary facilities was not separated from construction activities for permanent facilities and pipelines. Therefore, air emissions associated with construction and operations activities for temporary facilities are estimated as part of the total construction-related emissions for the pipeline as provided in Section 7.2.4.3.

7.3.4.2 Potential Effects and Mitigation Measures

Identified Potential Effects

Potential effects on the air emissions indicator that are associated with the construction and operation of temporary construction camps and other temporary facilities are listed in Table 7.3.4-1. These interactions were based on the results of the literature review, desktop analysis and the professional experience of the assessment team.

A summary of the mitigation measures as provided in Table 7.3.4-1 was principally developed in accordance with Trans Mountain standards and accepted construction methods for temporary facility construction-related activities.

TABLE 7.3.4-1

POTENTIAL EFFECTS, MITIGATION MEASURES AND RESIDUAL EFFECTS OF CONSTRUCTION AND OPERATIONS OF TEMPORARY FACILITIES ON AIR EMISSIONS

Potential Effect	Temporary Facility Type	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
1. Air Emissions Indicator – Primary Emissions of Criteria Air Contaminants and Volatile Organic Compounds				
1.1 Project contribution to emissions	All	RSA	• See recommended mitigation measures outlined in Table 7.2.4-3 Air Emissions. • Ensure that borrow site activities adhere to local air bylaws unless otherwise approved by municipal authorities.	• Increase in air emissions during construction of temporary facilities.
1.2 Dust during construction	Temporary access roads Staging and stockpile sites Borrow sites	RSA	• Trans Mountain will consult with and inform landowners with the potential to be affected by dust emissions from construction activities prior to commencement of these activities in proximity to the respective landowners [Section 8.2]. • When warranted, spray water on access roads, material storage piles, and work areas within borrow sites to minimize dust emissions. Install dust skirts on stockpiling and loading equipment to limit dust emissions where the potential for generation of large quantities of fugitive dust exists [Section 11.0]. • During stockpiling and loading at borrow sites, the drop height will be limited to reduce or avoid the potential for dust generation. The contractor will ensure that dump truck loads are covered prior to travelling on public roads and gate seals are kept tight on dump trucks [Section 11.0]. • Reduce the backhoe bucket drop height during stockpiling and loading of soils and aggregate to limit the potential for noise and dust emissions [Section 10.0].	• Increase in fugitive dust during construction of temporary facilities.

Notes: 1 RSA = Air Quality RSA.
2 Detailed mitigation measures are outlined in the Pipeline EPP (Volume 6B).

7.3.4.3 Potential Residual Effects

The potential residual environmental effects on the air emissions indicator associated with the construction and operation of the temporary construction camps and other temporary facilities (Table 7.3.4-1) are:

- an increase in air emissions during construction of temporary facilities; and
- an increase in fugitive dust during construction of temporary facilities.

7.3.4.4 Significance Evaluation of Potential Residual Effects

Where there are no standards, guidelines, objectives or other established and accepted thresholds to define quantitative rating criteria or where quantitative thresholds are not appropriate, the qualitative method is considered to be the appropriate method for determining the significance of the anticipated residual environmental effects. Consequently, a qualitative assessment of air emissions was determined to be the most appropriate method where the evaluation of significance of each of the potential residual effects relies on the professional judgment of the assessment team.

Table 7.3.4-2 provides a summary of the significance evaluation of the potential residual environmental effects on air emissions from the construction and operation of the temporary construction camps and other temporary facilities.

TABLE 7.3.4-2

SIGNIFICANCE EVALUATION OF POTENTIAL RESIDUAL EFFECTS OF CONSTRUCTION AND OPERATIONS OF TEMPORARY FACILITIES ON AIR EMISSIONS

Potential Residual Effects		Impact Balance	Spatial Boundary[1]	Temporal Context: Duration	Temporal Context: Frequency	Temporal Context: Reversibility	Magnitude	Probability	Confidence	Significance[2]
1.	Air Emissions Indicator – Primary Emissions of Criteria Air Contaminants and Volatile Organic Compounds									
1(a)	Increase in air emissions during construction.	Negative	RSA	Short-term	Isolated	Short-term	Medium	High	Moderate	Not significant
1(b)	Increase in fugitive dust during construction.	Negative	RSA	Short-term	Isolated	Short-term	Medium	High	Moderate	Not significant
1(c)	Combined effects on the primary emissions of CACs and VOCs indicator (1[a] and 1[b]).	Negative	RSA	Short-term	Isolated	Short-term	Medium	High	Moderate	Not significant

Notes: 1 RSA = Air Quality RSA.

2 Significant Residual Environmental Effect: A high probability of occurrence of a permanent or long-term residual effect of high magnitude that cannot be technically or economically mitigated.

The significance evaluation of the potential residual effects on the primary emissions of CACs and VOCs indicator (Table 7.3.4-2, points 1[a] to 1[c]) was determined to be the same for the construction and operations of temporary facilities as for pipeline construction and operations. The evaluation of potential residual effects in and their significance on the primary emissions of CACs and VOCs indicator in Table 7.2.4-4, points 1[a], [c], and [d], and the accompanying discussion in Section 7.2.4.6 is also applicable temporary facilities.

7.3.4.5 Summary

As identified in Table 7.3.4-2, there are no situations where there is a high probability of occurrence of a permanent or long-term residual environmental effect on the air emissions indicator of high magnitude that cannot be technically or economically mitigated. Consequently, it is concluded that the residual environmental effects of construction and operation of the temporary facilities on air emissions will be not significant.

7.3.5 Greenhouse Gas Emissions

As discussed in Section 7.2.5.3, during the construction of temporary facilities, site preparation, operation of vehicles and equipment, and other construction activities will result in GHG emissions. During operation of the temporary facilities, GHG emissions are caused by transportation and activities associated with the residence of workers (*e.g.,* space heating and electricity use). All GHG emissions associated with construction and operation of temporary facilities will be intermittent and limited in duration to the construction phase of the Project.

The assessment of effects on GHG emissions has been conducted considering all the Project components in an integrated manner (*e.g.,* pipeline, temporary facilities, pump stations [including power lines], tanks, Westridge Marine Terminal and pipeline reactivation), since GHG emissions associated with the construction and operation of each Project component are aggregated for the Project as a whole and then compared to provincial and federal GHG inventory totals.

The assessment of effects on GHG emissions for the Project as a whole is presented in Section 7.2.5. Table 7.2.5-8 and accompanying discussion in Section 7.2.5.3 provide an evaluation of potential residual effects of temporary facilities on GHG indicators.

7.3.6 Acoustic Environment

Sections 7.2.6.1, 7.2.6.2 and 7.2.6.3 provide the assessment indicators, measurement endpoints, spatial boundaries and acoustic environment context for the assessment of potential effects of the proposed temporary facilities on acoustic environment.

7.3.6.1 Potential Effects and Mitigation Measures

Identified Potential Effects

Potential environmental effects associated with the construction and operations of the temporary construction camps and other temporary facilities, as well as the proposed mitigation measures and resulting potential residual effects, are listed in Table 7.3.6-1. These potential effects were based on the results of the literature review, desktop analysis and the professional experience of the assessment team. Note that no interactions between temporary facilities and the vibration indicator were predicted and, consequently, no potential effects were identified.

A summary of mitigation measures provided in Table 7.3.6-1 was principally developed in accordance with Trans Mountain standards and industry and provincial regulatory guidelines as described in Section 7.2.6.4.

TABLE 7.3.6-1

POTENTIAL EFFECTS, MITIGATION MEASURES AND RESIDUAL EFFECTS OF CONSTRUCTION AND OPERATIONS OF TEMPORARY FACILITIES ON THE ACOUSTIC ENVIRONMENT

Potential Effect	Temporary Facility Type	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
1. Acoustic Environment Indicator – Sound Levels				
1.1 Changes in sound levels during construction and operations of the temporary facilities	All	LSA	• See recommended mitigation measures in Table 7.2.6-2 Acoustic Environment.	• Increase in sound levels associated with temporary facilities during the construction period of the Project.

Notes: 1 LSA = Acoustic Environment LSA.
2 Detailed mitigation measures are outlined in the Pipeline EPP (Volume 6B).

7.3.6.2 Residual Effects

The potential residual environmental effects on the acoustic environment indicator associated with the construction and operations of the temporary construction camps and other temporary facilities (Table 7.3.6-1) include increase in sound levels during the construction period of the Project.

7.3.6.3 Significance of Residual Effects

Table 7.3.6-2 provides a summary of the significance evaluation of the potential residual environmental effects of the construction and operations of temporary construction camps and other temporary facilities on the acoustic environment indicator.

TABLE 7.3.6-2

SIGNIFICANCE EVALUATION OF POTENTIAL RESIDUAL EFFECTS OF CONSTRUCTION AND OPERATIONS OF TEMPORARY FACILITIES ON THE ACOUSTIC ENVIRONMENT

Potential Residual Effects	Impact Balance	Spatial Boundary[1]	Temporal Context			Magnitude	Probability	Confidence	Significance[2]
			Duration	Frequency	Reversibility				
1. Acoustic Environment Indicator – Sound Levels									
1(a) Increase in sound levels associated with temporary facilities during the construction period of the Project.	Negative	LSA	Short-term	Isolated	Short-term	Low to medium	High	Moderate	Not significant

Notes: 1 LSA = Acoustic Environment LSA.

2 Significant Residual Environmental Effect: A high probability of occurrence of a permanent or long-term residual effect of high magnitude that cannot be technically or economically mitigated.

It is anticipated that the increase in sound levels due to the construction and operations of the temporary facilities during the construction period of the Project (Table 7.3.6-2, point 1[a]) will be similar to the sound levels generated by the construction of the proposed pipeline. The sound levels associated with the use of the temporary facilities during pipeline construction is expected to be less than those associated with the construction of the pipeline itself. Details on the residual effects associated with the pipeline construction are described in detail in Section 7.2.6.6.

7.3.6.4 Summary

As identified in Table 7.3.6-2, there are no situations with respect to the construction and operations of the temporary facilities where there is a high probability of occurrence of a permanent or long-term residual environmental effect on acoustic environment indicators of high magnitude. Consequently, is it concluded that the residual environmental effects of construction and operations of the temporary facilities on the acoustic environment will be not significant.

7.3.7 Fish and Fish Habitat

Temporary facilities may interact with fish and fish habitat indicators through the construction of temporary access roads and vehicle crossings, which may lead to increased sedimentation in watercourses. This can cause an alteration to instream habitat and may lead to fish mortality and injury. The construction of temporary access roads may also result in increased access to watercourses, which may affect riparian habitat, instream habitat and may lead to fish mortality and injury as a result of recreational fishing pressures.

The assessment of effects on fish and fish habitat has been conducted considering all the Project components in an integrated manner (*e.g.,* pipeline, temporary facilities, pump stations [including power lines], tanks and pipeline reactivation), since the components will have similar effect pathways (*i.e.,* riparian habitat, instream habitat and fish mortality and injury) on fish indicators and disaggregation of effects by Project component is not meaningful at an individual or population level for fish indicators.

The assessment of effects on fish and fish habitat for the Project as a whole is presented in Section 7.2.7. Table 7.2.7-3 and accompanying discussion in Section 7.2.7.6 provide an evaluation of potential residual effects of temporary facilities on fish indicators.

7.3.8 Wetland Loss or Alteration

Sections 7.2.8.1, 7.2.8.2 and 7.2.8.3 provide the assessment indicators, measurement endpoints, spatial boundaries and ecological context for the assessment of potential effects of the proposed temporary facilities on wetland loss or alteration.

7.3.8.1 Potential Effects and Mitigation Measures

Identified Potential Effects

Although the need for and the respective general location of some of these sites are the responsibility of the pipeline construction contractor, all temporary facility site locations will require the approval of Trans Mountain's Inspector(s). Although unlikely, there is the potential for wetlands to be affected by one or more of these facilities.

Potential effects associated with the construction and operations of the proposed temporary facilities on the wetland indicator are listed in Table 7.3.8-1. These interactions are based on the results of the literature review, available research literature desktop analysis and the professional experience of the assessment team.

A summary of mitigation measures provided in Table 7.2.8-1 was principally developed in accordance with Trans Mountain standards as well as industry and provincial regulatory guidelines learnings from wetland post-construction environmental monitoring for previous projects and peer-reviewed publications on wetland function as described in Section 7.2.8.4.

TABLE 7.3.8-1

POTENTIAL EFFECTS, MITIGATION MEASURES AND RESIDUAL EFFECTS OF CONSTRUCTION AND OPERATIONS OF TEMPORARY FACILITIES ON WETLAND LOSS OR ALTERATION

Potential Effect	Temporary Facility Type	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
1. Wetland Loss or Alteration Indicator – Wetland Function				
1.1 Potential loss or alteration of wetlands of High Functional, High-Moderate, Low-Moderate and Low Functional Condition (*i.e.,* habitat, hydrology, biogeochemistry)	All	LSA	• See recommended mitigation measures outlined in Table 7.2.8-2 Wetland Loss or Alteration.	• Alteration of wetland habitat, hydrological and biogeochemical function from the facilities during construction activities until vegetation is re-established and sedimentation is controlled.
1.2 Potential contamination of wetland function (*i.e.,* habitat, hydrology, biogeochemistry) due to a spill during construction	All	LSA	• See recommended mitigation measures outlined in Table 7.2.8-2 Wetland Loss or Alteration.	• Reduction of wetland habitat, hydrological and biogeochemical function in the event of a spill from stored equipment during construction (depending on the volume and type of substance spilled).

Note: 1 LSA = Wetland LSA.
2 Detailed mitigation measures are outlined in the Pipeline EPP (Volume 6B).

7.3.8.2 Potential Residual Effects

The potential residual environmental effects on the wetland indicator associated with the construction and operations of the temporary facilities (Table 7.3.8-1) are:

- alteration of wetland function (*i.e.,* habitat, hydrological, biogeochemical) from temporary facilities during construction until vegetation is re-established, grade and natural flow patterns are restored and until sedimentation is controlled; and
- reduction of wetland habitat, hydrological and biogeochemical function in the event of a spill from stored equipment during construction (depending on the volume and type of substance spilled).

7.3.8.3 Significance Evaluation of Potential Residual Effects

Table 7.3.8-2 provides a summary of the significance evaluation of the potential residual environmental effects of the construction and operations of temporary facilities on the wetland indicator.

TABLE 7.3.8-2

SIGNIFICANCE EVALUATION OF POTENTIAL RESIDUAL EFFECTS OF CONSTRUCTION AND OPERATIONS OF TEMPORARY FACILITIES ON WETLAND LOSS OR ALTERATION

Potential Residual Effects		Impact Balance	Spatial Boundary[1]	Temporal Context			Magnitude	Probability	Confidence	Significance[2]
				Duration	Frequency	Reversibility				
1.	Wetland Loss or Alteration Indicator – Wetland Function									
1(a)	Alteration of wetland habitat, hydrological and biogeochemical functions during construction activities until vegetation is re-established, grade and natural flow patterns are restored and sedimentation is controlled.	Negative	LSA	Short -term	Isolated	Medium to long-term	Low	High	High	Not significant
1(b)	Reduction of wetland habitat, hydrological and biogeochemical functions in the event of a spill from stored equipment during construction.	Negative	LSA	Immediate	Accidental	Short to long-term	Low to high	Low	High	Not significant

Notes: 1 LSA = Wetland LSA.

2 Significant Residual Environmental Effect: A high probability of occurrence of a permanent or long-term residual effect of high magnitude that cannot be technically or economically mitigated.

The significance evaluation of the potential residual effects on the wetland function indicator was determined to be generally the same for the construction and operations of temporary facilities as for pipeline construction and operations (Table 7.3.8-2, points 1[a] and 1[b]). The exception is the frequency of the event causing alteration of wetland habitat, hydrological and biogeochemical function which for temporary facilities is limited to the construction period of the Project (*i.e.,* isolated). Table 7.2.8-4 and the accompanying discussion in Section 7.2.8.6 provide an evaluation of significance of the potential residual effects of the construction of temporary facilities on wetland loss or alteration.

7.3.8.4 Summary

As identified in Table 7.3.8-2, there are no situations where there is a high probability of occurrence of a permanent or long-term residual environmental effect on the wetland indicator of high magnitude that cannot be technically or economically mitigated. Consequently, is it concluded that the residual environmental effects of construction and operations of the temporary facilities on wetland loss or alteration will be not significant.

7.3.9 Vegetation

Sections 7.2.9.1, 7.2.9.2 and 7.2.9.3 provide the assessment indicators, measurement endpoints, spatial boundaries and ecological context for the assessment of potential effects of the proposed temporary facilities on vegetation.

7.3.9.1 Potential Effects and Mitigation Measures

Identified Potential Effects

Although the need for and the respective general location of some of these sites are the responsibility of the pipeline construction contractor, all temporary facility site locations will require the approval of Trans Mountain's Inspector(s). It is assumed that temporary facilities will be located within previously disturbed areas and, consequently, the probability of temporary facilities affecting rare ecological communities or plant and lichen species of concern are low. However, should it be determined that temporary facilities may affect native vegetation with potential for rare ecological communities or plant and lichen species of concern, the mitigation measures from the Rare Ecological Community and Rare Plant Population Management Plan (Volume 6B) will be implemented as appropriate.

Potential effects associated with the construction and operations of the proposed temporary facilities on vegetation are listed in Table 7.3.9-1. These interactions are based on the results of the literature review, desktop analysis and the professional experience of the assessment team.

A summary of mitigation measures provided in Table 7.3.9-1 was principally developed in accordance with Trans Mountain standards as well as industry and provincial regulatory guidelines as described in Section 7.2.9.4.

TABLE 7.3.9-1

POTENTIAL EFFECTS, MITIGATION MEASURES AND RESIDUAL EFFECTS OF CONSTRUCTION AND OPERATIONS OF TEMPORARY FACILITIES ON VEGETATION

Potential Effect	Temporary Facility Type	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
1. Vegetation Indicator – Vegetation Communities of Concern				
1.1 Alteration of native vegetation	All	Footprint	• See recommended mitigation measures outlined in Table 7.2.9-3 Vegetation.	• Incremental alteration of the composition of native vegetation.
1.2 Alteration of grasslands in the BG BGC Zone	Temporary facilities in Kamloops area	LSA	• See recommended mitigation measures outlined in Table 7.2.9-3 Vegetation.	• Some disturbance or alteration of grassland communities in the BG BGC Zone.
2. Vegetation Indicator – Presence of Infestations of Provincial Weed Species and Other Invasive Non-Native Species Identified as a Concern				
2.1 Weed introduction and spread	All	RSA	• See recommended mitigation measures outlined in Table 7.2.9-3 Vegetation.	• Weed introduction and spread.

Notes: 1 LSA = Vegetation LSA; RSA = Vegetation RSA.
2 Detailed mitigation measures are outlined in the Pipeline EPP (Volume 6B).

7.3.9.2 Potential Residual Effects

The potential residual environmental effects on vegetation indicators associated with the construction and operations of the temporary facilities (Table 7.3.9-1) are:

- incremental alteration of the composition of native vegetation;
- some disturbance or alteration of grassland communities in the BG BGC Zone; and
- weed introduction and spread.

7.3.9.3 Significance Evaluation of Potential Residual Effects

Table 7.3.9-2 provides a summary of the significance evaluation of the potential residual environmental effects of the construction and operations of temporary facilities on vegetation indicators.

TABLE 7.3.9-2

SIGNIFICANCE EVALUATION OF POTENTIAL RESIDUAL EFFECTS OF CONSTRUCTION AND OPERATIONS OF TEMPORARY FACILITIES ON VEGETATION

Potential Residual Effects	Impact Balance	Spatial Boundary[1]	Temporal Context			Magnitude	Probability	Confidence	Significance[2]
			Duration	Frequency	Reversibility				
1. Vegetation Indicator – Vegetation Communities of Concern									
1(a) Incremental alteration of the composition of native vegetation.	Negative	Footprint	Short-term	Isolated	Medium to long-term	Low to medium	High	Moderate	Not significant

TABLE 7.3.9-2 Cont'd

Potential Residual Effects	Impact Balance	Spatial Boundary[1]	Temporal Context: Duration	Temporal Context: Frequency	Temporal Context: Reversibility	Magnitude	Probability	Confidence	Significance[2]
1(b) Some disturbance or alteration of grassland communities in the BG BGC Zone.	Negative	Footprint	Short-term	Isolated	Medium to long-term	Low to medium	Low	Moderate	Not significant
2. Vegetation Indicator – Presence of Infestations of Provincial Weed Species and Other Invasive Non-native Species Identified as a Concern									
2(a) Weed introduction and spread.	Negative	RSA	Short-term	Isolated	Short to medium-term	Low to medium	High	High	Not significant

Notes: 1 LSA = Vegetation LSA; RSA = Vegetation RSA.

2 Significant Residual Environmental Effect: A high probability of occurrence of a permanent or long-term residual effect of high magnitude that cannot be technically or economically mitigated.

The significance evaluation of the potential residual effects on the vegetation communities of concern indicator and the presence of infestations of Provincial weed species and other invasive non-native species identified as a concern indicator (Table 7.3.9-2, points 1[a], 1[b] and 2[a]) was determined to be generally the same for the construction and operations of temporary facilities as for pipeline construction and operations. There are two exceptions: the frequency of the event causing the residual effects for the vegetation communities of concern indicator which for temporary facilities, is confined to the construction period of the Project (*i.e.,* isolated); and the probability of some disturbance or alteration of grassland communities in the BG BGC Zone is low due to the expected placement of the temporary facilities. Table 7.2.9-3 and the accompanying discussion in Section 7.2.9.6 provide an evaluation of potential residual effects of temporary facilities and their significance on the applicable vegetation indicator.

7.3.9.4 Summary

As identified in Table 7.3.9-2, there are no situations where there is a high probability of occurrence of a permanent or long-term residual environmental effect on the vegetation indicators of high magnitude that cannot be technically or economically mitigated. Consequently, is it concluded that the residual environmental effects of the construction and operations of the temporary facilities on vegetation will be not significant.

7.3.10 Wildlife and Wildlife Habitat

The assessment of effects on wildlife and wildlife habitat has been conducted considering all the Project components in an integrated manner (*e.g.,* pipeline, temporary facilities, pump stations [including power lines], tanks, other ancillary facilities, and the Westridge Marine Terminal), since the components will have similar effect pathways (*i.e.,* change in habitat movement and mortality risk) on wildlife indicators and disaggregation of effects by Project component is not meaningful at an individual or population level for wildlife indicators.

The assessment of effects on wildlife and wildlife habitat for the Project as a whole is presented in Section 7.2.10. Table 7.2.10-6 and accompanying discussion in Section 7.2.10.9 provide the evaluation of potential residual effects of temporary facilities on mammal indicators, Table 7.2.10-9 and accompanying discussion in Section 7.2.10.10 provide the evaluation of potential residual effects of temporary facilities on bird indicators, Table 7.2.10-12 and accompanying discussion in Section 7.2.10.11 provide the evaluation of potential residual effects of temporary facilities on amphibian indicators, and Table 7.2.10-15 and accompanying discussion in Section 7.2.10.12 provide the evaluation of potential residual effects of temporary facilities on the reptile indicator.

7.3.11 Species at Risk

The assessment indicators for fish, vegetation and wildlife and wildlife habitat include species at risk that may be affected by Project activities. Sections 7.3.7, 7.3.9 and 7.3.10 provide the effects assessment of construction and operations of temporary facilities on species at risk for fish, vegetation and wildlife, respectively.

7.4 Effects Assessment – Pump Stations

To accommodate the expansion, the Project will include construction and operations of new pump stations serving the new pipeline at 10 of the existing pump station sites at Edmonton, Gainford, Wolf, Edson and Hinton in Alberta, and at Rearguard, Blue River, Blackpool, Kamloops and Kingsvale in BC. Two new pump stations will also be constructed and operated at a new greenfield site at Black Pines, BC. In addition, the Project also involves expansion, replacement, reactivation and deactivation of pump stations and pump buildings as well as other associated components such as access roads and power lines. Table 7.4-1 describes the activities to be conducted at each pump station facility and whether new lands outside of the existing facility are required.

TABLE 7.4-1

PROJECT ACTIVITIES TO BE CONDUCTED AT PUMP STATION FACILITIES

Pump Station Facility	New Pump Units	Deactivation/ Reactivation	Disturbance of Previously Undisturbed Areas within Existing Fenceline	New Lands Outside of Existing Fenceline	Other Activities
Edmonton, AB	4 x 5,000 HP 1 spare 5,000 HP	No	No	No	• New scraper facilities (sending) on TMEP • New substation • New power line (to be determined by provincial regulatory authority) • Fencing
Gainford, AB	3 x 5,000 HP	No	Yes (forested lands outside existing fenceline but within existing property boundary)	No	• Upgrades to existing substation • Fencing
Niton, AB	No	Reactivation of 2 x 5,000 HP pump units	No	No	• None
Wolf, AB	2 X 5,000 HP	Deactivation	No	No	• Existing pump building will be deactivated • Fencing
Edson, AB	3 x 5,000 HP	No	No	No	• New scraper facilities (sending and receiving) on TMEP • Replace existing substation • New power line (to be determined by provincial regulatory authority) • Fencing and on-site gravel road
Hinton, AB	3 x 5,000 HP	No	No	Yes (0.3 ha of forested lands)	• New scraper facilities (sending) on TMPL • Fencing
Jasper, AB	No	No	No	No	• Relocate two existing 2,500 HP pumps from the TMX Anchor Loop pipeline to TMPL (currently deactivated) • Drag resistant agent injection facility requiring a small storage tank (with secondary containment) and high pressure injection pump
Rearguard, BC	2 x 5,000 HP	No	No	Yes (0.7 ha of disturbed lands)	• Remove scraper facilities (sending and receiving) from Hargreaves • New scraper facilities (sending and receiving) on TMPL and TMEP • Fencing and on-site gravel road
Blue River, BC	3 x 5,000 HP	Deactivation	No	No	• Existing pump building will be deactivated
Blackpool, BC	3 x 5,000 HP	No	No	No	• Upgrade existing transformer • Fencing and on-site gravel road
Darfield, BC	No	No	No	Yes (0.07 ha of agricultural land)	• New scraper facilities (receiving) on TMEP • Fencing

TABLE 7.4-1 Cont'd

Pump Station Facility	New Pump Units	Deactivation/ Reactivation	Disturbance of Previously Undisturbed Areas within Existing Fenceline	New Lands Outside of Existing Fenceline	Other Activities
Black Pines, BC	2 x 2,500 HP 2 x 5,000 HP	No	No	Yes – new facility site on forested lands (2.3 ha)	• New substation to serve both lines • New scraper facilities (sending and receiving) on TMPL and TMEP • New access road approximately 5 m x 25 m • New 138 kV power line approximately 50 m x 2.2 km • Fencing and on-site gravel road
Kamloops, BC	3 x 5,000 HP 1 spare 5,000 HP	No	No	No	• New substation to serve TMEP • New scraper facilities (sending and receiving) on TMEP
Kingsvale, BC	2 x 5,000 HP	No	Yes (forested)	No	• Replace existing substation • New 138 kV power line approximately 50 m x 23.5 km • Fencing
Sumas, BC	1 x 2,500 HP serving the Puget Sound line	No	No	No	• Upgrade existing substation
Total Number of New Pump Units: 35					

A detailed description of the Project activities at pump station facilities is provided in Section 2.0 of this volume and in Volume 2.

Using the assessment methodology described in Section 7.1, the following subsections evaluate the potential environmental effects arising from the Project activities at pump stations (including construction and operations of new pump units and a new pump station facility, associated power lines, and reactivation of existing pump stations).

Environmental elements potentially interacting with the Project activities at pump station facilities are identified in Table 7.4-2. The table also describes the rationale for those environmental elements which are not considered to interact with the Project activities at pump station facilities. Spatial boundaries for the assessment of pump station facilities are the same as in the applicable subsection of Section 7.2 unless otherwise noted.

TABLE 7.4-2

ELEMENT INTERACTION WITH PROJECT ACTIVITIES AT PUMP STATION FACILITIES

Element	Interaction with Pump Station Component		
	Construction	Operations[1]	Reactivation
Physical and Meteorological Environment	Yes	Yes	No – physical environment will not be disturbed as a result of reactivation activities
Soil and Soil Productivity	Yes	Yes	No – soil will not be disturbed as a result of reactivation activities
Water Quality and Quantity	Yes	Yes	No – reactivation activities are not expected to affect water quality or quantity
Air Emissions	Yes	Yes	Yes
GHG Emissions	Yes	Yes	Yes
Acoustic Environment	Yes	Yes	Yes
Fish and Fish Habitat	Yes	Yes	No – reactivation activities are not expected to affect fish or fish habitat
Wetland Loss or Alteration	Yes	No – pump station operations is not expected to impact wetlands	No – reactivation activities are not expected to affect wetlands
Vegetation	Yes	Yes	No – reactivation activities are not expected to affect vegetation
Wildlife and Wildlife Habitat	Yes	Yes	No – reactivation activities are not expected to affect wildlife and wildlife habitat
Species at Risk	Yes	Yes	No – reactivation activities are not expected to affect species at risk

Note: 1 Activities during operations include maintenance activities and vegetation management (*e.g.,* weed control).

7.4.1 Physical and Meteorological Environment

Sections 7.2.1.1 and 7.2.1.2 provide the assessment indicators, measurement endpoints and spatial boundaries for the assessment of potential effects of Project activities at pump station facilities on the physical environment.

7.4.1.1 Physical Environment Context

Considerable grading may be required at Black Pines, Kingsvale and Kamloops pump stations and along the proposed operations access road to Black Pines Pump Station. No considerable grading is anticipated for construction of the proposed 2.2 km power line extending to Black Pines Pump Station and the proposed 23.5 km power line extending to Kingsvale Pump Station.

7.4.1.2 Potential Effects and Mitigation Measures

<u>Identified Potential Effects</u>

Potential effects associated with the construction and operations of pump stations, power lines and the operations access road were based on the results of the literature review, desktop analysis, engagement with Aboriginal communities, landowners, regulatory authorities, stakeholders and the general public (Section 3.0), and the professional experience of the assessment team. Potential effects associated with physical environment indicators that are not anticipated to result from Project activities at pump stations are: terrain instability at watercourses; alteration of topography from blasting; and acid generation or metal leaching. Furthermore, through proper pole placement and installation, no terrain instability or alteration in topography is anticipated along the power lines.

A summary of mitigation measures provided in Table 7.4.1-1 was principally developed in accordance with Trans Mountain standards and industry and provincial regulatory guidelines as described in Section 7.2.1.4.

TABLE 7.4.1-1

POTENTIAL EFFECTS, MITIGATION MEASURES AND RESIDUAL EFFECTS OF PROJECT ACTIVITIES AT PUMP STATION FACILITIES ON PHYSICAL ENVIRONMENT

Potential Effect	Pump Station Facility	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
1. Physical Environment Indicator – Terrain Instability				
1.1 Terrain instability	Black Pines Pump station Access road Kamloops Kingsvale Pump station	LSA	Pump Stations • Retain vegetation mat outside of the development zone if a competent vegetation mat layer exists, if feasible. In these areas, grade only within the development zone in order to reduce disturbance to the vegetation mat. Grading of the vegetation mat layer will not be permitted on level terrain in these areas [Section 8.2]. • Grade the surface to facilitate water drainage into water conveyance features (*e.g.,* ditches and culverts) [Section 8.2]. • Assess the erosion hazard prior to the commencement of rough and final clean-up. This assessment, to be conducted by the Inspector, in consultation with the Construction Manager, will consider topography, degree of disturbance, soil erodibility, snow depth, access limitations, timing constraints, and the likely schedule for rough clean-up, final clean-up and seeding. Request assistance in conducting the assessment, if warranted, from the Environmental Manager, or the Geotechnical, Soil or Reclamation Resource Specialist [Section 8.4]. Operations Access Roads • Develop/upgrade each access road only to the extent necessary to accommodate the intended construction traffic during the period of planned use [Section 9.0]. • Provide adequate spillways for culverts in unstable areas or where road-fill materials are unprotected [Section 9.0]. • Maintain all side cuts in roads in a stabilized and revegetated condition, to the extent feasible. Apply geotechnical or bioengineering techniques, where warranted, to control chronic slumping problems [Section 9.0].	• No residual effect identified.
2. Physical Environment Indicator – Topography				
2.1 Alteration of topography	Black Pines Pump station Access road Kamloops Kingsvale Pump station	LSA	Pump Stations • Ensure that there is no grading beyond the stakes unless additional workspace rights have been obtained. Grade only those areas essential for construction [Section 8.2]. • Ensure graded material does not spread off-site [Section 8.2]. • Recontour areas disturbed during facility construction outside of the development zone to pre-construction contours (where feasible) and drainage channels if frozen soil conditions prevented completion of this task during facility construction [Section 8.4]. • Regrade areas with vehicle ruts and erosion features [Section 8.4]. • Dispose of excess rock displaced from excavation at an approved location as determined by the Inspector or the appropriate regulatory authority [Section 8.4]. Operations Access Roads • See recommended mitigation measures outlined in potential effect 1.1 of this table.	• Alteration of topography at pump stations and the operations access road where grading is required.

Notes: 1 LSA = Physical Environment LSA.
2 Detailed mitigation measures are outlined in the Facilities EPP (Volume 6C).

7.4.1.3 Potential Residual Effects

The potential residual environmental effect on physical environment indicators associated with Project activities at pump station facilities is alteration of topography at pump stations and the operations access road where grading is required (Table 7.4.1-1).

Potential terrain instability resulting from construction and operations of pump stations and the operations access road is concluded not to have a residual effect because instability potential is predicted to be eliminated through the implementation of mitigation measures (Table 7.4.1-1).

7.4.1.4 Significance Evaluation of Potential Residual Effects

Table 7.4.1-2 provides a summary of the significance evaluation of the potential residual environmental effects on physical environment indicators resulting from Project activities at pump station facilities. The rationale used to evaluate the significance of each of the residual environmental effects is provided below.

TABLE 7.4.1-2

SIGNIFICANCE EVALUATION OF POTENTIAL RESIDUAL EFFECTS OF PROJECT ACTIVITIES AT PUMP STATION FACILITIES ON PHYSICAL ENVIRONMENT

Potential Residual Effects		Impact Balance	Spatial Boundary[1]	Temporal Context			Magnitude	Probability	Confidence	Significance[2]
				Duration	Frequency	Reversibility				
1.	Physical Environment Indicator – Topography									
1(a)	Alteration of topography at pump stations and the operations access road where grading is required.	Negative	Footprint	Short-term	Isolated	Permanent	Low	High	High	Not significant

Notes: 1 LSA = Physical Environment LSA.

2 Significant Residual Environmental Effect: A high probability of occurrence of a permanent or long-term residual effect of high magnitude that cannot be technically or economically mitigated.

Alteration of Topography Where Grading is Required

As a result of construction, topography may be altered at locations where considerable grading is required to obtain a level profile at pump stations. Grading will vary from only topsoil salvaging in some areas to extensive cuts and fills in other areas. Any bedrock encountered will be ripped mechanically using bulldozers and excavators. Following construction, areas disturbed during facility construction outside of the fenced area of the site will be recontoured to pre-construction contours where feasible.

The impact balance of this residual effect is considered negative since local topographic alteration is considered a detriment to the environment. Although this unavoidable consequence is considered to be permanent and of high probability, magnitude is considered to be low (Table 7.4.1-2, point 1[a]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Footprint – alterations in topography will be limited to the construction workspace.
- Duration: short-term – the event causing the alterations in topography is construction of the pump stations and access road.
- Frequency: isolated – the event causing the alteration in topography is construction of the pump stations and access road.
- Reversibility: permanent – alterations in topography resulting from levelling of terrain at pump stations will not be reversed (*i.e.,* pre-construction contours will not fully be restored during decommissioning and abandonment).
- Magnitude: low – the extent of alteration of topography at pump stations is considered low due to the limited extent of grading required and because the most extensive grading will take place at existing pump station sites designated for industrial use.
- Probability: high – based on data pertinent to the Project area and the professional experience of the assessment team.

- Confidence: high – based on data pertinent to the Project area and the professional experience of the assessment team.

7.4.1.5 Summary

As identified in Table 7.4.1-2, there are no situations where there is a high probability of occurrence of a permanent or long-term residual environmental effect on physical environment indicators of high magnitude that cannot be technically or economically mitigated. Consequently, it is concluded that the residual environmental effects associated with Project activities at pump station facilities on the physical environment will be not significant.

7.4.2 Soil and Soil Productivity

Sections 7.2.2.1 and 7.2.2.2 provide the assessment indicators, measurement endpoints and spatial boundaries for the assessment of potential effects of Project activities at pump station facilities on soil and soil productivity.

7.4.2.1 Soil Context

Disturbance to soils is expected at the Gainford Pump Station, Hinton Pump Station, Rearguard Pump Station, Darfield Pump Station and Kingsvale Pump Station and associated power line, as well as at the proposed Black Pines Pump Station and associated power line. Section 7.2.2.3 provides additional context on soils.

7.4.2.2 Potential Effects and Mitigation Measures

<u>Identified Potential Effects</u>

Potential effects associated with the Project activities at pump station facilities on soil and soil productivity indicators are listed in Table 7.4.2-1. These interactions were based on the results of the literature review, desktop analysis, field work, engagement with landowners, regulatory authorities, stakeholders and the general public (Section 3.0), and the professional experience of the assessment team.

A summary of mitigation measures provided in Table 7.4.2-1 was principally developed in accordance with Trans Mountain standards as well as industry and provincial regulatory guidelines as described in Section 7.2.2.4.

TABLE 7.4.2-1

POTENTIAL EFFECTS, MITIGATION MEASURES AND RESIDUAL EFFECTS OF PROJECT ACTIVITIES AT PUMP STATION FACILITIES ON SOIL AND SOIL PRODUCTIVITY

Potential Effect	Pump Station Facility	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
1. Soil Indicator – Soil Productivity				
1.1 Decreased topsoil/root zone material productivity during topsoil/root zone material salvaging	Gainford Hinton Rearguard Darfield Black Pines Pump station Access road Power line Kingsvale Power line	Footprint	<u>Facilities</u> • Salvage topsoil/root zone material from the development zone and areas to be graded within the facility footprint that will be disturbed during construction (see Drawing [Pump Station Construction – Topsoil/Root Zone Material Salvage] provided in Appendix R) [Section 8.2]. • Salvage all available topsoil/root zone material (minimum 15 cm or 50% organic material) using the Environmental Facility Drawings as a guide, unless the material is unsuitable (*e.g.,* bedrock, gravel, rock) [Section 8.2]. See additional measures under Section 8.2 of the Facilities EPP. • Salvage very deep surface soils to a maximum depth of 70 cm, if encountered [Section 8.2]. • Salvage very shallow surface soils to a minimum depth of 15 cm. If minimum depth of surface soils cannot be salvaged because the underlying material is unsuitable (*e.g.,* bedrock, gravel, rock), salvage all available topsoil [Section 8.2].	• Mixing of topsoil/root zone material and subsoil.

TABLE 7.4.2-1 Cont'd

Potential Effect	Pump Station Facility	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
1.1 Decreased topsoil/root zone material productivity during topsoil/root zone material salvaging (cont'd)	See above	Footprint	• Salvage topsoil/root zone material using specialized equipment capable of accurately separating variable depths of topsoil from subsoil (*e.g.,* frozen topsoil cutter, topsoil mulcher or equivalent, if available) [Section 8.2]. See additional measures in Section 8.2 of the Facilities EPP. • Overstrip shallow topsoils to the depth as indicated on the Environmental Facility Drawings [Section 8.2]. • Keep grade subsoil windrow separate from topsoil/root zone material windrow/berm. Maintain a minimum separation distance of 1 m between topsoil/root zone and grade subsoil windrows (see Drawing [Pump Station Construction – Topsoil/Root Zone Material Salvage] provided in Appendix R) [Section 8.2]. • Locate topsoil/root zone material windrows/berms along the boundaries of the facility footprint outside of the development zone area so they do not alter natural drainage patterns during periods of short and long-term storage and, if feasible, locate them on the upslope side of the site to avoid contamination from accidental spills [Section 8.2]. <u>Access Roads</u> • Do not salvage topsoil/root zone material from areas of the access road where construction activities will not result in extensive mixing of surface and subsoils or excessive damage to the upper soils, as determined by the Inspector [Section 9.0]. • Salvage all topsoil or the upper 15 cm of root zone material, where present, for use during clean-up and closure of new and upgraded access roads as directed by the Inspector [Section 9.0]. • Salvage topsoil/root zone material at new permanent and temporary access roads where grading, bar ditches, fill or other materials are necessary [Section 9.0]. <u>Power Lines</u> • Do not salvage topsoil/root zone material from areas of the power line right-of-way where construction activities will not result in extensive mixing of surface and subsoils or excessive damage to the upper soils, as determined by the Lead Activity Inspector and the Inspector [Section 11.1]. • Salvage all topsoil or the upper 15-20 cm of root zone material, where present and as required, for use during clean-up as directed by the Lead Activity Inspector and the Inspector [Section 11.1]. • Ensure enough workspace is available (approximately 0.5 m) to allow for the storage of augured subsoil material onto subsoil to reduce the risk of subsoil material sloughing into the hole on cultivated and poorly-sodded tame pasture and hay lands during nonfrozen soil conditions [Section 11.2]. • Ensure enough workspace is available (approximately 0.5 m) to allow for the storage of augured subsoil material onto unsalvaged topsoil/root zone material to reduce the risk of subsoil material sloughing into the hole on well-sodded tame pasture and hay lands, native grasslands and forested areas during nonfrozen soil conditions [Section 11.2].	• See above.

TABLE 7.4.2-1 Cont'd

Potential Effect	Pump Station Facility	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
1.1 Decreased topsoil/root zone material productivity during topsoil/root zone material salvaging (cont'd)	See above	Footprint	• During frozen soil conditions, ensure enough workspace is available (approximately 0.5 m) to allow for the storage of augured subsoil on a 10 cm buffer of snow, if available, or onto unsalvaged topsoil/root zone material to reduce the risk of subsoil material sloughing into the hole [Section 11.2]. • Feather-out excess subsoil material across the area where topsoil/root zone material has been salvaged [Section 11.2]. • Salvage topsoil/root zone material from areas where anchor pits will be excavated and store the topsoil/root zone material separately from material removed to excavate the pit, if applicable [Section 11.3]. • Place soil material removed to accommodate plate anchors utilized to secure the conductor during stringing activities adjacent to the site for use during backfilling [Section 11.3].	• See above.
1.2 Decreased soil productivity from flooding of soil as a result of release of hydrostatic test water on land	All	LSA	• See recommended mitigation measures from Table 7.2.2-2 which are also provided in Section 8.3 of the Facilities EPP.	• No residual effect identified.
1.3 Decreased soil productivity from soil diseases (*i.e.*, clubroot disease and potato cyst nematode)	Gainford Hinton Rearguard Darfield Black Pines Pump station Access road Power line Kingsvale Power line	LSA	• Ensure all construction equipment and vehicles, as well as personnel footwear, arrive on the construction site in a clean condition to reduce the risk of introducing or spreading clubroot disease or other crop disease(s) prior to topsoil/root zone material salvage activities. Refer to the Agriculture Management Plan (see Appendix C) for specific measures [Section 7.0]. • Apply tackifier (see Soil Erosion and Sediment Control Contingency Plan in Appendix B) to topsoil windrows in areas of known disease concern when there is potential for topsoil transfer during windy conditions, or if topsoil windrows are to be maintained over the winter, to prevent the possible spread of clubroot or other disease [Section 8.2].	• Clubroot disease introduction and spread. Potato cyst nematode introduction and spread.
2. Soil Indicator – Soil Degradation				
2.1 Degradation of soil structure due to compaction and rutting	Gainford Hinton Rearguard Darfield Black Pines Pump station Access road Power line Kingsvale Power line	Footprint	• Adhere to the measures outlined in the Wet/Thawed Soils Contingency Plan (Appendix B) during wet/thawed soil conditions [Section 7.0]. • Postpone construction, suspend equipment travel or utilize construction alternatives in the event of wet or thawed soils in order to reduce terrain disturbance and soil structure damage [Section 7.0]. • Ensure that there is sufficient frost or low enough soil moisture to allow construction without causing excessive rutting or soil compaction outside of the development zone [Section 8.2]. • Rip compacted subsoils with a multi-shank ripper or breaking disc to a depth of 30 cm or the depth of compaction, whichever is deeper. If soils are moist, postpone ripping of subsoils until soils dry to ensure that the soils fracture when ripped [Section 8.4]. • Cultivate or rip cultivated fields and hay, tame pasture, bush or woodlands on areas utilized during construction found outside of the fenced development zone, where poor sod development exists to a depth adequate to alleviate surface compaction and in a manner acceptable to the landowner. Do not cultivate into the subsoil [Section 8.4].	• Degradation of soil structure and impairment of rooting zone due to compaction and rutting.

TABLE 7.4.2-1 Cont'd

Potential Effect	Pump Station Facility	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
2.2 Loss of topsoil/root zone material through wind and water erosion	Gainford Hinton Rearguard Darfield Black Pines Pump station Access road Power line Kingsvale Power line	Footprint	Facilities • Ensure the potential for soil erosion by water is reduced during construction activities by avoiding ponding of water or the unintentional channelization of surface water flow [Section 7.0]. • Provide surface drainage of adequate capacity across the facility site and other Project-related facilities [Section 7.0]. • Inspect all water conveyance installations (*e.g.,* ditches and culverts) and ensure they are functioning appropriately. Take appropriate action prior to and during the spring freshet to clear culverts blocked by ice or debris [Section 7.0]. • Install erosion and sediment control structures and materials (*e.g.,* subsoil berm or sediment fencing) and implement, as warranted, erosion control measures outlined in the Soil Erosion and Sediment Control Contingency Plan (see Appendix B) to ensure that sediments in surface water draining from the facility site do not adversely affect the surrounding terrain or watercourses/wetlands/lakes. In particular, control erosion on grade cuts adjacent to the development zone at facility sites [Section 7.0]. • Revegetate the topsoil/root zone material windrows and areas of vegetation disturbed during construction to stabilize topsoil/root zone material and reduce weed growth [Section 8.2]. • Monitor topsoil/root zone material windrows during the growing season for wind and water erosion, and weed growth until the soils are replaced or stored in berms. Implement remedial measures to control erosion and weed growth, when warranted (see Soil Erosion and Sediment Control Contingency Plan in Appendix B and the Weed and Vegetation Management Plan in Appendix C) [Section 8.2]. • Revegetate as soon as practical following final clean-up to establish a long-term cover and reduce or avoid soil erosion. Seed immediately following topsoil/root zone material replacement [Section 8.4.3]. • Establish long-term topsoil/root zone material storage berms at locations away from regular facility operational activity and areas with potential for overland water flow and storage berm erosion [Section 8.4.3]. • Further mitigation measures for erosion control can be found in Sections 7.0, 8.2 and 8.4 of the Facilities EPP. Access Roads • Store all salvaged topsoil and root zone material from the new permanent or temporary access road bed area in windrows along one or both edges of the access road in a manner that does not alter natural drainage patterns [Section 9.0]. • Implement appropriate erosion and sediment control measures on topsoil/root zone material windrows (see Weed and Vegetation Management Plan in Appendix C) [Section 9.0]. • Seed the topsoil/root zone material immediately with a cereal grass cover crop species (see Section 8.0), unless otherwise directed by the Lead Activity Inspector and the Inspector, to reduce the risk of erosion [Section 9.0]. • Ensure adequate drainage by maintaining the proper grade and installing culverts to allow for cross drainage. Outslope the crown of the road so that it is a minimum of 15 cm higher than the shoulders to allow the road surface to drain and dry [Section 9.0].	• Surface erosion of topsoil/root zone material can be expected until a vegetative cover is established.

TABLE 7.4.2-1 Cont'd

Potential Effect	Pump Station Facility	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
2.2 Loss of topsoil/root zone material through wind and water erosion (cont'd)	See above	Footprint	• Top the road with clean gravel, where warranted. Consider using underlay felt liners, geotextiles, filter mats or matting if the soil conditions and drainage are poor and there is potential for rutting and erosion [Section 9.0] • Install/implement drainage and erosion control measures (*e.g.,* check dams, sediment traps, culverts), as warranted, during the development of new access roads and upgrading of existing roads/trails [Section 9.0]. • Seed disturbed side slopes and bar ditches (if present) on new and upgraded roads with an approved seed mix as provided in the Reclamation Management Plan (see Appendix C) [Section 9.0]. Power Lines • Store all salvaged topsoil/root zone material in windrows along one or both edges of the power line right-of-way in a manner that does not alter natural drainage patterns [Section 11.1]. • Seed the topsoil/root zone material immediately with a cereal grass cover crop species (see Section 8.0), unless otherwise directed by the Lead Activity Inspector and the Inspector, to reduce the risk of erosion or creation of weed habitat [Section 11.1].	• See above.
2.3 Degradation of soil structure due to pulverization of soil and sod	Gainford Hinton Rearguard Darfield Black Pines Pump station Access road Power line Kingsvale Power line	Footprint	• Assess the wind erosion hazard, competency of the sod, and potential for soil pulverization due to droughty soils. Notify the contractor if measures applicable to droughty, wind erodible soils, or where the biological soil crust has been disturbed, will be required to avoid or reduce the effect of soil pulverization and wind erosion [Section 8.2]. • Trans Mountain will consult with and inform landowners with the potential to be affected by dust emissions from construction activities prior to commencement of these activities in proximity to the respective landowners [Section 8.2]. • Salvage topsoil/root zone material in areas of equipment and vehicle travel where it is determined that soils may be prone to pulverization [Section 8.2]. • Limit cultivation in areas of fine textured soils to prevent pulverization of the soil [Section 8.4.3].	• Pulverization resulting in fugitive dust and loss of soil structure can be expected during dry conditions.
2.4 Erosion of soil as a result of release of hydrostatic test water on land	All	LSA	• Monitor discharge locations to ensure that no erosion, flooding or icing occurs. If conditions become saturated to the extent that adequate natural filtration is no longer occurring, suspend dewatering and move the discharge to another approved location (confirm that appropriate approvals and, if warranted, soil testing have been completed) or construct a holding pond for the water and release the water when natural filtration is again feasible [Section 8.3]. • See recommended mitigation measures from Table 7.2.2-2 which are also provided in Section 8.3 of the Facilities EPP.	• No residual effect identified.
3. Soil Indicator – Soil Contamination				
3.1 Disturbance of previously contaminated soil	All	Footprint	• Implement the Contamination Discovery Contingency Plan (Appendix B) and applicable measures for the Waste Management Standard (see Appendix C) in the event contaminated soils are encountered during construction.	• No residual effect identified.
3.2 Contamination of soil as a result of hydrostatic test water on land	All	LSA	• See recommended mitigation measures from Table 7.2.2-2 which are also provided in Section 8.3 of the Facilities EPP.	• No residual effect identified.

TABLE 7.4.2-1 Cont'd

Potential Effect	Pump Station Facility	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
3.3 Soil contamination due to spot spills during construction	All	Footprint	• Maintain all appropriate spill response equipment/supplies at all work sites. Assess the risk of resource-specific spills to determine the appropriate type and quantity of spill response equipment and materials to be stored on-site and a suitable location for storage [Section 7.0]. • Ensure that during construction no fuel, lubricating fluids, hydraulic fluids, methanol, antifreeze, herbicides, biocides, or other chemicals are released on the ground or into any watercourse/wetland/lake. In the event of a spill, implement the Spill Contingency Plan (see Appendix B) [Section 7.0]. • See additional spill prevention and clean up measures in Section 7.0 of the Facilities EPP.	• No residual effect identified.

Notes: 1 LSA = Soil LSA.
2 Detailed mitigation measures are outlined in the Facilities EPP (Volume 6C).

7.4.2.3 Potential Residual Effects

The potential residual environmental effects on soil and soil productivity indicators associated with Project activities at pump station facilities (Table 7.4.2-1) are:

- mixing of topsoil/root zone material and subsoil;
- clubroot disease and potato cyst nematode introduction and spread;
- degradation of soil structure and impairment of rooting zone due to compaction and rutting;
- surface erosion of topsoil/root zone material can be expected until a vegetative cover is established; and
- pulverization resulting in fugitive dust and loss of soil structure can be expected during dry conditions.

Some of the potential effects on element indicators associated with Project activities at pump station facilities are predicted to be eliminated through the implementation of mitigation measures (Table 7.4.2-1). The potential effects determined not to have a residual effect are:

- decreased soil productivity from flooding of soil as a result of release of hydrostatic test water on land;
- erosion of soil as a result of release of hydrostatic test water on land;
- disturbance of previously contaminated soil;
- contamination of soil as a result of hydrostatic test water on land; and
- soil contamination due to spot spills during construction.

7.4.2.4 Significance Evaluation of Potential Residual Effects

Table 7.4.2-2 provides a summary of the significance evaluation of the potential residual environmental effects on soil and soil productivity indicators resulting from Project activities at pump station facilities.

TABLE 7.4.2-2

SIGNIFICANCE EVALUATION OF POTENTIAL RESIDUAL EFFECTS OF PROJECT ACTIVITIES AT PUMP STATION FACILITIES ON SOIL AND SOIL PRODUCTIVITY

Potential Residual Effects		Impact Balance	Spatial Boundary[1]	Temporal Context			Magnitude	Probability	Confidence	Significance[2]
				Duration	Frequency	Reversibility				
1.	Soil Indicator – Soil Productivity									
1(a)	Mixing of topsoil/root zone material and subsoil.	Negative	Footprint	Short-term	Isolated	Medium to long-term	Low	High	High	Not significant
1(b)	Clubroot disease and potato cyst nematode introduction and spread.	Negative	LSA	Short-term	Accidental	Long-term	High	Low	Moderate	Not significant
2.	Soil Indicator – Soil Degradation									
2(a)	Degradation of soil structure and impairment of rooting zone due to compaction and rutting.	Negative	Footprint	Short-term	Isolated	Short to medium-term	Low	High	High	Not significant
2(b)	Surface erosion of topsoil/root zone material can be expected until a vegetative cover is established.	Negative	Footprint	Short-term	Isolated	Medium-term	Low	High	High	Not significant
2(c)	Pulverization resulting in fugitive dust and loss of soil structure can be expected during dry conditions.	Negative	Footprint	Short-term	Isolated	Short to medium-term	Low	Low to high	High	Not significant
2(d)	Combined effects on the soil degradation indicator (2[a] to 2[c]).	Negative	Footprint	Short-term	Isolated	Short to medium-term	Low	High	High	Not significant

Notes: 1 LSA = Soil LSA.

2 Significant Residual Environmental Effect: A high probability of occurrence of a permanent or long-term residual effect of high magnitude that cannot be technically or economically mitigated.

The significance evaluation of the potential residual effects on the soil productivity indicator and soil degradation indicator was determined to be generally the same for the construction and operations of pump station facilities as for pipeline construction and operations (Table 7.4.2-2, points 1[a] and 1[b], 2[a] to 2[d]). The exception is the reversibility of mixing of topsoil/root zone material and subsoil (point 1[a]), which is considered medium-term for power lines, or areas replaced around the proposed development zone, but long-term where topsoil is stored in berms (*i.e.,* access roads). Table 7.2.2-3 and the accompanying discussion in Section 7.2.2.6 provides an evaluation of potential residual effects of Project activities at pump station facilities and their significance on the applicable soil and soil productivity indicator.

7.4.2.5 Summary

As identified in Table 7.4.2-2, there are no situations where there is a high probability of occurrence of a permanent or long-term residual environmental effect on soil and soil productivity indicators of high magnitude that cannot be technically or economically mitigated. Consequently, it is concluded that the residual environmental effects associated with Project activities at pump station facilities on soil and soil productivity will be not significant.

7.4.3 Water Quality and Quantity

Sections 7.2.3.1 and 7.2.3.2 provides the assessment indicators, measurement endpoints and spatial boundaries for the assessment of potential effects of the Project activities at pump station facilities on water quality and quantity.

7.4.3.1 Water Quality and Quantity Context

No construction activities at pump stations are anticipated to occur within 30 m of any watercourse and the proposed operations access road to Black Pines Pump Station does not cross any watercourses. However, the proposed 2.2 km power line extending to Black Pines Pump Station crosses the North Thompson River and Otter and Voght creeks, and the proposed 23.5 km power line extending to Kingsvale Pump Station crosses Kanevale, Kimble, Howarth and Nisson creeks. Several NCDs and NVCs are also crossed.

Alteration of natural surface drainage patterns may occur during construction and operations of pump stations, particularly where considerable grading may be required (*e.g.,* Black Pines, Kingsvale, Kamloops), and along power lines and the proposed operations access road to Black Pines Pump Station.

Section 6.1 provides additional setting information related to water quality and quantity at the pump stations.

7.4.3.2 Potential Effects and Mitigation Measures

<u>Identified Potential Effects</u>

Potential effects associated with the Project activities at pump station facilities on the water quality and quantity indicators listed in Table 7.4.3-1 were based on the results of the literature review, desktop analysis, field work, TEK, engagement with Aboriginal communities, landowners, regulatory authorities, stakeholders and the general public (Section 3.0), and the professional experience of the assessment team.

A summary of mitigation measures provided in Table 7.4.3-1 was principally developed in accordance with Trans Mountain standards and industry and provincial regulatory guidelines as described in Section 7.2.3.4.

TABLE 7.4.3-1

POTENTIAL EFFECTS, MITIGATION MEASURES AND RESIDUAL EFFECTS OF PROJECT ACTIVITIES AT PUMP STATION FACILITIES ON WATER QUALITY AND QUANTITY

Potential Effect	Pump Station Facility	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
1. Water Quality and Quantity Indicator – Surface Water Quality				
1.1 Contamination of surface water due to accidental release of hazardous materials during power line construction	Black Pines Power line Kingsvale Power line	LSA	• Isolate work areas in the vicinity of watercourses/wetlands/lakes to ensure water does not experience an increase in alkalinity beyond ambient conditions during construction [Section 11.2]. • Ensure that any concrete, cement, mortars or other lime-containing construction materials are not deposited, directly or indirectly, into or near any watercourse/wetland/lake [Section 11.2]. • Provide containment facilities for the wash-down water from cement delivery trucks, concrete pumping equipment and other tools and equipment [Section 11.2]. • Frequently monitor pH in watercourses immediately downstream of the isolated work site until completion of the cement or concrete residue work if located within 30 m of a watercourse/wetland/lake [Section 11.2]. • Prevent water that contacts uncured or partly cured concrete during activities such as exposed aggregate wash-off, wet curing or equipment washing from directly or indirectly entering a watercourse, waterbody or wetland [Section 11.2].	• No residual effect identified.

TABLE 7.4.3-1 Cont'd

Potential Effect	Pump Station Facility	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
1.1 Contamination of surface water due to accidental release of hazardous materials during power line construction (cont'd)	See above	LSA	• Isolate and hold any water that contacts uncured or partly cured concrete until the pH is between 6.5 and 8.0, and the turbidity is less than 25 NTU measured to an accuracy of +/- 2 NTU [Section 11.2]. • See additional mitigation measures in Section 11.2 of the Facilities EPP.	• See above.
1.2 Suspended sediment in water column	Black Pines Power line Kingsvale Power line	LSA	• Install erosion and sediment control structures and materials (*e.g.,* subsoil berm or sediment fencing) [Section 7.0] and implement, as warranted, erosion control measures outlined in the Soil Erosion and Sediment Control Contingency Plan [Appendix B]. • Install sediment fences near the base of cut slopes following grading (see Sediment Fence Drawing provided in Appendix R of the Pipeline EPP). Inspect the temporary sediment control structures on a daily basis and repair, if warranted, before the end of each working day [Section 8.2]. • Dewater the augured hole if warranted, prior to the installation of the pole. Pump water onto stable and well-vegetated areas, tarpaulins or sheeting in a manner that does not cause erosion or any unfiltered or silted water to directly re-enter a watercourse/wetland/lake [Section 11.0]. • Ensure that dewatering points are not located within 50 m of a watercourse/wetland/lake. Dewatering locations must be approved by the Lead Activity Inspector and the Inspector [Section 11.0]. • Revegetate as soon as feasible to reduce or avoid soil erosion and establish long-term cover [Section 8.4]. • Reclaim all disturbances within one growing season. If feasible, seed and plant seedlings during early spring to take advantage of the spring precipitation [Section 8.4]. • Adhere to additional guidance provided in the Reclamation Management Plan [Appendix C]. • See also potential effects 1.2 of Table 7.2.3-2 and 1.2 of Table 7.3.3-2 for additional mitigation measures.	• Reduction in surface water quality due to suspended sediment during construction and operations of the Black Pines and Kingsvale power lines.
1.3 Reduction of surface water quality due to small spill during construction	Black Pines Power Line Kingsvale Power Line	LSA	• Maintain the identified separation distances between the following areas and a watercourse/wetland/lake when constructing the facility site, unless otherwise approved: - fuel or hazardous material storage site - 300 m; - burning site - 100 m; and - oil change area - 100 m [Section 7.0]. • See Section 7.0 of the Facilities EPP for additional measures for hazardous materials storage, servicing vehicles and spill equipment needs. • Ensure that during construction no fuel, lubricating fluids, hydraulic fluids, methanol, antifreeze, herbicides, biocides, or other chemicals are dumped on the ground or into watercourses/wetlands/lakes. In the event of a spill, implement the Spill Contingency Plan [Appendix B] [Section 7.0].	• Contamination of surface water due to a small spill during construction.

TABLE 7.4.3-1 Cont'd

Potential Effect	Pump Station Facility	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
1.3 Reduction of surface water quality due to small spill during construction (cont'd)	See above	See above	• Conduct refuelling a minimum of 100 m from any watercourse/wetland/lake unless otherwise approved by the appropriate regulatory authority [Section 7.0]. See additional measures for refuelling near watercourses/wetlands/lakes in Section 7.0 of the Facilities EPP.	• See above.
2. Water Quality and Quantity Indicator – Surface Water Quantity				
2.1 Localized alteration of natural surface drainage patterns during construction and operations	Gainford Hinton Rearguard Darfield Black Pines Pump station Power line Access road Kamloops Kingsvale Pump station Power line	LSA	• Cut and fill the development zone, if required, to level the surface to be developed. Grade the surface to facilitate water drainage into water conveyance features (*e.g.*, ditches and culverts) [Section 8.2]. • Ensure the potential for soil erosion by water is reduced during construction activities by avoiding ponding of water or the unintentional channelization of surface water flow [Section 7.0]. • Establish long-term topsoil/root zone material storage berms at locations away from areas with potential for overland water flow [Section 8.4]. • Maintain or, when the area is stabilized, remove drainage and erosion control devices and materials, at all sites that are no longer in use [Section 7.0]. • Store all salvaged topsoil and root zone material from the new permanent access road and power line corridors in windrows along one or both edges of the access road and power line corridors in a manner that does not alter natural drainage patterns [Sections 9.0 and 11.1]. • Backfill to the surface and mound to allow for drainage away from the tower structure and settlement of soils. Mounding will not exceed 30 cm above grade, where feasible [Section 11.2]. • Feather-out excess subsoil material across the area where topsoil/root zone material has been salvaged. Avoid mixing topsoil/root zone material and feathered subsoil material. Blend feathered material into the natural grade of the area so as to not change local surface drainage patterns [Section 11.2]. • Recontour areas disturbed during facility construction outside of the development zone to pre-construction contours (where feasible) and drainage channels [Section 8.4]. • Provide surface drainage of adequate capacity across the facility site and other Project-related facilities [Section 7.0].	• Localized alteration of natural surface drainage patterns at pump stations, operations access road and along power lines.
3. Water Quality and Quantity Indicator – Groundwater Quality				
3.1 Reduction of groundwater quality as a result of a small spill during construction	Black Pines Power line Kingsvale Power line	LSA	• Implement mitigation measures from the Facility EPP to reduce the risk possibility of a spill during construction.	• Contamination of groundwater as a result of a small spill during construction.

Notes: 1 LSA = Water Quality and Quantity LSA.
2 Detailed mitigation measures are outlined in the Facilities EPP (Volume 6C).

7.4.3.3 Potential Residual Effects

The potential residual environmental effects on water quality and quantity indicators associated with Project activities at pump station facilities (Table 7.4.3-1) are:

- reduction in surface water quality due to suspended sediment during construction and operations of the Black Pines and Kingsvale power lines;
- contamination of surface water from a small spill during construction;
- localized alteration of natural surface drainage patterns at pump stations, operations access road and along power lines; and
- contamination of groundwater as a result of a small spill during construction.

Potential effects on the surface water quality indicator as a result of accidental release of hazardous materials at pump station facilities are predicted to be eliminated through the implementation of mitigation measures and no residual effect is anticipated (Table 7.4.3-1).

7.4.3.4 Significance Evaluation of Potential Residual Effects

Table 7.4.3-2 summarizes the significance evaluation of the potential residual environmental effects on water quality and quantity indicators resulting from Project activities at pump station facilities.

TABLE 7.4.3-2

SIGNIFICANCE EVALUATION OF POTENTIAL RESIDUAL EFFECTS OF PROJECT ACTIVITIES AT PUMP STATION FACILITIES ON WATER QUALITY AND QUANTITY

	Potential Residual Effects	Impact Balance	Spatial Boundary[1]	Temporal Context			Magnitude	Probability	Confidence	Significance[2]
				Duration	Frequency	Reversibility				
1.	Water Quality and Quantity Indicator – Surface Water Quality									
1(a)	Reduction in surface water quality due to suspended sediment during construction and operations of the Black Pines and Kingsvale power lines.	Negative	LSA	Immediate to short-term	Isolated to occasional	Immediate to short-term	Low	High	High	Not significant
1(b)	Contamination of surface water due to a small spill during construction.	Negative	LSA	Immediate	Accidental	Short to medium-term	Low to high	Low	Moderate	Not significant
2.	Water Quality and Quantity Indicator – Surface Water Quantity									
2(a)	Localized alteration of natural surface drainage patterns at pump stations, operations access road and along power lines.	Negative	LSA	Short-term	Isolated to occasional	Short to long-term	Low	High	High	Not significant
3.	Water Quality and Quantity Indicator – Groundwater Quality									
3(a)	Contamination of groundwater as a result of a small spill during construction.	Negative	LSA	Immediate	Accidental	Short to medium-term	Low to high	Low	Moderate	Not significant

Notes: 1 LSA = Water Quality and Quantity LSA.

2 Significant Residual Environmental Effect: A high probability of occurrence of a permanent or long-term residual effect of high magnitude that cannot be technically or economically mitigated.

The significance evaluation of contamination of surface water and groundwater due to a small spill during construction (Table 7.4.3-2, points 1[b] and 3[a]) was determined to be the same for the construction and operations of pump station facilities as for pipeline construction and operations. Table 7.2.3-3 and the accompanying discussion in Section 7.2.3.6 provides an evaluation of these potential residual effects of pump station facilities and their significance on the surface water quality and groundwater quality indicators. The rationale used to evaluate the significance of each of the remaining residual environmental effects on the water quality and quantity indicators is provided below.

Water Quality and Quantity Indicator – Surface Water Quality

The following provides the evaluation of significance of potential residual effects on the surface water quality indicator.

Suspended Sediment Release

Some erosion may cause sediment input and subsequent reduction in surface water quality during construction and operations of the Black Pines and Kingsvale power lines. The impact balance of this potential residual effect is considered negative since the erosion could decrease surface water quality of nearby waterbodies.

Power line towers will be installed outside of the riparian area of any watercourses, reducing the potential for any eroded sediments to enter the water column. In addition to disturbance around towers, soil disturbance will be required where anchor pits will be excavated for conductor stringing and possibly at other areas of the power line rights-of-way where soil disturbance necessitates construction (*e.g.,* vehicle and equipment use). However, given the limited surface disturbance required for power line construction, and through implementation of mitigation measures in Table 7.4.3-1 and the Facilities EPP (Volume 6C), any reduction in surface water quality due to suspended sediment during construction and operations of the Black Pines and Kingsvale power lines is anticipated to be of low magnitude. This residual effect is reversible in the immediate to short-term (Table 7.4.3-2, point 1[a]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Water Quality and Quantity LSA – any sedimentation caused by erosion will be carried downstream until it disperses and/or naturally settles out within the predicted ZOI.
- Duration: immediate to short-term – the event causing the erosion and sedimentation of surface water is construction or maintenance activities (*e.g.,* pole replacements), the latter of which is completed during any one year during the operations phase.
- Frequency: isolated to occasional – the event resulting in sedimentation caused by erosion is confined to a specific phase of the assessment period (*i.e.,* power line construction) or will occur intermittently and sporadically over the assessment period (*i.e.,* power line maintenance).
- Reversibility: immediate to short-term – an increase in suspended sediments has the potential to occur until effective erosion and sediment control measures are in place following power line construction.
- Magnitude: low – any increase in suspended sediments would occur over a short-term timeframe and is anticipated to be within CCME guidelines given the implementation of mitigation measures to reduce sedimentation.
- Probability: high – it is reasonable to anticipate that a minor amount of sediment may enter a waterbody during construction and maintenance activities along the Black Pines and Kingsvale power lines.
- Confidence: high – based on data pertinent to the Project area and the professional experience of the assessment team.

Water Quality and Quantity Indicator – Surface Water Quantity

The following provides the evaluation of significance of potential residual effects on the surface water quantity indicator.

Alteration of Natural Drainage Patterns

Drainage patterns will be altered at Black Pines Pump Station and associated operations access road, as well as at existing pump stations where grading is required and along new power lines. The impact balance of this potential residual effect is considered negative since it could alter or disrupt natural above ground hydrologic conditions. However, reducing impacts to natural drainage patterns is an important aspect of site selection, facility design and construction, and routing. Given that pump stations and the operations access road have been sited to reduce alteration of natural drainage patterns (*i.e.,* by avoiding to the extent feasible areas requiring extensive grading and surface alteration), and through implementation of mitigation measures in Table 7.4.3-1 and the Facilities EPP (Volume 6C) to ensure the maintenance of surrounding surface water drainage patterns (*e.g.,* culverts to ensure cross drainage under access roads), disruption of surface flow patterns during construction and operations is likely to be minor. Nevertheless, the residual effect is reversible in the long-term since natural drainage patterns at pump stations and operations access roads will be restored during decommissioning and abandonment of the Project (*i.e.,* greater than 10 years).

Due to the limited surface disturbance required for power line construction (*i.e.,* typically at pole installation sites and where disturbance is required for conductor stringing), and given mitigation measures in Table 7.4.3-1 and the Facilities EPP (Volume 6C), power line construction is expected to have a minimal effect on surface flow patterns. The residual effect is reversible in the short to long-term since natural drainage patterns at pump stations and the access road may not be fully restored until decommissioning and abandonment.

In the event that construction or maintenance activities result in changes in surface water regimes, corrective action, in consultation with the appropriate authorities, will be conducted to resolve the issue. The residual effect is considered to be of low magnitude (Table 7.4.3-2, point 2[a]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Water Quality and Quantity LSA – although alteration of natural drainage patterns is generally confined to the disturbed portion of pump stations, operations access road and power lines, potential changes in hydrology may extend beyond the facility, road and power line easements.
- Duration: short-term – the event causing alteration of natural drainage is construction of the operations access road as well as construction or maintenance activities (*e.g.,* site maintenance, pole replacements) at Black Pines Pump Station, existing pump stations where activities are planned and along new power lines.
- Frequency: isolated to occasional – the event causing alteration of natural drainage is confined to a specific phase of the assessment period (*i.e.,* construction) or will occur intermittently and sporadically over the assessment period (*i.e.,* maintenance of the pump stations, operations access road and power lines).
- Reversibility: short to long-term – short to medium-term for power lines where it may take more than one year to restore natural drainage patterns and long-term (*i.e.,* greater than 10 years) for pump stations and the access road where natural drainage patterns will not be fully restored until decommissioning and abandonment.
- Magnitude: low – surface water passage will be unimpeded at the Black Pines Pump Station and associated operations access road, as well as along power lines, and any alteration of surface water drainage at existing pump stations where construction activities are planned is expected to be minor.
- Probability: high – construction and operations of the pump station facilities, operations access road and power lines is likely to affect natural drainage patterns in localized areas.
- Confidence: high – based on data pertinent to the Project area and the professional experience of the assessment team.

7.4.3.5 Summary

As identified in Table 7.4.3-2, there are no situations where there is a high probability of occurrence of a permanent or long-term residual environmental effect on water quality and quantity indicators of high magnitude that cannot be technically or economically mitigated. Consequently, it is concluded that the residual environmental effects associated with Project activities at pump station facilities on water quality and quantity will be not significant.

7.4.4 Air Emissions

Sections 7.2.4.1 and 7.2.4.2 provide the assessment indicator, measurement endpoints and spatial boundaries for the assessment of potential effects of Project activities at pump station facilities on air emissions. Estimated air emissions from pump station construction and operation are described in Section 7.2.4.3 and summarized in Table 7.2.4-2.

7.4.4.1 Potential Effects and Mitigation Measures

Effects Considerations

No advanced dispersion modelling was performed to estimate ambient VOC concentrations associated with fugitive VOC emissions during pump station operation. Instead, a screening level assessment was performed using the AERSCREEN model for the Edson, Gainford and Wolf pump stations representing large, medium, and small pump stations in terms of fugitive emission rates. The Edson Pump Station has two existing 2000 HP pumps for the existing TMPL system and three existing 75 HP booster pumps, and will be expanded by three 5000 HP pumps for TMEP. The Gainford Pump Station has three existing 2000 HP pumps for the existing TMPL system, and the TMEP will introduce three 5000 HP pumps. At the Wolf Pump Station, two 5000 HP pumps will be added for TMEP. The AERSCREEN results indicate that maximum predicted 1-hour concentrations of BTEX and mercaptans would be <1% of their respective ambient air quality objectives except for benzene, which is predicted to be <3% of the ambient objective. As a result of this very low level of effect, a residual potential effects assessment was not performed for fugitive emissions from pump station operation.

Air emissions also occur during site-specific maintenance and inspection activities (*e.g.,* from vehicles and fuel usage for space heating). These emissions are expected to be very low compared to other existing emissions in the Air Quality RSA for example from non-Project related vehicles movements. Furthermore, it is not clear if the Project will lead to additional maintenance and inspection activities. Therefore, a residual potential effects assessment was not performed for air emissions from the maintenance and inspection of pump stations.

Identified Potential Effects

Potential effects on the air emissions indicator that are associated with the Project activities at pump stations and listed in Table 7.4.4-1 were based on the results of the literature review, desktop analysis, consultation with stakeholders and the general public (Section 3.0), and the professional experience of the assessment team.

The summary of the mitigation measures provided in Table 7.4.4-1 was principally developed in accordance with Trans Mountain standards and accepted facility construction methods for construction-related activities.

TABLE 7.4.4-1

POTENTIAL EFFECTS, MITIGATION MEASURES AND RESIDUAL EFFECTS OF PROJECT ACTIVITIES AT PUMP STATION FACILITIES ON AIR EMISSIONS

Potential Effect	Pump Stations	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
1. Air Emissions Indicator – Primary Emissions of Criteria Air Contaminants and Volatile Organic Compounds				
1.1 Project contribution to emissions	All	RSA	• Trans Mountain will consult with and inform landowners of the potential to be affected by emissions from construction activities prior to commencement of these activities in proximity to the respective landowners [Section 7.0]. • Restrict the duration that vehicles and equipment are allowed to sit and idle to less than one hour unless air temperatures are less than 0°C [Section 7.0]. • Ensure equipment is well-maintained during construction to minimize air emissions [Section 7.0].	• Increase in air emissions during construction of pump stations.

TABLE 7.4.4-1 Cont'd

Potential Effect	Pump Stations	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
1.1 Project contribution to emissions (cont'd)	See above	See above	• Use multi-passenger vehicles for the transportation of crews to and from the job sites, where feasible [Section 7.0].	• See above.
1.2 Dust during construction	All	RSA	• Trans Mountain will consult with and inform landowners with the potential to be affected by dust emissions from construction activities prior to commencement of these activities in proximity to the respective landowners [Section 8.2].	• Increase in fugitive dust during construction of pump stations.

Notes: 1 RSA = Air Quality RSA.
2 Detailed mitigation measures are outlined in the Facilities EPP (Volume 6C).

7.4.4.2 Potential Residual Effects

The potential residual environmental effects on the air emissions indicator associated with the construction and operations of pump stations (Table 7.4.4-1) are:

- an increase in air emissions during construction of pump stations; and
- an increase in fugitive dust during construction of pump stations.

7.4.4.3 Significance Evaluation of Potential Residual Effects

A qualitative assessment of air emissions from pump station construction activities was determined to be the most appropriate approach to evaluate the significance of potential residual environmental effects since there is a lack of regulatory thresholds, standards, or guidelines for indicators associated with construction emissions. Consequently, the evaluation of significance of each of the potential residual effects relies on the professional judgment of the assessment team.

Table 7.4.4-2 provides a summary of the significance evaluation of the potential residual environmental effects of the construction and operations of pump stations on the air emissions indicator.

TABLE 7.4.4-2

SIGNIFICANCE EVALUATION OF POTENTIAL RESIDUAL EFFECTS OF PROJECT ACTIVITIES AT PUMP STATION FACILITIES ON AIR EMISSIONS

Potential Residual Effects	Impact Balance	Spatial Boundary[1]	Temporal Context			Magnitude	Probability	Confidence	Significance[2]
			Duration	Frequency	Reversibility				
1. Air Emissions Indicator – Primary Emissions of Criteria Air Contaminants and Volatile Organic Compounds									
1(a) Increase in air emissions during construction of pump stations.	Negative	RSA	Short-term	Isolated	Short-term	Medium	High	Moderate	Not significant
1(b) Increase in fugitive dust during construction of pump stations.	Negative	RSA	Short-term	Isolated	Short-term	Medium	High	Moderate	Not significant
1(c) Combined effects on the primary emissions of CACs and VOCs indicator (1[a] to 1[b]).	Negative	RSA	Short-term	Isolated	Short-term	Medium	High	Moderate	Not significant

Notes: 1 RSA = Air Quality RSA.
2 Significant Residual Environmental Effect: A high probability of occurrence of a permanent or long-term residual effect of high magnitude that cannot be technically or economically mitigated.

The significance evaluation of the potential residual effects on the primary emissions of CACs and VOCs indicator (Table 7.4.4-2, points 1[a] to 1[c]) was determined to be the same for the construction and operations of pump station facilities as for pipeline construction and operations. Table 7.2.4-4, points 1[a], 1[c], and 1[d], and the accompanying discussion in Section 7.2.4.6 provide an evaluation of potential residual effects of Project activities at pump station facilities and their significance on the primary emissions of CACs and VOCs indicator.

7.4.4.4 Summary

As identified in Table 7.4.4-2, there are no situations where there is a high probability of occurrence of a permanent or long-term residual environmental effect on the air emissions indicators of high magnitude that cannot be technically or economically mitigated. Consequently, it is concluded that the residual environmental effects of Project activities at pump station facilities on air emissions will be not significant.

7.4.5 Greenhouse Gas Emissions

As discussed in Section 7.2.5.3, during the construction phase, land clearing for pump station facilities and associated power lines, site preparation, operation of vehicles and equipment, and other construction activities will result in GHG emissions. During operation of the pump stations, direct GHG emissions are caused by fuel combustion for space heating, and fugitive emissions from valves, connectors, and pumps. Electricity consumption by the pump assemblies will result in indirect GHG emissions. Pump station related GHG emissions are summarized in Table 7.2.5-3.

The assessment of effects on GHG emissions has been conducted considering all the Project components in an integrated manner (*e.g.,* pipeline, temporary facilities, pump stations [including power lines], tanks, Westridge Marine Terminal and pipeline reactivation), since GHG emissions associated with the construction and operation of each Project component are aggregated for the Project as a whole and then compared to provincial and federal GHG inventory totals.

The assessment of effects on GHG emissions for the Project as a whole is presented in Section 7.2.5. Table 7.2.5-8 and accompanying discussion in Section 7.2.5.3 provide an evaluation of potential residual effects of Project activities at pump station facilities on GHG indicators.

7.4.6 Acoustic Environment

Sections 7.2.6.1, 7.2.6.2 and 7.2.6.3 provide the assessment indicators, measurement endpoints, spatial boundaries and acoustic environment context for the assessment of potential effects of the Project activities at pump station facilities on the acoustic environment.

In addition to the endpoints presented previous in Section 7.2.6.1, Health Canada document entitled "*Guidance for Evaluating Human Health Impacts in EA: Noise*" suggests alternative methods that differ from the BC OGC *Noise Control Best Practices Guideline* and AER *Directive 038* documents as well as the upper limit threshold. This guidance alternative will provide a secondary set of limits for the operational condition of the pump station operations that provides a greater perspective for effects from changes in sound levels in urban or densely developed areas. A draft Health Canada guidance document (Health Canada 2011) suggests annoyance based criteria (% highly annoyed or %HA) which relates noise levels to subjective human responses in order to establish criteria. Details on this alternative approach are provided in the Terrestrial Noise and Vibration Technical Report of Volume 5C.

TABLE 7.4.6-1

ASSESSMENT INDICATOR AND MEASUREMENT ENDPOINTS FOR ACOUSTIC ENVIRONMENT

Acoustic Environment Indicator	Measurement Endpoint(s)	Rationale for Indicator Selection
Sound levels	• Energy equivalent (L_{eq}) sound level measured in A-weighted decibels • Percent highly annoyed (%HA)	The L_{eq} indicator is defined by the assessment methods cited in the NEB *Filing Manual* under the acoustic environment element in Table A-2. The %HA indicator is representative of densely populated areas.

7.4.6.1 Potential Effects and Mitigation Measures

<u>Identified Potential Effects</u>

The potential effects associated with the Project activities at pump station facilities on the acoustic environment indicators listed in Table 7.4.6-1 were based on the results of desktop analysis, modelling and engagement with Aboriginal communities, landowners, regulatory authorities, stakeholders and the general public (Section 3.0), and the professional experience of the assessment team.

A summary of mitigation measures provided in Table 7.4.6-2 was principally developed in accordance with Trans Mountain standards and industry and provincial regulatory guidelines as described in Section 7.2.6.4.

TABLE 7.4.6-2

POTENTIAL EFFECTS, MITIGATION MEASURES AND RESIDUAL EFFECTS OF PROJECT ACTIVITIES AT PUMP STATION FACILITIES ON ACOUSTIC ENVIRONMENT

Potential Effect	Pump Station Facility	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
1. Acoustic Environment Indicator – Sound Level				
1.1 Changes in sound levels during construction	Edmonton Gainford Wolf Niton Edson Hinton Jasper Rearguard Blue River Black Pool Darfield Black Pines Pump station Access road Power line Kamloops Kingsvale Pump station Power line Sumas	LSA	• Adhere to all federal (*i.e.,* Environment Canada, *Motor Vehicle Safety Act*, *Oil and Gas Occupational Safety and Health Regulations*, Health Canada) and provincial (*i.e.,* Alberta's Energy Resource Conservation Board through Directive 038: Noise Control, BC OGC, *Worker's Compensation Act*, *Occupational Health and Safety Regulations* [BC Reg 296/97 as amended] Section 7.2 [BC Reg. 382/2004, s.1]) guidelines and legislation for noise management [Section 7.0]. • Schedule construction activities to be conducted within 300 m of residences, cabins, occupied campgrounds or parks in accordance with applicable municipal noise bylaws or approval conditions [Section 7.0]. • Noise abatement and construction scheduling will be considered at noise-sensitive locations and during noise-sensitive periods, to limit disruption to sensitive receptors (*i.e.*, neighbouring landowners, wildlife migratory periods, nesting birds) [Section 7.0]. • Enforce vehicle speed limits and inform contractor truck drivers and equipment operators that engine retarder braking in urban areas is prohibited [Section 7.0]. • Maintain equipment in good working condition and in accordance with manufacturer guidelines [Section 7.0]. • Maintain noise suppression equipment on all construction machinery and vehicles in good order [Section 7.0]. • Enclose noisy equipment and use baffles, where and when feasible, to limit the transmission of noise beyond the construction site. • Use only the size and power of tools necessary limit noise from power tool operations [Section 7.0]. • Locate stationary equipment, such as compressors and generators located away from noise receptors, to the extent feasible, and follow applicable municipal, provincial and federal guidelines [Section 7.0].	• Increase in sound levels at pump station and associated facilities during construction period.

TABLE 7.4.6-2 Cont'd

Potential Effect	Pump Station Facility	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
1.1 Changes in sound levels during construction (cont'd)	See above	LSA	• Implement mitigation measures where residences are located within 300 m of the construction right-of-way or facility site as outlined in the Noise Management Plan [Section 7.0]. • Implement mitigation measures where night-time activity (*e.g.,* horizontal directional drill) on the construction right-of-way or facility site is located within 500 m of residences as outlined in the Noise Management Plan [Section 7.0].	• See above.
1.1 Changes in sound levels during operations	Edmonton Gainford Wolf Niton Edson Hinton Rearguard Blue River Black Pool Black Pines Kamloops Kingsvale Sumas	LSA	• Review and analyze equipment specifications to ensure sound emissions from mechanical equipment are equal to or less than the sound emissions used in the Terrestrial Noise and Vibration Technical Report. • Limit helicopter inspections to weekdays only where practical. • Use of off-road vehicles for inspection should be limited to weekdays.	• Increase in continuous sound levels from operations of new pump stations.

Notes: 1 LSA = Acoustic Environment LSA.
2 Detailed mitigation measures are outlined in the Facilities EPP (Volume 6C).

7.4.6.2 Residual Effects

The potential residual environmental effects on the acoustic environment indicators associated with Project activities at pump station facilities (Table 7.4.6-2) are:

- increases in sound levels at pump station and associated facilities during construction period; and
- increase in continuous sound levels from operations of new pump stations.

7.4.6.3 Significance of Residual Effects

Table 7.4.6-3 provides a summary of the significance evaluation of the potential residual environmental effects on the acoustic environment indicator resulting from Project activities at pump station facilities.

A quantitative assessment of the acoustic environment was determined to be the most appropriate approach to evaluate the significance of potential residual environmental effects for pump station facilities. The evaluation of significance of each of the potential residual effects for the acoustic environment relies primarily on the magnitude, duration and frequency of the potential change. The general definitions for these elements are provided in Table 7.1-2. However, magnitude of residual effects requires further definition for the acoustic environment evaluation and is indicator specific. Magnitude for sound level has been defined based on the degree of compliance with provincial and suggested Health Canada guidelines. Details on the guidelines and legislation used to establish the magnitude ratings are provided in the Terrestrial Noise and Vibration Technical Report.

The definitions of magnitude for the L_{eq} in dBA indicator for construction activities at pump station facilities are the same as the pipeline construction in Section 7.2.6.6.

The sound levels indicator definitions of magnitude for pump station operations are as follows.

- **Negligible:** Below BC OGC and AER ASL.

- **Low:** Below BC OGC/AER PSL limits and suggested Health Canada percent Highly Annoyed (%HA) guidance.
- **Medium:** Equal to or slightly lower than the BC OGC/AER PSL limit in rural or sub-urban areas; or Health Canada %HA guidance in urban areas.
- **High:** Greater than either the BC OGC/AER PSL limit or the Health Canada %HA guidance.

TABLE 7.4.6-3

SIGNIFICANCE EVALUATION OF POTENTIAL RESIDUAL EFFECTS OF PROJECT ACTIVITIES AT PUMP STATION FACILITIES ON THE ACOUSTIC ENVIRONMENT

	Potential Residual Effects	Impact Balance	Spatial Boundary[1]	Temporal Context			Magnitude	Probability	Confidence	Significance[2]
				Duration	Frequency	Reversibility				
1.	Acoustic Environment Indicator – Sound Levels									
1(a)	Increase in sound levels at pump stations and associated facilities during construction period.	Negative	LSA	Short-term	Isolated	Short-term	Negligible to high	High	Moderate	Not significant
1(b)	Increase in continuous sound levels from operations of new pump stations.	Negative	LSA	Long-term	Continuous	Long-term	Negligible to medium	High	Moderate	Not significant
1(c)	Combined effects on the sound levels indicator (1[a] and 1[b]).	Negative	LSA	Long-term	Continuous	Long-term	Negligible to medium	High	Moderate	Not significant

Notes: 1 LSA = Acoustic Environment LSA.

2 Significant Residual Environmental Effect: A high probability of occurrence of a permanent or long-term residual effect of high magnitude that cannot be technically or economically mitigated.

Acoustic Environment Indicator – Sound Levels

Increases in Sound Levels During Construction

The potential for the increase in sound levels for human receptors associated with Project construction is considered to have a negative impact balance. It is anticipated that the sound levels due to the construction of the pipeline will be greater than the sound levels generated by the construction at each pump station and associated power lines due to the reduced number of active pieces of construction equipment required. Although some incremental clearing is required at Gainford, Hinton, Rearguard and Darfield pump stations, only the Black Pines Pump Station will require clearing activity for a new site. All other sites will use already cleared space and earthworks or excavation is expected to be minimal. Therefore, sound emitted by pump station construction is evaluated at receptors based on the “Installation of Building Structures and Equipment” in Figure 7.2.6-1, with the exception of Black Pines where “Clearing” from Figure 7.2.6-1 is considered. Details on the residual effects from pipeline construction are described in detail in Section 7.2.6.6. All of the significance criteria rankings and supporting rationale, with the exception of magnitude, will be the same as Section 7.2.6.6.

The results for the construction of the pump stations indicates the magnitude of changes in sound levels that will be experienced by people living within 1.5 km of a station where new pumps are proposed. Noise controls that will be used during the construction phase, particularly the use of silencers on mobile equipment and developing a noise management plan are expected to control the amount of sound to within acceptable levels as established in the Terrestrial Noise and Vibration Technical Report of Volume 5C. Controlling the magnitude of sound levels also limits the spatial extent of the potential change.

The only variation in residual affects is the magnitude of potential effects. This varies depending on the distance between the construction activities and the surrounding receptors. Table 7.4.6-4 presents a summary of the relevant parameters and predicted magnitude.

TABLE 7.4.6-4

SUMMARY OF SOUND LEVEL MAGNITUDE FOR APPLICABLE PUMP STATION CONSTRUCTION

Pump Station Facility	Distance to Closest Receptor (m)	Predicted Sound Level (dBA)	Criteria		Magnitude
			BC OGC/AER Daytime PSL (dBA)	Health Canada Guidance (dBA)	
Edmonton, AB	No receptor within the Acoustic Environment LSA. Closest receptor is 1.9 km.	56	60	75	Low
Gainford, AB	140	79	65	75	High
Edson, AB	360	71	65	75	Medium
Hinton, AB	820	64	65	75	Low
Rearguard, BC	No receptor within the Acoustic Environment LSA. Closest receptor is 3.5 km.	<51	65	75	Negligible
Blackpool, BC	150	78	65	75	High
Black Pines, BC	100	84	65	75	High
Kamloops, BC	520	68	63	75	Medium
Kingsvale, BC	300	72	60	75	Medium
Sumas, BC	110	81	65	75	High

Other pump stations, though not numerically assessed, may have construction activities related to the Project. Construction sound levels are anticipated to fall within the ranges listed above. If a high magnitude is predicted, a detailed noise management plan for construction should be implemented. A summary of the rationale for all of the significance criteria is provided below (Table 7.4.6-3, point 1[a]).

- Spatial Boundary: Acoustic Environment LSA – compliance with the AER *Directive 038* (ERCB 2007) and BC OGC *Noise Control Best Practices Guideline* (BC OGC 2009) are achieved within the Acoustic Environment LSA.
- Duration: short term – the event causing the increase in sound levels occur during the construction phase.
- Frequency: isolated – the events causing the increase in sound levels occur only during the construction phase in which the activity is planned.
- Reversibility: short-term – the increases in sound levels will occur during construction activities at pump stations which will last up to 2 years. All construction sound level changes are reversible as the sound will cease when construction is finished.
- Magnitude: negligible to high – increases in sound levels range primarily between negligible to medium. High magnitude ratings at Black Pines and Sumas pump stations can be controlled to within the range of medium magnitude effects with the implementation of a detailed noise management plan.
- Probability: high – based on the proximity of residences to the pump station facility, increased sound levels may affect receptors during construction.
- Confidence: moderate – based on the nature of data inputs.

Increase in Continuous Sound Levels from Operations of New Pump Stations

The potential for the increase in sound levels for human receptors associated with Project pump station operations is considered to have a negative impact balance. Noise from pump station facility operations where new pumps have been added for the Project will be continuous sound from pumping and support equipment located on these sites. Where new pump stations have been sited, these sounds will be new to the local area. For replacements or reactivation of existing pump stations, sounds would be similar to those already generated on these sites.

The spatial extent of the increase in sound levels during operations of the pump stations is limited to the Acoustic Environment LSA. The duration of the pump station sounds is long-term, throughout the operating life of the pump station. The increase in sound levels during operations will extend for the operating life of the pump station and, consequently, is of long-term reversibility. However, effect is reversible as the increase in sound levels cease as soon as the sound stops, which would be following Project decommissioning.

The only variation in residual affects at the pump stations is the magnitude of potential effects. This varies depending on the relative increase in sound emitting equipment, distance between the pump station and the surrounding receptors. As such, Table 7.4.6-5 presents a summary of the relevant parameters and resulting predicted magnitude.

TABLE 7.4.6-5

SUMMARY OF SOUND LEVEL MAGNITUDE FOR APPLICABLE PUMP STATION OPERATIONS

Pump Station Facility	Distance to Closest Receptor (m)	Predicted Sound Level (L_{eq} in dBA/%HA)	Criteria		Magnitude
			BC OGC/AER Nighttime PSL (dBA)	Health Canada Guidance (% HA)	
Edmonton, AB	No receptor within Acoustic Environment LSA. Compliance is demonstrated at Acoustic Environment LSA limit of 1.5 km.	36/1.2	40	6.5%	Low
Gainford, AB	140	45/3.2	45	6.5%	Medium
Wolf, AB	--	--/--	--	--	Negligible[1]
Edson, AB	360	42/2.6	45	6.5%	Low
Hinton, AB	820	40/2.2	45	6.5%	Negligible
Rearguard, BC	No receptor within Acoustic Environment LSA. Compliance is demonstrated at Acoustic Environment LSA limit of 1.5 km.	35/1.2	40	6.5%	Negligible
Blue River, BC	--	--/--	--	--	Negligible[1]
Blackpool, BC	150	43/2.8	45	6.5%	Low
Black Pines, BC	100	38/1.4	40	6.5%	Low
Kamloops, BC	520	39/1.8	43	6.5%	Low
Kingsvale, BC	300	37/1.3	40	6.5%	Low
Sumas, BC	110	47/3.9	55	6.5%	Low

Note: 1 No numeric assessment completed since at the time of the assessment, the pump unit changes consisted of replacement of equipment which have equivalent units.

A summary of the rationale for all of the significance criteria is provided below (Table 7.4.6-3, point 1[b]).

- Spatial Boundary: Acoustic Environment LSA – compliance with the AER *Directive 038* (ERCB 2007) and BC OGC *Noise Control Best Practices Guideline* (BC OGC 2009) are achieved within the Acoustic Environment LSA.
- Duration: long-term – the event causing the increase in sound levels is the operation of the pump stations which occurs over the life of the operating pipeline.
- Frequency: continuous – the pump stations operate continuously over the life of the operating pipeline.
- Reversibility: long-term – the increase in sound levels during operations at pump stations will extend over the life of the operating pipeline. All sound level changes are reversible as the sound will cease when the pipeline is decommissioned.
- Magnitude: negligible to low – with the implementation of appropriate mitigation measures at the pumps stations, noise levels at receptors are expected to comply with AER, BC OGC and Health Canada limits.

- Probability: high – the new pumps are mechanical sources of sound and will increase sound levels for nearby receptors during operations.
- Confidence: moderate – the assessment is based on a combination of measured existing data, theoretical formulae and current Project design.

Combined Effects on Sound Levels

The evaluation of the combined effects of Project activities at pump station facilities on the acoustic environment considers collectively the assessment of the likely potential residual effects on the sound levels indicators. The residual effects for the sound levels indicator do not combine to result in new ratings for the various components since the occurrences of sound happen at different times during the Project. Therefore, the combined effects represents the worst-case or most negative effect for each evaluation criteria between the two residual effects (Table 7.4.6-3, point 1[c]). Effectively, this is the effect from pump station operations, since pump station construction is of short-term duration and reversibility. Pump station operations will occur continuously over the life of the operating pipeline. A summary of the rationale for all of the significance criteria of combined effects on sound levels is provided below.

- Spatial Boundary: Acoustic Environment LSA – compliance with the AER *Directive 038* (ERCB 2007) and BC OGC *Noise Control Best Practices Guideline* (BC OGC 2009) are achieved within the Acoustic Environment LSA.
- Duration: long-term – the combined effect on sound levels reflects the operations of the pump stations which occur over the life of the operating pipeline.
- Frequency: continuous – the event causing combined effects on sound levels is the operation of pump stations which occur continuously over the life of the operating pipeline.
- Reversibility: long-term – the combined effect of sound levels reflect operations at pump stations which will extend over the life of the operating pipeline. All sound level changes are reversible since the sound will cease when the pump station is decommissioned.
- Magnitude: negligible to medium – with the implementation of appropriate mitigation measures at the pumps stations, noise levels at receptors are expected to comply with AER, BC OGC and Health Canada limits.
- Probability: high – the new pumps are mechanical sources of sound and will increase sound levels for nearby receptors during operation.
- Confidence: moderate – the assessment is based on a combination of measured existing data, theoretical formulae and current Project design.

7.4.6.4 Summary

As identified in Table 7.4.6-3, there are no situations arising from Project activities at pump station facilities where there is a high probability of occurrence of a permanent or long-term residual environmental effect on acoustic environment indicators of high magnitude that cannot be technically or economically mitigated. Consequently, it is concluded that the residual effects associated with the Project activities at pump station facilities on the acoustic environment will be not significant.

7.4.7 Fish and Fish Habitat

The construction of power lines associated with construction of the Black Pines and Kingsvale pump stations may cause an interaction with fish and fish habitat indicators through a disturbance to riparian habitat and effects to indicator species.

Four indicator species (*i.e.,* bull trout/Dolly Varden, Chinook salmon, coho salmon and rainbow trout/steelhead) are known to occur in the Lower North Thompson, Lower Nicola and Similkameen river watersheds, in which the power lines associated with the Black Pines and Kingsvale pump stations are located.

The proposed power line associated with the Black Pines Pump Station crosses the North Thompson River, Otter Creek and Voght Creek, of which only the North Thompson River was determined to be fish-bearing (Section 5.4 of the Fisheries [British Columbia] Technical Report of Volume 5C). The proposed power line associated with the Kingsvale pump station crosses two fish-bearing watercourses, Kanevale Creek and Howarth Creek (Section 5.5 of the Fisheries [British Columbia] Technical Report of Volume 5C). In the event that power line towers associated with either pump station are constructed in riparian habitat, there may be an effect to riparian habitat overall and for the four indicator species present in the watershed.

The assessment of effects on fish and fish habitat has been conducted considering all the Project components in an integrated manner (*e.g.,* pipeline, temporary facilities, pump stations [including power lines], tanks and pipeline reactivation), since the components will have similar effect pathways (*i.e.,* riparian habitat, instream habitat and fish mortality and injury) on fish indicators and disaggregation of effects by Project component is not meaningful at an individual or population level for fish indicators.

The assessment of effects on fish and fish habitat for the Project as a whole is presented in Section 7.2.7. Table 7.2.7-3 and accompanying discussion in Section 7.2.7.6 provide an evaluation of potential residual effects of pump station activities on fish indicators.

7.4.8 Wetland Loss or Alteration

Sections 7.2.8.1 and 7.2.8.2 provide the assessment indicators, measurement endpoints and spatial boundaries for the assessment of potential effects of the Project activities at pump station facilities on wetlands.

7.4.8.1 Ecological Context

Wetlands near or within the boundaries of the pump stations and along the proposed power lines were initially identified during helicopter overflights and through satellite imagery interpretation using key indicators such as terrain, surficial material (*i.e.,* mineral or organic), vegetation cover and the presence or absence of surficial hydrology. Through this method it was determined that 1 potential wetland is located within the Blackpool Pump Station boundary, however, Trans Mountain has confirmed that the proposed construction works at the Blackpool Pump Station will not affect this wetland, and nor the 23 potential wetlands which may be crossed by the proposed Kingsvale power line. Wetland classification and delineations will be confirmed during the 2014 supplemental wetland field surveys (see Section 9.0). Section 7.2.8.3 provides additional ecological context information.

7.4.8.2 Potential Effects and Mitigation Measures

<u>Identified Potential Effects</u>

Potential effects associated with the Project activities at pump station facilities on wetland loss or alteration are listed in Table 7.4.8-1. These interactions are based on the results of the literature review, available research literature, desktop analysis, TEK, engagement with Aboriginal communities, landowners, regulatory authorities, stakeholders and the general public (Section 3.0), and the professional experience of the assessment team.

A summary of mitigation measures provided in Table 7.4.8-1 was principally developed in accordance with Trans Mountain standards as well as industry and provincial regulatory guidelines, learnings from wetland post-construction environmental monitoring for previous projects and peer-reviewed publications on wetland function as described in Section 7.2.8.4.

TABLE 7.4.8-1

POTENTIAL EFFECTS, MITIGATION MEASURES AND RESIDUAL EFFECTS OF PROJECT ACTIVITIES AT PUMP STATION FACILITIES ON WETLAND LOSS OR ALTERATION

	Potential Effect	Pump Station Facility	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
1.	Wetland Loss or Alteration – Wetland Function				
1.1	Potential loss or alteration of wetlands of High Functional, High-Moderate, Low-Moderate and Low Functional Condition (*i.e.,* habitat, hydrology, biogeochemistry)	Blackpool Kingsvale Power line	LSA	<u>Habitat</u> • Ensure that all required approvals, licenses and permits are in place prior to commencing applicable construction activities [Section 6.0]. • Ensure TWS does not encroach within vegetated buffers at waterbodies or wetlands unless approved by the appropriate regulatory authority [Section 6.0]. • Ensure approvals are in place prior to works where the facility boundary encounters the boundaries of wetlands [Section 7.0]. • Protect vegetation mat from construction disturbance, to the extent feasible. Any TWS located within the boundary of a wetland must be approved by the Inspector [Section 7.0]. • Locate all additional work areas (such as graded areas or additional topsoil/root zone material storage areas) a minimum of 10 m from wetland boundaries except where adjacent upland is cultivated or hay land, or disturbed land, unless otherwise approved. Ensure landowner/land authority approvals are in place for all additional TWS prior to use [Section 7.0]. • Conduct ground level cutting, mowing and/or mulching of wetland vegetation instead of grubbing. The method of removal of wetland vegetation is subject to approval by the Inspector [Section 7.0]. • Prevent ground disturbance by using a protective layer such as frost packing, snow, ice or matting between wetland vegetation mat/seedbed and construction equipment [Section 7.0]. • Allow wetlands to recover naturally (*i.e.,* do not seed wetland areas) [Section 7.0]. • Restrict root grubbing in wet areas, where practical, to avoid creation of bog holes [Section 8.1]. • Align new access roads or extensions of existing roads to avoid wetlands and peatlands, to the extent feasible [Section 9.0]. • Conduct pre-clearing of timber and/or mowing of native pasture/hay where directed by the Inspector prior to the onset of the migratory bird nesting season (see Appendix L for listing of dates) [Section 8.1]. • Consider install bird deterrents (*e.g.,* avian reflectors, marker balls, swinging markers, flappers) on shield wires (where applicable) in the vicinity of select wetlands and riparian areas to deter birds away from the infrastructure [Section 11.3]. <u>Hydrology</u> • Install berms and/or cross ditches on approach slopes to wetlands, where warranted [Section 7.0]. • Ensure that dewatering points are not located within 50 m of a watercourse/wetland/lake. Dewatering locations must be approved by the Lead Activity Inspector and the Inspector [Section 11.2].	• Loss or alteration of wetland habitat, hydrological and biogeochemical function from the facilities during construction activities until vegetation is re-established and sedimentation is controlled.

TABLE 7.4.8-1 Cont'd

Potential Effect	Pump Station Facility	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
1.1 Potential loss or alteration of wetlands of High Functional, High-Moderate, Low-Moderate and Low Functional Condition (*i.e.,* habitat, hydrology, biogeochemistry) (cont'd)	Blackpool Kingsvale Power line	LSA	• Maintain sediment fences in place at non-peat wetland boundaries, where warranted, until a vegetation cover has stabilized the adjacent construction areas [Section 7.0]. • Adhere to the measures outlined in the Wet/Thawed Soils Contingency Plan (see Appendix B) during wet/thawed soil conditions [Section 7.0 and 8.2]. • Postpone construction, suspend equipment travel or utilize construction alternatives in the event of wet or thawed soils in order to reduce terrain disturbance and soil structure damage [Section 7.0]. • Install erosion and sediment control structures and materials (*e.g.,* subsoil berm or sediment fencing) and implement, as warranted, erosion control measures outlined in the Soil Erosion and Sediment Control Contingency Plan (see Appendix B) to ensure that sediments in surface water draining from the facility site do not adversely affect the surrounding terrain or waterbodies. In particular, control erosion on grade cuts adjacent to the development zone at facility sites [Section 7.0]. • Ensure that hydrovac slurry will not be pumped into or allowed to flow into a watercourse/wetland/lake [Section 8.1]. • Do not apply dust control suppressants to roads during windy conditions or within 300 m of a watercourse/wetland/lake [Section 9.0]. • Store mixtures of snow and soil in a manner that prevents sedimentation of watercourses/wetlands/lakes when the snow melts [Section 11.1]. • Isolate work areas in the vicinity of watercourses/wetlands/lakes to ensure water does not experience an increase in alkalinity beyond ambient conditions during construction [Section 11.2]. • Ensure that any concrete, cement, mortars or other lime-containing construction materials are not deposited, directly or indirectly, into or near any watercourse/wetland/lake. All forms, if applicable, shall be examined by qualified Inspector(s) prior to pour to ensure they are tight [Section 11.2].	• See above.

TABLE 7.4.8-1 Cont'd

Potential Effect	Pump Station Facility	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
1.2 Potential contamination of wetland function (*i.e.,* habitat, hydrology, biogeochemistry) due to a spill during construction	Blackpool Kingsvale Power line	LSA	• Prevent water that contacts uncured or partly cured concrete during activities such as exposed aggregate wash-off, wet curing or equipment washing from directly or indirectly entering a watercourse /wetland/lake [Section 11.2]. • Maintain the identified separation distances between the following areas and a waterbody when constructing the facility site, unless otherwise approved: - fuel or hazardous material storage site - 300 m; - cleared area - 100 m; - burning site - 100 m; - subsoil pile - 100 m; and - oil change area - 100 m. • Ensure that during construction no fuel, lubricating fluids, hydraulic fluids, methanol, antifreeze, herbicides, biocides, or other chemicals are released on the ground or into any watercourse or wetland. In the event of a spill, implement the Spill Contingency Plan (see Appendix B) [Section 7.0]. • See additional spill prevention measures related to hazardous material storage and refuelling in Section 7.0 of the Facilities EPP.	• Reduction of wetland habitat, hydrological and biogeochemical function in the event of a spill from stored equipment during construction (depending on the volume and type of substance spilled).

Notes: 1 LSA = Wetland LSA.

2. Detailed mitigation measures are outlined in the Facilities EPP (Volume 6C).

7.4.8.3 Potential Residual Effects

The potential residual environmental effects on the wetland indicator of the Project activities at pump station facilities (Table 7.4.8-1) are:

- loss or alteration of wetland function (*i.e.,* habitat, hydrological, biogeochemical) during and following construction activities until vegetation is re-established, grade and natural flow patterns are restored and until sedimentation is controlled; and
- reduction of wetland habitat, hydrological and biogeochemical function in the event of a spill from stored equipment during construction (depending on the volume and type of substance spilled).

7.4.8.4 Significance Evaluation of Potential Residual Effects

The quantitative analysis revealed that there are approximately 0.6 ha of potential wetland located within the Blackpool Pump Station existing boundary. However, disturbance associated with the proposed pump station facility expansions at this station are not expected to affect this wetland due to the focus of the expansion works on areas that have already been disturbed and the possibility to avoid working within the wetland boundaries during construction. For the Kingsvale power line, it is unknown at this time the exact area which may be disturbed by the power line structures until a route and placement of these structures has been finalized.

Table 7.4.8-2 provides a summary of the significance evaluation of the potential residual environmental effects of the construction and operations of the Project activities at pump station facilities on wetlands. The rationale used to evaluate the significance of each of the residual environmental effects is provided below.

TABLE 7.4.8-2

SIGNIFICANCE EVALUATION OF POTENTIAL RESIDUAL EFFECTS OF PROJECT ACTIVITIES AT PUMP STATION FACILITIES ON WETLAND LOSS OR ALTERATION

Potential Residual Effects	Impact Balance	Spatial Boundary[1]	Temporal Context: Duration	Temporal Context: Frequency	Temporal Context: Reversibility	Magnitude	Probability	Confidence	Significance[2]
1. Wetland Loss or Alteration – Wetland Function									
1(a) Loss or alteration of wetlands of High Functional, High-Moderate, Low-Moderate and Low Functional Condition (*i.e.,* habitat, hydrology, biogeochemistry).	Negative	LSA	Short-term	Isolated	Medium to long-term	Low	High	High	Not significant
1(b) Contamination of wetland function (*i.e.,* habitat, hydrology, biogeochemistry) due to a spill during construction.	Negative	LSA	Immediate	Accidental	Short to long-term	Low to high	Low	High	Not significant

Notes: 1 LSA = Wetland LSA.

2. Significant Residual Environmental Effect: A high probability of occurrence of a permanent or long-term residual effect of high magnitude that cannot be technically or economically mitigated.

The significance evaluation of alteration of potential contamination of wetland function due to a spill during construction was determined to be the same for the construction and operations of Project activities at pump station facilities as for pipeline construction and operations. The exception is frequency which is isolated. Table 7.2.8-3 and the accompanying discussion in Section 7.2.8.6 provide an evaluation of potential residual effects of Project activities at pump station facilities, including power lines, and their significance on the wetland function indicator.

Wetland Loss or Alteration Indicator – Wetland Function

As with the effects assessment for the pipeline construction and operations, Project activities along power lines (*e.g.,* Kingsvale) may result in a potential loss or alteration of wetland function through a loss of wetland area. Trans Mountain will discuss any reduced function loss with Environment Canada.

Construction activities at the Blackpool Pump Station are not anticipated to affect wetland habitat function. However, construction activities at structure locations along the Kingsvale power line may potentially disturb wetland area resulting in a reduction in wetland habitat function. This is considered to have a negative impact balance. Given that many of the wetlands in the area around the proposed Kingsvale power line have been affected by existing anthropogenic disturbance, the possibility that a slight reduction in wetland area does not result in an overall loss of wetland function, and/or by fulfilling any potential compensation requirements through consultation with Environment Canada, the magnitude of the residual effect of the loss of wetland area and reduction of wetland habitat function is considered to be low. It is anticipated that this residual effect can be reversible in the long-term since wetland function will not be reclaimed until the end of the life of the operating power line. The proposed power line works could result in a reduction to the wetland footprint. Any reduction will be discussed with Environment Canada to see if compensation is required. The time for any compensation measures to become effective is conservatively estimated to be in the medium to long-term depending on the scope for the potential wetland compensation projects (Table 7.4.8-2, point 1[a]).

The construction of the proposed power line works may alter wetland hydrological function along the Kingsvale power line. The residual effect is limited to the Wetland LSA, permanent and of low magnitude. The potential changes to hydrologic flow (*i.e.,* surface or groundwater flow) of wetlands as a result of construction or operations activities at the Blackpool Pump Station and along the Kingsvale power line may include wetland drainage, water diversion and natural flow impedance. Each of these alterations is an interruption to the natural hydrologic regime and is considered an adverse environmental effect. The vertical and horizontal water movements in wetlands are easily disrupted. The hydraulic conductivity of the wetland's substrate can be affected by compaction or mixing of the soil structure. Excessive wetland drainage or diversion will result in an unnatural decrease to wetland area while flow impedance (*i.e.,* inadequate drainage) modifies or creates wetland habitat. Loss of wetland hydrological function may occur along the Kingsvale power line at structure locations, however, by fulfilling potential compensation requirements through consultation with Environment Canada wetland hydrological function will be enhanced at the chosen restoration site resulting in a reversibility of the effect of medium to long-term. The time for the compensation measures to become effective is conservatively estimated to be in the short to long-term depending on the scope for the wetland compensation projects.

Activity in or near wetlands during the proposed pump station and power line works may result in increased sediment deposition and turbidity of surface waters, thereby decreasing overall biogeochemical function. Additionally, permanent infilling is detrimental to a wetland's capacity to reduce overland flow and provide sediment retention. However, given the application of sedimentation control mitigation measures (*i.e.,* sediment fencing) for adjacent wetlands, the likelihood of alteration to nearby wetlands is reduced. Other detrimental effects regarding loss of wetland biogeochemistry capacity include the potential for loss of groundwater quality as a result of interference with shallow groundwater movement and changes to nutrient levels due to flow impedance. The impact balance of the loss of biogeochemical function is considered to be negative. With the implementation of a wetland compensation plan to be carried out through either reclamation, restoration or financial contribution, the potential loss of wetland biogeochemical function is considered to be reversible in the medium to long-term and of low magnitude.

A summary of the rationale for all of the significance criteria of effects on wetland function (*i.e.,* habitat, hydrological and biogeochemical) is provided below (Table 7.4.8-2, point 1[a]).

- Spatial Boundary: Wetland LSA – loss of wetland function (*i.e.,* habitat, hydrological and biogeochemical) resulting from pump station facility expansion.
- Duration: short-term – the events causing the loss of wetland function are construction activities.
- Frequency: isolated – loss of wetland function (*i.e.,* habitat, hydrological and biogeochemical) occurs during the construction phase of the Project.
- Reversibility: medium to long-term – loss of wetland function reversibility depends on the growth time of wetland species (medium-term) found within the restoration/enhancement site and the time for biogeochemical processes in the restoration/enhancement site to be restored/created (medium to long-term), the reversibility of the residual effect may take longer than one year with the possibility of being greater than 10 years.
- Magnitude: low – with the implementation of compensation, there will be no net loss of wetlands (for all effects).
- Probability: high – the proposed pump station facilities encounter some wetlands and disturbances within these wetlands will likely occur during construction activities at the pump stations.
- Confidence: high – based on available research literature, results of mitigation measures and post-construction environmental monitoring programs of past pipeline projects and the professional experience of the assessment team.

7.4.8.5 Summary

As identified in Table 7.4.8-2, there are no situations where there is a high probability of occurrence of a permanent or long-term residual environmental effect on the wetland indicator of high magnitude that cannot be technically or economically mitigated. Consequently, it is concluded that the residual environmental effects associated with Project activities at pump station facilities on wetland loss or alteration will be not significant.

7.4.9 Vegetation

Sections 7.2.9.1 and 7.2.9.2 provide the assessment indicators, measurement endpoints and spatial boundaries for the assessment of potential effects of the Project activities at pump station facilities on vegetation.

7.4.9.1 Ecological Context

Activities that require clearing of land have the potential to affect vegetation. The Project includes six pump station locations that will require clearing of previously undisturbed land (*i.e.,* Gainford, Hinton, Black Pines, Kingsvale, Rearguard and Sumas). The Gainford, Sumas, Rearguard, Kingsvale and Hinton pump stations will require minimal clearing of existing trees and are located adjacent to several other disturbances such roads and existing rights-of-way. Therefore, activities at these pump stations are not expected to have a notable effect on vegetation. The Kingsvale power line and the Black Pines Pump Station and associated power line will require substantial clearing and, therefore, have the potential to affect vegetation. There are no pump stations or power lines in the BG BGC that will require clearing of previously undisturbed land. The introduction and spread of weeds has the potential to occur during any anthropogenic disturbance and, therefore, considered with all pump stations.

Section 7.2.9.3 provides further details on the ecological context for vegetation.

7.4.9.2 Potential Effects and Mitigation Measures

<u>Identified Potential Effects</u>

Potential effects associated with the construction and operations of the proposed pump stations and power lines on vegetation indicators are listed in Table 7.4.9-1. These interactions are based on the results of the literature review, available research literature, desktop analysis, field work, modelling and TEK, engagement with Aboriginal communities, landowners, regulatory authorities, stakeholders and the general public (Section 3.0) and the professional experience of the assessment team.

The summary of mitigation measures provided in Table 7.4.9-1 was principally developed in accordance with Trans Mountain standards as well as industry and provincial regulatory guidelines as described in Section 7.2.9.4.

TABLE 7.4.9-1

POTENTIAL EFFECTS, MITIGATION MEASURES AND RESIDUAL EFFECTS OF PROJECT ACTIVITIES AT PUMP STATION FACILITIES ON VEGETATION

Potential Effect	Pump Station Facilities	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
1. Vegetation Indicator – Vegetation Communities of Concern				
1.1 Alteration of native vegetation	Gainford Hinton Rearguard Black Pines Pump station Power line Kingsvale Power line	Footprint	• The proposed pump station facilities have been sited to utilize existing disturbances as much as practical and the proposed Project Footprint kept to a minimum to reduce loss of native vegetation to the maximum extent feasible. • Confine all pre-clearing/mowing and general clearing activities within the staked/flagged facility construction boundaries. Adhere to clearing restrictions associated with special environmental features and buffer areas in addition to those areas outlined in the resource-specific mitigation tables (see Appendices E to Q) [Section 8.1]. • Use hand clearing methods where directed by the Inspector to avoid or reduce disturbance to the ground surface on sensitive terrain [Section 8.1]. • Restrict root grubbing in wet areas, where practical, to avoid creation of bog holes [Section 8.1]. • Install temporary erosion control on exposed moderately to highly erodible soils where there is potential for water or wind erosion prior to re-establishment of vegetation [Section 8.4].	• Loss or alteration of the composition of 11 ha of native vegetation.

TABLE 7.4.9-1 Cont'd

Potential Effect	Pump Station Facilities	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
1.1 Alteration of native vegetation (cont'd)	See above	See above	• Seed the topsoil/root zone material immediately with a cereal grass cover crop species (see Section 8.0), unless otherwise directed by the Lead Activity Inspector and the Inspector, to reduce the risk of erosion [Section 11.0] • Schedule construction on native grasslands to occur when ground conditions are dry or frozen, where feasible [Section 11.0].	• See above.
1.2 Alteration of rare ecological communities	Gainford Hinton Rearguard Black Pines Pump station Power line Kingsvale Power line	LSA	• See potential effect 1.1 of this table for mitigation regarding alteration of native vegetation. • For wetland ecological communities of concern, refer to mitigation measures detailed in Table 7.4.8-1. • Upon discovery of a rare ecological community, refer to the mitigation measures provided in Rare Ecological Community and Rare Plant Population Management Plan [Appendix C, Section 4.0]. • Review mitigation measures of rare plants/rare ecological communities with Trans Mountain's Inspector(s) in advance of construction to ensure there is full understanding of the procedures involved [Section 7.0]. • Refer to environmental resource-specific mitigation tables for rare plants/rare ecological communities provided in Appendix J and as shown on the Facility Environmental Drawings.	• Some disturbance or alteration of a rare ecological community, if avoidance is not practical and mitigation measures do not completely protect a site. • If rare ecological communities are located adjacent to the pump stations they may be indirectly affected by changes in hydrology or light levels.
2. Vegetation Indicator – Plant and Lichen Species of Concern				
2.1 Loss or alteration of rare plant and/or lichen occurrences	Gainford Hinton Rearguard Black Pines Pump station Power line Kingsvale Power line	LSA	• Vegetation surveys were conducted at Gainford, Hinton, Black Pines, and Kingsvale pump stations. See Section 9.0 for details regarding supplemental surveys. • See potential effect 1.1 of this table for mitigation measures regarding alteration of native vegetation. • Flag or fence-off resource-specific environmental features (*e.g.,* rare plant species, rare ecological communities) prior to commencing construction in the vicinity of the resource site [Section 6.0]. See additional measures in Section 8.6 of the Pipeline EPP. • Water down construction sites and access roads, when warranted, to reduce or avoid the potential for dust emissions. Increase the frequency of watering roads and sites during periods of high risk (*e.g.,* high winds). Implement additional dust abatement measures (*e.g.,* covering topsoil windrows, installing sediment fences, applying a tackifier) will be implemented, when warranted, during clearing and construction activities. See additional measures to control dust in Section 8.1 of the Facilities EPP. • Recontour the landscape to pre-construction conditions during decommissioning [Section 6.0 of Appendix C].	• Some disturbance or alteration of a rare plant or lichen occurrence, if avoidance is not practical and mitigation measures do not completely protect a site. • If rare plant and lichen sub-populations are located adjacent to the pump stations they may be affected by changes in hydrology or light levels.

TABLE 7.4.9-1 Cont'd

Potential Effect	Pump Station Facilities	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
3. Vegetation Indicator – Presence of Infestations of Provincial Weed Species and Other Invasive Non-Native Species Identified as a Concern				
3.1 Weed introduction and spread	All	RSA	• Conduct a pre-construction weed survey at each TMEP facility site. Flag areas identified as having noxious weed infestations prior to commencement of construction [Section 6.0]. • Follow recommendations made in the pre-construction weed survey to limit the risk of spreading weed seeds [Section 6.0]. • Implement weed management (*i.e.*, using proper application of herbicides, mowing, or a combination of both) at locations identified within the pre-construction weed survey to a level that is consistent with weed management observed adjacent to the facility site to reduce the potential for weed infestations following construction. Refer to the Weed and Vegetation Management Plan provided in Appendix C [Section 6.0]. • Ensure equipment arrives at all construction sites clean and free of soil or vegetative debris. Inspect and identify equipment deemed to be in appropriate condition with a suitable marker, such as a sticker. Any equipment arriving in a dirty condition will not be allowed on-site until it has been cleaned [Section 7.0]. • Consider implementing the Weed and Vegetation Management Plan as necessary (see Appendix C) [Section 7.0]. • Immediately record any sites located outside of the facility site development zone where equipment was specifically cleaned due to concerns associated with weeds and communicate to the Inspector [Section 7.0]. • Monitor weed growth on topsoil/root zone material piles during the course of construction and conduct corrective measures (*i.e.*, spraying), if warranted [Section 7.0]. • Conduct basic shovel and sweep cleaning before moving equipment from any locations identified as having a Prohibited Noxious or Noxious weed infestation (see Weed and Vegetation Management Plan and Agriculture Management Plan in Appendix C) [Section 7.0]. • Additional mitigation measures to reduce weed growth and spread may be warranted if topsoil/root zone material replacement is delayed due to construction scheduling [Section 7.0]. • Refer to environmental resource-specific mitigation tables for vegetation provided in Appendix J [Section 7.0]. • Use only Certified Canada No. 1 or the best available agronomic seed. For native seed, the highest seed grade available will be obtained. Do not accept seed lots that contain any Prohibited Noxious or Noxious weeds as identified in the Certificate of Analysis. Retain the Certificates of Analysis obtained for both agronomic and native seed for future documentation. The Certificates of Analysis will be presented to the landowner/Crown land authority upon request [Section 8.6].	• Weed introduction and spread.

Notes: 1 LSA = Vegetation LSA; RSA = Vegetation RSA.
2 Detailed mitigation measures are outlined in the Facilities EPP (Volume 6C).

7.4.9.3 Potential Residual Effects

The potential residual environmental effects on vegetation indicators of Project activities at pump station facilities (Table 7.4.9-1) are:

- alteration of the composition of 11 ha of native vegetation;
- some disturbance or alteration of a rare ecological community, if avoidance is not practical and mitigation measures do not completely protect a site;
- if rare ecological communities are located adjacent to the pump stations they may be indirectly affected by changes in hydrology or light levels;
- some disturbance or alteration of a rare plant or lichen occurrence, if avoidance is not practical and mitigation measures do not completely protect a site;
- if rare plant or lichen sub-populations are located adjacent to the pump stations they may be affected by changes in hydrology or light levels; and
- weed introduction and spread.

7.4.9.4 Significance Evaluation of Potential Residual Effects

Table 7.4.9-2 provides a summary of the significance evaluation of the potential residual environmental effects of the construction and operations of Project activities at pump station facilities on vegetation. The rationale used to evaluate the significance of each of the residual environmental effects is provided below.

TABLE 7.4.9-2

SIGNIFICANCE EVALUATION OF POTENTIAL RESIDUAL EFFECTS OF PROJECT ACTIVITIES AT PUMP STATION FACILITIES ON VEGETATION

	Potential Residual Effects	Impact Balance	Spatial Boundary[1]	Temporal Context			Magnitude	Probability	Confidence	Significance[2]
				Duration	Frequency	Reversibility				
1.	Vegetation Indicator – Vegetation Communities of Concern									
1(a)	Loss or alteration of the composition of 11 ha of native vegetation.	Negative	Footprint	Short-term	Periodic	Medium to long-term	Low to medium	High	High	Not significant
1(b)	Some disturbance or alteration of a rare ecological community, if avoidance is not practical and mitigation measures do not completely protect a site.	Negative	Footprint	Short-term	Isolated	Medium to long-term	Medium	Low	High	Not significant
1(c)	If rare ecological communities are located adjacent to the pump stations they may be indirectly affected by changes in hydrology or light levels.	Negative	LSA	Short-term	Isolated	Medium to long-term	Low	Low	Moderate	Not significant
2.	Vegetation Indicator – Plant and Lichen Species of Concern									
2(a)	Some disturbance or alteration of a rare plant occurrence, if avoidance is not practical and mitigation measures do not completely protect a site.	Negative	Footprint	Short-term	Periodic	Medium to long-term	Medium	High	High	Not significant
2(b)	Some disturbance or alteration of a rare lichen occurrence, if avoidance is not practical and mitigation measures do not completely protect a site.	Negative	Footprint	Short-term	Periodic	Short to medium-term	Medium	Low	High	Not significant
2(c)	If rare plant sub-populations are located adjacent to the pump station they may be affected by changes in hydrology or light levels.	Negative	LSA	Short-term	Periodic	Short to long-term	Low	High	High	Not significant

TABLE 7.4.9-2 Cont'd

Potential Residual Effects		Impact Balance	Spatial Boundary[1]	Temporal Context			Magnitude	Probability	Confidence	Significance[2]
				Duration	Frequency	Reversibility				
2(d)	Combined effects on the plant and lichen species of concern indicator (2[a] and 2[b]).	Negative	LSA	Short-term	Periodic	Medium to long-term	Medium	High	High	Not significant
3.	Vegetation Indicator – Presence of Infestations of Provincial Weed Species and Other Invasive Non-Native Species Identified as a Concern									
3(a)	Weed introduction and spread.	Negative	RSA	Short-term	Periodic	Short to medium-term	Low to medium	High	High	Not significant

Notes: 1 LSA = Vegetation LSA; RSA = Vegetation RSA.

2 Significant Residual Environmental Effect: A high probability of occurrence of a permanent or long-term residual effect of high magnitude that cannot be technically or economically mitigated.

The significance evaluation of potential residual effects on most of the vegetation indicators was determined to be the same for the construction and operations of Project activities at pump station facilities as for pipeline construction and operations. The exception is the probability of the event causing the residual effects for the vegetation communities of concern indicators 1(b) and 1(c), which for the pump station facilities is considered low due to the unlikely occurrence of rare ecological communities within the footprint and LSA of the Project activities. Table 7.2.9-3 and the accompanying discussion in Section 7.2.9.6 provide an evaluation of potential residual effects of Project activities at pump station facilities, including power lines, and their significance on the applicable vegetation indicator.

7.4.9.5 Summary

As identified in Table 7.4.9-2, there are no situations where there is a high probability of occurrence of a permanent or long-term residual environmental effect on the vegetation indicators of high magnitude that cannot be technically or economically mitigated. Consequently, is it concluded that the residual environmental effects associated with Project activities at pump stations on vegetation will be not significant.

7.4.10 Wildlife and Wildlife Habitat

Activities that require clearing of previously undisturbed lands have the potential to affect Wildlife and Wildlife Habitat. The Project includes four pump station locations that will require clearing of previously undisturbed land (*i.e.,* Gainford, Hinton, Black Pines, Kingsvale) (Table 7.4-1 in Section 7.4). The Gainford and Hinton pump stations will require minimal clearing of existing trees and are located adjacent to several other disturbances such roads and existing rights-of-way. Therefore, the habitat value at the Gainford and Hinton pump stations is expected to be low and activities are not expected to have a notable effect on Wildlife and Wildlife Habitat beyond that which is covered in the pipeline effects assessment (Section 7.2). The Black Pines and Kingsvale pump stations and their associated power lines will require substantial clearing of lands that habitat value. Therefore, activities at the Black Pines and Kingsvale pump stations and their associated power lines have the potential to affect Wildlife and Wildlife Habitat. Pump stations that will not require clearing of previously undisturbed lands are not expected to have a notable effect on Wildlife and Wildlife Habitat (*i.e.,* Edmonton, Niton, Wolf, Edson, Jasper, Rearguard, Blue River, Blackpool, Darfield, Kamloops and Sumas Pump Station).

The assessment of effects on wildlife and wildlife habitat has been conducted considering all the Project components in an integrated manner (*e.g.,* pipeline, temporary facilities, pump stations [including power lines], tanks, other ancillary facilities, and the Westridge Marine Terminal), since the components will have similar effect pathways (*i.e.,* change in habitat movement and mortality risk) on wildlife indicators and disaggregation of effects by Project component is not meaningful at an individual or population level for wildlife indicators.

The assessment of effects on wildlife and wildlife habitat for the Project as a whole is presented in Section 7.2.10. Table 7.2.10-6 and accompanying discussion in Section 7.2.10.9 provide the evaluation of potential residual effects of pump station activities on mammal indicators, Table 7.2.10-9 and accompanying discussion in Section 7.2.10.10 provide the evaluation of potential residual effects of pump station activities on bird indicators, Table 7.2.10-12 and accompanying discussion in Section 7.2.10.11 provide the evaluation of potential residual effects of pump station activities on amphibian indicators, and Table 7.2.10-15 and accompanying discussion in Section 7.2.10.12 provide the evaluation of potential residual effects of pump station activities on the reptile indicator.

7.4.11 Species at Risk

The construction and operations of Project activities at pump stations and power line may affect fish, vegetation and wildlife species at risk. Section 7.2.11 provides a discussion of the fish and wildlife species used as indicators for species at risk. Vegetation species at risk are considered under the plant and lichen species of concern indicator. Although not all species at risk are discussed explicitly under each indicator, potential Project effects were assessed in consideration of all species at risk. The indicators used to represent fish and fish habitat, vegetation and wildlife and wildlife habitat were carefully selected to ensure that the full range of potential Project effects on species at risk was addressed and measures to reduce these effects will apply to all species at risk, not just the indicators. Section 7.2.7 Fish and Fish Habitat, Section 7.2.9 Vegetation and Section 7.2.10 Wildlife and Wildlife Habitat provide the significance rationale for applicable indicator species. No significant adverse effects on species at risk have been identified as a result of the pipeline and facilities component of the Project.

7.5 Effects Assessment – Tank Installation and Operations

Preliminary assessment indicates that to accommodate the expanded pipeline operations, the Project will require a total of 20 additional tanks ranging in shell capacities from 75,000 bbl to 400,000 bbl to accommodate the expanded pipeline operations. Further study is underway to verify the number and capacities of the new tanks that are optimal to support the expanded system. The location, number and capacity of the new tanks are identified in Table 7.5-1.

TABLE 7.5-1

PROJECT TANKS AND ASSOCIATED TERMINAL WORK

Terminal	Number of New Tanks	Disturbance of Previously Undisturbed Areas	Activities
Edmonton, AB	5	No	• Four new tanks will be installed (2 x 34,980 m^3 [220,000 bbl] and 2 x 63,600 m^3 [400,000 bbl]) • An existing 12,720 m^3 (80,000 bbl) tank will be dismantled and a new 11,920 m^3 (75,000 bbl) tank will be installed • On-site access roads to each new tank • Power requirements/upgrades
Sumas, BC	1	Yes	• One new 27,820 m^3 (175,000 bbl) tank will be installed • On-site access road to the new tank • Relocate existing power line • Clearing of treed area and grading
Burnaby, BC	14	Yes (disturbance to natural watercourse within existing fenceline)	• 14 new tanks will be installed (2 x 39,750 m^3 [250,000 bbl], 10 x 45,310 m^3 [285,000 bbl] and 2 x 53,260 m^3 [335,000 bbl]) • One 12,720 m^3 (80,000 bbl) existing tank will be dismantled and replaced by one of the 45,310 m^3 (285,000 bbl) tanks • New scraper facilities for new pipeline (receiving) and Westridge delivery lines (sending) • Power requirements/upgrades will be determined by BC Hydro • On-site access roads to each new tank and other associated facilities

A detailed description of the proposed tank activities is provided in Section 2.0 of this volume and in Volume 2.

Using the assessment methodology described in Section 7.1, the following subsections evaluate the potential environmental effects arising from the construction and operations of the proposed tanks and associated terminal work.

Environmental elements potentially interacting with the construction and operations of the proposed tanks are identified in Table 7.5-2. The table also describes the rationale for those environmental elements which are not considered to interact with proposed tank activities and associated terminal work. Spatial boundaries for the assessment of pump station facilities are the same as in the applicable subsection of Section 7.2 unless otherwise noted.

TABLE 7.5-2

ELEMENT INTERACTION WITH THE PROPOSED TANKS AND ASSOCIATED TERMINAL WORK

Element	Interaction with Proposed Tanks	
	Construction	Operations[1]
Physical and Meteorological Environment	Yes	Yes
Soil and Soil Productivity	Yes	Yes
Water Quality and Quantity	Yes	Yes
Air Emissions	Yes	Yes
GHG Emissions	Yes	Yes
Acoustic Environment	Yes	Yes
Fish and Fish Habitat	Yes	Yes
Wetland Loss or Alteration	No – wetlands are not expected to be disturbed by construction of storage tanks and associated activities	No - wetlands are not expected to be disturbed operations.
Vegetation	Yes	Yes
Wildlife and Wildlife Habitat	Yes	Yes
Species At Risk	Yes	Yes

Note: 1 Activities during operations include maintenance activities and vegetation management (*e.g.*, weed control).

7.5.1 Physical and Meteorological Environment

Sections 7.2.1.1 and 7.2.1.2 provide the assessment indicators, measurement endpoints and spatial boundaries for the assessment of potential effects of proposed tanks and terminal work on the physical environment.

7.5.1.1 Physical Environment Context

Grading will be required at Burnaby and Sumas terminals in order to accommodate the storage tanks and associated infrastructure.

7.5.1.2 Potential Effects and Mitigation Measures

Identified Potential Effects

Potential effects associated with the construction and operations of storage tanks and associated terminal work were based on the results of the literature review, desktop analysis and the professional experience of the assessment team.

A summary of mitigation measures provided in Table 7.5.1-1 was principally developed in accordance with Trans Mountain standards and industry and provincial regulatory guidelines as described in Section 7.2.1.4.

TABLE 7.5.1-1

POTENTIAL EFFECTS, MITIGATION MEASURES AND RESIDUAL EFFECTS OF CONSTRUCTION AND OPERATIONS OF THE PROPOSED TANKS AND ASSOCIATED TERMINAL WORK ON PHYSICAL ENVIRONMENT

Potential Effect		Terminal	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
1.	Physical Environment Indicator – Terrain Instability				
1.1	Terrain instability	Sumas Burnaby	LSA	• See recommended mitigation measures provided in Table 7.4.1-1 Physical Environment.	• No residual effect identified.
2.	Physical Environment Indicator – Topography				
2.1	Alteration of topography	Sumas Burnaby	LSA	• See recommended mitigation measures provided in Table 7.4.1-1 Physical Environment.	• Alteration of topography at Sumas and Burnaby terminals where grading is required.

Notes: 1 LSA = Physical Environment LSA.

2 Detailed mitigation measures are outlined in the Facilities EPP (Volume 6C).

7.5.1.3 Potential Residual Effects

The potential residual environmental effect on physical environment indicators associated with storage tanks and associated terminal work is topography will be altered at Sumas and Burnaby terminals where grading is required (Table 7.5.1-1).

Potential terrain instability resulting from construction and operations of storage tanks and associated terminal work is concluded not to have a residual effect because instability potential is predicted to be eliminated through the implementation of mitigation measures (Table 7.5.1-1).

7.5.1.4 Significance Evaluation of Potential Residual Effects

Table 7.5.1-2 provides a summary of the significance evaluation of the potential residual environmental effects on physical environment indicators resulting from construction and operations of storage tanks and associated terminal work. The rationale used to evaluate the significance of the residual environmental effect is provided below.

TABLE 7.5.1-2

SIGNIFICANCE EVALUATION OF POTENTIAL RESIDUAL EFFECTS OF CONSTRUCTION AND OPERATIONS OF THE PROPOSED TANKS AND ASSOCIATED TERMINAL WORK ON PHYSICAL ENVIRONMENT

Potential Residual Effects		Impact Balance	Spatial Boundary[1]	Temporal Context			Magnitude	Probability	Confidence	Significance[2]
				Duration	Frequency	Reversibility				
1.	Physical Environment Indicator – Topography									
1(a)	Alteration of topography at Sumas and Burnaby terminals where grading is required.	Negative	Footprint	Short-term	Isolated	Permanent	Low	High	High	Not significant

Notes: 1 LSA = Physical Environment LSA.

2 Significant Residual Environmental Effect: A high probability of occurrence of a permanent or long-term residual effect of high magnitude that cannot be technically or economically mitigated.

The significance evaluation of alteration of topography at the Sumas and Burnaby terminals (Table 7.5.1-2, point 1[a]) was determined to be the same for the construction and operations of new storage tanks as for as for pump station construction and operations (Table 7.5.1-2, point 1[a]).

Table 7.4.1-2 and the accompanying discussion in Section 7.4.1.4 provide an evaluation of this potential residual effect of new storage tanks and its significance on the applicable physical environment indicator.

7.5.1.5 Summary

As identified in Table 7.5.1-2, there are no situations where there is a high probability of occurrence of a permanent or long-term residual environmental effect on the physical environment indicator of high magnitude that cannot be technically or economically mitigated. Consequently, it is concluded that the residual environmental effects associated with construction and operations of the proposed tanks and associated terminal work on the physical environment will be not significant.

7.5.2 Soil and Soil Productivity

Sections 7.2.2.1 and 7.2.2.2 provide the assessment indicators, measurement endpoints and spatial boundaries for the assessment of potential effects of proposed tanks and terminal work on soil and soil productivity.

7.5.2.1 Soil Context

Disturbance to soils is expected at the Sumas Terminal and Burnaby Terminal. Section 7.2.2.3 provides additional context on soils.

7.5.2.2 Potential Effects and Mitigation Measures

Identified Potential Effects

Potential effects associated with the construction and operations of the proposed tanks and associated terminal work on soil and soil productivity indicators are listed in Table 7.5.2-1. These interactions were based on the results of the literature review, desktop analysis and the professional experience of the assessment team.

A summary of mitigation measures provided in Table 7.5.2-1 was principally developed in accordance with Trans Mountain standards as well as industry and provincial regulatory guidelines as described in Section 7.2.2.4.

TABLE 7.5.2-1

POTENTIAL EFFECTS, MITIGATION MEASURES AND RESIDUAL EFFECTS OF CONSTRUCTION AND OPERATIONS OF THE PROPOSED TANKS AND ASSOCIATED TERMINAL WORK ON SOIL AND SOIL PRODUCTIVITY

Potential Effect	Terminal	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
1. Soil Indicator – Soil Productivity				
1.1 Decreased topsoil/root zone material productivity during topsoil/root zone material salvaging	Sumas Burnaby	Footprint	• See recommended mitigation measures outlined in Table 7.4.2-1 Soil and Soil Productivity.	• Mixing of topsoil/root zone material and subsoil.
1.2 Decreased soil productivity from flooding of soil as a result of release of hydrostatic test water on land	All	LSA	• See recommended mitigation measures outlined in Table 7.4.2-1 Soil and Soil Productivity.	• No residual effect identified.
1.3 Decreased soil productivity from soil diseases (*i.e.,* clubroot disease and potato cyst nematode)	Sumas	LSA	• See recommended mitigation measures outlined in Table 7.4.2-1 Soil and Soil Productivity.	• Clubroot disease introduction and spread. Potato cyst nematode introduction and spread.
2. Soil Indicator – Soil Degradation				
2.1 Degradation of soil structure due to compaction and rutting	Sumas Burnaby	Footprint	• See recommended mitigation measures outlined in Table 7.4.2-1 Soil and Soil Productivity.	• Degradation of soil structure and impairment of rooting zone due to compaction and rutting.
2.2 Loss of topsoil/root zone material through wind and water erosion	Sumas Burnaby	Footprint	• See recommended mitigation measures outlined in Table 7.4.2-1 Soil and Soil Productivity.	• Surface erosion of topsoil/root zone material can be expected until a vegetative cover is established.

TABLE 7.5.2-1 Cont'd

Potential Effect	Terminal	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
2.3 Degradation of soil structure due to pulverization of soil and sod	Sumas Burnaby	Footprint	• See recommended mitigation measures outlined in Table 7.4.2-1 Soil and Soil Productivity.	• Pulverization resulting in fugitive dust and loss of soil structure can be expected during dry conditions.
2.4 Erosion of soil as a result of release of hydrostatic test water on land	All	LSA	• See recommended mitigation measures outlined in Table 7.4.2-1 Soil and Soil Productivity.	• No residual effect identified.
3. Soil Indicator – Soil Contamination				
3.1 Disturbance of previously contaminated soil	All	Footprint	• See recommended mitigation measures outlined in Table 7.4.2-1 Soil and Soil Productivity.	• No residual effect identified.
3.2 Contamination of soil as a result of hydrostatic test water on land	All	LSA	• See recommended mitigation measures outlined in Table 7.4.2-1 Soil and Soil Productivity.	• No residual effect identified.
3.3 Soil contamination due to spot spills during construction	All	Footprint	• See recommended mitigation measures outlined in Table 7.4.2-1 Soil and Soil Productivity.	• No residual effect identified.

Notes: 1 LSA = Soil LSA.
2 Detailed mitigation measures are outlined in the Facilities EPP (Volume 6C).

7.5.2.3 Potential Residual Effects

The potential residual environmental effects on soil and soil productivity indicators of the construction and operations of the proposed tanks and associated terminal work (Table 7.5.2-1) are:

- mixing of topsoil/root zone material and subsoil;
- clubroot disease and potato cyst nematode introduction and spread;
- degradation of soil structure and impairment of rooting zone due to compaction and rutting;
- surface erosion of topsoil/root zone material can be expected until a vegetative cover is established; and
- pulverization resulting in fugitive dust and loss of soil structure can be expected during dry conditions.

Some of the potential effects on element indicators of the construction and operations of the proposed tanks and associated terminal work are predicted to be eliminated through the implementation of mitigation measures (Table 7.5.2-1). The potential effects determined not to have a residual effect are:

- decreased soil productivity from flooding of soil as a result of release of hydrostatic test water on land;
- erosion of soil as a result of release of hydrostatic test water on land;
- disturbance of previously contaminated soil;
- contamination of soil as a result of hydrostatic test water on land; and
- soil contamination due to spot spills during construction.

7.5.2.4 Significance Evaluation of Potential Residual Effects

Table 7.5.2-2 provides a summary of the significance evaluation of the potential residual environmental effects on soil and soil productivity indicators associated with construction and operations of the proposed tanks and associated terminal work.

TABLE 7.5.2-2

SIGNIFICANCE EVALUATION OF POTENTIAL RESIDUAL EFFECTS OF CONSTRUCTION AND OPERATIONS OF THE PROPOSED TANKS AND ASSOCIATED TERMINAL WORK ON SOIL AND SOIL PRODUCTIVITY

				Temporal Context						
	Potential Residual Effects	Impact Balance	Spatial Boundary[1]	Duration	Frequency	Reversibility	Magnitude	Probability	Confidence	Significance[2]
1.	Soil Indicator – Soil Productivity									
1(a)	Mixing of topsoil/root zone material and subsoil.	Negative	Footprint	Short-term	Isolated	Long-term	Low	High	High	Not significant
1(b)	Clubroot disease and potato cyst nematode introduction and spread.	Negative	LSA	Short-term	Accidental	Long-term	High	Low	Moderate	Not significant
2.	Soil Indicator – Soil Degradation									
2(a)	Degradation of soil structure and impairment of rooting zone due to compaction and rutting.	Negative	Footprint	Short-term	Isolated	Short to medium-term	Low	High	High	Not significant
2(b)	Surface erosion of topsoil/root zone material can be expected until a vegetative cover is established.	Negative	Footprint	Short-term	Isolated	Medium-term	Low	High	High	Not significant
2(c)	Pulverization resulting in fugitive dust and loss of soil structure can be expected during dry conditions.	Negative	Footprint	Short-term	Isolated	Short to medium-term	Low	Low to high	High	Not significant
2(d)	Combined effects on the soil degradation indicator (2[a] to 2[c]).	Negative	Footprint	Short-term	Isolated	Short to medium-term	Low	High	High	Not significant

Notes: 1 LSA = Soil LSA.

2 Significant Residual Environmental Effect: A high probability of occurrence of a permanent or long-term residual effect of high magnitude that cannot be technically or economically mitigated.

The significance evaluation of the potential residual effects on the soil productivity indicator and soil degradation indicator (Table 7.5.2-2, points 1[a] and 1[b], and 2[a] to 2[d] respectively), was determined to be the same for the construction and operations of new storage tanks as for pump station construction and operations. The exception is the reversibility of mixing of topsoil/root zone material and subsoil (point 1[a]), which is considered long-term where topsoil is stored in berms (similar to pump stations as noted in Table 7.4.2-2). Table 7.4.2-2 and the accompanying discussion in Section 7.4.2.4 provide an evaluation of potential residual effects of the proposed tanks and associated terminal work and their significance on the applicable element indicator.

7.5.2.5 Summary

As identified in Table 7.5.2-2, there are no situations where there is a high probability of occurrence of a permanent or long-term residual environmental effect on soil and soil productivity indicators of high magnitude that cannot be technically or economically mitigated. Consequently, it is concluded that the residual environmental effects associated with the construction and operations of the proposed tanks and associated terminal work on soil and soil productivity will be not significant.

7.5.3 Water Quality and Quantity

Sections 7.2.3.1 and 7.2.3.2 provide the assessment indicators, measurement endpoints and spatial boundaries for the assessment of potential effects of the proposed tanks and terminal work on water quality and quantity.

7.5.3.1 Water Quality and Quantity Context

No work will occur within 30 m of any watercourses or waterbodies at the Edmonton Terminal or the Sumas Terminal. The headwaters of Eagle Creek are within the existing property boundaries of the Burnaby Terminal and will be within 30 m of planned work. Eagle Creek drains into Burnaby Lake, which flows south via the Brunette River into the Fraser River.

Water discharge volumes are not expected to increase from construction and operations of new tanks at the Edmonton Terminal. However, an incremental increase in volume of stormwater discharge is anticipated at the Sumas and Burnaby terminals. Stormwater at the Sumas Terminal is discharged into a wet area identified through desktop review to be a potential shrubby swamp associated with an ephemeral drainage (to be confirmed during supplemental studies [see Section 9.0]). Given the limited areal requirements associated with the additional tank proposed at the terminal, this area is not anticipated to be affected by any resulting incremental increases in stormwater discharge. Stormwater at the Burnaby Terminal, however, is discharged into the Eagle Creek watershed, which may experience an increase in stormwater discharge as a result of the 14 proposed storage tanks.

Hydrostatic testing is planned for the piping and new tanks to be installed within the terminals. Water may be withdrawn and released from Trans Mountain’s existing fire water ponds at the terminals. Alternatively, test water may be diverted from a nearby river, subject to obtaining a water withdrawal permit, or purchased from municipalities depending on availability from natural sources. Following testing, water will be tested for contaminants before being treated and either discharged back into the fire water pond, trucked away, or released to a natural water body or the municipal sewer system.

Alteration of natural surface drainage patterns may occur during construction and operations of the storage tanks, particularly where considerable grading is required at the Sumas and Burnaby terminals.

Section 6.1 provides additional setting information related to water quality and quantity at the Edmonton, Sumas and Burnaby terminals.

7.5.3.2 Potential Effects and Mitigation Measures

<u>Identified Potential Effects</u>

Potential effects associated with construction and operations of the proposed tanks and associated terminal work on the water quality and quantity indicators listed in Table 7.5.3-1 were based on the results of the literature review, desktop analysis, engagement with Aboriginal communities, regulatory authorities, stakeholders and the general public (Section 3.0), and the professional experience of the assessment team. Note that no interactions between proposed tanks and associated terminal work and groundwater indicators were predicted and, consequently, no potential effects were identified.

A summary of mitigation measures provided in Table 7.5.3-1 was principally developed in accordance with Trans Mountain standards and industry and provincial regulatory guidelines as discussed in Section 7.2.3.4.

TABLE 7.5.3-1

POTENTIAL EFFECTS, MITIGATION MEASURES AND RESIDUAL EFFECTS OF CONSTRUCTION AND OPERATIONS OF THE PROPOSED TANKS AND ASSOCIATED TERMINAL WORK ON WATER QUALITY AND QUANTITY

Potential Effect	Terminal	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
1. Water Quality and Quantity Indicator – Surface Water Quality				
1.1 Suspended sediment in water column	Burnaby	LSA	• Install erosion and sediment control structures and materials (*e.g.,* sediment berms) and implement, as warranted, erosion control measures outlined in the Soil Erosion and Sediment Control Contingency Plan [Appendix B]. • See recommended mitigation measures outlined in Table 7.4.3-1 Water Quality and Quantity.	• Reduction in surface water quality due to suspended sediment during construction and operations of new storage tanks at the Burnaby Terminal.
1.2 Potential contamination from stormwater discharge during operations	Edmonton Sumas Burnaby	LSA	• Ensure the stormwater management system at the facility sites is expanded to accommodate additional tanks, as applicable [Section 7.0]. • Construct and operate storage tanks and stormwater management systems in accordance with provincial and federal requirements, including the CCME *Environmental Code of Practice for Aboveground and Underground Storage Tank Systems Containing Petroleum and Allied Petroleum Products.* • Conduct all stormwater quality sampling and monitoring in compliance with existing, amended or new provincial discharge permit conditions.	• No residual effect identified.
1.3 Alteration or contamination of aquatic environment as a result of withdrawal and release of hydrostatic test water	Edmonton Sumas Burnaby	LSA	• Obtain all applicable regulatory authority approvals for water withdrawal and discharge to allow for hydrostatic testing of the facility and ensure conditions of approvals are satisfied during water withdrawal for hydrostatic testing [Section 8.3]. • Conduct hydrostatic testing activities in accordance with the *NEB OPR*, provincial legislation, Transport Canada's *Minor Works for Water Intakes* as well as the latest version of CSA Z662 and *BC Oil and Gas Waste Regulation* Section 7(2)(e), BC Reg. 254/2005 [Section 8.3]. • Collect samples of source water, hydrostatic test water and soil of the receiving environment and analyze according to the parameters listed in Water Withdrawal and Discharge Procedures Management Plan [Appendix C] [Section 8.3]. • Ensure that water trucks, if used to transport test water to the fill site, are clean [Section 8.3]. • Follow all measures outlined in the Water Withdrawal and Discharge Procedures Management Plan and in the Water Withdrawal and Discharge Form [see Appendix C] related to test water withdrawal and dewatering [Sections 8.3]. • Employ sediment reduction methods (*e.g.,* sediment mat, sediment fence, sand bag, coffer dam), where warranted, to prevent increased sedimentation or reduced water quality where excavation of a sump in the substrate of the watercourse is necessary [Section 8.3]. • Isolate test pumps, generators and fuel storage tanks with an impermeable lined dike or depression to capture and retain any spills of fuels or lubricants [Section 8.3]. • Recover all remaining water and water contaminants (*e.g.,* methanol) in tanks and return to the supplier or dispose of contaminated test water at approved sites/facilities [Section 8.3]. • Recover methanol or methanol/water mix, if used, and return to supplier or dispose of in accordance with appropriate government legislation. Ensure the method and location of disposal has been approved by Trans Mountain and is in accordance with applicable legislation [Section 8.3].	• Alteration or contamination of aquatic environment as a result of withdrawal and release of hydrostatic test water.

TABLE 7.5.3-1 Cont'd

Potential Effect	Terminal	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
1.3 Alteration or contamination of aquatic environment as a result of withdrawal and release of hydrostatic test water (cont'd)	See above	LSA	• Ensure that if test water contains chemical additives, the test water is sampled and treated, if warranted, and discharged in accordance with applicable federal and provincial requirements directed by the appropriate regulatory authority [Section 8.3]. • Dewater onto approved areas where water will be filtered through vegetation and soils before returning to a watercourse/wetland/lake. Provide scour protection (*e.g.,* use of rock aprons, plastic sheeting, plywood, straw bales) or an energy diffuser (*e.g.,* cone with baffles, frog's foot) at the discharge site as directed by Trans Mountain. The rate of discharge will be reduced if these measures are ineffective [Section 8.3]. • See Section 7.5.2 Soil and Soil Productivity for discussion on the release of hydrostatic test water on land. • See Section 7.2.5 Infrastructure and Services of Volume 5B for discussion on potential effect of withdrawal of hydrostatic test water on downstream water users.	• See above.
1.4 Reduction of surface water quality due to small spill during construction	Edmonton Sumas Burnaby	LSA	• See recommended mitigation measures outlined in Table 7.4.3-1 Water Quality and Quantity.	• Contamination of surface water due to a small spill during construction.
2. Water Quality and Quantity Indicator – Surface Water Quantity				
2.1 Localized alteration of natural surface drainage patterns during construction and operations	Edmonton Sumas Burnaby	LSA	• Provide surface drainage of adequate capacity across the facility site and other Project-related facilities [Section 7.0]. • Install drainage features that ensure no off-site originating runoff will be allowed to enter the proposed development area [Section 7.0]. • Inspect all water conveyance installations (*e.g.,* ditches and culverts) and ensure they are functioning appropriately. Take appropriate action prior to and during the spring freshet to clear culverts blocked by ice or debris [Section 7.0]. • Discharge runoff from stormwater containment ponds in compliance with maximum authorized rates of discharge as per existing provincial permit conditions. • See recommended mitigation measures outlined in Table 7.4.3-1 Water Quality and Quantity.	• Localized alteration of natural surface drainage patterns at the Edmonton, Sumas and Burnaby terminals. • Localized alteration of natural streamflow patterns at the Burnaby Terminal. • Localized alteration of natural streamflow patterns downstream of the Burnaby Terminal.

Notes: 1 LSA = Water Quality and Quantity LSA.
2 Detailed mitigation measures are outlined in the Facilities EPP (Volume 6C).

7.5.3.3 Potential Residual Effects

The potential residual environmental effects on water quality and quantity indicators of the construction and operations of the proposed tanks and associated terminal work (Table 7.5.3-1) are:

- reduction in surface water quality due to suspended sediment during construction and operations of new storage tanks at the Burnaby Terminal;
- alteration or contamination of aquatic environment as a result of withdrawal and release of hydrostatic test water;
- contamination of surface water from a small spill during construction;
- localized alteration of natural surface drainage patterns at the Edmonton, Sumas and Burnaby terminals;
- localized alteration of natural streamflow patterns at the Burnaby Terminal; and

- localized alteration of natural streamflow patterns downstream of the Burnaby Terminal.

Potential contamination from stormwater discharge during operations is concluded not to have a residual effect because contamination potential is predicted to be eliminated through the implementation of mitigation measures (Table 7.5.3-1).

7.5.3.4 Significance Evaluation of Potential Residual Effects

Table 7.5.3-2 summarizes the significance evaluation of the potential residual environmental effects on water quality and quantity indicators associated with construction and operations of the proposed tanks and associated terminal work.

TABLE 7.5.3-2

SIGNIFICANCE EVALUATION OF POTENTIAL RESIDUAL EFFECTS OF CONSTRUCTION AND OPERATIONS OF THE PROPOSED TANKS AND ASSOCIATED TERMINAL WORK ON WATER QUALITY AND QUANTITY

	Potential Residual Effects	Impact Balance	Spatial Boundary[1]	Temporal Context			Magnitude	Probability	Confidence	Significance[2]
				Duration	Frequency	Reversibility				
1.	Water Quality and Quantity Indicator – Surface Water Quality									
1(a)	Reduction in surface water quality due to suspended sediment during construction and operations of new storage tanks at the Burnaby Terminal.	Negative	LSA	Short-term	Isolated to occasional	Immediate to short-term	Low	High	High	Not significant
1(b)	Alteration or contamination of aquatic environment as a result of withdrawal and release of hydrostatic test water.	Negative	LSA	Short-term	Isolated	Immediate to short-term	Low	Low	High	Not significant
1(c)	Contamination of surface water due to a small spill during construction.	Negative	LSA	Immediate	Accidental	Short to medium-term	Low to high	Low	Moderate	Not significant
2.	Water Quality and Quantity Indicator – Surface Water Quantity									
2(a)	Localized alteration of natural surface drainage patterns at the Edmonton, Sumas and Burnaby terminals.	Negative	LSA	Short-term	Isolated to occasional	Short to long-term	Low	High	High	Not significant
2(b)	Localized alteration of natural streamflow patterns at the Burnaby Terminal.	Negative	LSA	Short-term	Continuous	Permanent	Medium	High	High	Not significant
2(c)	Localized alteration of natural streamflow patterns downstream of the Burnaby Terminal.	Negative	RSA	Immediate to short-term	Periodic	Medium-term to permanent	Low	Low	Moderate	Not significant
2(d)	Combined effects on the surface water quantity indicator (2[a] and 2[b]).	Negative	LSA	Short-term	Isolated	Short-term to permanent	Low to medium	High	High	Not significant

Notes: 1 LSA = Water Quality and Quantity LSA.

2 Significant Residual Environmental Effect: A high probability of occurrence of a permanent or long-term residual effect of high magnitude that cannot be technically or economically mitigated.

The significance evaluation of alteration or contamination of aquatic environment as a result of withdrawal and release of hydrostatic test water and contamination of surface water due to a spill during construction was determined to be the same for the construction and operations of new storage tanks as for new pipeline segments (Table 7.5.3-2, points 1[b] and 1[c]). Table 7.2.3-3 and the accompanying discussion in Section 7.2.3.6 provide an evaluation of these potential residual effects of new storage tanks and their significance on the surface water quality indicator. In addition, evaluation of significance of reduction in surface water quality due to suspended sediment during construction and operations of new storage tanks at the Burnaby Terminal and localized alteration of natural surface drainage patterns at the Edmonton, Sumas and Burnaby terminals was determined to be the same as pump station construction and operations (Table 7.5.3-2, points 1[a] and 2[a]). The exception is the duration of the event which for tanks is considered to be short-term. Table 7.4.3-2 and the accompanying discussion in Section 7.4.3.4

provide an evaluation of these potential residual effects of new storage tanks and their significance on the applicable water quality and quantity indicator. The rationale used to evaluate the significance of each of the remaining residual environmental effects is provided below.

Water Quality and Quantity Indicator – Surface Water Quantity

The following provides the evaluation of significance of potential residual effects on the surface water quantity indicator.

Alteration of Natural Streamflow Patterns at the Burnaby Terminal

In order to avoid new disturbance beyond the existing Trans Mountain property, installation of the proposed 14 new storage tanks will result in permanent alteration of natural streamflow patterns of a segment of upper Eagle Creek and a number of its smaller tributaries located within the existing property. The impact balance of this potential residual effect is considered negative since it will alter or disrupt natural above ground hydrologic conditions at the Burnaby Terminal.

The current proposed diversion method is to expand the existing below ground conveyance system for Eagle Creek and its tributaries to accommodate new storage tanks at the north end of the Trans Mountain property. During a City of Burnaby Integrated Stormwater Management Visionary Workshop for Eagle Creek Watershed held in November 2012, a member of the Eagle Creek Streamkeepers Society voiced preference for an above ground conveyance system that reproduces more natural flow regimes. However, expanding the existing below ground water conveyance system was deemed the least impact approach to constructing and operating the proposed new storage tanks in the Eagle Creek watershed. Furthermore, expanding the below ground system was deemed to have the least risk to downstream water quality in the event of an accidental leak or spill during normal terminal operations.

During decommissioning and abandonment of the Burnaby Terminal, reclamation of upper Eagle Creek and its affected tributaries will be conducted with the goal of restoring natural streamflow patterns to be similar to pre-construction conditions. Recognizing complete restoration to exact pre-construction conditions will not be feasible. The residual effect is considered permanent, however, the effect is considered to be consistent with permit conditions and, therefore, is of medium magnitude (Table 7.5.3-2, point 2[b]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Water Quality and Quantity LSA – although alteration of natural streamflow patterns is generally confined to the disturbed portion of the Burnaby Terminal, potential changes in hydrology may extend beyond the terminal.
- Duration: short-term – the event causing alteration of natural streamflow is construction of the storage tanks.
- Frequency: continuous – alteration of natural streamflow in a below ground system will occur continuously during operations.
- Reversibility: permanent – although natural streamflow patterns will be re-established following decommissioning and abandonment, complete restoration to pre-Project conditions will not be possible.
- Magnitude: medium – the existing draining system will be expanded within existing Trans Mountain property, thereby reducing the overall effects to the watershed until natural streamflow patterns are restored similar to pre-construction conditions during decommissioning and abandonment.
- Probability: high – installation of culverts to direct flow will affect natural streamflow patterns.
- Confidence: high – based on operations of the existing conveyance systems to date at the Burnaby Terminal and the professional experience of the assessment team.

Alteration of Natural Streamflow Patterns Downstream of the Burnaby Terminal

During a City of Burnaby Integrated Stormwater Management Visionary Workshop for Eagle Creek Watershed held in November 2012, maintaining natural flow regimes and reducing the magnitude of flash discharge events was emphasized as an important aspect to reduce erosion and sedimentation and maintain or enhance watershed health. Construction of the additional proposed new storage tanks has the potential to reduce capacity of the watershed to store rainwater, thereby contributing to altered natural streamflow patterns of Eagle Creek downstream of the Burnaby Terminal. The impact balance of this potential residual effect is considered negative since it may alter or disrupt natural above ground hydrologic conditions downstream of the Burnaby Terminal.

Runoff from the Burnaby Terminal may potentially increase from vegetation loss, construction of new asphalt road surfaces and the addition of impermeable liners for tank secondary containment. The resulting reduced storage capacity of the watershed to store rainwater at the terminal has the potential to contribute to increased erosion and sedimentation along Eagle Creek downstream of the terminal during flash discharge events. Although the amount of stormwater discharge is expected to increase as a function of increased disturbance and development at the Burnaby Terminal, no considerable increase in the rate of stormwater discharge from the existing stormwater containment pond is anticipated. The potential for increased discharge rates from the stormwater containment pond will be determined during the detailed engineering and design phase of the Project.

Trans Mountain will incorporate expansion of the Burnaby Terminal into its existing stormwater monitoring program, whereby Trans Mountain will continue to monitor flash drainage events in an effort to identify potential effects and implement necessary measures to reduce or avoid Project-related effects to the Eagle Creek watershed. Consequently, any increased discharge volumes resulting from construction of the new storage tanks will comply with permit conditions and, therefore, is considered to be of low magnitude (Table 7.5.3-2, point 2[c]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Water Quality and Quantity RSA – alteration of natural streamflow patterns extend downstream of the Burnaby Terminal.
- Duration: immediate to short-term – the event causing alteration of natural streamflow is flash discharge events intensified from operations of the terminal, which may on occasion extend beyond two days.
- Frequency: periodic – the event causing alteration of natural streamflow (*i.e.,* flash discharge events from operations of the terminal) occurs intermittently but repeatedly during operations.
- Reversibility: medium-term to permanent – downstream alteration of natural streamflow patterns may cause permanent alteration to the watercourse unless restoration measures are implemented at identified areas.
- Magnitude: low – overall changes in downstream streamflow patterns resulting from increased discharge from the terminal are expected to be minimal.
- Probability: low – increased discharge resulting from expansion of the terminal is not anticipated to substantively contribute to alteration of downstream streamflow patterns.
- Confidence: moderate – based on current observations at the existing terminal and the professional experience of the assessment team, and pending determination of containment pond discharge rates during the detailed engineering and design phase of the Project.

Combined Effects on Surface Water Quantity

The combined effects evaluation considers the individual potential residual effects evaluated in Section 7.5.3.4 (points 2[a] and 2[b] of Table 7.5.3-2) that are likely to occur, and could act in combination on the surface water quantity indicator.

The following potential residual effects are likely to act in combination to result in overall effects on the surface water quantity indicator:

- localized alteration of natural surface drainage patterns at Edmonton, Sumas and Burnaby terminals; and

- localized alteration of natural streamflow patterns at the Burnaby Terminal.

The adverse effects identified have the potential to act in combination to affect surface water quantity at the Burnaby Terminal. The reversibility of this residual effect is considered short-term to permanent; short-term where construction workspace is required and full restoration is possible following construction, and permanent where complete restoration to pre-Project conditions may be difficult where considerable drainage pattern and streamflow alteration is required for operations. The magnitude of the combined effects on the surface water quantity indicator is considered to be low to medium since the combined effect is localized and will be reduced to the extent feasible through implementation of mitigation measures (Table 7.5.3-2, point 2[d]). A summary of the rationale for all of the significance criteria of combined effects on surface water quantity is provided below.

- Spatial Boundary: Water Quality and Quantity LSA – although alteration of surface drainage and streamflow patterns is generally confined to the disturbed portion of the Burnaby Terminal, potential changes in hydrology may extend beyond the terminal.
- Duration: short-term – the event causing alteration of natural streamflow is construction of the storage tanks.
- Frequency: isolated – the event causing the combined effects on the surface water quantity indicator (*i.e.,* terminal construction) will occur during construction.
- Reversibility: short-term to permanent – short-term where construction workspace is required and full restoration is possible following construction, and permanent where complete restoration to pre-Project conditions may be impossible where alteration of natural drainage and streamflow patterns is required for operations.
- Magnitude: low to medium – although the combined effect on the surface water quantity indicator will be reduced to the extent feasible through implementation of mitigation measures, natural drainage and streamflow patterns will not be restored similar to pre-construction conditions until decommissioning and abandonment.
- Probability: high – installation of culverts and permanent above ground structures will affect surface drainage and natural streamflow patterns.
- Confidence: high – based on operations of the existing conveyance systems to date at the Burnaby Terminal and the professional experience of the assessment team.

7.5.3.5 Summary

As identified in Table 7.5.3-2, there are no situations where there is a high probability of occurrence of a permanent or long-term residual environmental effect on the water quality and quantity indicators of high magnitude that cannot be technically or economically mitigated. Consequently, it is concluded that the residual environmental effects associated with construction and operations of the proposed tanks and associated terminal work on water quality and quantity will be not significant.

7.5.4 Air Emissions

7.5.4.1 Assessment Indicators and Measurement Endpoints

The selection of indicators for air emissions considered: filing requirements in the NEB *Filing Manual*; experience gained during previous projects with similar conditions/potential issues; initial feedback from Aboriginal engagement, landowners, regulatory authorities, stakeholders and the general public; available research literature; and the professional judgment of the assessment team. The assessment indicators and measurement endpoints used for the air emissions assessment for tank installation and operation are summarized in Table 7.5.4-1. The proposed air emission indicators were discussed during the Edmonton, Kamloops and Surrey ESA Workshops. There was general consensus among workshop participants that the proposed air emissions indicators were appropriate for evaluating effects of tank installation and operation on air emissions. Consideration was also given to Canadian National Ambient Air Quality Objectives, Canadian Ambient Air Quality Standards, Provincial Ambient Air Quality Objectives of Alberta and BC, and World Health Organization Guidelines. Input on indicator selection was sought from Environment Canada, BC MOE, FVRD, Metro Vancouver and PMV (Section 3.0); no additional indicators were suggested for consideration in assessment of tank installation and operation.

Both quantitative and qualitative measurement endpoints were applied to assess potential effects of tank installation and operation on the air emissions indicators. During tank installation, construction equipment will emit CACs including VOCs. During tank operations, Project-related CAC emissions are less than 50 gram per year, and H_2S and mercaptans emissions are also small (Table 7.2.4-2 in Section 7.2.4.3). The main emissions during tank operations are fugitive VOCs.

In addition to these direct emissions from tank operations, secondary pollutants will be formed from reactions between primary pollutants in the atmosphere. In the presence of sunlight, precursors such as NO_X and VOCs undergo a complex sequence of reactions to form ozone (O_3). In addition, secondary PM can be formed from reactions between NO_X, SO_X and ammonia (NH_3). Primary and secondary PM can absorb and scatter sunlight, causing haze and obscuring visibility. No modelling of secondary pollutant formation was performed for construction activities. During operations of tanks, only fugitive VOC emissions are anticipated to be released, and therefore, no effects on secondary PM and visibility are expected.

Advanced photochemical modelling was performed to estimate the difference in the formation of secondary PM and ozone between existing emissions and total emissions after the addition of Project related: CAC and VOC emissions in the LFV from increased shipping; fugitive emissions at tanks in the Burnaby and Sumas terminals; and CAC emissions from equipment and fugitive emissions from loading products on ships and tank storage at the Westridge Marine Terminal. Note that the chemical interaction between primary pollutants and the formation of secondary ozone is non-linear, in particular, are not additive. It is therefore not possible to determine the contribution of tank operations, only, to overall ozone formation in the LFV.

TABLE 7.5.4-1

ASSESSMENT INDICATORS AND MEASUREMENT ENDPOINTS FOR AIR EMISSIONS FROM TANK INSTALLATION AND OPERATION

Air Emissions Indicators	Measurement Endpoint	Rationale for Indicator Selection
Primary emissions of criteria air contaminants and speciated volatile organic compounds	• Emissions from tank construction and comparison to existing emissions • Emissions from increased storage tanks and comparison to emissions from existing storage tanks • Predicted levels of ground-level concentrations and comparison to ambient air quality criteria	The selection of indicators and measurement endpoints considered NEB *Filing Manual* requirements for air emissions in Table A-2, addressed concerns raised by participants of the ESA Workshops and were informed by regulators (*i.e.*, Environment Canada, BC MOE, Metro Vancouver, FVRD, PMV).
Formation of secondary ozone	• Predicted levels of ambient ground-level ozone concentrations and comparison to ambient air quality criteria	
Hydrogen sulphide (H_2S) and mercaptans emissions which have the potential to cause nuisance odours	• Predicted levels of ambient ground-level concentrations and comparison to odour detection thresholds	

7.5.4.2 Spatial Boundaries

The spatial boundaries for the study areas for primary pollutant emissions, secondary formation of PM2.5 and ozone, and visibility are provided in Section 7.2.4.2.

7.5.4.3 Project Associated Air Emissions

Estimated air emissions from tank installation and operation (net change from existing conditions) are described in Section 7.2.4.3 and summarized in Table 7.2.4-2.

7.5.4.4 Potential Effects and Mitigation Measures

Identified Potential Effects

Potential effects that are associated with the construction and operations of the proposed tanks and associated terminal work on air emissions listed in Table 7.5.4-2 were based on the results of the desktop analysis, field work, modelling, consultation with regulatory authorities, stakeholders, and the general public (Section 3.0), and the professional experience of the assessment team.

A summary of the mitigation measures provided in Table 7.5.4-2 was principally developed in accordance with Trans Mountain standards, accepted facility construction methods for construction-related activities, and preliminary design engineering, where emission control techniques (TVAUs) were identified to reduce fugitive emissions of H_2S and VOCs at the Sumas and Burnaby terminals.

TABLE 7.5.4-2

POTENTIAL EFFECTS, MITIGATION MEASURES AND RESIDUAL EFFECTS OF CONSTRUCTION AND OPERATIONS OF THE PROPOSED TANKS AND ASSOCIATED TERMINAL WORK ON AIR EMISSIONS

Potential Effect	Terminal	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
1. Air Emissions Indicator – Primary Emissions of Criteria Air Contaminants and Volatile Organic Compounds				
1.1 Primary emissions of criteria air contaminants	All	RSA	• Trans Mountain will consult with and inform landowners of the potential to be affected by emissions from construction activities prior to commencement of these activities in proximity to the respective landowners [Section 7.0]. • Restrict the duration that vehicles and equipment are allowed to sit and idle to less than one hour unless air temperatures are less than 0°C [Section 7.0]. • Ensure equipment is well-maintained during construction to minimize air emissions [Section 7.0]. • Use multi-passenger vehicles for the transportation of crews to and from the job sites, where feasible [Section 7.0].	• Increase in ambient ground-level concentrations of CACs during construction of storage tanks.
1.2 Primary emissions of volatile organic compounds	All	RSA	• Install TVAUs at Sumas and Burnaby terminals. • All Project-related storage tanks are required to adhere to CCME standards that will reduce fugitive VOC emissions.	• Fugitive emissions released to atmosphere create increase in ambient ground-level concentrations of VOCs.
2. Air Emissions Indicator – Formation of Secondary Particulate Matter and Ozone				
2.1 Formation of secondary ozone	Sumas Burnaby	LFV	• All Project-related storage tanks are required to adhere to CCME standards that will reduce air emissions.	• Increase in ambient ground-level concentrations of ozone.
3. Air Emissions Indicator – Hydrogen Sulphide and Mercaptans Emissions				
3.1 Emissions of H_2S and mercaptans	All	RSA	• Install TVAUs at Sumas and Burnaby. • All Project-related storage tanks are required to adhere to CCME standards that will reduce fugitive VOC emissions.	• Increase in ambient ground-level concentrations of H_2S and mercaptans.

Notes: 1 RSA = Air Quality RSA; LFV= Lower Fraser Valley.
2 Detailed mitigation measures are outlined in the Facilities EPP (Volume 6C).
3 Only Sumas and Burnaby terminal related emissions were modelled in the CMAQ model, because emissions from other terminals will not contribute to secondary ozone formation in the LFV, but mitigation measures and residual effects apply to all Project-related terminals.

7.5.4.5 Potential Residual Effects

The potential residual environmental effects on air emission indicators of the construction and operations of proposed tanks and associated terminal work (Table 7.5.4-2) are:

- an increase in ambient ground-level concentrations of CACs during construction of storage tanks;
- fugitive emissions released to the atmosphere create an increase in ambient ground-level concentrations of VOCs;
- an increase in ambient ground-level concentrations of ozone; and
- an increase in ambient ground-level concentrations of H_2S and mercaptans.

7.5.4.6 Significance Evaluation of Potential Residual Effects

A combination of a quantitative and qualitative assessment of air emissions was determined to be the most appropriate approach to evaluate the significance of potential residual environmental effects. Emissions from Project activities during the construction phase were estimated using available information (Table 7.2.4-2). A qualitative assessment of air emissions during maintenance activities was considered appropriate given the short duration of these activities and anticipated volumes of emissions, relying on the professional judgment of the assessment team.

No significant emissions of CACs are expected during tank operations; hence, dispersion modelling for CACs was not performed. Table 7.5.4-3 presents dispersion modelling results of increases in ambient concentrations of VOCs from Project-related tank operation at Edmonton, Sumas, and Burnaby terminals. Applicable regulatory objectives are available for Edmonton only (Alberta Ambient Air Quality Objectives, AESRD 2013b). These are shown to facilitate the evaluation of the magnitude of the increases in ambient ground-level concentrations of of VOCs. Increases are small and do not approach regulatory standards where available. Therefore, the magnitude for the residual effect is evaluated as low. Given similarly low predictions for Sumas and Burnaby and in the absence of applicable objectives, the same assessment of low magnitude was applied.

TABLE 7.5.4-3

DISPERSION MODELLING RESULTS FOR AMBIENT VOC CONCENTRATIONS FOR EMISSIONS FROM TANK OPERATION AND COMPARISON WITH APPLICABLE REGULATORY STANDARDS (EXPRESSED AS NET CHANGE FROM EXISTING CONDITIONS) (in µg/m^3)

Terminal	Pollutant	Averaging Period	Project	Objective[1]
Edmonton	Benzene	1-hour	0.25	30
		Annual	0.01	3
	Ethylbenzene	1-hour	0.02	2,000
	Toluene	1-hour	0.23	1,880
		24-hour	0.16	400
	Xylenes	1-hour	0.098	2,300
		24-hour	0.061	700
Sumas	Benzene	1-hour	0.09	N/A[2]
		Annual	-4.1E-07	N/A
	Ethylbenzene	1-hour	0.01	N/A
	Toluene	1-hour	0.07	N/A
		24-hour	0.02	N/A
	Xylenes	1-hour	0.02	N/A
		24-hour	0.01	N/A
Burnaby	Benzene	1-hour	1.69	N/A
		Annual	0.02	N/A
	Ethylbenzene	1-hour	0.50	N/A
	Toluene	1-hour	7.10	N/A
		24-hour	1.42	N/A
	Xylenes	1-hour	2.42	N/A
		24-hour	0.48	N/A

Notes: 1 Alberta Ambient Air Quality Objectives (AESRD 2013b).
2 N/A: not available.

Table 7.5.4-4 presents the results of photochemical modelling of secondary ozone and $PM_{2.5}$ and visibility. Shown are the differences between model predictions with combined emissions from increased Project-related marine vessel traffic and operations at Burnaby, Sumas and Westridge Marine Terminals and without these emissions sources. The values provided are spatial maxima over all land-based receptors. Concentration increases of ozone and $PM_{2.5}$ are small compared to current and future applicable standards; therefore their magnitude is rated low. No standard is applicable to visibility. A visibility reduction of one deciview (dv) is small but noticeable in a pristine environment with very good visibility (Colls and Tiwary 2009). The predicted visibility reduction of 3.9 dv in Table 7.5.4-4 is likely noticeable in the LFV, and a conservatively high assessment of medium magnitude was chosen.

TABLE 7.5.4-4

PHOTOCHEMICAL MODELLING RESULTS OVER LAND FOR OZONE, $PM_{2.5}$, AND VISIBILITY FOR COMBINED EMISSIONS FROM INCREASED PROJECT-RELATED MARINE VESSEL TRAFFIC AND OPERATIONS AT BURNABY, SUMAS, AND WESTRIDGE MARINE TERMINAL (EXPRESSED AS NET CHANGE FROM EXISTING CONDITIONS) AND COMPARISON WITH APPLICABLE REGULATORY STANDARDS

	Predicted[1]	Canada Wide Standard (2010)	CAAQS (2015)	CAAQS (2020)
Ozone (maximum rolling 8-hour average in ppb)[2]	0.3	65	63	62
$PM_{2.5}$ (maximum 24-hour average in µg/m^3)[3]	0.1	30	28	27
Visibility (maximum 1-hour in deciview[4])	3.9	N/A	N/A	N/A

Notes:
1 Maximum increase over land in the LFV predicted from Community Multiscale Air Quality (CMAQ) modelling of a ten-day episode of strong secondary formation from June 24 to July 3, 2006, caused by Project emissions.
2 Metric in Canada Wide Standard and Canadian Ambient Air Quality Standards (CAAQS) is the 3-year average of the annual 4th highest daily maximum 8-hour average concentrations.
3 Metric in Canada Wide Standard and CAAQS is the 3-year average of the annual 98th percentile of the daily 24-hour average concentrations.
4 The deciview or dv is unitless. The deciview scale is linear in relation to humanly perceived changes in visibility due to changes in air quality. For example a 400 km visual range corresponds to 0.0 dv, while a 4 km visual range is about 46 dv.

A quantitative assessment was performed for H_2S and mercaptans on the basis of dispersion modelling and odour detection thresholds. 3-minute and 10-minute averages for H_2S and total mercaptans, respectively, were calculated by scaling predictions of maximum 1-hour average ambient ground-level concentrations. The results for each terminal are presented in Table 7.5.4-5. No exceedances of odour detection thresholds are predicted.

TABLE 7.5.4-5

DISPERSION MODELLING RESULTS FOR H_2S AND TOTAL MERCAPTANS FOR TANK OPERATION (EXPRESSED AS NET CHANGE FROM EXISTING CONDITIONS) (in µg/m^3)

Component or Facility	H_2S Modelled Maximum 3-minute[2]	Total Mercaptans Modelled Maximum[1] 10-minute[2]
Edmonton[3]	0.0118	0.047
Sumas	0.0004	0.018
Burnaby	0.0108	0.024
Odour detection threshold	*13.1*[4]	*13*[4]

Notes:
1 No individual species within the chemical group of mercaptans nor other additional species were predicted to exceed known odour detection thresholds (see the Air Quality and Greenhouse Gas Technical Report of Volume 5C for further information).
2 3-minute and 10-minute averages were calculated from 1-hour modelled data based on the model guideline for Ontario (Ontario ministry of Environment [MOE] 2009).
3 9th highest Concentrations were used in lieu of 1-hour maximum concentrations based on the model guideline for Alberta (AESRD 2013a).
4 Odour detection threshold for H_2S is the geometric mean air odour detection threshold reported by AIHA (1989) and Total Mercaptans threshold is based on the Ontario Air Standard for Total Reduced Sulphur (Ontario MOE 2007).

Table 7.5.4-6 provides a summary of the significance evaluation of the potential residual environmental effects on air emissions indicators associated with construction and operation of the proposed tanks and associated terminal work.

TABLE 7.5.4-6

SIGNIFICANCE EVALUATION OF POTENTIAL RESIDUAL EFFECTS OF CONSTRUCTION AND OPERATIONS OF THE PROPOSED TANKS AND ASSOCIATED TERMINAL WORK ON AIR EMISSIONS

	Potential Residual Effects	Impact Balance	Spatial Boundary[1]	Temporal Context: Duration	Temporal Context: Frequency	Temporal Context: Reversibility	Magnitude	Probability	Confidence	Significance[2]
1.	Air Emissions Indicator – Primary Emissions of Criteria Air Contaminants and Volatile Organic Compounds									
1(a)	Increase in ambient ground-level concentrations of CACs during construction of storage tanks.	Negative	RSA	Short-term	Isolated	Short-term	Low	High	Moderate	Not significant
1(b)	Fugitive emissions released to atmosphere create increase in ambient ground-level concentrations of VOCs.	Negative	RSA	Long-term	Continuous	Long-term	Low	High	High	Not significant
1(c)	Combined effects on the primary emissions of CACs and VOCs indicator (1[a] and 1[b]).	Negative	RSA	Long-term	Continuous	Long-term	Low	High	Moderate	Not significant
2.	Air Emissions Indicator – Formation of Secondary Particulate Matter and Ozone									
2(a)	Increase in ambient ozone concentrations.	Negative	LFV	Long-term	Continuous	Long-term	Medium	High	Moderate	Not significant
3.	Air Emissions Indicator – Hydrogen Sulphide and Mercaptans Emissions									
3(a)	Increase in ambient ground-level concentrations of H_2S and mercaptans.	Negative	RSA	Long-term	Continuous	Long-term	Low	High	Moderate	Not significant

Notes: 1 RSA = Air Quality RSA; LFV= Lower Fraser Valley.

2 Significant Residual Environmental Effect: A high probability of occurrence of a permanent or long-term residual effect of high magnitude that cannot be technically or economically mitigated.

Air Emissions Indicator – Primary Emissions of Criteria Air Contaminants and Volatile Organic Compounds

The following provides the evaluation of significance of potential residual effects on the CACs and VOCs indicator.

Increase in Ambient Ground-level Concentrations of CACs During Construction of Storage Tanks

The increase in ambient ground-level concentrations of CACs is considered to have a negative impact balance. As shown in Table 7.5.4-6 point 1(a), the increase in ambient ground-level concentrations of CACs from construction is confined to the Air Quality RSA. Air emissions are expected to change ambient concentrations of CACs only during storage tank construction, therefore, the frequency is rated as isolated. The increase in CAC concentrations is likely measurable but small compared to BC and Alberta ambient objectives. Therefore, the magnitude is expected to be low. The probability of this occurring is high, because the construction equipment will emit CACs. Since the cause-effect relationships are well understood but detailed information on Project-specific construction equipment is unavailable, the confidence in the residual effects assessment is moderate. A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Air Quality RSA – changes to ambient ground-level concentrations of CACs from construction are expected to occur within the Air Quality RSA.
- Duration: short-term – the event resulting in emissions of CACs is storage tank installation which is limited to the construction phase of the Project.

- Frequency: isolated – the event resulting in emissions of CACs (*i.e.*, storage tank construction) is confined to a specific period.
- Reversibility: short-term – emissions of CACs will cease and increases in ambient ground-level concentrations will reverse within a few days at the end of the tank construction.
- Magnitude: low – the increase in ambient ground-level concentrations of CACs is expected to be small relative to existing conditions and not expected to approach regulatory limits.
- Probability: high – storage tank construction will result in emissions of CACs.
- Confidence: moderate – residual effects assessment is based on a good understanding of cause-effect relationships between construction and air emissions but reliant on vehicle and equipment estimates from previous projects.

Fugitive Tank Emissions Released to Atmosphere Create Increase in Ambient Ground-level Concentrations of VOCs

The increase in ambient ground-level concentrations of VOCs is considered to have a negative impact balance. As shown in Table 7.5.4-6 point 1(b), the increase in ambient ground-level concentrations of VOCs is confined to the Air Quality RSA. Emissions are expected to change ambient VOC concentrations continuously in the RSA due to the handling and storage of product. As shown in Table 7.5.4-3, the increase of VOC concentrations is likely measureable, but the only applicable objectives for Edmonton Terminal in Alberta are not approached at any terminal. Therefore, the change is considered to be of low magnitude. The residual effect will extend for more than 10 years over the life of the operating terminal and is, therefore, reversible in the long-term. The probability of this occurring is high, because fugitive emissions will occur. The cause-effect relationships are well understood and estimations of VOC emissions were based on design information for the Project. Therefore, confidence in the residual effects assessment is high. A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Air Quality RSA – changes to ambient ground-level concentrations of VOCs are expected to occur within the Air Quality RSA.
- Duration: long-term – fugitive emissions of VOCs and subsequent changes to ambient ground-level concentrations are expected to occur for the life of the operating facility and, therefore, are considered long-term.
- Frequency: continuous – fugitive emissions of VOCs will occur continuously throughout the operations phase due to working and standing losses of product.
- Reversibility: long-term – fugitive emissions of VOCs during operations at the terminals will extend over the operational life of the terminal. Fugitive emissions of VOCs cease when the facility is decommissioned.
- Magnitude: low – the increase in ambient ground-level concentrations of VOCs is expected to be small relative to existing conditions and not expected to approach regulatory limits.
- Probability: high – an increase in Project volumes of product being handled and stored will result in an increase in emissions of VOCs.
- Confidence: high – based on a good understanding of cause-effect relationships between the Project and air emissions.

Combined Effects of Tanks on Primary Emissions of CACs and VOCs

The increase in ambient ground-level concentrations of CACs and VOCs during tank installation and operation is considered to have a negative impact balance. As shown in Table 7.5.4-6 point 1(c), the combined increase in ambient ground-level concentrations of CACs and VOCs is confined to the Air Quality RSA. Emissions are expected to change ambient VOC concentrations continuously in the Air Quality RSA due to the handling and storage of product. The change is considered to be of low magnitude and reversible in the long-term. The probability of this occurring is high, and the confidence in the residual effects assessment is moderate, because Project-specific equipment information was not available for tank installation. A summary of the rationale for all of the significance criteria of combined effects on CACs and VOCs is provided below.

- Spatial Boundary: Air Quality RSA – combined effects on CACs and VOCs are expected to occur within the Air Quality RSA.
- Duration: long-term – combined effects on CACs and VOCs and subsequent changes to ambient ground-level concentrations are expected to occur for the operational life of the terminals and, therefore, are considered long-term.
- Frequency: continuous – the combined effects on CACs and VOCs reflect the fugitive emissions of VOCs which occur continuously due to working and standing losses of product.
- Reversibility: long-term – combined effects on CACs and VOCs reflect fugitive emissions of VOCs during operations at the terminals which will extend for the life of the operating terminal. Combined emissions are reversible as the fugitive emissions will cease when the facility is decommissioned.
- Magnitude: low – the combined effects on CACs and VOCs are expected to be small relative to existing conditions and not expected to approach regulatory limits.
- Probability: high – storage tank construction will result in emissions of CACs, and an increase in Project volumes of product being handled and stored will result in an increase in emissions of VOCs only.
- Confidence: moderate – based on a good understanding of cause-effect relationships between the Project and air emissions, but for tank construction it is reliant on vehicle and equipment estimates from previous projects.

Air Emissions Indicator - Formation of Secondary Particulate Matter and Ozone

The following provides the evaluation of significance of potential residual effects of tanks on the formation of secondary PM and ozone indicator.

Increase in Ambient Ozone Concentrations

The increase in ambient ground-level concentrations of ozone is considered to have a negative impact balance. As shown in Table 7.5.4-6 point 2(a), the increase in ambient ground-level concentrations of ozone is confined to the LFV photochemical model domain. Fugitive VOC emissions during tank operation will contribute chemical precursors for secondary pollutants continuously due to product working and standing losses from handling and storage. The photochemical modelling results in Table 7.5.4-3 show a small increase in ambient ground-level concentrations of ozone relative to existing concentrations; however, since monitoring stations in the eastern part of the Lower Fraser Valley show ozone concentrations close to Canadian Ambient Air Quality Standards, the increase of ambient ground-level concentrations is interpreted as approaching the standard and, therefore, considered to be of medium magnitude. Since the residual effect continues over the life of the operating terminal, reversibility is long-term. The probability of this occurring is high, because the photochemical modelling suggests that there will be an increase in ambient ground-level ozone concentrations as a result of increased precursor emissions in the LFV. Confidence in the residual effects assessment is moderate; while the assessment is based on a good understanding of cause-effect relationships between the Project, air emissions, and atmospheric reactions, there is uncertainty with respect to non-Project emissions, and atmospheric chemical reactions are complex. A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: LFV – changes to ambient ground-level concentrations of ozone are expected to occur within the Lower Fraser Valley within the LFV photochemical modelling domain.

- Duration: long-term – emissions of precursors and subsequent changes to ambient ground-level concentrations of ozone are expected to occur for the operational life of the terminals and, therefore, are considered long-term.
- Frequency: continuous – fugitive precursor (VOC) emissions occur continuously during tank operations.
- Reversibility: long-term – fugitive emissions of VOCs which are chemical precursors for secondary pollutants will extend for the operational life of the terminal. All VOC emissions are reversible as the fugitive emissions will cease when the facility is decommissioned.
- Magnitude: medium – the increase in ambient ground-level concentrations of ozone is expected to be small relative to existing concentrations, but for some areas within the LFV might approach Canadian Ambient Air Quality Standards for ozone.
- Probability: high – an increase in Project-related product storage and handling in tanks will result in precursor (VOC) emissions, which will contribute to secondary ozone formation.
- Confidence: moderate – based on a good understanding of cause-effect relationships between the Project, air emissions, and atmospheric reactions; however, there is uncertainty with respect to non-Project emissions, and atmospheric chemical reactions are complex.

Air Quality Indicator – Fugitive Hydrogen Sulphide and Mercaptans

The following provides the evaluation of significance of potential residual effects on the hydrogen sulphide and mercaptans emissions indicator.

Increase in Ambient Ground-level Concentrations of H_2S and Mercaptans

The increase in ambient ground-level concentrations of H_2S and mercaptans is considered to have a negative impact balance because of the associated odour nuisance in cases when the odour detection threshold is exceeded. As shown in Table 7.5.4-6 point 1(b), the increase in ambient ground-level concentrations of H_2S and mercaptans is confined to the Air Quality RSA. Emissions are expected to change ambient H_2S and mercaptans concentrations continuously in the RSA due to the handling and storage of product. As shown in Table 7.5.4-5, the Project-related increases of H_2S and mercaptans concentrations are well below their respective odour detection thresholds. Therefore, the potential residual effect is considered to be of low magnitude. The residual effect will extend for more than 10 years over life of the operating terminal and is, therefore, reversible in the long-term. The probability of this occurring is high, because H_2S and mercaptans emissions will occur and cause increases in ambient ground-level concentrations. The cause-effect relationships are well understood and estimations of H_2S and mercaptans emissions were based on design information for the Project. Therefore, confidence in the residual effects assessment is high. A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Air Quality RSA – changes to ambient ground-level concentrations of H_2S and mercaptans are expected to occur within the Air Quality RSA.
- Duration: long-term – emissions of H_2S and mercaptans and subsequent changes to ambient ground-level concentrations are expected to occur for the life of the operating terminal and, therefore, are considered long-term.
- Frequency: continuous – emissions of H_2S and mercaptans will occur continuously throughout the operations phase.
- Reversibility: long-term – emissions of H_2S and mercaptans during operations at the terminals will extend over the life of the operating terminal. Emissions of H_2S and mercaptans cease when the facility is decommissioned.

- Magnitude: low – the increase in ambient ground-level concentrations of H_2S and mercaptans is expected to cause odour nuisance at some locations but is not expected to approach regulatory limits.
- Probability: high – an increase in Project volumes of product being handled and stored will result in an increase in emissions of H_2S and mercaptans.
- Confidence: moderate – based on a good understanding of cause-effect relationships but assumptions were made for equipment based on previous project pending Project design.

7.5.4.7 Summary

As identified in Table 7.5.4-6, there are no situations where there is a high probability of occurrence of a permanent or long-term residual environmental effect on air emissions indicators of high magnitude that cannot be technically or economically mitigated. Consequently, it is concluded that the residual environmental effects associated with the construction and operation of the proposed tanks and associated terminal work on air emissions will not be significant.

7.5.5 Greenhouse Gas Emissions

As discussed in Section 7.2.5.3, during the installation of the proposed tanks and associated terminal work, site preparation, operation of vehicles and equipment, and other construction activities will result in GHG emissions. During operations, the main sources of direct GHG emissions will be regular transportation and equipment use during maintenance activities and normal operations, as well as fugitive emissions from working and standby losses from storage tanks and the fugitive emissions from the corresponding valves and connectors. Electricity consumption at the terminals, mainly by the booster pumps, will result in large amounts of indirect GHG emissions. Tank-related GHG emissions are summarized in Table 7.2.5-4.

The assessment of effects on GHG emissions has been conducted considering all the Project components in an integrated manner (*e.g.,* pipeline, temporary facilities, pump stations [including power lines], tanks, Westridge Marine Terminal and pipeline reactivation), since GHG emissions associated with the construction and operation of each Project component are aggregated for the Project as a whole and then compared to provincial and federal GHG inventory totals.

The assessment of effects on GHG emissions for the Project as a whole is presented in Section 7.2.5. Table 7.2.5-8 and accompanying discussion in Section 7.2.5.3 provide an evaluation of potential residual effects of tank installation and associated work on GHG indicators.

7.5.6 Acoustic Environment

Sections 7.2.6.1, 7.2.6.2 and 7.4.6 provide the assessment indicators, measurement endpoints, spatial boundaries and acoustic environment context for the assessment of potential effects of the proposed tanks and terminal work on the acoustic environment.

7.5.6.1 Potential Effects and Mitigation Measures

Identified Potential Effects

Potential effects associated with proposed tanks and terminal work on the acoustic environment indicators listed in Table 7.5.6-1 were based on the results of desktop analysis, modelling and engagement with Aboriginal communities, landowners, regulatory authorities, stakeholders and the general public (Section 3.0), and the professional experience of the assessment team.

A summary of mitigation measures provided in Table 7.5.6-1 was principally developed in accordance with Trans Mountain standards and industry and provincial regulatory guidelines as described in Section 7.2.6.4.

TABLE 7.5.6-1

POTENTIAL EFFECTS, MITIGATION MEASURES AND RESIDUAL EFFECTS OF CONSTRUCTION AND OPERATIONS OF THE PROPOSED TANKS AND ASSOCIATED TERMINAL WORK ON THE ACOUSTIC ENVIRONMENT

Potential Effect	Terminal	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
1. Acoustic Environment Indicator – Sound Levels				
1.1 Changes in sound levels during construction	All	LSA	• See recommended mitigation measures outlined in Table 7.4.6-1 Acoustic Environment.	• Increase in sound levels at terminals during construction period.
1.2 Changes in sound levels during operations	All	LSA	• Review and analyze equipment specifications to ensure sound emissions from mechanical equipment are equal to or less than the sound emissions used in the Terrestrial Noise and Vibration Technical Report. • See recommended mitigation measures outlined in Table 7.4.6-1 Acoustic Environment.	• Increase in continuous sound levels from operations of new equipment at terminals.

Notes: 1 LSA = Acoustic Environment LSA.
2 Detailed mitigation measures are outlined in the Facilities EPP (Volume 6C).

7.5.6.2 Residual Effects

The potential residual environmental effects on the acoustic environment indicators associated with proposed tanks and terminal work (Table 7.5.6-1) are:

- increases in sound levels at terminals during construction period; and
- Increase in continuous sound levels from operation of new equipment at terminals.

7.5.6.3 Significance of Residual Effects

Table 7.5.6-2 provides a summary of the significance evaluation of the potential residual environmental effects on the acoustic environment indicator resulting from proposed tanks and terminal work.

A quantitative assessment of the acoustic environment was determined to be the most appropriate approach to evaluate the significance of potential residual environmental effects for proposed tanks and terminal work. The evaluation of significance of each of the potential residual effects for the acoustic environment relies primarily on the magnitude, duration and extent of the potential change. The definitions for these elements are provided in Table 7.1-2. However, magnitude of residual effects requires further definition for the acoustic environment evaluation and is indicator specific. Magnitude for sound levels was defined in Section 7.4.6.3 based on a combination of the degree of compliance with provincial guidelines or legislation and the amount of change in the existing conditions that may be experienced.

TABLE 7.5.6-2

SIGNIFICANCE EVALUATION OF POTENTIAL RESIDUAL EFFECTS OF CONSTRUCTION AND OPERATIONS OF THE PROPOSED TANKS AND ASSOCIATED TERMINAL WORK ON THE ACOUSTIC ENVIRONMENT

Potential Residual Effects	Impact Balance	Spatial Boundary[1]	Temporal Context			Magnitude	Probability	Confidence	Significance[2]
			Duration	Frequency	Reversibility				
1. Acoustic Environment Indicator – Sound Levels									
1(a) Increase in sound levels during construction period.	Negative	LSA	Short-term	Isolated	Short-term	Low to medium	High	Moderate	Not Significant
1(b) Increase in continuous sound levels from operations of new tanks.	Negative	LSA	Long-term	Continuous	Long-term	Negligible to medium	High	Moderate	Not Significant
1(c) Combined effects on the sound levels indicator (1[a] and 1[b]).	Negative	LSA	Long-term	Continuous	Long-term	Negligible to medium	High	Moderate	Not Significant

Notes: 1 LSA = Acoustic Environment LSA.

2 Significant Residual Environmental Effect: A high probability of occurrence of a permanent or long-term residual effect of high magnitude that cannot be technically or economically mitigated.

Acoustic Environment Indicator – Sound Levels

Increase in Sound Levels During Construction Period

The potential for the increase in daytime or nighttime sound levels for human receptors associated with construction of proposed tanks and associated terminal work is considered to have a negative impact balance. Based on the results of the analysis in the Terrestrial Noise and Vibration Technical Report of Volume 5C, the spatial extent of changes to sound levels from construction at Edmonton, Sumas and Burnaby terminals were limited to within the Acoustic Environment RSA. However, the significance of changes is based on the compliance with regulatory guidance for noise. Compliance with regulatory requirements occurs within the Acoustic Environment LSA. The duration of the sounds experienced at receptors is dependent on the activity; each type of sound will last only for the particular phase of construction (*e.g.,* earthworks, tank construction, foundations).

The frequency of sound emissions during each construction activity will be isolated since construction is cyclic and involves use of mobile equipment and intermittent use of tools. All sound level changes are immediately reversible. As soon as construction activity stops, the sound level changes are reversed.

The results of predictive modelling for construction of new equipment at the terminal indicates the magnitude of changes in sound levels that will be experienced by people living within 1.5 km of a terminal. Noise controls that will be in use during the construction phase, particularly the use of silencers on mobile equipment and the implementation of a Noise Management Plan are expected to control the amount of sound to within acceptable levels as established in the Terrestrial Noise and Vibration Technical Report. Controlling the magnitude of sound levels also limits the spatial extent of the potential change.

The only variation in residual affects is the magnitude of potential effects. The definition for magnitude follows the construction descriptors found in Section 7.4.6.3. This varies depending on the distance between the construction activities and the surrounding receptors. As such, Table 7.5.6-3 presents a summary of the relevant parameters and resulting predicted magnitude.

TABLE 7.5.6-3

SUMMARY OF SOUND LEVEL MAGNITUDE FOR APPLICABLE TERMINAL CONSTRUCTION

Terminal Facility	Distance to Closest Receptor (m)	Predicted Sound Level (Leq in dBA)	Criteria		Magnitude
			BC OGC/AER Daytime PSL (dBA)	Health Canada Guidance (dBA)	
Edmonton, AB	No receptor within the Acoustic Environment LSA. Closest receptor is 1.9 km.	< 56	60	75	Low
Sumas, BC	60	85	60	75	High[1]
Burnaby, BC	50	86	66	75	High[1]

Note: 1 Without additional mitigation. A noise management plan focussed on urban construction is expected to manage these noise levels to a medium magnitude.

While the prediction results indicate there is potential for high magnitude effects at receptors due to construction noise, the predictions represent a snapshot of the highest expected activity. Normal construction sounds will vary throughout the day, and can be controlled through detailed planning and use of sound reduced equipment in densely populated areas. The detailed construction planning required to fully assess urban sound levels is not available at this stage of project planning. A detailed noise management plan to be prepared for use during construction in urban environments is expected to bring potential sound levels to within medium magnitude levels. A summary of the rationale for all of the significance criteria is provided below (Table 7.5.6-2, point 1[a]).

- Spatial Boundary: Acoustic Environment LSA – compliance with the AER *Directive 038* (ERCB 2007) and BC OGC *Noise Control Best Practices Guideline* (BC OGC 2009) are achieved within the Acoustic Environment LSA.
- Duration: short-term – the events causing changes in sound levels will occur only during the construction phase.
- Frequency: isolated – the events causing changes in sound levels will occur at residential dwellings during the construction phase
- Reversibility: short-term – the period over which the change in sound levels extends is the construction period. However, sound level changes will cease when construction activities have finished.
- Magnitude: low to medium – at the Edmonton Terminal, low magnitude effects are predicted; however, for Burnaby and Sumas terminals, high magnitude noise predictions can be mitigated to a medium effect by ensuring detailed noise management in urban areas.
- Probability: high – based on the proximity of residences to the terminals.
- Confidence: moderate – based on the nature of data inputs.

Increase in Continuous Sound Levels From Operations of Equipment

Noise from tank terminal operations will be continuous sound from pumping and support equipment located on these sites. Since these are expansions of existing terminals, sounds would be similar to those already generated on these sites.

The spatial extent of the sound would be limited to the Acoustic Environment LSA. The duration of the tank terminal sounds is long-term, throughout the life of the pipeline. The effect of an increase in sound levels during operations will extend for the life of the terminals and, consequently, is of long-term reversibility. However, the effect is reversible since the increase in sound levels cease as soon as the sound stops, which would be at tank decommissioning.

The only variation in residual affects is the magnitude of potential effects. The definition for magnitude follows the operation descriptors found in Section 7.4.6.3. This varies depending on the distance between the terminal and the surrounding receptors. As such, Table 7.5.6-4 presents a summary of the relevant parameters and resulting predicted magnitude.

TABLE 7.5.6-4

SUMMARY OF SOUND LEVEL MAGNITUDE FOR APPLICABLE TERMINAL OPERATION

Terminal Facility	Distance to Closest Receptor (m)	Predicted Sound Level (L_{eq} in dBA/%HA)	Criteria		Magnitude
			BC OGC/AER Nighttime PSL (dBA)	Health Canada Guidance (% HA)	
Edmonton, AB	No receptor within Acoustic Environment LSA. Compliance is demonstrated at Acoustic Environment LSA limit of 1.5 km.	36/1.2	40	6.5	Low
Sumas, BC	60	35/1.2	40	6.5	Negligible
Burnaby, BC	50	46/3.5	46	6.5	Medium

A summary of the rationale for all of the significance criteria is provided below (Table 7.5.6-2, point 1[b]).

- Spatial Boundary: Acoustic Environment LSA – compliance with the AER *Directive 038* (ERCB 2007) and BC OGC *Noise Control Best Practices Guideline* (BC OGC 2009) are achieved within the Acoustic Environment LSA.
- Duration: long-term – the event causing the increase in sound levels is the operation of the proposed tanks which occurs over the operational life of the terminals.
- Frequency: continuous – the event causing the increase in sound levels is the operation of the tanks which occurs continually over the assessment period.
- Reversibility: long-term – the increase in sound levels during operations at the terminals will extend over the operational life of the terminals. All sound level changes are reversible as the sound will cease when the facility is decommissioned.
- Magnitude: negligible to medium – with the implementation of appropriate mitigation measures, sound levels at receptors are expected to comply with AER, and BC OGC *Noise Control Best Practices Guideline* and Health Canada guidance.
- Probability: high – the new equipment are mechanical sources of sound and will increase sound levels for nearby receptors during operations.
- Confidence: moderate – the assessment is based on a combination of measured existing data, theoretical formulae and current Project design.

Combined Effects on Sound Levels

The evaluation of the combined effects of proposed tanks and associated terminal work on the acoustic environment considers collectively the assessment of the likely potential residual effects on the sound levels indicator. The residual effects for the sound levels indicator do not combine to result in new ratings for the various components since the occurrences of sound happen at different times during the Project Therefore, the combined effects represents the worst-case or most negative effect for each evaluation criteria between the two residual effects (Table 7.5.6-2, point 1[c]). Effectively, this is the effects from terminal operations, as terminal construction is of short-term duration and reversibility.

A summary of the rationale for all of the significance criteria of combined effects on sound levels is provided below.

- Spatial Boundary: Acoustic Environment LSA – compliance with the AER Directive 038 and BC OGC *Noise Control Best Practices Guideline* are achieved within the Acoustic Environment LSA.
- Duration: long-term – the event causing the combined effects on sound levels reflects the operations of the terminal which occurs over the operational life of the terminals.
- Frequency: continuous – the event causing the combined effects on sound levels reflects the operations of the terminal which occurs continually over the assessment period.
- Reversibility: long-term – the combined effects on sound levels reflect operations at terminal which will extend over the operational life of the terminals. All sound level changes are reversible as the sound will cease when the pipeline is decommissioned.
- Magnitude: negligible to low – with the implementation of appropriate mitigation measures, sound levels at receptors are expected to comply with AER, and BC OGC *Noise Control Best Practices Guideline* and Health Canada guidance.
- Probability: high – the new equipment are mechanical sources of sound and will increase sound levels for nearby receptors during operation.
- Confidence: moderate - the assessment is based on a combination of measured existing data, theoretical formulae and current Project design.

7.5.6.4 Summary

As identified in Table 7.5.6-2, there are no situations where there is a high probability of occurrence of a permanent or long-term residual environmental effect of high magnitude on the acoustic environment indicators that cannot be technically or economically mitigated. Consequently, it is concluded that the residual effects arising from the construction and operations of the proposed tanks and associated terminal work on the acoustic environment will be not significant.

7.5.7 Fish and Fish Habitat

Hydrostatic testing is planned for the piping and new tanks to be installed within the Edmonton, Sumas and Burnaby terminals. The Edmonton Terminal is located in the Lower North Saskatchewan River Watershed, which is known to contain three Alberta indicator species (*i.e.,* burbot, northern pike and walleye). The Sumas Terminal is located in the Chilliwack River Watershed, which contains all five BC indicator species. The Burnaby Terminal is located in the Lower Fraser River Watershed, which is known to contain all five BC indicator species (*i.e.,* bull trout/Dolly Varden, Chinook salmon, coho salmon, cutthroat trout and rainbow trout/steelhead). In addition, the headwaters of Eagle Creek are located within 30 m of the proposed Footprint for the Burnaby Terminal. At the time of writing, the locations of source water for hydrostatic testing had not been confirmed. Test water may be diverted from a nearby river or creek, or purchased from municipalities depending on availability from natural sources. If hydrostatic test water is obtained from a river or creek this will cause an interaction with fish and fish habitat indicators, specifically riparian habitat, instream habitat and the indicator species found in the watershed from which test water is withdrawn.

The assessment of effects on fish and fish habitat has been conducted considering all the Project components in an integrated manner (*e.g.,* pipeline, temporary facilities, pump stations [including power lines], tanks and pipeline reactivation), since the components will have similar effect pathways (*i.e.,* riparian habitat, instream habitat and fish mortality and injury) on fish indicators and disaggregation of effects by Project component is not meaningful at an individual or population level for fish indicators.

The assessment of effects on fish and fish habitat for the Project as a whole is presented in Section 7.2.7. Table 7.2.7-3 and accompanying discussion in Section 7.2.7.6 provide an evaluation of potential residual effects of proposed tanks and terminal work on fish indicators.

7.5.8 Vegetation

Sections 7.2.9.1 and 7.2.9.2 provide the assessment indicators, measurement endpoints and spatial boundaries for the assessment of potential effects of proposed tanks and terminal work on vegetation.

7.5.8.1 Ecological Context

Activities that require clearing of previously undisturbed lands have the potential to affect native vegetation. Project activities at the Edmonton Terminal and the Burnaby Terminal will not involve clearing of previously undisturbed lands and, therefore, are not expected to have an effect on native vegetation. Project activities at the Sumas Terminal will require clearing of undisturbed lands and, therefore, have the potential to affect native vegetation. The introduction and spread of weeds has the potential to occur during any anthropogenic disturbance.

Section 7.2.9.3 provides additional details on the ecological context for vegetation.

7.5.8.2 Potential Effects and Mitigation Measures

Identified Potential Effects

Potential effects associated with the construction and operations of the proposed tanks and terminal work on vegetation indicators are listed in Table 7.5.8-1. These interactions are based on the results of the literature review, desktop analysis, engagement with Aboriginal communities, regulatory authorities, stakeholders and the general public (Section 3.0) and the professional experience of the assessment team.

A summary of mitigation measures provided in Table 7.5.8-1 was principally developed in accordance with Trans Mountain standards as well as industry and provincial regulatory guidelines as described in Section 7.2.9.4.

TABLE 7.5.8-1

POTENTIAL EFFECTS, MITIGATION MEASURES AND RESIDUAL EFFECTS OF CONSTRUCTION AND OPERATIONS OF PROPOSED TANKS AND ASSOCIATED TERMINAL WORK ON VEGETATION

Potential Effect	Terminal	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
1. Vegetation Indicator – Vegetation Communities of Concern				
1.1 Loss or alteration of native vegetation	Sumas	Footprint	• See recommended mitigation measures outlined in Table 7.4.9-1 Vegetation.	• Loss or alteration of the composition of 0.7 ha of native vegetation.
1.2 Loss or alteration of rare ecological communities	Sumas	LSA	• See recommended mitigation measures outlined in Table 7.4.9-1 Vegetation.	• Some disturbance or alteration of a rare ecological community, if avoidance is not practical and mitigation measures do not completely protect a site. • If rare ecological communities are located adjacent to the tanks and terminal work they may be indirectly affected by changes in hydrology or light levels.
2. Vegetation Indicator – Plant and Lichen Species of Concern				
2.1 Loss or alteration of rare plant occurrences	Sumas	LSA	• See recommended mitigation measures outlined in Table 7.4.9-1 Vegetation.	• Some disturbance or alteration of a rare plant occurrence, if avoidance is not practical and mitigation measures do not completely protect a site. • If rare plant sub-populations are located adjacent to the tanks and terminal work they may be affected by changes in dust, hydrology or light levels.
2.2 Loss or alteration of rare lichen occurrences	Sumas	LSA	• See recommended mitigation measures outlined in Table 7.4.9-1 Vegetation.	• Some disturbance or alteration of a rare lichen occurrence, if avoidance is not practical and mitigation measures do not completely protect a site. • If rare lichen sub-populations are located adjacent to the tanks and terminal work they may be affected by changes in dust, hydrology or light levels.

TABLE 7.5.8-1 Cont'd

Potential Effect	Terminal	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
3. Vegetation Indicator – Presence of Infestations of Provincial Weed Species and Other Invasive Non-Native Species Identified as a Concern				
3.1 Weed introduction and spread	All	RSA	• See recommended mitigation measures outlined in Table 7.4.9-1 Vegetation.	• Weed introduction and spread.

Notes: 1 LSA = Vegetation LSA; RSA = Vegetation RSA.
2 Detailed mitigation measures are outlined in the Facilities EPP (Volume 6C).

7.5.8.3 Potential Residual Effects

The potential residual environmental effects on vegetation indicators associated with Project activities associated with the construction and operations of the proposed tanks and terminal work (Table 7.5.8-1) are:

- alteration of the composition of 0.7 ha of native vegetation;
- some disturbance or alteration of a rare ecological community, if avoidance is not practical and mitigation measures do not completely protect a site;
- if rare ecological communities are located adjacent to the proposed tanks and terminal work they may be indirectly affected by changes in hydrology or light levels;
- some disturbance or alteration of a rare plant occurrence, if avoidance is not practical and mitigation measures do not completely protect a site;
- if rare plant sub-populations are located adjacent to the proposed tanks and terminal work they may be affected by changes in dust, hydrology or light levels;
- some disturbance or alteration of a rare lichen occurrence, if avoidance is not practical and mitigation measures do not completely protect a site;
- if rare lichen sub-populations are located adjacent to the proposed tanks and terminal work they may be affected by changes in dust, hydrology or light levels; and
- weed introduction and spread.

7.5.8.4 Significance Evaluation of Potential Residual Effects

Table 7.5.8-2 provides a summary of the significance evaluation of the potential residual environmental effects of the construction and operations of proposed tanks and terminal work on vegetation. The rationale used to evaluate the significance of each of the residual environmental effects is provided below.

TABLE 7.5.8-2

SIGNIFICANCE EVALUATION OF POTENTIAL RESIDUAL EFFECTS OF CONSTRUCTION AND OPERATIONS OF PROPOSED TANKS AND ASSOCIATED TERMINAL WORK ON VEGETATION

	Potential Residual Effects	Impact Balance	Spatial Boundary[1]	Temporal Context			Magnitude	Probability	Confidence	Significance[2]
				Duration	Frequency	Reversibility				
1.	Vegetation Indicator – Vegetation Communities of Concern									
1(a)	Loss or alteration of the composition of 0.7 ha of native vegetation.	Negative	Footprint	Short-term	Isolated	Medium to long-term	Low to medium	High	High	Not significant
1(b)	Some disturbance or alteration of a rare ecological community, if avoidance is not practical and mitigation measures do not completely protect a site.	Negative	Footprint	Short-term	Isolated	Medium to long-term	Medium	Low	High	Not significant
1(c)	If rare ecological communities are located adjacent to the proposed tanks and terminal work they may be indirectly affected by changes in dust, hydrology or light levels.	Negative	LSA	Short-term	Isolated	Medium to long-term	Low	Low	Moderate	Not significant
2.	Vegetation Indicator – Plant and Lichen Species of Concern									
2(a)	Some disturbance or alteration of a rare plant occurrence, if avoidance is not practical and mitigation measures do not completely protect a site.	Negative	Footprint	Short-term	Isolated	Medium to long-term	Medium	High	High	Not significant
2(b)	Some disturbance or alteration of a rare lichen occurrence, if avoidance is not practical and mitigation measures do not completely protect a site.	Negative	Footprint	Short-term	Isolated	Short to medium-term	Medium	Low	High	Not significant
2(c)	If rare plant and lichen sub-populations are located adjacent to the proposed tanks and terminal work they may be affected by changes in dust, hydrology or light levels.	Negative	LSA	Short-term	Isolated	Short to long-term	Low	Low	High	Not significant
3.	Vegetation Indicator – Presence of Infestations of Provincial Weed Species and Other Invasive Non-native Species Identified as a Concern									
3(a)	Weed introduction and spread.	Negative	RSA	Short-term	Isolated	Short to medium-term	Low to medium	High	High	Not significant

Notes: 1 LSA = Vegetation LSA; RSA = Vegetation RSA.

2 Significant Residual Environmental Effect: A high probability of occurrence of a permanent or long-term residual effect of high magnitude that cannot be technically or economically mitigated.

The significance evaluation of the potential residual effects on the vegetation communities of concern indicator and the rare plant and lichen species of concern indicator was determined to be the same for the construction and operations of proposed tanks and terminal work as for pump station construction and operations (Table 7.5.8-2, points 1[a] to 1[c], 2[a] to 2[c]). Table 7.4.9-2 and the accompanying discussion in Section 7.4.9.4 provide an evaluation of potential residual effects of Project activities at pump station facilities and their significance on the applicable vegetation indicator. The exceptions are in Table 7.5.8-2, points 1[b] and 1[c] where probability is low due to the unlikely occurrence of rare ecological communities within the footprint and LSA of the Project activities and point 2[c] where the probability is low because of the limited amount of native vegetation being cleared (0.7 ha) and the surrounding disturbance makes for low potential rare plant habitat. In addition, the significance evaluation of the potential residual effect on the presence of infestations of provincial weed species and other invasive non-native species identified as a concern indicator was determined to be the same for the construction and operations of proposed tanks and terminal work as for pipeline construction and operations (Table 7.5.8-2, point 3[a]). Table 7.2.9-3 and the accompanying discussion in Section 7.2.9.6 provide an evaluation of potential residual effects of Project activities and their significance on this vegetation indicator.

7.5.8.5 Summary

As identified in Table 7.5.8-2, there are no situations where there is a high probability of occurrence of a permanent or long-term residual environmental effect on vegetation indicators of high magnitude that cannot be technically or economically mitigated. Consequently, is it concluded that the residual environmental effects arising from the construction and operations of the proposed tanks and associated terminal work on vegetation will be not significant.

7.5.9 Wildlife and Wildlife Habitat

Activities that require clearing of previously undisturbed lands have the potential to affect wildlife and wildlife habitat. Project activities at the Edmonton Terminal will not involve clearing of previously undisturbed lands and, therefore, are not expected to have a notable effect on wildlife and wildlife habitat. Project activities at the Burnaby Terminal will require clearing of some remnant treed patches within the existing fenceline. Given that these patches are small, fragmented and surrounded by highly disturbed areas, the habitat value within the existing fenceline in the Burnaby Terminal is considered to be low and, therefore, Project activities at the Burnaby Terminal are also not expected to have a notable effect on wildlife and wildlife habitat. Project activities at the Sumas Terminal will require clearing of undisturbed forested habitat that is contiguous with adjacent forests and, therefore, have the potential to affect wildlife and wildlife habitat.

The assessment of effects on wildlife and wildlife habitat has been conducted considering all the Project components in an integrated manner (*e.g.,* pipeline, temporary facilities, pump stations [including power lines], tanks, other ancillary facilities, and the Westridge Marine Terminal), since the components will have similar effect pathways (*i.e.,* change in habitat movement and mortality risk) on wildlife indicators and disaggregation of effects by Project component is not meaningful at an individual or population level for wildlife indicators. Since the activities at the Edmonton and Burnaby terminals are not expected to have a notable impact on wildlife indicators, the Edmonton and Burnaby terminals were not carried through the effects assessment. Wildlife indicators that may be affected by proposed tanks and terminal work at the Sumas Terminal include coastal riparian small mammals, bats, mature/old forest birds, early seral forest birds, riparian and wetland birds, rusty blackbird, western screech-owl, great blue heron, bald eagle, common nighthawk, northern goshawk, olive-sided flycatcher, pond-dwelling amphibians, and stream dwelling amphibians.

The assessment of effects on wildlife and wildlife habitat for the Project as a whole is presented in Section 7.2.10. Table 7.2.10-6 and accompanying discussion in Section 7.2.10.9 provide the evaluation of potential residual effects of proposed tank and terminal work on mammal indicators, Table 7.2.10-9 and accompanying discussion in Section 7.2.10.10 provide the evaluation of potential residual effects of proposed tank and terminal work on bird indicators, Table 7.2.10-12 and accompanying discussion in Section 7.2.10.11 provide the evaluation of potential residual effects of proposed tank and terminal work on amphibian indicators, and Table 7.2.10-15 and accompanying discussion in Section 7.2.10.12 provide the evaluation of potential residual effects of proposed tank and terminal work on the reptile indicator. No significant adverse effect on the wildlife indicators has been identified as a result of the Project.

7.5.10 Species at Risk

The construction and operations of proposed tanks and the associated terminal may affect fish, vegetation and wildlife species at risk. Section 7.2.11 provides a discussion of the fish and wildlife species used as indicators for species at risk. Vegetation species at risk are considered under the plant and lichen species of concern indicator. Although not all species at risk are discussed explicitly under each indicator, potential Project effects were assessed in consideration of all species at risk. The indicators used to represent fish and fish habitat, vegetation and wildlife and wildlife habitat were carefully selected to ensure that the full range of potential Project effects on species at risk was addressed and mitigation measures to reduce these effects will apply to all species at risk, not just the indicators. Section 7.2.7 Fish and Fish Habitat, Section 7.2.9 Vegetation and Section 7.2.10 Wildlife and Wildlife Habitat provide the significance rationale for applicable indicator species. No significant adverse effects on species at risk have been identified as a result of the pipeline and facilities component of the Project.

7.6 Effects Assessment – Westridge Marine Terminal Expansion and Operations

Using the assessment methodology described in Section 7.1, the following subsections evaluate the potential environmental effects associated with the construction and operations of the Westridge Marine Terminal component of the Project. Environmental elements potentially interacting with construction and operations of the Westridge Marine Terminal are identified in Table 7.6-1.

TABLE 7.6-1

ELEMENT INTERACTION WITH THE PROPOSED WESTRIDGE MARINE TERMINAL COMPONENT

Element	Interaction with Westridge Marine Terminal Component	
	Construction	Operations[1]
Physical and Meteorological Environment	Yes	Yes
Soil and Soil Productivity	Yes	Yes
Water Quality and Quantity	Yes	Yes
Air Emissions	Yes	Yes
GHG Emissions	Yes	Yes
Acoustic Environment	Yes	Yes
Fish and Fish Habitat (freshwater)	No – freshwater fish and fish habitat will not be affected by construction of the Westridge Marine Terminal	No – freshwater fish and fish habitat will not be affected by operations of the Westridge Marine Terminal
Wetlands	No – wetlands will not be affected by construction of the Westridge Marine Terminal	No – wetlands will not be affected by operations of the Westridge Marine Terminal
Vegetation	Yes	Yes
Marine Sediment and Water Quality	Yes	Yes
Marine Fish and Fish Habitat	Yes	Yes
Wildlife and Wildlife Habitat	Yes	Yes
Marine Mammals	Yes	No – marine mammals will not be affected by operations of the Westridge Marine Terminal
Marine Birds	Yes	Yes
Species at Risk	Yes	Yes

Note: 1 Activities during operations include loading and unloading operations, vegetation management, storage of jet fuel and spill response capabilities.

The potential environmental effects associated with the Westridge Marine Terminal, as well as the accompanying proposed mitigation measures and resulting residual effects are presented in the following subsections for each environmental element. In addition, the evaluation of significance using the criteria presented in Table 7.1-2 for the residual effects associated with the applicable environmental elements is also provided.

7.6.1 Physical Environment and Meteorlogical Environment

Sections 7.2.1.1 and 7.2.1.2 provide the assessment indicators, measurement endpoints and spatial boundaries for the assessment of potential effects of construction and operations of the Westridge Marine Terminal on the physical environment.

7.6.1.1 Physical Environment Context

Grading and foreshore expansion will be required at the Westridge Marine Terminal to accommodate equipment and infrastructure associated with dock construction and operations.

7.6.1.2 Potential Effects and Mitigation Measures

<u>Identified Potential Effects</u>

Potential effects associated with the construction and operations activities at the Westridge Marine Terminal were based on the results of the literature review and desktop analysis, and the professional experience of the assessment team. No interactions between construction and operations activities at the

Westridge Marine Terminal and some of the physical environment indicators were predicted and, consequently, no potential effects were identified for the following indicators: terrain instability at watercourses; alteration of topography from blasting; and acid generation or metal leaching.

A summary of mitigation measures, provided in Table 7.6.1-1, was principally developed in accordance with Trans Mountain standards as well as industry and provincial regulatory guidelines as described in Section 7.2.1.4.

TABLE 7.6.1-1

POTENTIAL EFFECTS, MITIGATION MEASURES AND RESIDUAL EFFECTS OF CONSTRUCTION AND OPERATIONS AT THE WESTRIDGE MARINE TERMINAL ON PHYSICAL ENVIRONMENT

Potential Effect	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
1. Physical Environment Indicator – Terrain Instability			
1.1 Terrain and seabed instability	LSA	• Use hand clearing methods where directed by the Inspector to avoid or reduce disturbance to the ground surface on sensitive terrain [Section 8.1]. • Grade the work site to the specifications of the geotechnical or civil engineer [Section 8.1]. • Ensure graded material does not spread off-site [Section 8.1]. • Place rock armouring progressively, where required, to minimize erosion and prevent the loss of infill material [see Infilling – Rock Armouring Drawing in Appendix Q] [Section 8.2].	• No residual effect identified.
2. Physical Environment Indicator – Topography			
2.1 Alteration of topography and bathymetry	LSA	• Ensure all conditions outlined in authorizations, approvals and/or permits are met during marine infilling [Section 8.2]. • Review and abide by all specifications for infilling activities as defined in the Trans Mountain's Infill Design (Volume 4A) and as directed by a qualified engineer [Section 8.2]. • See additional recommended mitigation measures provided for potential effect 1.1 of this table.	• Alteration of topography and bathymetry along the shoreline where foreshore expansion is required.

Notes: 1 LSA = Physical Environment LSA.

2 Detailed mitigation measures are outlined in the Westridge Marine Terminal EPP (Volume 6D).

7.6.1.3 Potential Residual Effects

The potential residual environmental effect on physical environment indicators associated with construction and operations activities at Westridge Marine Terminal is alteration of topography and bathymetry along the shoreline where foreshore expansion is required (Table 7.6.1-1).

Potential terrain and seabed instability resulting from construction and operations activities at Westridge Marine Terminal is concluded not to have a residual effect because instability potential is predicted to be eliminated through the implementation of mitigation measures (Table 7.6.1-1).

7.6.1.4 Significance Evaluation of Potential Residual Effects

Table 7.6.1-2 provides a summary of the significance evaluation of the potential residual environmental effects on physical environment indicators resulting from construction and operations activities at Westridge Marine Terminal. The rationale used to evaluate the significance of the residual environmental effect is provided below.

TABLE 7.6.1-2

SIGNIFICANCE EVALUATION OF POTENTIAL RESIDUAL EFFECTS OF CONSTRUCTION AND OPERATIONS AT THE WESTRIDGE MARINE TERMINAL ON PHYSICAL ENVIRONMENT

	Potential Residual Effects	Impact Balance	Spatial Boundary[1]	Temporal Context			Magnitude	Probability	Confidence	Significance[2]
				Duration	Frequency	Reversibility				
1.	Physical Environment Indicator – Topography									
1(a)	Alteration of topography along the shoreline where foreshore expansion is required.	Negative	Footprint	Short-term	Isolated	Permanent	Low	High	High	Not significant

Notes: 1 LSA = Physical Environment LSA.

2 Significant Residual Environmental Effect: A high probability of occurrence of a permanent or long-term residual effect of high magnitude that cannot be technically or economically mitigated.

The significance evaluation of alteration of topography at the Westridge Marine Terminal (Table 7.6.1-2, point 1[a]) was determined to be the same for the construction and operations activities at the Westridge Marine Terminal as for the construction and operations of the proposed pump stations. Table 7.4.1-2 and the accompanying discussion in Section 7.5.1.4 provide an evaluation of this potential residual effect at the Westridge Marine Terminal and its significance on the applicable physical environment indicator.

7.6.1.5 Summary

As identified in Table 7.6.1-2, there are no situations where there is a high probability of occurrence of a permanent or long-term residual environmental effect on physical environment indicators of high magnitude that cannot be technically or economically mitigated. Consequently, it is concluded that the residual environmental effects associated with construction and operations activities at the Westridge Marine Terminal on the physical environment will be not significant.

7.6.2 Soil and Soil Productivity

Sections 7.2.2.1 and 7.2.2.2 provide the assessment indicators, measurement endpoints and spatial boundaries for the assessment of potential effects of construction and operations of the Westridge Marine Terminal on soil and soil productivity.

7.6.2.1 Soil Context

Activities at the Westridge Marine Terminal will be conducted on previously disturbed lands owned by Trans Mountain. Refer to Section 7.2.2.3 for additional soil context.

7.6.2.2 Potential Effects and Mitigation Measures

<u>Identified Potential Effects</u>

Potential effects associated with the construction and operations activities at the Westridge Marine Terminal on the soil and soil productivity indicators are listed in Table 7.6.2-1. These interactions were based on the results of the literature review, desktop analysis, and the professional experience of the assessment team.

A summary of mitigation measures provided in Table 7.6.2-1 was principally developed in accordance with Trans Mountain standards and industry and provincial regulatory guidelines as described in Section 7.2.2.4.

TABLE 7.6.2-1

POTENTIAL EFFECTS, MITIGATION MEASURES AND RESIDUAL EFFECTS OF CONSTRUCTION AND OPERATIONS AT THE WESTRIDGE MARINE TERMINAL ON SOIL AND SOIL PRODUCTIVITY

Potential Effect	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
1. Soil Indicator – Soil Productivity			
1.1 Decreased topsoil/root zone material productivity during topsoil/root zone material salvaging	Footprint	• Salvage topsoil from locations in the Westridge Marine Terminal site where grading and/or padding is necessary [Section 8.1]. • Locate topsoil piles outside of the construction area where topsoil will be replaced following earthworks. Locate topsoil storage piles on the upslope side of the site to avoid contamination from accidental spills and away from natural drainage patterns [Section 8.1]. • Salvage all available topsoil (min. 15-20 cm or 50% organic material and 50% mineral soil), unless the material is unsuitable (*e.g.,* bedrock, gravel, rock) using the Environmental Facility Drawings of Westridge Marine Terminal as a guide [Section 8.1]. • Keep subsoil piles separate from topsoil/root zone material piles. Maintain a minimum separation distance of 1 m between topsoil/root zone material and subsoil piles [Section 8.1].	• Mixing of topsoil/root zone material and subsoil.
1.2. Decreased soil productivity from flooding of soil as a result of release of hydrostatic test water on land	LSA	• Follow all measures outlined in the Water Discharge Procedures Management Plan and in the Water Discharge Form (see Appendix C) related to dewatering [Section 8.3]. • Monitor discharge locations to ensure that no erosion, flooding or icing occurs. If conditions become saturated to the extent that adequate natural filtration is no longer occurring, suspend dewatering and move the discharge to another approved location (confirm that appropriate approvals and, if warranted, soil testing have been completed) or construct a holding pond for the water and release the water when natural filtration is feasible [Section 8.3]. • Ensure the areas that are to receive discharged water are approved by the Lead Activity Inspector and the Inspector in accordance with the applicable regulatory guidance [Section 8.3]. • Dewater onto approved areas where water will be filtered through vegetation and soils before returning to a waterbody. Provide scour protection (*e.g.,* use of rock aprons, plastic sheeting, plywood, straw bales) or an energy diffuser (*e.g.,* cone with baffles, frog's foot) at the discharge site as directed by the Inspector. The rate of discharge will be reduced if these measures are ineffective [Section 8.3]. • See additional erosion control measures in Section 8.1 of the Westridge Marine Terminal EPP.	• No residual effect identified.
2. Soil Indicator – Soil Degradation			
2.1 Degradation of soil structure due to compaction and rutting	Footprint	• Adhere to the measures outlined in the Wet Soils Contingency Plan (see Appendix B) during earthworks on non-gravel padded areas during wet soil conditions [Section 8.1]. • Postpone construction, suspend equipment travel or utilize construction alternatives in the event of wet soils located outside of the development zone in order to reduce terrain disturbance and soil structure damage or areas within the development zone prior to gravel padding to prevent excessive sediment production [Section 8.1]. • The wet soil conditions shut-down decision will be made by the Construction Manager in consultation with the Lead Activity Inspector and the Inspector [Section 8.1]. • Ensure that there is low enough soil moisture to allow construction without causing excessive rutting or soil compaction [Section 8.1]. • See additional compaction and rutting mitigation measures in Section 8.1 of the Westridge Marine Terminal EPP.	• Degradation of soil structure and impairment of rooting zone due to compaction and rutting.
2.2 Loss of topsoil/root zone material through wind and water erosion	Footprint	• Trans Mountain will implement a monitoring program to determine the effectiveness of the erosion and sediment control mitigation measures during construction in preventing terrestrial sediment loading into the marine environment [Section 7.0]. • Maintain existing surface drainage across the Westridge Marine Terminal [Section 8.1]. • Implement the Soil Erosion and Sediment Control Contingency Plan, if necessary (see Appendix B) [Section 8.1].	• Surface erosion of topsoil/root zone material can be expected until a vegetative cover is established.

TABLE 7.6.2-1 Cont'd

Potential Effect	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
2.2 Loss of topsoil/root zone material through wind and water erosion (cont'd)	Footprint	• Install temporary erosion and sediment control measures in areas of exposed soils or soil piles (see Drawing [Sediment Fence] provided in Appendix F) [Section 8.1]. • Install erosion and sediment control structures and materials (*e.g.,* sediment fencing) and implement as warranted, erosion control measures outlined in the Soil Erosion and Sediment Control Contingency Plan (see Appendix B), as soon as practical following a heavy rain event, to ensure that sediments in water flowing from the Westridge Marine Terminal do not adversely affect the marine environment and the surrounding terrain [Section 8.1]. • All surface water runoff generated during construction will be redirected and stored in a settling pond or will be suitably filtered. Surface water runoff will be tested and treated, if necessary, and discharged into vegetated areas or into the marine environment, where practical [Section 8.1]. • Monitor topsoil piles during the growing season for wind and water erosion, and weed growth until the soils are replaced or stored in berms. Implement remedial measures to control erosion (see Soil Erosion and Sediment Control Contingency Plan in Appendix B) and weed growth (see Weed and Vegetation Management Plan in Appendix C), when warranted [Section 8.1]. • Postpone replacement during wet conditions or high winds to prevent damage to soil structure or erosion of topsoil/root zone material [Section 8.4]. • Establish long-term topsoil/root zone material storage berms at locations away from regular Westridge Marine Terminal operational activity and areas with potential for overland water flow and storage berm erosion [Section 8.4]. • See additional erosion control measures in Section 8.1 and 8.4 of the Westridge Marine Terminal EPP.	• See above.
2.3 Degradation of soil structure due to pulverization of soil and sod	Footprint	• Apply water or approved tackifier to disturbed areas if traffic and wind conditions result in excessive dust. The frequency of dust abatement measures will be increased during periods of high wind [Section 8.1]. • Control dust emissions by applying dust suppressants, if warranted. Ensure the Inspector approves the dust suppressants prior to use [Section 8.1]. • Additional dust abatement measures (*e.g.,* covering topsoil piles, installing wind fences, applying tackifier) will be implemented, when warranted, during topsoil/root zone salvage and construction activities [Section 8.1].	• Pulverization resulting in fugitive dust and loss of soil structure can be expected during dry conditions.
2.4 Erosion of soil as a result of release of hydrostatic test water on land	LSA	• See recommended mitigation measures outlined in potential effect 1.2 of this table.	• No residual effect identified.
3. Soil Indicator – Soil Contamination			
3.1 Disturbance of previously contaminated soil	Footprint	• Implement the Contamination Discovery Contingency Plan (see Appendix B) and applicable measures from the Waste Management Standard (see Appendix C) in the event contaminated soils are encountered during soil handling procedures [Section 8.1].	• No residual effect identified.
3.2 Contamination of soil as a result of hydrostatic test water on land	LSA	• Ensure that the appropriate testing and treatment measures are implemented in accordance with Sections 7(2) and 7(3) of the *BC Oil and Gas Waste Regulation* [Section 8.3].	• No residual effect identified.

TABLE 7.6.2-1 Cont'd

Potential Effect	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
3.3 Soil contamination due to spot spills during construction	Footprint	• Maintain all appropriate spill response equipment at all work sites. Assess the risk of resource-specific spills to determine the appropriate type and quantity of spill response equipment and materials to be stored on-site and a suitable location for storage (see Emergency Response Plan in Volume 4B) [Section 7.0]. • Ensure that during construction no fuel, lubricating fluids, hydraulic fluids, methanol, antifreeze, herbicides, biocides, or other chemicals are released into the ground or the marine environment. In the event of a spill onshore that does not have the potential to migrate into the marine environment, implement the Marine Spill Contingency Plan (see Appendix B). In the event of a spill in the marine environment, or onshore with the potential to migrate into the marine environment, implement the Marine Spill Contingency Plan (see Appendix B) [Section 7.0]. • Place an impervious tarp or drip tray underneath equipment/vehicles while servicing equipment/vehicles when there exists the potential for accidental spills (*e.g.,* oil changes, servicing of hydraulic systems) [Section 7.0]. • See additional spill prevention and clean-up measures in Section 7.0 of the Westridge Marine Terminal EPP.	• No residual effect identified.

Notes: 1 LSA = Soil LSA.

2 Detailed mitigation measures are outlined in the Westridge Marine Terminal EPP (Volume 6D).

7.6.2.3 Potential Residual Effects

The potential residual environmental effects on the soil and soil productivity indicators associated with the construction and operations activities at the Westridge Marine Terminal (Table 7.6.2-1) are:

- mixing of topsoil/root zone material and subsoil;
- degradation of soil structure and impairment of rooting zone due to compaction and rutting;
- surface erosion of topsoil/root zone material can be expected until a vegetative cover is established; and
- pulverization resulting in fugitive dust and loss of soil structure can be expected during dry conditions.

Some of the potential effects on soil and soil productivity associated with the construction and operations of the Westridge Marine Terminal are predicted to be eliminated through the implementation of mitigation measures (Table 7.6.2-1). The potential effects determined not to have a residual effect are:

- decreased soil productivity from flooding of soil as a result of release of hydrostatic test water on land;
- erosion of soil as a result of release of hydrostatic test water on land;
- disturbance of previously contaminated soil;
- contamination of soil as a result of hydrostatic test water on land; and
- soil contamination due to spot spills during construction.

7.6.2.4 Significance Evaluation of Potential Residual Effects

Table 7.6.2-2 provides a summary of the significance evaluation of the potential residual environmental effects of construction and operations activities at the Westridge Marine Terminal on soil and soil productivity.

TABLE 7.6.2-2

SIGNIFICANCE EVALUATION OF POTENTIAL RESIDUAL EFFECTS OF CONSTRUCTION AND OPERATIONS AT THE WESTRIDGE MARINE TERMINAL ON SOIL AND SOIL PRODUCTIVITY

Potential Residual Effects	Impact Balance	Spatial Boundary	Temporal Context			Magnitude	Probability	Confidence	Significance[1]
			Duration	Frequency	Reversibility				
1. Soil Indicator – Soil Productivity									
1(a) Mixing of topsoil/root zone material and subsoil.	Negative	Footprint	Short-term	Isolated	Long-term	Low	High	High	Not significant
2. Soil Indicator – Soil Degradation									
2(a) Degradation of soil structure and impairment of rooting zone due to compaction and rutting.	Negative	Footprint	Short-term	Isolated	Short to medium-term	Low	High	High	Not significant
2(b) Surface erosion of topsoil/root zone material can be expected until a vegetative cover is established.	Negative	Footprint	Short-term	Isolated	Medium-term	Low	High	High	Not significant
2(c) Pulverization resulting in fugitive dust and loss of soil structure can be expected during dry conditions.	Negative	Footprint	Short-term	Isolated	Short to medium-term	Low	Low to high	High	Not significant
2(d) Combined effects on the soil degradation indicator (2[a] to 2[c]).	Negative	Footprint	Short-term	Isolated	Short to medium-term	Low	High	High	Not significant

Note: 1 Significant Residual Environmental Effect: A high probability of occurrence of a permanent or long-term residual effect of high magnitude that cannot be technically or economically mitigated.

The significance evaluation of the potential residual effects on the soil productivity indicator and soil degradation indicator (Table 7.6.2-2, points 1[a], 2[a] to 2[d]) was determined to generally be the same for the construction and operations of the Westridge Marine Terminal as for pipeline construction and operations. The exception is the reversibility of mixing of topsoil/root zone material and subsoil (point 1[a]), which is considered long-term where topsoil is stored in berms (similar to pump stations as noted in Table 7.4.2-2). Table 7.2.2-3 and the accompanying discussion in Section 7.2.2.6 provide an evaluation of potential residual effects of construction and operations of the Westridge Marine Terminal and their significance on the applicable soil and soil productivity indicator.

7.6.2.5 Summary

As identified in Table 7.6.2-2, there are no situations where there is a high probability of occurrence of a permanent or long-term residual environmental effect on the soil and soil productivity indicators of high magnitude that cannot be technically or economically mitigated. Consequently, it is concluded that the residual environmental effects of construction and operations activities at the Westridge Marine Terminal on soil and soil productivity will be not significant.

7.6.3 Water Quality and Quantity

Sections 7.2.3.1 and 7.2.3.2 provide the assessment indicators, measurement endpoints and spatial boundaries for the assessment of potential effects of the construction and operations of the Westridge Marine Terminal on water quality and quantity.

7.6.3.1 Water Quality and Quantity Context

There are no watercourses or freshwater waterbodies within 30 m of construction or operations activities at the Westridge Marine Terminal. Effects on marine sediment and water quality are discussed in Section 7.6.8.

There are no water supply wells, nor mapped aquifers within the Footprint of the Westridge Marine Terminal, although it is expected, with the proximity to the waters of Burrard Inlet that the groundwater is shallow. No water level data are available. It is likely that groundwater flow is directed to the north toward the inlet.

7.6.3.2 Potential Effects and Mitigation Measures

Effects Considerations

Potential contamination from stormwater discharge during operations of the Westridge Marine Terminal was scoped out of the effects assessment for surface water quality because stormwater, once treated, will be discharged into Burrard Inlet and, therefore, is assessed under the marine sediment and water quality element (Section 7.6.8). Furthermore, since no watercourses or freshwater waterbodies are located within 30 m of construction or operations activities at the Westridge Marine Terminal, reduction of surface water quality due to a spill during construction or operations or from suspended sediment entering the water column were also scoped out of the effects assessment. Small spills during construction or operations have the potential to enter Burrard Inlet and, therefore, this potential effect is assessed under the marine sediment and water quality element (Section 7.6.8).

Identified Potential Effects

Potential effects associated with the construction and operations activities at the Westridge Marine Terminal on the water quality and quantity indicators listed in Table 7.6.3-1 were based on the results of the literature review, desktop analysis and the professional experience of the assessment team.

A summary of mitigation measures provided in Table 7.6.3-1 was principally developed in accordance with Trans Mountain standards and industry and provincial regulatory guidelines as discussed in Section 7.2.3.4.

TABLE 7.6.3-1

POTENTIAL EFFECTS, MITIGATION MEASURES AND RESIDUAL EFFECTS OF CONSTRUCTION AND OPERATIONS AT THE WESTRIDGE MARINE TERMINAL ON WATER QUALITY AND QUANTITY

Potential Effect	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
1. Water Quality and Quantity Indicator – Surface Water Quantity			
1.1 Localized alteration of natural drainage patterns during construction and operations	LSA	• Ensure the potential for soil erosion by water is reduced during construction activities by avoiding ponding of water or the unintentional channelization of surface water flow [Section 8.1]. • Maintain existing surface drainage across the Westridge Marine Terminal [Section 8.1]. • Install culverts in bar ditches when ramped to maintain drainage. Culvert specifications will be determined by the Inspector [Section 8.1]. • Remove drainage and erosion control devices and materials at all sites when the area is stabilized and no longer in use including infrastructure pads, permanent access, TWS (required for railway boring) and stockpile sites [Section 8.1]. • Establish long-term topsoil/root zone material storage berms at locations away from regular Westridge Marine Terminal operational activity and areas with potential for overland water flow and storage berm erosion [Section 8.4].	• Localized alteration of natural surface drainage patterns at the Westridge Marine Terminal.
2. Water Quality and Quantity Indicator – Groundwater Quality			
2.1 Localized change in the location of the groundwater/seawater interface	LSA	• Ensure that measures are taken to reduce the amount of water discharged to the subsurface [Section 8.1]. • Ensure that amount of pumping of groundwater is kept to a minimum to avoid ingress of seawater into water supply wells [Section 8.1].	• No residual effect identified.

Notes: 1 LSA = Water Quality and Quantity LSA.
2 Detailed mitigation measures are outlined in the Westridge Marine Terminal EPP (Volume 6D).

7.6.3.3 Potential Residual Effects

The potential residual environmental effect on the water quality and quantity indicators associated with the construction and operations activities at the Westridge Marine Terminal (Table 7.6.3-1) is localized alteration of natural surface drainage patterns at the Westridge Marine Terminal. The potential effect of localized change in the location of the groundwater/seawater interface is predicted to be eliminated through the implementation of mitigation measures (Table 7.6.3-1).

7.6.3.4 Significance Evaluation of Potential Residual Effects

Table 7.6.3-2 provides a summary of the significance evaluation of the potential residual environmental effects of construction and operations activities at the Westridge Marine Terminal on water quality and quantity. The rationale used to evaluate the significance of the residual environmental effect is provided below.

TABLE 7.6.3-2

SIGNIFICANCE EVALUATION OF POTENTIAL RESIDUAL EFFECTS OF CONSTRUCTION AND OPERATIONS AT THE WESTRIDGE MARINE TERMINAL ON WATER QUALITY AND QUANTITY

Potential Residual Effects	Impact Balance	Spatial Boundary[1]	Temporal Context			Magnitude	Probability	Confidence	Significance[2]
			Duration	Frequency	Reversibility				
1. Water Quality and Quantity Indicator – Surface Water Quantity									
1(a) Localized alteration of natural surface drainage patterns at the Westridge Marine Terminal.	Negative	LSA	Short-term	Isolated	Long-term	Low	High	High	Not significant

Notes: 1 LSA = Water Quality and Quantity LSA.

2 Significant Residual Environmental Effect: A high probability of occurrence of a permanent or long-term residual effect of high magnitude that cannot be technically or economically mitigated.

The significance evaluation of localized alteration of natural surface drainage patterns at the Westridge Marine Terminal was determined to be generally the same for the construction and operations activities at the Westridge Marine Terminal as for pump station construction and operations (Table 7.6.3-2, point 1[a]). The exception is the reversibility of localized alteration of drainage patterns, which for the Westridge Marine Terminal is considered to be long-term since natural drainage patterns will not be fully restored until decommissioning and abandonment. Table 7.4.3-2 and the accompanying discussion in Section 7.4.3.4 provide an evaluation of this potential residual effect and its significance on the surface water quantity indicator.

7.6.3.5 Summary

As identified in Table 7.6.3-2, there are no situations where there is a high probability of occurrence of a permanent or long-term residual environmental effect on the water quality and quantity indicators of high magnitude that cannot be technically or economically mitigated. Consequently, it is concluded that the residual environmental effects of construction and operations activities at the Westridge Marine Terminal on water quality and quantity will be not significant.

7.6.4 Air Emissions

7.6.4.1 Assessment Indicators and Measurement Endpoints

Assessment indicators used in the evaluation of the potential effects of the construction and operation of the Westridge Marine Terminal on air emissions include primary emissions of CACs and VOCs; formation of secondary $PM_{2.5}$ and ozone; and emissions of H_2S and mercaptans. The rationale for selection of these indicators has been previously discussed in Sections 7.2.4 and 7.5.4.

Both quantitative and qualitative measurement endpoints are applied to assess the potential effects of Westridge Marine Terminal expansion and operation on the air emissions indicators. During the Westridge Marine Terminal expansion, construction equipment will emit CACs and VOCs. During operation, Westridge Marine Terminal is the Project's largest source of fugitive VOC, H_2S, and mercaptans emissions. As a result of the installation of TVAUs, emissions of some CACs are expected to decrease (Table 7.2.4-2).

7.6.4.2 Spatial Boundaries

The spatial boundaries for the study areas for primary pollutant emissions and formation of secondary pollutant are described in Section 7.5.4.2.

7.6.4.3 Project Associated Air Emissions

Estimated air emissions from Westridge Marine Terminal expansion and operation are described in Section 7.2.4.3 and summarized in Table 7.2.4-2.

7.6.4.4 Potential Effects and Mitigation Measures

<u>Identified Potential Effects</u>

Potential effects on the air emissions indicators that are associated with the construction and operation activities at the Westridge Marine Terminal are listed in Table 7.6.4-1 and were based on the results of the literature review, desktop analysis, field work, interviews with design engineers, modelling, and consultation with regulatory authorities, and other stakeholders (Section 3.0), as well as the professional experience of the assessment team.

A summary of the mitigation measures provided in Table 7.6.4-1 was principally developed in accordance with Trans Mountain standards, accepted facility construction methods for construction-related activities, and industry and provincial regulatory guidelines including *Guidelines for Air Quality Dispersion Modelling in British Columbi*a (BC MOE 2008), Canadian Ambient Air Quality Standards (Government of Canada 2013) and BC ambient air quality objectives (BC MOE 2013a).

TABLE 7.6.4-1

POTENTIAL EFFECTS, MITIGATION MEASURES AND RESIDUAL EFFECTS OF CONSTRUCTION AND OPERATION AT THE WESTRIDGE MARINE TERMINAL ON AIR EMISSIONS

Potential Effect	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
1. Air Emissions Indicator – Primary Emissions of Criteria Air Contaminants and Volatile Organic Compounds			
1.1 Primary emissions of criteria air contaminants	RSA	• Trans Mountain will consult with and inform the City of Burnaby and neighbouring landowners of the existing Westridge Marine Terminal with the potential to be affected by emissions from construction activities, prior to the commencement of these activities [Section 7.0]. • Trans Mountain will reduce the duration that vehicles and equipment are allowed to sit and idle to less than one hour unless air temperatures are less than 0°C [Section 7.0]. • Ensure equipment is well-maintained during construction to minimize air and noise emissions [Section 7.0]. • Use multi-passenger vehicles for the transportation of crews to and from the Westridge Marine Terminal, as much as possible [Section 7.0]. • Control emissions to ambient air from new construction at the Westridge Marine Terminal so that concentrations of pollutants do not exceed Metro Vancouver Ambient Air Quality Objectives [Section 7.0].	• Increase in ambient concentrations of CACs.
1.2 Primary emissions of volatile organic compounds	RSA	• Install vapour recovery units to capture vapours from tankers during loading. • Complete engineering design to find suitable vapour destruction systems for VOCs and reduced sulphurs. Preliminary design considers an absorption vessel for removing sulphur compounds and activated carbon adsorption for removing hydrocarbons. Design of vapour recovery system will be completed during detailed engineering design.	• Increase in ambient concentrations of VOCs.

TABLE 7.6.4-1 Cont'd

Potential Effect	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
2. Air Emissions Indicator – Formation of Secondary Particulate Matter and Ozone			
2.1 Formation of secondary particulate matter and ozone	LFV	• All Project-related storage tanks are required to adhere to CCME standards that will reduce fugitive VOC emissions.	• Increase in ambient concentrations of secondary ozone and particulate matter. • Reduced visibility.
3. Air Emissions Indicator – Hydrogen Sulphide and Mercaptans			
3.1 Emissions of H_2S and mercaptans	RSA	• Install TVAUs and vapour recovery system at WMT.	• Increase in ambient ground-level concentrations of H_2S and mercaptans.

Notes: 1 RSA = Air Quality RSA; LFV = Lower Fraser Valley.
2 Detailed mitigation measures are outlined in the Westridge Marine Terminal EPP (Volume 6D).

7.6.4.5 Potential Residual Effects

The potential residual environmental effects on the air quality indicators associated with the construction and operation activities at the Westridge Marine Terminal (Table 7.6.4-2) are:

- an increase in ambient concentrations of CACs;
- an increase in ambient concentrations of VOCs;
- an increase in ambient concentrations of secondary ozone and particulate matter;
- reduced visibility; and
- an increase in ambient ground-level concentrations of H_2S and mercaptans.

7.6.4.6 Significance Evaluation of Potential Residual Effects

The significance evaluation of potential residual effects at the Westridge Marine Terminal follows the same combination of a quantitative and qualitative assessment of air emissions as for tank installation and operation in Section 7.5.4.6.

Detailed information is presented in the Air Emissions and Greenhouse Gas Technical Report (Volume 5C). Data for the quantitative assessment of ambient concentrations of CACs and VOCs are shown in Table 7.6.4-2. For some CACs, Project operation is expected to reduce total emissions at Westridge Marine Terminal from current base case emissions (Table 7.2.4-2). However, note that emission sources shift. In particular, emissions from ships at berth are expected to increase. Table 7.6.4-2 presents the greatest increase in ambient concentrations across all receptors. While many receptors are predicted to see a decrease in ambient concentrations, receptors that are affected strongly by emissions from ships at berth are predicted to see a net increase. Total Project case emissions of NH_3 are predicted to be *de minimus* (9 kg per year, Table 7.2.4-2). Therefore, no potential residual effects are expected during Project operation for primary emissions of CACs.

TABLE 7.6.4-2

DISPERSION MODELLING RESULTS FOR AMBIENT CAC AND VOC CONCENTRATIONS FOR EMISSIONS FROM WESTRIDGE MARINE TERMINAL AND COMPARISON WITH APPLICABLE REGULATORY STANDARDS (EXPRESSED AS NET CHANGE FROM EXISTING CONDITIONS) (in µg/m^3)

Pollutant[1]	Averaging Period	Project at Westridge Marine Terminal	MV Objective
Total Suspended Particulate (TSP)	24-hour	16.00	-
	Annual	0.04	-
Respirable Particulate Matter (PM_{10})	24-hour	15.97	50
	Annual	0.034	20
Inhalable Particulate Matter ($PM_{2.5}$)	24-hour	15.97	25
	Annual	0.025	8
Carbon Monoxide (CO)	1-hour	62.62	30,000
	8-hour	39.19	10,000
Nitrogen dioxide (NO_2)	1-hour	89.88	200
	24-hour	68.10	-
	Annual	5.83	40
Sulphur Dioxide (SO_2)	1-hour	20.18	450
	24-hour	5.08	125
	Annual	0.24	30
Benzene	1-hour	34.27	-
	Annual	0.60	-
Ethylbenzene	1-hour	0.84	-
Toluene	1-hour	24.26	-
	24-hour	4.35	-
Xylenes	1-hour	8.08	-
	24-hour	1.44	-

Note: 1 No primary emissions of NH_3 were modelled in CALPUFF, only the contribution of NH_3 to secondary formation of $PM_{2.5}$ was modelled in CMAQ (see Table 7.5.4-4).

A quantitative assessment was performed for H_2S and mercaptans on the basis of dispersion modelling and odour detection thresholds. Three-minute and 10-minute averages for H_2S and total mercaptans, respectively, were calculated by scaling predictions of maximum 1-hour average ambient ground-level concentrations. The results for each terminal are presented in Table 7.6.4-3. No exceedances of odour detection thresholds are predicted to occur.

TABLE 7.6.4-3

DISPERSION MODELLING RESULTS FOR H_2S AND TOTAL MERCAPTANS FOR THE WESTRIDGE MARINE TERMINAL (EXPRESSED AS NET CHANGE FROM EXISTING CONDITIONS) (in µg/m^3)

Component or Facility	H_2S 3-minute[2]	Total Mercaptans[1] 10-minute[2]
Westridge	0.0015	5.3
Odour detection threshold	*13.1*[3]	*13*[3]

Notes: 1 No individual species within the chemical group of mercaptans nor other additional species were predicted to exceed known odour detection thresholds (see the Air Quality and Greenhouse Gas Technical Report of Volume 5C for further information).

2 3-minute and 10-minute averages were calculated from 1-hour modelled data based on the model guideline for Ontario (Ontario MOE 2009).

3 Odour detection threshold for H_2S is the geometric mean air odour detection threshold reported by AIHA (1989) and Total Mercaptans threshold is based on the Ontario Air Standard for Total Reduced Sulphur (Ontario MOE 2007).

Table 7.6.4-4 provides a summary of the significance evaluation of the potential residual environmental effects of construction and operation activities at the Westridge Marine Terminal on air emissions.

TABLE 7.6.4-4

SIGNIFICANCE EVALUATION OF POTENTIAL RESIDUAL EFFECTS OF CONSTRUCTION AND OPERATIONS AT THE WESTRIDGE MARINE TERMINAL ON AIR EMISSIONS

	Potential Residual Effects	Impact Balance	Spatial Boundary[1]	Temporal Context			Magnitude	Probability	Confidence	Significance[2]
				Duration	Frequency	Reversibility				
1.	Air Emissions Indicator – Primary Emissions of Criteria Air Contaminants and Volatile Organic Compounds									
1(a)	Increase in ambient concentrations of CACs.	Negative	RSA	Short to long-term	Isolated to periodic	Long-term	Low to medium	High	Moderate	Not significant
1(b)	Increase in ambient concentrations of VOCs.	Negative	RSA	Long-term	Continuous	Long-term	Low	High	High	Not significant
1(c)	Combined effects on the primary emissions of CACs and VOCs indicator (1[a] and 1[b]).	Negative	RSA	Long-term	Continuous	Long-term	Low	High	Moderate	Not significant
2.	Air Emissions Indicator – Formation of Secondary Particulate Matter and Ozone									
2(a)	Increase in ambient concentrations of secondary ozone and particulate matter.	Negative	LFV	Long-term	Continuous	Long-term	Medium	High	Moderate	Not significant
2(b)	Reduced visibility.	Negative	LFV	Long-term	Periodic	Long-term	Low	High	Moderate	Not significant
2(c)	Combined effects on the formation of secondary particulate matter and ozone indicator (2[a] and 2[b]).	Negative	LFV	Long-term	Continuous	Long-term	Medium	High	Moderate	Not significant
3.	Air Emissions Indicator – Hydrogen Sulphide and Mercaptans									
3(a)	Increase in ambient ground-level concentrations of H_2S and mercaptans.	Negative	RSA	Long-term	Continuous	Long-term	Low	High	Moderate	Not significant

Notes: 1 RSA = Air Quality RSA; LFV = Lower Fraser Valley.

2 Significant Residual Environmental Effect: A high probability of occurrence of a permanent or long-term residual effect of high magnitude that cannot be technically or economically mitigated.

The evaluation of significance of potential residual effects in Table 7.6.4-3, points 1(b), 1(c), 2(a), and 3(a) is determined to be the same for the construction and operation of the Westridge Marine Terminal as for the tank construction and operation. Table 7.5.4-6 and the accompanying discussion in Section 7.5.4 provide an evaluation of these potential residual effects at the Westridge Marine Terminal and its significance on the applicable air emissions indicators.

Air Emissions Indicator – Primary Emissions of Criteria Air Contaminants and Volatile Organic Compounds

The following provides the evaluation of significance of potential residual effects on the primary emissions of CACs and VOCs indicator.

Increase in Ambient Concentrations of CACs

The increase in ambient ground-level concentrations of CACs is considered to have a negative impact balance. As shown in Table 7.6.4-4 point 1(a), the increase in ambient ground-level concentrations of CACs is confined to the Air Quality RSA. Air emissions are expected to change ambient concentrations of CAC's during Westridge Marine Terminal expansion; the frequency of these construction activities is rated as isolated, while the net increase in CAC emissions from operational activities will be periodic. The increase in CAC concentrations during the expansion is likely measurable but small compared to Metro Vancouver objectives. Project-related increases of ambient CAC concentrations are mostly small compared to Metro Vancouver objectives; for the 24-hour average $PM_{2.5}$ concentration, the Metro Vancouver objective is approached, but not exceeded (Table 7.6.4-2). Therefore, the magnitude is expected to be low to medium. The probability of this occurring is high, because the construction equipment will emit CACs. Because the cause-effect relationships are well understood but detailed information on construction equipment is unavailable, the confidence in the residual effects assessment is moderate. A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Air Quality RSA – changes to ambient ground-level concentrations of CACs from construction are expected to occur within the Air Quality RSA.
- Duration: short to long-term – the event resulting in emissions of CACs is facility construction (short-term) and tankers at berth and some terminal equipment (boilers) (long-term).
- Frequency: periodic – the events resulting in emissions of CACs occur intermittently but repeatedly over the assessment period.
- Reversibility: long-term – emissions of CACs will continue for the life of the operating terminal but will cease when the facility is decommissioned.
- Magnitude: low to medium – the increase in ambient ground-level concentrations of CACs is expected to be small relative to existing conditions and not expected to approach regulatory limits.
- Probability: high – storage tank construction will result in emissions of CACs.
- Confidence: moderate – residual effects assessment is based on a good understanding of cause-effect relationships between construction and air emissions but reliant on vehicle and equipment estimates from previous projects.

Air Emissions Indicator - Formation of Secondary Particulate Matter and Ozone

The following provides the evaluation of significance of potential residual effects on the formation of secondary particulate matter and ozone indicator.

Reduced Visibility

Reduced visibility, as a result of increased ambient concentrations of particulate matter, is considered to have a negative impact balance. As shown in Table 7.6.4-4 point 2(b), reduced visibility is confined to the LFV photochemical model domain. Equipment use at the Westridge Marine Terminal will periodically contribute chemical precursors for secondary particulate matter formation. Currently, no visibility objectives or standards that could be approached exist. $PM_{2.5}$ concentrations, which can reduce visibility, are regulated, however, expected increases in ambient concentrations of $PM_{2.5}$ are small compared to the Canadian Ambient Air Quality Standards, and it is not expected that any location in the LFV will approach the Canadian Ambient Air Quality Standards for $PM_{2.5}$. Therefore, the change in visibility is considered to be of low magnitude. This reduced visibility could be caused over Project lifetime, and the reversibility is therefore long-term. The probability of this occurring is high. Confidence in the residual effects assessment is moderate, because the cause-effect between primary emissions and subsequent reduced visibility is reasonably well understood but the atmospheric chemistry is complex. A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: LFV – reduced visibility expected to occur within the Lower Fraser Valley within the LFV photochemical modelling domain.
- Duration: long-term – emissions of precursors and subsequent reduced visibility are expected to occur for the operational life of the Westridge Marine Terminal and, therefore, are considered long-term.
- Frequency: periodic – precursor emissions from equipment used at Westridge Marine Terminal will cause the formation of secondary PM and reduced visibility to occur intermittently but repeatedly during operations.
- Reversibility: long-term – emissions of precursors and subsequent reduced visibility will extend for the life of the operating terminal. Reduced visibility is reversible as the precursor emissions will cease when the facility is decommissioned.
- Magnitude: low – the reduction in visibility caused by increased ambient $PM_{2.5}$ concentrations is expected to be small relative to existing concentrations but for some areas within the LFV might approach Canadian Ambient Air Quality Standards for $PM_{2.5}$.

- Probability: high – an increase in Project-related equipment use at Westridge Marine Terminal will result in precursor emissions for secondary particulate matter formation and lead to visibility reduction.
- Confidence: moderate – based on a good understanding of cause-effect relationships between the Project, air emissions, and atmospheric reactions; however, there is uncertainty with respect to non-Project emissions, and atmospheric chemical reactions are complex.

Combined Effects on Formation of Secondary Particulate Matter and Ozone

The increase in ambient ground-level concentrations of particulate matter and ozone and the reduction in visibility are considered to have a negative impact balance. As shown in Table 7.6.4-4 point 2(c), the increase in ambient ground-level concentrations of particulate matter and ozone and the reduction in visibility are confined to the LFV photochemical model domain. Emissions during operation at the Westridge Marine Terminal will contribute chemical precursors for secondary ozone formation continuously due to product working and standing losses from handling and storage and ship loading. The changes are considered to be of medium magnitude, because for some areas within the LFV, ambient ground-level concentrations of ozone already approach Canadian Ambient Air Quality Standards. Reversibility is long-term because primary emissions leading to secondary pollutant formation will continue over the life of the operating terminal. The probability of this occurring is high. Confidence in the residual effects assessment is moderate because of the complexity of atmospheric chemistry governing secondary pollutant formation. A summary of the rationale for all of the significance criteria for combined effects on secondary particulate matter and ozone is provided below.

- Spatial Boundary: LFV – changes to ambient ground-level concentrations of secondary PM and ozone and visibility reductions are expected to occur within the LFV photochemical modelling domain.
- Duration: long-term – the combined effects on secondary particulate matter and ozone are expected to occur for the operational life of the Westridge Marine Terminal and, therefore, are considered long-term.
- Frequency: continuous – the combined effects on secondary particulate matter and ozone (*i.e.*, mostly from VOC fugitive precursor emissions and combustion products causing formation of ozone) occur continuously during Westridge Marine Terminal operations.
- Reversibility: long-term – combined effects on secondary particulate matter and ozone reflect fugitive emissions of VOCs during operations at the terminals which will extend for the life of the operating terminal. Combined emissions are reversible as the increase in ambient particulate matter and ozone will cease when the facility is decommissioned.
- Magnitude: medium – the increase in ambient ground-level concentrations of particulate matter and ozone and reduction in visibility are expected to be small relative to existing conditions, but for some areas within the LFV, ambient ground-level concentrations of ozone might approach Canadian Ambient Air Quality Standards.
- Probability: high – an increase in Project-related product storage, handling, and loading as well as equipment use will result in precursor emissions, which contribute to secondary PM and ozone formation and reduced visibility.
- Confidence: moderate – based on a good understanding of cause-effect relationships between the Project, air emissions, and atmospheric reactions; however, there is uncertainty with respect to non-Project emissions, and atmospheric chemical reactions are complex.

7.6.4.7 Summary

As identified in Table 7.6.4-4, there are no situations where there is a high probability of occurrence of a permanent or long-term residual environmental effect on the air emissions indicators of high magnitude that cannot be technically or economically mitigated. Consequently, it is concluded that the residual environmental effects of construction and operation activities at the Westridge Marine Terminal on air emissions will be not significant.

7.6.5 Greenhouse Gas Emissions

As discussed in Section 7.2.5.3, during the construction phase at the Westridge Marine Terminal, dredging, dewatering, and other construction activities as well as operation of vehicles and product loading will result in GHG emissions. During the operations phase, most of the GHG emissions associated with the Westridge Marine Terminal will result from fugitives released during vapour combustion and product loading. Regular transportation, space heating, and equipment use during maintenance activities and normal operations, as well as fugitive emissions from storage tanks, associated valves and connectors, and ship holds are also sources of direct GHG emissions. Electricity consumption at the terminal will result in indirect GHG emissions. GHG emissions related to the construction and operations of the Westridge Marine Terminal are summarized in Table 7.2.5-5.

The assessment of effects on GHG emissions has been conducted considering all the Project components in an integrated manner (*e.g.,* pipeline, temporary facilities, pump stations [including power lines], tanks, Westridge Marine Terminal and pipeline reactivation), since GHG emissions associated with the construction and operation of each Project component are aggregated for the Project as a whole and then compared to provincial and federal GHG inventory totals.

The assessment of effects on GHG emissions for the Project as a whole is presented in Section 7.2.5. Table 7.2.5-8 and accompanying discussion in Section 7.2.5.3 provide an evaluation of potential residual effects of the construction and operation of the Westridge Marine Terminal on GHG indicators.

7.6.6 Acoustic Environment

Sections 7.2.6.1, 7.2.6.2 and 7.4.6 provide the assessment indicators, measurement endpoints, spatial boundaries and acoustic environment context for the assessment of potential effects of the proposed Westridge Marine Terminal expansion work on the acoustic environment.

7.6.6.1 Potential Effects and Mitigation Measures

Identified Potential Effects

Potential effects associated with proposed Westridge Marine Terminal expansion work on the acoustic environment indicators listed in Table 7.6.6-1 were based on the results of desktop analysis, modelling and engagement with regulatory authorities, stakeholders and the general public (Section 3.0), and the professional experience of the assessment team.

A summary of mitigation measures provided in Table 7.6.6-1 was principally developed in accordance with Trans Mountain standards and industry, federal, provincial and municipal regulatory guidelines as described in Section 7.2.6.4.

TABLE 7.6.6-1

POTENTIAL EFFECTS, MITIGATION MEASURES AND RESIDUAL EFFECTS OF CONSTRUCTION AND OPERATIONS OF THE WESTRIDGE MARINE TERMINAL ON THE ACOUSTIC ENVIRONMENT

Potential Effect	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
1. Acoustic Environment Indicator – Sound Levels			
1.1 Changes in sound levels during construction	LSA	• Adhere to all federal (*i.e.,* Environment Canada, *Motor Vehicle Safety Act*, *Oil and Gas Occupational Safety and Health Regulations*, Health Canada), and provincial (Noise Control, BC OGC, *Worker's Compensation Act*, *Occupational Health and Safety Regulations* [BC Reg 296/97 as amended] Section 7.2 [BC Reg. 382/2004, s.1]) and municipal guidelines and regulations for noise management [Section 7.0]. • Implement mitigation measures where night time activity (*e.g.,* HDD) on the facility site is located within 500 m of residences as outlined in the Noise Management Plan [Section 7.0]. • Ensure that Westridge Marine Terminal construction activities adhere to the City of Burnaby Noise and Sound Abatement Bylaw 1979 (Number 7332), including approved hours of work, unless otherwise approved by municipal authorities. Schedule construction activities during the period from 07:00 to 20:00, during weekdays, and 09:00 to 20:00, during weekends, if feasible [Section 7.0]. • Construction activities located within onshore or marine wildlife setback distances will be scheduled to occur within least risk windows or proceed with the approval of the appropriate regulatory authority [Section 7.0]. • Noise abatement and construction scheduling will be considered during noise-sensitive periods, to limit disruption to sensitive receptors (*i.e.,* neighbouring landowners, wildlife migratory periods, nesting birds) [Section 7.0]. • Enforce vehicle speed limits and inform contractor truck drivers and mobile equipment operators that engine retarder braking in urban areas is prohibited [Section 7.0]. • Consider the placement and orientation of equipment to be used at the Westridge Marine Terminal prior to construction in order to reduce the noise disturbance of residents and sensitive wildlife in the vicinity of the Westridge Marine Terminal [Section 7.0]. • Enclose noisy equipment and use baffles, where and when feasible, to limit the transmission of noise beyond the construction site [Section 7.0]. • Use only the size and power of tools necessary to limit noise from power tool operations [Section 7.0]. • Use vibratory methods of pile installation, to the extent feasible. Limit impact piling to daytime only, if feasible [Section 7.0]. • Locate stationary equipment, such as compressors and generators, away from sensitive wildlife, to the extent feasible, and follow the applicable municipal, provincial and federal guidelines [Section 7.0]. • Maintain noise suppression equipment on all construction machinery and vehicles in good order [Section 7.0].	• Increase in sound levels during construction period at the Westridge Marine Terminal.
1.1 Changes in sound levels during operations	LSA	• Review and analyse equipment specifications to ensure sound emissions from mechanical equipment are equal to or less than the sound emissions used in the Terrestrial Noise and Vibration Technical Report. • Ensure ground vehicles are well maintained, especially mufflers. • Use of off-road vehicles for inspection should be limited to week days.	• Increase in continuous sound levels from operations of new equipment at the Westridge Marine Terminal.

Notes: 1 LSA = Acoustic Environment LSA.

2 Detailed mitigation measures are outlined in the Westridge Marine Terminal EPP (Volume 6D).

7.6.6.2 Residual Effects

The potential residual environmental effects on the acoustic environment indicators associated with the construction and operations activities at the Westridge Marine Terminal (Table 7.6.6-1) are:

- increases in sound levels during construction period; and
- increase in continuous sound levels from operation of new equipment.

7.6.6.3 Significance of Residual Effects

Table 7.6.6-2 provides a summary of the significance evaluation of the potential residual environmental effects on the acoustic environment indicator resulting from Project activities at the Westridge Marine Terminal.

A quantitative assessment of the acoustic environment was determined to be the most appropriate approach to evaluate the significance of potential residual environmental effects of construction and operations activities at the Westridge Marine Terminal. The evaluation of significance of each of the potential residual effects for the acoustic environment relies primarily on the magnitude, duration and frequency of the potential change. The definitions for these elements are provided in Table 7.1-2. However, magnitude of residual effects requires further definition for the acoustic environment evaluation and is indicator specific. Magnitude for sound level has been defined based on the degree of compliance with provincial and Health Canada guidelines. Details on the guidelines and legislation used to establish the magnitude ratings can be found in the Terrestrial Noise and Vibration Technical Report.

The definitions of magnitude for the L_{eq} in dBA indicator for construction activities at the Westridge Marine Terminal are as follows.

- **Negligible:** Below BC OGC *Noise Control Best Practices Guideline* daytime ASL (56 and 61 dBA based on receptor).
- **Low:** Below BC OGC *Noise Control Best Practices Guideline* PSL daytime limits (61 and 66 dBA based on receptor) and Health Canada guidance of 75 dBA.
- **Medium:** Less than Health Canada 75 dBA guidance but greater than the BC OGC *Noise Control Best Practices Guideline* daytime PSL (61 and 66 dBA based on receptor).
- **High:** Greater than Health Canada 75 dBA guidance.

The sound levels indicator definitions of magnitude during operations at the Westridge Marine Terminal are as follows.

- **Negligible:** Below BC OGC *Noise Control Best Practices Guideline* nighttime ASL (46 and 51 dBA based on receptor).
- **Low:** Below BC OGC *Noise Control Best Practices Guideline* PSL nighttime limits (46 and 51 dBA based on receptor) and Health Canada %HA limit.
- **Medium:** Equal to or slightly lower than the BC OGC *Noise Control Best Practices Guideline* PSL nighttime limit or Health Canada %HA limit.
- **High:** Greater than either the BC OGC *Noise Control Best Practices Guideline* PSL nighttime limit or the Health Canada %HA limit.

TABLE 7.6.6-2

SIGNIFICANCE EVALUATION OF POTENTIAL RESIDUAL EFFECTS OF CONSTRUCTION AND OPERATIONS AT THE WESTRIDGE MARINE TERMINAL ON THE ACOUSTIC ENVIRONMENT

Potential Residual Effects	Impact Balance	Spatial Boundary[1]	Temporal Context			Magnitude	Probability	Confidence	Significance[2]
			Duration	Frequency	Reversibility				
1. Acoustic Environment – Sound Level									
1(a) Increase in sound levels during construction period.	Negative	Acoustic LSA	Short-term	Isolated	Short-term	Medium	High	Moderate	Not Significant
1(b) Increase in continuous sound levels from operating equipment.	Negative	Acoustic LSA	Long-term	Continuous	Long-term	Negligible to low	High	Moderate	Not Significant
1(c) Combined effects on the sound levels indicator (1[a] and 1[b]).	Negative	Acoustic LSA	Long-term	Continuous	Long-term	Negligible to low	High	Moderate	Not Significant

Notes: 1 LSA = Acoustic Environment LSA.

2 Significant Residual Environmental Effect: A high probability of occurrence of a permanent or long-term residual effect of high magnitude that cannot be technically or economically mitigated.

Acoustic Environment Indicator – Sound Levels

Increase in Sound Levels During Construction Period

The potential for the increase in daytime or nighttime sound levels for human receptors associated with construction at the Westridge Marine Terminal is considered to have a negative impact balance. Based on the results of the analysis in the Terrestrial Noise and Vibration Technical Report, the spatial extent of changes to sound levels from the proposed Westridge Marine Terminal expansion was limited to within the Acoustic Environment RSA. However, the significance of changes is based on the compliance with regulatory guidance for noise. Compliance with regulatory requirements occurs within the Acoustic Environment LSA. The duration of the sounds experienced at receptors is dependent on the activity; each type of sound will last only for the particular phase of construction (*e.g.,* earthworks, tank construction, foundations).

The frequency of sound emissions during each construction activity will be isolated, as construction is cyclic and involves use of mobile equipment and intermittent use of tools. Construction is assessed based on daytime activity only, in compliance with Burnaby Municipal Bylaw 7332. Additional mitigation planning that includes low noise equipment and limits on the types and duration of activities would be required if some activities are required at night. The effect is reversible in the short-term as sound level changes due to construction at the Westridge Marine Terminal will cease as soon as the construction stops.

The results of predictive modelling for construction of a terminal indicates the magnitude of changes in sound levels that will be experienced by people living within 1.5 km of a terminal. Noise controls that will be in use during the construction phase, particularly the use of silencers on mobile equipment, limiting nighttime construction to daytime hours wherever possible, and executing a communications plan with affected persons are expected to control the effects on changes in sound to within acceptable levels as established in the Terrestrial Noise and Vibration Technical Report of Volume 5C. Controlling the magnitude of sound levels effects also limits the spatial extent of the potential change.

The definition for magnitude follows the construction descriptors found in Section 7.6.6.3. The magnitude changes depending on the distance between the construction activities and the surrounding receptors. The highest predicted sound level due to construction activities at the closest affected receptor was predicted to be approximately 70 dBA. Other mitigation measures may be used along with quieter than predicted equipment to lower this sound level. Given the current information, the magnitude would be rated as medium.

The sound levels at the homes will vary throughout the day, and can be controlled through detailed planning and use of sound reduced equipment in densely populated areas. The detailed construction planning required to fully assess urban sound levels is not available at this stage of project planning. A detailed noise management plan that is used during the planning for construction in urban environments can reduce the potential sound levels. A summary of the rationale for all of the significance criteria is provided below (Table 7.6.6-2, point 1[a]).

- Spatial Boundary: Acoustic Environment LSA – compliance with the BC OGC *Noise Control Best Practices Guideline* are achieved within the Acoustic Environment LSA.
- Duration: short-term – the events causing changes in sound levels will occur only during the construction phase.
- Frequency: isolated – the events causing changes in sound levels will occur at residential dwellings during the construction phase.
- Reversibility: short-term – the period over which the change in sound levels extends is the construction period. However, sound level changes will cease when construction activities have finished.
- Magnitude: medium – the magnitude is medium or lower with the implementation of a detailed noise management plan for construction. High magnitude sound levels could occur if nighttime construction is required but can be mitigated to a medium effect with additional mitigation planning.
- Probability: high – based on the proximity of residences to the terminals.
- Confidence: moderate – based on the nature of data inputs.

Increase in Continuous Sound Levels from Operating Equipment

The potential for the increase in daytime or nighttime sound levels for human receptors associated with operations of the Westridge Marine Terminal is considered to have a negative impact balance. Noise from the normal operations of the proposed Westridge Marine Terminal expansion will be sound from pumps, ship loading, ship berthing and support equipment located on the site. Since this is an expansion of the existing terminal, the types of sounds would be similar to those already generated on the site.

The spatial extent of the sound level change is limited to the Acoustic Environment LSA. The duration of the terminal sound is long-term, throughout the life of the terminal. The frequency is continuous, since the Westridge Marine Terminal could operate 24 hours per day, 7 days per week. The effect is reversible as sound level changes stop as soon as the sound stops, which would be at terminal decommissioning.

The definition for magnitude follows the operation descriptors found in Section 7.4.6.3. This varies depending on the distance between the terminal and the surrounding receptors. The predicted sound level created by the Westridge Marine Terminal including the proposed expansion is approximately 49 dBA at the nearest homes west of the site, during the more stringent nighttime period. The predictions include tank terminal equipment, ship loading equipment, one ship idling at the berth, and one ship being manoeuvred to the berth by three tugs and the BC OGC mandated ambient sound level. The combination of ship being manoeuvred by tug was more conservative than having two ships loading. The 49 dBA results indicates a 3 dBA increase over ambient conditions, but is compliant with the BC OGC *Noise Control Best Practices Guideline* limit of 51 dBA at night for the level of development in the area. Given the current information, the magnitude would be rated as negligible to low. A summary of the rationale for all of the significance criteria is provided below (Table 7.6.6-2, point 1[b]).

- Spatial Boundary: Acoustic Environment LSA – compliance with the BC OGC *Noise Control Best Practices Guideline* are achieved within the Acoustic Environment LSA.
- Duration: long-term – the event causing the increase in sound levels is the operation of the Westridge Marine Terminal which occurs over the operational life of the terminal.
- Frequency: continuous – the operation of the Westridge Marine Terminal occurs continually over the assessment period. Ship movements will be periodic. These sound forms the normal cyclic sounds that will occur over the life of the operating terminal.

- Reversibility: long-term – the increase in sound levels during operations at the Westridge Marine Terminal will extend over the life of the operating terminal. All sound level changes are reversible as the sound will cease when the facility is decommissioned.
- Magnitude: negligible to low – with the implementation of appropriate mitigation measures from Table 7.6.6-2 and the Westridge Marine Terminal EPP, sound emitted from the Westridge Marine Terminal and ship loading activities is expected to be controlled within BC OGC *Noise Control Best Practices Guideline* and Health Canada guidance.
- Probability: high – the operations of the terminal will increase sound levels for nearby receptors.
- Confidence: moderate – the assessment is based on a combination of measured existing data, theoretical formulae and current Project design.

Combined Effects on Sound Levels

The evaluation of the combined effects of the construction and operations of the Westridge Marine Terminal on the acoustic environment considers collectively the assessment of the likely potential residual effects on the sound levels indicators. The residual effects for the sound levels indicator do not combine to result in new ratings for the various components since the occurrences of sound happen at different times during the Project. Therefore, the combined effects represents the worst-case or most negative effect for each evaluation criteria between the two residual effects (Table 7.6.6-2, point 1[c]). Effectively, this is the effects from Westridge Marine Terminal operations, as Westridge Marine Terminal construction is of short-term duration and reversibility. A summary of the rationale for all of the significance criteria of combined effects on sound levels is provided below.

- Spatial Boundary: Acoustic Environment LSA – compliance with the BC OGC Noise *Control Best Practices Guideline* are achieved within the Acoustic Environment LSA.
- Duration: long-term – the event causing the combined effects on sound levels reflects the operations of the Westridge terminal which occurs over the life of the operating terminal.
- Frequency: continuous – the event causing combined effects on sound levels reflects the operations of the Westridge Marine Terminal which occurs continually over the assessment period. Ship movements will be periodic. These sounds form the normal cyclic sounds that will occur over the operational life of the terminal.
- Reversibility: long-term – the combined effects on sound levels reflect operations at the Westridge Marine Terminal and will extend over the operational life of the terminal. All sound levels changes are reversible as the sound will cease when the facility is decommissioned.
- Magnitude: negligible to low – the combined effects on sound levels from the Westridge Marine Terminal and ship loading activities is expected to be controlled within BC OGC *Noise Control Best Practices Guideline* and Health Canada guidance with the implementation of appropriate mitigation measures.
- Probability: high – combined effects on sound levels which reflect the operations of the Westridge Marine Terminal are likely to occur.
- Confidence: moderate – the assessment is based on a combination of measured existing data, theoretical formulae and current Project design.

7.6.6.4 Summary

As identified in Table 7.6.6-2, there are no situations where there is a high probability of occurrence of a permanent or long-term residual environmental effect on acoustic environment indicators of high magnitude that cannot be technically or economically mitigated. Consequently, it is concluded that the residual effects associated with the construction and operations of the construction and operations of the Westridge Marine Terminal on the acoustic environment will be not significant.

7.6.7 Vegetation

Sections 7.2.9.1, 7.2.9.2 and 7.2.9.3 provide the assessment indicators, measurement endpoints, spatial boundaries and ecological context for the assessment of potential effects of the proposed Westridge Marine Terminal expansion on vegetation.

7.6.7.1 Potential Effects and Mitigation Measures

Identified Potential Effects

Potential effects associated with the construction and operations of the Westridge Marine Terminal on vegetation indicators are listed in Table 7.6.7-1. These interactions are based on the results of the desktop analysis and the professional experience of the assessment team.

A summary of mitigation measures provided in Table 7.6.7-1 was principally developed in accordance with Trans Mountain standards as well as industry and provincial regulatory guidelines as described in Section 7.2.9.4.

TABLE 7.6.7-1

POTENTIAL EFFECTS, MITIGATION MEASURES AND THE RESIDUAL EFFECTS OF CONSTRUCTION AND OPERATIONS AT THE WESTRIDGE MARINE TERMINAL ON VEGETATION

Potential Effect	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
1. Vegetation Indicator – Presence of Infestations of Provincial Weed Species and Other Invasive Non-Native Species Identified as a Concern			
1.1 Weed introduction and spread	RSA	• See recommended mitigation measures outlined in Table 7.4.9-1 Vegetation.	• Weed introduction and spread.

Notes: 1 RSA = Vegetation RSA.
2 Detailed mitigation measures are outlined in the Westridge Marine Terminal EPP (Volume 6D).

7.6.7.2 Potential Residual Effects

The potential residual environmental effect on vegetation indicators from Project activities associated with the construction and operations of the Westridge Marine Terminal (Table 7.6.7-1) is weed introduction and spread.

7.6.7.3 Significance Evaluation of Potential Residual Effects

Table 7.6.7-2 provides a summary of the significance evaluation of the potential residual environmental effect of the construction and operations of the Westridge Marine Terminal on vegetation. The rationale used to evaluate the significance of the residual environmental effect is provided below.

TABLE 7.6.7-2

SIGNIFICANCE EVALUATION OF POTENTIAL RESIDUAL EFFECTS OF CONSTRUCTION AND OPERATIONS AT THE WESTRIDGE MARINE TERMINAL ON VEGETATION

Potential Residual Effects	Impact Balance	Spatial Boundary[1]	Temporal Context			Magnitude	Probability	Confidence	Significance[2]
			Duration	Frequency	Reversibility				
1. Vegetation Indicator – Presence of Infestations of Provincial Weed Species and Other Invasive Non-native Species Identified as a Concern									
1(a) Weed introduction and spread.	Negative	RSA	Short-term	Isolated	Short to medium-term	Low	High	High	Not significant

Notes: 1 RSA = Vegetation RSA.
2 Significant Residual Environmental Effect: A high probability of occurrence of a permanent or long-term residual effect of high magnitude that cannot be technically or economically mitigated.

The significance evaluation of the potential residual effect on the presence of infestations of provincial weed species and other invasive non-native species identified as a concern indicator (Table 7.6.7-2, point 1[a]) was determined to be the same for the construction and operations of the Westridge Marine Terminal as for pipeline construction and operations. The exception is low magnitude given the localized area of disturbance. Table 7.2.9-3 and the accompanying discussion in Section 7.2.9.6 provide an evaluation of the potential residual effect of project activities and their significance on this vegetation indicator.

7.6.7.4 Summary

As identified in Table 7.6.7-2, there are no situations where there is a high probability of occurrence of a permanent or long-term residual environmental effect of high magnitude that cannot be technically or economically mitigated. Consequently, is it concluded that the residual environmental effects arising from the construction and operations of the Westridge Marine Terminal on vegetation will be not significant.

7.6.8 Marine Sediment and Water Quality

Marine sediment and water quality are important components of the marine environment as they are physical elements that support aquatic life. Marine sediments are formed by the accumulation of particulate matter that settles out of the water column, and may consist of anything from coarse gravel and sand to clay and organic matter. Human activities in the Burrard Inlet watershed have resulted in discharges from water and land-based sources over many years, which have led to locally or regionally elevated contaminant levels in sediments. Processes that occur in surface marine sediments (*e.g.,* diffusion to water, re-suspension during sediment disturbance, or accumulation by benthic organisms) can affect the local and global cycling of these contaminants. Because of these mechanisms, sediments may continue to release contaminants long after the sources have been eliminated and, therefore, have potential for adverse effects on living organisms and ecosystems.

Elevated levels of contaminants in seawater or sediment can present increased risk of toxicity to marine organisms. Project activities with potential to release existing contaminants (*e.g.,* in sediment) or introduce additional contaminants (*e.g.,* through discharges to Burrard Inlet) are assessed in this subsection.

7.6.8.1 Assessment Indicators and Measurement Endpoints

The process of selecting indicators for the assessment of marine sediment and water quality was guided by the potential effects identified for the expansion of the Westridge Marine Terminal (change in sediment quality and change in water quality), regulatory considerations (permits that could be required for the Project, screening criteria, and guidelines for protection of marine life), comments provided during engagement with Aboriginal communities, regulatory authorities, stakeholders and the general public, and the professional experience of the assessment team.

Table 7.6.8-1 lists the indicators used to assess potential effects on marine sediment and water quality, the quantitative measurement endpoints used and the rationale for their selection.

TABLE 7.6.8-1

ASSESSMENT INDICATORS AND MEASUREMENT ENDPOINTS FOR MARINE SEDIMENT AND WATER QUALITY

Marine Sediment and Water Quality Indicators	Measurement Endpoints	Rationale for Indicator Selection
Marine sediment quality	• Comparison of sediment concentrations of selected contaminants that represent bitumen and refined products chemistry (light extractable petroleum hydrocarbons [LEPH], heavy extractable petroleum hydrocarbons [HEPH], PAH, [BTEX (benzene, toluene, ethylbenzene and xylene), volatile petroleum hydrocarbons [VPH]), other contaminants (PCB, metals) to: - *Canadian Environmental Protection Act 1999 (CEPA): Disposal at Sea Regulations* for the disposal of dredged material (SOR/2001-275) - CCME Interim Sediment Quality Guidelines (ISQG) and Probable Effects Levels (PEL) (CCME 2013) - Draft Burrard Inlet Sediment PAH Guidelines (Swain 2009) and Objectives for Burrard Inlet (Nijman 1990) - BC MOE working guidelines for sediment (Nagpal *et al.* 2006)	• Potential to release existing contaminants from sediment into the water column during construction activities (dredging for Westridge Marine Terminal berths). • Information required to assess options for sediment disposal (permit under *Disposal at Sea Regulations*).
Marine water quality	• Comparison of water concentrations of selected general parameters and contaminants that represent water chemistry (*e.g.,* metals, nutrients, total suspended solids [TSS], turbidity, salinity, total extractable hydrocarbon [TEH]) to: - permit limits for TEH (*Petroleum Storage and Distribution Facilities Storm Water Regulation* (BC MOE 2004) - CCME Water Quality Guidelines for the Protection of Aquatic Life (CCME 2013) - BC Approved Water Quality Guidelines (BC MOE 2013) - BC Working Water Quality Guidelines (Nagpal *et al.* 2006) - Ambient water quality objectives for Burrard Inlet Coquitlam-Pitt River area (Nijman 1990)	• Potential to release contaminants or TSS into Burrard Inlet during construction (*e.g.,* dredging) and operations (from treated stormwater). • Effluent characteristics will be described in a required permit.

7.6.8.2 Spatial Boundaries

Spatial boundaries for the assessment of potential Project effects on marine sediment and water quality are defined as follows.

- Project Footprint: the area directly affected by construction of the Westridge Marine Terminal.
- Marine Sediment and Water Quality LSA: the ZOI likely to be affected by construction and operations of the Westridge Marine Terminal, defined as the area within 500 m of the proposed water lease expansion.
- Marine RSA: the area where the direct and indirect influence of other activities could overlap with Project-specific effects and cause cumulative effects on marine sediment and water quality, defined as Burrard Inlet east of the First Narrows, including Indian Arm and Port Moody Arm.

The ZOI for the Marine Sediment and Water Quality LSA was selected to encompass the area over which sediments disturbed during in-water construction activities may disperse before settling to the seafloor.

Study area boundaries for marine sediment and water quality are shown on Figures 6.2-1 and 6.2-2.

7.6.8.3 Marine Sediment and Water Quality Context

The Westridge Marine Terminal is located in the Central Harbour of Burrard Inlet, which encompasses the area east of the Second Narrows and south of the entrance to Indian Arm. Though less developed than the Inner Harbour (between the First and Second Narrows), water and sediment quality has been affected by human activities related to residential, industrial, commercial and shipping activities over the years.

<u>Sediment</u>

Sediment quality in the waters surrounding the Westridge Marine Terminal reflects ambient conditions for Burrard Inlet and historical and current activities at the terminal.

Hydrocarbons contaminants (*e.g.,* PAH, LEPH, and HEPH) are the main parameters of concern for the Project, which involves shipping of hydrocarbons. Construction activities have the potential to disturb contaminants during dredging (release of small amounts of sediment) or during disposal. The extent of dredging required has not been finalized, but if required, it is expected to be within a small area along the shoreline to allow for geotechnical stability required for proposed infill. Dredging in deeper waters to provide increased under-keel clearance of vessels is not anticipated. The Environment Canada Disposal at Sea program provides a regulatory framework for evaluating disposal options for dredged sediment and screening criteria for disposal at sea. The province of *BC Contaminated Sites Regulation* provides a regulatory framework for evaluating disposal options on land. DFO provides work windows and best management practices (BMPs) for dredging and material handling.

Sediment quality in the Footprint, Marine Sediment and Water Quality LSA and Marine RSA is discussed in the Marine Sediment and Water Quality – Westridge Marine Terminal Technical Report of Volume 5C. The Footprint itself is relatively undisturbed and does not include the existing dock at the Westridge Marine Terminal, which is within the Marine Sediment and Water Quality LSA. Historical activities at the Westridge Marine Terminal resulted in elevated levels of PAHs, cadmium and mercury in subtidal sediment adjacent to the pier, as noted prior to dredging in 2006; following dredging, total PAH levels in sediment were 1.5 mg/kg or less (BGC Engineering Inc. 2006), below the screening criteria for disposal at sea (2.5 mg/kg) and the draft Burrard Inlet objective (1.68 mg/kg; Swain 2009). In 2007, a rupture of the Trans Mountain pipeline on Barnet Highway resulted in introduction of crude oil into Burrard Inlet through the storm drain infrastructure, which affected intertidal sediment; following clean up and remediation, sediment PAH levels have been below the Burrard Inlet draft objective (Stantec 2010, 2012).

The 2013 subtidal sediment sampling program conducted in the Footprint and Marine Sediment and Water Quality LSA provides the most recent and site-specific data for the Westridge Marine Terminal (see Marine Sediment and Water Quality – Westridge Marine Terminal Technical Report of Volume 5C). Results indicate generally good sediment quality, meeting the majority of disposal at sea screening criteria and the CCME sediment quality guidelines. There are some exceedances for metals, reflecting human activities in the Burrard Inlet watershed, at levels similar to other locations within the Marine RSA (BC MWLAP 2004d). The majority of sediment samples (53 of 54) met the disposal at sea screening criteria for total PAH of 2.5 mg/kg; the exception was one sample with 3.66 mg/kg. Hydrocarbons that could indicate the presence of fresh oil (LEPH, HEPH and BTEX) were not detectable. PCB levels were below detection in most samples and below the screening criterion in all but one sample collected from northwest of the proposed berths (0.276 mg/kg compared to the 0.1 mg/kg screening criterion). Copper, arsenic, lead and cadmium levels were higher than the screening guidelines and CCME ISQGs in some samples; however, maximum concentrations were lower than the CCME probable effects levels (PELs). Concentrations below the ISQG are not expected to be associated with any adverse biological effects, whereas concentrations above the PEL are expected to be frequently associated with adverse biological effects. Concentrations between the ISQG and the PEL represent the range in which effects are occasionally observed. Distribution of these metals in core samples (from surface to 2 m sampled) suggests a combination of natural and human-related sources.

- Arsenic levels reflect natural occurrence (similar levels at all depths throughout the sampling area, up to 10.9 mg/kg compared to ISQG of 7.24 mg/kg and PEL of 41.6 mg/kg).
- Cadmium and lead levels reflect human sources (levels higher than the ISQG only in the 0-0.5 m samples, throughout the sampling area; cadmium up to 0.75 mg/kg compared to screening criterion of 0.6 mg/kg, ISQG of 0.7 mg/kg and PEL of 4.2 mg/kg; lead up to 59.3 mg/kg compared to ISQG of 30.2 mg/kg and PEL of 112 mg/kg).
- Copper levels reflect both natural and human sources (levels higher than the ISQG at all depths sampled and throughout the sampling area, with highest concentrations in the 0-0.5 m interval; up to 88.3 mg/kg compared to ISQG of 18.7 mg/kg and PEL of 108 mg/kg).

The spatial distribution of PAHs and metals in the Footprint and Marine Sediment and Water Quality LSA reflects ambient sources of contaminants (*e.g.,* from stormwater runoff and vessel traffic) of a historical and current nature, with no specific areas of concern ("hot spots") identified.

Water

The waters near the Westridge Marine Terminal are well-circulated, with freshwater input from the Seymour River and tidal exchange in the Second Narrows (BIEAP 2011). General water quality characteristics in Burrard Inlet are discussed in the Marine Sediment and Water Quality – Westridge Marine Terminal Technical Report of Volume 5C. Ambient water quality, while generally considered good, is affected by release of contaminants from uncontrolled sources, such as the many stormwater outfalls in the area (BIEAP 2011, EVS Environmental Consultants 2003), vessel traffic and marinas. Small spills from equipment during construction or operations of the terminal are another potential source of hydrocarbons.

Discharges from petroleum handling facilities are managed under permit (*Waste Discharge Regulation* of the *Environmental Management Act* [BC MOE 2004]), and typically regulate hydrocarbon release, as indicated in the existing permit for the Westridge Marine Terminal.

Limited data are available for hydrocarbons in water within the Footprint and Marine Sediment and Water Quality LSA. The effluent discharge permit for the Westridge Marine Terminal requires monitoring of TEH monthly; monitoring reports for 2010 and 2011 indicate effluent met the permit requirement of < 5.0 mg/L TEH, and that levels were typically below detection (0.08-0.20 mg/L). PAH concentrations in water were measured in the Marine Sediment and Water Quality LSA and parts of the Marine RSA after the 2007 accidental oil release from the Trans Mountain pipeline into Burrard Inlet; levels were below the detection limit (0.05 µg/L) on the two dates sampled in 2007, with the exception of one sample collected from Port Moody (0.21 µg/L).

7.6.8.4 Potential Effects and Mitigation Measures

Effects Considerations

This subsection describes issues/effects that were considered for inclusion in the assessment of potential Project effects on marine sediment and water quality but were scoped out of the assessment. Some of these issues were raised through consultation with regulatory authorities and other stakeholders, and others were identified by the assessment team based on past experience with similar projects. For each issue/effect identified below, a rationale is provided for why it was not carried through the assessment.

Release of ballast and bilge water is not addressed in the marine sediment and water quality assessment for the Westridge Marine Terminal. These activities are highly regulated by Transport Canada through the *Canada Shipping Act, 2001*. The *Ballast Water Control and Management Regulations* (SOR/2006-129) govern release of ballast water, to avoid release of alien invasive species to local waters. Release of ballast water, which could occur at the Westridge Marine Terminal during cargo loading, is addressed in Section 7.6.9 Marine Fish and Fish Habitat. The *Vessel Pollution and Dangerous Chemicals Regulations* (SOR/2012-69) prohibit the release of untreated bilge water. Nonetheless, unregulated (accidental) discharges from any size of vessel may occur, and could affect marine water quality. This activity is further discussed in Section 4.3.13 of Volume 8A.

Identified Potential Effects

Potential effects associated with construction and operations activities at the Westridge Marine Terminal on the marine sediment and water quality indicators listed in Table 7.6.8-2 were identified based on the results of a literature review, desktop analysis, field work, engagement with regulatory authorities and other stakeholders (Section 3.0), and the professional experience of the assessment team. Given that berth construction details have not been finalized, and may or may not require dredging, the assessment assumes conservatively that some dredging may be required. Similarly, the proposed shoreline infill may require dredging; however, those details have not been finalized.

A summary of mitigation measures provided in Table 7.6.8-2 was principally developed in accordance with Trans Mountain standards and industry best practices, federal regulatory requirements (*Disposal at Sea Regulations*, *Fisheries Act*) and provincial regulatory requirements including the *Environmental Management Act*, which regulates discharge of effluent (*Petroleum Storage and Distribution Facilities Storm Water Regulation*) and disposal of contaminated materials (*Contaminated Sites Regulation*).

TABLE 7.6.8-2

POTENTIAL EFFECTS, MITIGATION MEASURES AND RESIDUAL EFFECTS OF CONSTRUCTION AND OPERATIONS AT THE WESTRIDGE MARINE TERMINAL ON MARINE SEDIMENT AND WATER QUALITY

Potential Effect	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
1. Marine Sediment and Water Quality Indicator – Marine Sediment Quality			
1.1 Change in sediment quality during construction	LSA	• Limit dredging to the extent feasible, for Westridge Marine Terminal construction [Section 8.2]. • Implement the least invasive method of dredging the marine environment (*i.e.*, clamshell dredging), if feasible, in order to reduce sedimentation [Section 8.2]. • Install sedimentation/turbidity control methods (*e.g.*, turbidity curtains) during activities associated with dredging of the marine environment (from onshore or from the marine environment) in order to limit the dispersion and effects of sedimentation on sensitive species. Turbidity curtains will be attached to a floatation boom and will extend from the sea surface to 1-2 m from the sea bottom, if feasible, or as per engineered design [Section 8.2]. • Remove seabed sediment during activities associated with dredging of the marine environment from onshore or from the marine environment, and place all excavated material on a barge deck located inside the turbidity curtain and remove for disposal on sea (if approved by appropriate regulatory authorities) or at an approved location on land (if material does not meet disposal at sea screening criteria) [Section 8.2]. • Use sediment disposal methods appropriate to sediment quality (to see if screening criteria are met or to be disposed of at a designated facility if sediment does not meet disposal at sea screening criteria) [Section 8.2].	• Release of hydrocarbons (PAH), PCBs and metals during construction, through dredging and disposal of sediment (if required).
2. Marine Sediment and Water Quality Indicator – Marine Water Quality			
2.1 Change in water quality during construction or operations	LSA	• Limit dredging to the extent feasible, for Westridge Marine Terminal construction [Section 8.2]. • Implement the least invasive method of dredging the marine environment (*i.e.*, clamshell dredging), if feasible, in order to reduce sedimentation [Section 8.2]. • Install sedimentation/turbidity control methods (*e.g.*, turbidity curtains) during activities associated with dredging of the marine environment (from onshore or from the marine environment) in order to limit the dispersion and effects of sedimentation on sensitive species. Turbidity curtains will be attached to a floatation boom and will extend from the sea surface to 1-2 m from the sea bottom, if feasible, or as per engineered design [Section 8.2]. • Implement a water quality monitoring program during marine construction activities (*i.e.*, dredging of the marine environment from onshore and/or the marine environment, marine drilling, pile installation, infilling, etc.) in order to assess the effectiveness of mitigation measures in place to reduce potential effects to water quality and sediment quality during construction. The monitoring program will assess total suspended solids (TSS) and turbidity within sediment plumes created as a result of marine construction. TSS and turbidity levels will be monitored to ensure these concentrations remain within the Canadian Council of Ministers of the Environment's (CCME) *Canadian Environmental Quality Guidelines* (CCME 2007). In the event that TSS concentrations exceed allowable limits outside of the construction area, water samples will be collected and tested for polycyclic aromatic hydrocarbons (PAHs) in order to assess the risk of spread of these contaminants. The distance required for monitoring will be determined based on consultation with DFO [Section 8.2]. • Install sediment fences at the base of cut/fill areas to reduce sediment discharge into the marine environment, where warranted [Section 8.1].	• Release of hydrocarbons (TEH) during operations, through release of stormwater from the vicinity of hydrocarbon storage facilities and from the pier. • Release of TSS during construction.

TABLE 7.6.8-2 Cont'd

Potential Effect	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
2.1 Change in water quality during construction or operations (cont'd)	See above	• Store bulk tanks containing hazardous materials (*e.g.,* fuel for construction equipment) in a bermed area lined with an impervious polyethylene liner. Containment berms will be large enough to contain 110% of the largest tank plus 10% of the aggregate tank volume within the containment area or as otherwise specified by regulatory requirements. Note that secondary storage for fuel storage tanks is required as noted above for volumes exceeding 1,000 L. Design and size secondary containment for hydrocarbons in accordance with applicable provincial and federal requirements. Remove any rainwater which accumulates within the containment structure if authorized by the Environmental Inspector. If there is a visible hydrocarbon sheen, the water in the containment structure will be collected for proper storage and disposed of at an approved facility [Section 7.0]. • Treat stormwater from hydrocarbon storage and handling areas for removal of hydrocarbons prior to discharge to Burrard Inlet during operations (oil/water separator as directed through the BC *Environmental Management Act* (*Petroleum Storage and Distribution Facilities Storm Water Regulation, Contaminated Sites Regulation*).	• See above.

Notes: 1 LSA = Marine Sediment and Water Quality LSA.
2 Detailed mitigation measures are outlined in the Westridge Marine Terminal EPP (Volume 6D).

7.6.8.5 Potential Residual Effects

The potential residual environmental effects on the marine sediment and water quality indicators associated with construction and operations activities at the Westridge Marine Terminal (Table 7.6.8-2) are:

- release of hydrocarbons (PAH), PCBs, metals and TSS during construction, through dredging and disposal of sediment (if required); and
- release of hydrocarbons (TEH) during operations, through release of stormwater from the vicinity of hydrocarbon storage facilities and piers.

7.6.8.6 Significance Evaluation of Potential Residual Effects

A combination of quantitative and qualitative assessments of marine sediment and water quality was determined to be the most appropriate approach to evaluate the significance of potential residual environmental effects, due to the existence of regulatory thresholds, standards and guidelines for indicators associated with this element. Consequently, the evaluation of significance of each of the potential residual effects relies on both the application of standards and guidelines and the professional judgment of the assessment team.

Table 7.6.8-3 provides a summary of the significance evaluation of the potential residual environmental effects of the construction and operations activities at the Westridge Marine Terminal on marine sediment and water quality indicators. The rationale used to evaluate the significance of each of the residual environmental effects is provided below.

TABLE 7.6.8-3

SIGNIFICANCE EVALUATION OF POTENTIAL RESIDUAL EFFECTS OF CONSTRUCTION AND OPERATIONS AT THE WESTRIDGE MARINE TERMINAL ON MARINE SEDIMENT AND WATER QUALITY

Potential Residual Effects		Impact Balance	Spatial Boundary[1]	Temporal Context			Magnitude	Probability	Confidence	Significance[2]
				Duration	Frequency	Reversibility				
1.	Marine Sediment and Water Quality Indicator – Marine Sediment Quality									
1(a)	Release of hydrocarbons (PAH), PCB and metals during dredging and disposal of sediment.	Negative	LSA	Short-term	Isolated	Short-term	Low	High	High	Not significant
2.	Marine Sediment and Water Quality Indicator – Marine Water Quality									
2(a)	Release of TSS in the water column during construction.	Negative	LSA	Short-term	Isolated	Short-term	Low	High	High	Not significant
2(b)	Release of hydrocarbons (TEH) during operations (treated stormwater).	Negative	LSA	Long-term	Periodic	Short-term	Low	High	High	Not significant
2(c)	Combined effects on the marine water quality indicator (2[a] and 2[b]).	Negative	LSA	Long-term	Periodic	Short-term	Low	High	High	Not significant

Notes: 1 LSA = Marine Sediment and Water Quality LSA.

2 Significant Residual Environmental Effect: A high probability of occurrence of a permanent or long-term residual effect of high magnitude that cannot be technically or economically mitigated.

Marine Sediment and Water Quality Indicator – Marine Sediment Quality

The following subsection provides the evaluation of significance of the potential residual effect on the marine sediment quality indicator.

Release of Hydrocarbons (PAH), PCBs and Metals During Construction

Construction of the expanded Westridge Marine Terminal has the potential to affect marine sediment through release of existing contaminants during dredging or during disposal at sea. The Westridge Marine Terminal has been designed to reduce the amount of dredging needed; however, there is potential for small amounts of dredging at the berths or near the shoreline to improve geotechnical stability of proposed infill areas.

The use of mitigation measures such as clamshell dredges and turbidity curtains during construction (Table 7.6.8-2) is expected to effectively manage most of the adverse effects associated with dredging, should it be required. Adverse effects associated with release of sediment contaminants during dredging are unlikely to occur. The 2013 sediment sampling program conducted in the Footprint and Marine Sediment and Water Quality LSA indicated that contaminant levels in the area are low (Marine Sediment and Water Quality – Westridge Marine Terminal Technical Report of Volume 5C). Sediment quality was assessed for potential contaminants identified by Environment Canada (PAHs, LEPH, HEPH, BTEX, metals, PCBs), which could come from existing or historical Westridge Marine Terminal operations or the many ambient sources identified for Burrard Inlet (Balanced Environmental Services Inc. [BESI] 2010). Sediment quality generally meets screening criteria for disposal at sea and CCME sediment quality guidelines for PAH (exception with 1 of 39 samples, 1.5 times the screening criterion) and PCB (exception with 1 of 39 samples, 2.7 times the screening criterion), with both samples collected in areas away from potential dredge activity. Metals levels are the one potential area of concern. Copper, lead, and cadmium levels in surface sediment (0-0.5 m), and arsenic and copper at all depths sampled were present at levels higher than the CCME ISQG in all 29 locations sampled. Concentrations in the Footprint and Marine Sediment and Water Quality LSA are similar to those measured elsewhere in Burrard Inlet (BC MWLAP 2004d), so are consistent with ambient conditions. Exceedance of the ISQG and screening criteria does not in itself indicate that toxic effects will occur, as the guidelines are set conservatively to protect marine life. The metals concentrations are typically well below the PEL (the level above which adverse effects are frequently associated), suggesting low potential for toxicity if sediments are disturbed.

The maximum cadmium (0.75 mg/kg), lead (59 mg/kg), arsenic (10.9 mg/kg) and copper (88 mg/kg) levels are about 18%, 52%, 26% and 81%, respectively, of the PEL. The mean values for surface sediment (core and grab samples taken across the entire area) are lower than the ISQG for cadmium (0.50 mg/kg), lead (27.7 mg/kg) and arsenic (7.22 mg/kg) and above the ISQG for copper (61.7 mg/kg; 67% of the PEL). Overall, there is a low potential for toxicological effects on marine biota from sediment disturbance, and sediment dwelling organisms and benthic fish are already exposed to these metals levels.

The effect of sediment disturbance or disposal during dredging will be of short-term duration and reversibility and of low magnitude (Table 7.6.8-3, point 1[a]). There is high confidence in this conclusion, given that existing sediment quality meets either screening criteria for disposal at sea or, for metals, reflects ambient conditions for the Marine Sediment and Water Quality LSA and Marine RSA and is well below PEL; and that the effectiveness of the proposed mitigation measures (reducing the need to dredge through site selection; use of clamshell dredge and silt curtains for dredging) is well understood. A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Marine Sediment and Water Quality LSA – sediment disturbance and dispersal will be limited to the dredge area and a small area of the LSA where sediment may be dispersed.
- Duration: short-term – limited to the period of dredging during construction.
- Frequency: isolated – confined to the dredging period during construction.
- Reversibility: short-term – effect will cease within seven days of dredging (disturbed sediment will settle to the bottom again).
- Magnitude: low – residual effects are not detectable from existing (baseline) conditions; although it is noted that baseline conditions are not within the environmental and/or regulatory standards (CCME guidelines and disposal at sea criteria); however, no change from baseline conditions is expected.
- Probability: high – likely to be associated with dredging, should dredging occur.
- Confidence: high – there is a good understanding of the cause-effect relationships between sediment contaminant conditions and potential for adverse effects on marine life (with the caveat that there is considerable conservatism in the sediment quality guidelines used to assess potential toxicity), effectiveness of the mitigation measures, and site-specific data upon which to base the assessment.

Marine Sediment and Water Quality Indicator – Marine Water Quality

The following subsection provides the evaluation of significance of the potential residual effect on the marine water quality indicator.

Release of TSS During Construction

The use of mitigation measures during construction (Table 7.6.7-2) is expected to effectively manage most of the adverse effects on water quality associated with dredging, should it be required. A clamshell bucket typically releases about 1% of sediment during dredging, half near the bottom and half during movement to the surface (Schroeder and Ziegler 2004, Tavolaro 1984). This value is commonly used to model sediment plumes from dredging (*e.g.,* Fissel *et al.* 2006). Movement of any sediment plume associated with dredging will be restricted through use of a turbidity curtain if feasible. Modeling of sediment plumes for another port development project (proposed NGPLP terminal in Kitimat Arm) indicated that the highest concentrations of released sediment (as TSS) would occur near the dredge site at the bottom of the water column, and decrease rapidly with distance (Fissel *et al.* 2006). In that example, TSS levels were predicted to be below the CCME and BC water quality guideline maximum (an increase over baseline of 25 mg/L TSS) and to be above the CCME and BC water quality guideline mean (5 mg/L over background) only in the immediate dredging location. The mean guideline is more appropriate to continuous dredging activities. Although modeling of a sediment plume has not been conducted for this Project, a similar localized effect would be expected for Westridge Marine Terminal construction, and would be influenced by time of year, volume of dredged material, duration of dredging, particle size of the sediment and local tides and currents.

The effect of increased TSS levels during dredging will be of short-term duration and reversibility and of low magnitude (Table 7.6.8-3, point 2[a]). There is high confidence in this conclusion, given that the effectiveness of the proposed mitigation measures (reducing the need to dredge through site selection; use of clamshell dredge and turbidity curtains for dredging) is well understood. A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Marine Sediment and Water Quality LSA – increased TSS levels will be limited to the dredge area and a small area of the LSA where sediment may be dispersed.
- Duration: short-term – limited to the period of dredging during construction.
- Frequency: isolated – confined to the dredging period during construction.
- Reversibility: short-term – effect will cease within seven days of dredging (disturbed sediment will settle to the bottom again).
- Magnitude: low – residual effects will be measurable but within environmental and/or regulatory standards (CCME and BC guidelines).
- Probability: high – likely to be associated with dredging, should dredging occur.
- Confidence: high – there is a good understanding of the cause-effect relationships between sediment disturbance and generation of TSS, effectiveness of the mitigation measures, and site-specific data upon which to base the assessment.

Release of Hydrocarbons (Treated Stormwater) During Operations

Operation of the expanded Westridge Marine Terminal has the potential to affect marine water and, indirectly, sediment, through release of surface water (stormwater) runoff from the site. Runoff may contain hydrocarbons, metals and suspended sediment. of these, hydrocarbons are of particular concern at an oil shipping terminal, and are regulated in the discharge permit for the facility. Increased contaminant concentrations can lead to toxicity in marine biota. Given the many existing sources of stormwater contaminants in Burrard Inlet (BESI 2010), there is a confounded environment where it is difficult to identify specific contaminant sources.

The current and future mitigation measure is to direct runoff from the hydrocarbon handling areas to a stormwater treatment facility before release to Burrard Inlet. The existing facility has operated under a BC MOE discharge permit since 1974 (amended April 2005), which applies to oil/water separators for runoff from the jet fuel storage areas, with release of treated water into Burrard Inlet through two outfalls. The permit sets limits on effluent quantity and quality to protect the marine receiving environment. Effluent is monitored monthly for TEH (limit 5.0 mg/L) and once a year for toxicity (limit of 100% result from 96 hr LC50 for salmonid species). The annual average discharge limit is 26 m^3 per day, with a maximum discharge of 415 m^3 per day. Monitoring of TSS and metals is not required under the permit. The most recent stormwater monitoring reports from 2010 and 2011 show that TEH met the permit requirement and was below the detection limit (which ranged from 0.08-0.20 mg/L) in all samples and that effluent passed the 96 hr LC50 toxicity test. These results indicate good system performance and maintenance practices.

Stormwater discharge from the expanded terminal will also be treated to remove oil from water; the collection system and treatment facility will be expanded to ensure this. Surface water from the loading area of the dock and the process areas of the foreshore (*e.g.,* around vapour recovery units) will be directed to the oil/water separator and discharged through the existing outfall to Burrard Inlet. The dock roadway and all other areas outside of the process areas will continue to drain directly to Burrard Inlet. Conditions similar to baseline are expected, as the new treatment facility will have the same permit requirements (stipulated under the *Petroleum Storage and Distribution Facilities Storm Water Regulation*) and discharged water will be in compliance with the permit. However, it is possible the expanded facility will result in stormwater concentrations closer to the permit limit than the currently reported levels below the detection limit (greater volume of oil on site; the current system treats stormwater from the jet fuel storage area and jet fuel evaporates more quickly than oil).

Residual effects of treated stormwater release may include a small but measurable increase in hydrocarbons in water within a small mixing area around the outfalls; this is not predicted to result in toxicity risks to aquatic life, as the permit limits were set to protect biota. There may also be a localized change in temperature (temperature of effluent is closer to that of ambient air than to seawater), metal levels or salinity (freshwater discharge into seawater), similar to that associated with inputs from watercourses. With the use of a stormwater treatment facility to mitigate effects, the residual environmental effects on water quality are considered to be low magnitude and to occur in an area where there are many similar sources of contaminants (Table 7.6.8-3, point 2[a]).

The effect of stormwater discharge will be long-term but low magnitude (detectable but well within environmental and regulatory standards), and reversible in the short-term. There is high confidence in this conclusion, given the good understanding of cause-effect relationships (permit limits are set to protect sensitive marine organisms), effectiveness of the current and proposed mitigation measures (well-established method of stormwater treatment, subject to regular inspection and maintenance), and professional experience. A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Marine Sediment and Water Quality LSA – rapid dilution of treated stormwater within a short distance of the outfall (the outfall is located in the LSA).
- Duration: long-term – stormwater discharges will occur throughout the operations phase.
- Frequency: periodic – effluent release will occur intermittently but repeatedly over the assessment period (during rainfall events).
- Reversibility: short-term – each event is reversible after the release ends; however, the overall effect of stormwater discharge will not stop until the end of operations.
- Magnitude: low – site runoff will be within permit requirements, which are set to protect marine aquatic biota; expansion of Westridge Marine Terminal facilities will not result in quantifiable changes in measurable parameters as there will be no change from existing conditions.
- Probability: high – given the rainfall regime in the Project area.
- Confidence: high – there is a good understanding of the cause-effect relationships between Westridge Marine Terminal operations and stormwater, and effectiveness of the stormwater treatment facility is well known (proven mitigation technology).

Combined Effects on Marine Water Quality

The combined effects on marine water quality from release of TSS during construction (dredging) and hydrocarbons during operations (from treated stormwater) are the same as discussed as separate effects in the preceding sections. Because one effect occurs during construction and the other during operations, there will be no overlap in the two effects. As a result, combined residual Project effects on water quality will include a low magnitude increase in TSS levels, of short-term duration and reversibility during construction and a small but measurable increase in hydrocarbons in water within a small mixing area around the outfalls during operations (within permit levels, low in magnitude, long-term in duration and short-term in reversibility); both effects would be limited to the Marine Sediment and Water Quality LSA in an area where there are many similar sources of contaminants.

The effect of stormwater discharge will be long-term but low magnitude (detectable but well within environmental and regulatory standards), and reversible in the short-term. There is high confidence in this conclusion, given the good understanding of cause-effect relationships (permit limits are set to protect sensitive marine organisms), effectiveness of the current and proposed mitigation measures (well-established method of stormwater treatment, subject to regular inspection and maintenance), and professional experience.

A summary of the rationale for all of the significance criteria is provided below, based primarily on the effects during operations.

- Spatial Boundary: Marine Sediment and Water Quality LSA – rapid dispersion of TSS or dilution of treated stormwater within a short distance of the outfall (the outfall is located in the LSA).
- Duration: long-term – given that stormwater discharges will occur throughout the operations phase.
- Frequency: periodic – effluent release will occur intermittently but repeatedly over the assessment period (during rainfall events).
- Reversibility: short-term – each event is reversible after the release ends; however, the overall effect of stormwater discharge will not stop until the end of operations.
- Magnitude: low – site runoff will be within permit requirements, which are set to protect marine aquatic biota; expansion of Westridge Marine Terminal facilities will not result in quantifiable changes in measurable parameters as there will be no change from existing conditions.
- Probability: high – given the rainfall regime in the Project area.
- Confidence: high – there is a good understanding of the cause-effect relationships between Westridge Marine Terminal operations and stormwater, and effectiveness of the stormwater treatment facility is well known (proven mitigation technology).

7.6.8.7 Summary

As identified in Table 7.6.8-3, there are no situations where there is a high probability of occurrence of a permanent or long-term residual environmental effect on marine sediment and water quality indicators of high magnitude that cannot be technically or economically mitigated. Consequently, it is concluded that the residual environmental effects of construction and operations activities at the Westridge Marine Terminal on marine sediment and water quality will be not significant.

7.6.9 Marine Fish and Fish Habitat

Marine fish have high ecological, economic and cultural importance in BC. They support valuable commercial, recreational and Aboriginal food, social and ceremonial (FSC) fisheries, they provide food for a diversity of marine and terrestrial birds and mammals, and they have cultural value that transcends their economic and ecological importance. This subsection considers the potential effects of the construction and operations of the Westridge Marine Terminal on marine fish and their habitats. Key issues for marine fish and fish habitat were identified through discussions with federal regulatory authorities, including DFO, Environment Canada and PMV, feedback received from public participants at open houses and ESA Workshops held in the Lower Mainland and southern Vancouver Island, and the professional judgment of the assessment team. Key issues identified for marine fish and fish habitat are listed below:

- potential loss or alteration of marine fish habitat during construction of the Westridge marine Terminal;
- potential injury or mortality of marine fish during construction of the Westridge Marine Terminal; and
- potential introduction of invasive species during discharge of ballast water at the Westridge Marine Terminal.

This subsection considers only those effects that could arise during routine construction and operational activities at the Westridge Marine Terminal. For an assessment of the potential effects of an accidental hydrocarbon release at the Westridge Marine Terminal, the reader is referred to Section 8.0 of Volume 7.

7.6.9.1 Assessment Indicators and Measurement Endpoints

The process for selecting indicators for the assessment of marine fish and fish habitat began by identifying marine fish habitats and marine fish species known to occur in Burrard Inlet that could be affected by activities associated with the expansion of the Westridge Marine Terminal. This was refined by focusing on those habitats and species that support commercial, recreational and/or Aboriginal FSC fisheries. For the habitat-based indicators, all marine habitat types potentially affected by terminal construction were considered. For the species-based indicators, marine fish and invertebrates representative of broader taxonomic groups were considered. Preference was given to species that are: likely to occur seasonally or year-round in the terminal area; sensitive to the physical activities associated with terminal construction; and considered to be of conservation concern. The final selection of indicators took into consideration: experience gained during previous projects with similar ecological conditions and potential issues; feedback from regulators, Aboriginal communities and stakeholders; and professional experience of the assessment team.

The indicators selected to assess potential effects of the expansion of the Westridge Marine Terminal on fish and fish habitat are: marine riparian habitat; intertidal habitat; subtidal habitat; Dungeness crab (*Cancer magister*); inshore rockfish (*Sebastes* spp.); and Pacific salmon (*Oncorhynchus* spp.). The rationale for the selection of each of these indicators is provided in Table 7.6.9-1.

The measurement endpoints for marine fish and fish habitat include both quantitative and qualitative measurement of potential Project effects. For the habitat-based indicators, the measurement endpoint is the area of habitat altered or lost as a result of terminal construction. This was calculated based on the most current terminal engineering and design plans. For the species-based indicators, the measurement endpoints are: the change in productive capacity of suitable habitat as a result of terminal construction; and the likelihood of injury or mortality resulting from in-water construction activities. Productive capacity is defined as the maximum natural capacity of habitats to produce healthy fish, safe for human consumption, or to support or produce aquatic organisms upon which fish depend. Suitable habitat is defined as any habitat used by a given species during one or more life stages for rearing, foraging, spawning or migrating. The change in productive capacity was qualitatively assessed for each indicator species based on the amount of suitable habitat altered or lost as a result of terminal construction. In-water construction activities that have the potential to disturb marine fish were also considered in the assessment of change in productive capacity. The likelihood of injury or mortality was qualitatively assessed for each of the indicator species based on its known or inferred spatial and temporal distribution and its sensitivity to Project activities. Table 7.6.9-1 provides a summary of the measurement endpoints considered for each indicator.

TABLE 7.6.9-1

ASSESSMENT INDICATORS AND MEASUREMENT ENDPOINTS FOR MARINE FISH AND FISH HABITAT

Marine Fish and Fish Habitat Indicators	Measurement Endpoints	Rationale for Indicator Selection
Marine riparian habitat	• Area of habitat altered or lost (m^2)	• Will be affected by terminal construction. • Provides nutrient inputs to the nearshore marine environment. • Consideration of NEB *Filing Manual* requirements for fish and fish habitat in Table A-2.
Intertidal habitat	• Area of habitat altered or lost (m^2)	• Will be affected by terminal construction. • Inhabited by numerous sessile marine species (*e.g.,* algae and invertebrates). • Used by numerous mobile marine species (*e.g.,* fish and invertebrates) for rearing, foraging, spawning and migrating. • Consideration of NEB *Filing Manual* requirements for fish and fish habitat in Table A-2.
Subtidal habitat	• Area of habitat altered or lost (m^2)	• Will be affected by terminal construction. • Inhabited by numerous sessile marine species (*e.g.,* algae and invertebrates). • Used by numerous mobile marine species (*e.g.,* fish and invertebrates) for rearing, foraging, spawning and migrating.
Dungeness crab (*Cancer magister*)	• Change in productive capacity of suitable habitat • Likelihood of injury or mortality	• Representative benthic invertebrate. • Important Area for Dungeness crab, as identified by DFO, overlaps with the Marine Fish and Fish Habitat LSA. • Supports commercial, recreational and Aboriginal fisheries. • Consideration of NEB *Filing Manual* requirements for fish and fish habitat in Table A-2.

TABLE 7.6.9-1 Cont'd

Marine Fish and Fish Habitat Indicators	Measurement Endpoints	Rationale for Indicator Selection
Inshore rockfish (*Sebastes* spp.)	• Change in productive capacity of suitable habitat • Likelihood of injury or mortality	• Representative demersal finfish. • Suitable rocky habitat present within the Marine Fish and Fish Habitat LSA. • Rockfish Conservation Area (RCA) overlaps with the LSA. • Includes species of conservation concern. • Supports commercial, recreational and Aboriginal fisheries. • Consideration of NEB *Filing Manual* requirements for fish and fish habitat in Table A-2.
Pacific salmon (*Oncorhynchus* spp.)	• Change in productive capacity of suitable habitat • Likelihood of injury or mortality	• Representative pelagic finfish. • Important Area for Pacific salmon, as identified by DFO, overlaps with the Marine Fish and Fish Habitat LSA. • Important prey for marine birds and marine mammals. • Supports commercial, recreational and Aboriginal fisheries. • Consideration of NEB *Filing Manual* requirements for fish and fish habitat in Table A-2.

7.6.9.2 Spatial Boundaries

Spatial boundaries for the assessment of potential Project effects on marine fish and fish habitat are defined as follows.

- Project Footprint: the area directly affected by construction of the Westridge Marine Terminal.
- Marine Fish and Fish Habitat LSA: the ZOI likely to be affected by construction and operations of the Westridge Marine Terminal, defined as the area within 500 m of the proposed water lease expansion.
- Marine RSA: the area where the direct and indirect influence of other activities could overlap with Project-specific effects and cause cumulative effects on marine fish and fish habitat. This includes the area of Burrard Inlet east of the First Narrows, including Indian Arm and Port Moody Arm.

Study area boundaries for marine fish and fish habitat are shown on Figures 6.2-1 and 6.2-2.

7.6.9.3 Marine Fish and Fish Habitat Context

The Westridge Marine Terminal is located in the Central Harbour of Burrard Inlet, which encompasses the area east of the Second Narrows and south of the entrance to Indian Arm. Though less developed than the Inner Harbour (between the First and Second Narrows), numerous commercial and industrial developments in the Central Harbour have led to the modification of natural shoreline habitats. A study by Haggarty (2001) concluded that 27.8% of the approximately 38 km of shoreline habitat in the Central Harbour has been modified by human activity. In the Inner Harbour, human development has led to the alteration of 79.7% of the total shoreline habitat. Most of this alteration has been in the form of docks, rip rap, and seawalls. Approximately 34% of the 158 km of shoreline in the Marine RSA and 44% of the 2.3 km of shoreline in the Marine Fish and Fish Habitat LSA has been classified as man-made (BC MFLNRO 2005).

The original Westridge Marine Terminal dock was constructed in 1957 using wood piles and decking. At that time the shoreline south and west of the dock was extended seaward using rock and sediment fill. This marine reclamation area provided a working surface for construction equipment and was needed for piping and other infrastructure associated with the terminal. Over the course of the ensuing decades, the dock was upgraded several times. The original wood piles were replaced with large diameter steel piles, the wood decking was replaced with steel and concrete trestle and loading platform, and concrete caissons were constructed to support the loading platform and associated infrastructure. Large rip rap was also added along most of the shoreline to reinforce the area of infill.

As a result of historic development at the Westridge Marine Terminal, approximately 480 m of the 710 m (68%) of shoreline within the Westridge Marine Terminal water lot has been entirely replaced with fill material. This includes the length of shoreline between the western boundary of the water lot and the existing loading trestle. To the east of the trestle, the upper intertidal zone has been in-filled to support the CN rail line, while the mid and low intertidal zones remain largely natural.

7.6.9.4 Potential Effects and Mitigation Measures

Effects Considerations

This subsection describes issues/effects that were considered for inclusion in the assessment of potential Project effects on marine fish and fish habitat but were scoped out of the assessment. Some of these issues were raised through consultation with Aboriginal communities, regulatory authorities and other stakeholders, and others were identified by the assessment team based on past experience with similar projects. For each issue/effect identified below, a rationale is provided for why it was not carried through the assessment.

Introduction of Aquatic Invasive Species Due to Ballast Water Discharge

Aquatic invasive species (AIS) are non-native aquatic species that are intentionally or unintentionally introduced to Canadian waters by human activity and whose introduction will likely cause damage to the ecosystem, existing species, the economy, or human well-being (Johannessen and McCarter 2010). Introduced species that do not cause measurable damage are known as alien species, rather than invasive species, and alien and invasive species are collectively called non-native species (Johannessen and McCarter 2010). The absence of natural predators in Canadian waters means that AIS can spread rapidly and displace native species through direct competition for food and habitat and through habitat alteration (DFO 2013b). AIS can be very detrimental to both Canadian biodiversity and the economy. In Canada, AIS have already been implicated in both the vast reductions in, or outright extinction of, indigenous fish and the resulting devastation of local fisheries (DFO 2013b).

The main pathways through which invasive species enter and spread through Canadian waters include shipping, recreational and commercial boating, the use of live bait, the aquarium/water garden trade, live food fish, unauthorized introductions and transfers, and canals and water diversions (DFO 2013b). The rate at which AIS are being introduced into Canadian waters nearly doubled during the second half of the 20th century as compared to the first half (DFO 2013b). Ballast water in ships is considered to be the single greatest source of new AIS (DFO 2013b).

Ballast water is brought on board a vessel to increase the draft, change the trim, regulate the stability, or to maintain stress loads within acceptable limits (Transport Canada 2010). Vessels are designed to carry cargo; therefore, vessels transiting without cargo require ballast to ensure safe and optimal operating conditions (Transport Canada 2010). Ambient water is pumped into ballast tanks or empty cargo holds, increasing draft of the vessel and resulting in greater stability and manoeuvrability. Once a vessel arrives at a terminal and is ready for loading, ballast water is released and the cargo takes the place of the ballast, ensuring adequate draft for safe navigation according to the vessel's original design. Ballast may be used to adjust trim (the position of the vessel in water, where the bow, stern and sides ideally sit in the same depth of water) by adjusting ballast in various areas until the vessel sinks or floats to the desired markings. Vessels typically carry some ballast water when carrying a full load, to adjust draft for increased stability during inclement weather and to compensate as fuel is consumed during transit (Transport Canada 2010).

Ballast water that is pumped into vessels in foreign ports can contain foreign aquatic organisms. Although grates or mesh installed on ballast water intakes prevent larger objects or organisms from entering the ship's hull while ballast water is pumped into the ballast tanks or cargo holds, they do not screen out smaller organisms such as bacteria and microscopic algae, or plants and animals (Transport Canada 2010). Aquatic organisms taken up in ballast water at one port of call may be released at another port of call during ballast exchange where they can spread and become established.

There are at least 89 non-native species in the Strait of Georgia, representing nearly three times the number of non-native species in other parts of coastal BC (Johannessen and McCarter 2010, Levings *et al.* 2002). According to Johannessen and McCarter (2010), the number of non-native species reported in the Strait of Georgia has increased 40-fold over the last century; although they note that this increase is likely due in part to increased awareness and surveillance and the resolution of long-standing taxonomic issues. Aquaculture, estuarine circulation patterns, and international shipping have been identified as the main pathways of introduction in the Strait of Georgia (Gillespie 2007, Johannessen and McCarter 2010, Levings *et al.* 2002). Along the BC coast, the Japanese mahogany clam (*Nuttallia obscurata*) and dinoflagellates of the genus *Alexandrium* are thought to have been introduced in ballast water (Rankin *et al.* 2004, Transport Canada 2010). To date, no detrimental effects from non-native species in the Strait of Georgia have been identified (Johannessen and McCarter 2010, Levings *et al.* 2002).

The most effective way to mitigate the introduction of AIS is to regulate and manage pathways of introduction (DFO 2013b). In Canadian waters, the release of ballast water is regulated by the *Ballast Water Control and Management Regulations* (*Ballast Water Regulations*) pursuant to subsection 35(1) and section 190 of the *Canada Shipping Act*. According to Transport Canada (2012), the purpose of the *Ballast Water Regulations* is to protect waters under Canadian jurisdiction from non-indigenous aquatic organisms and pathogens that can be harmful to ecosystems by minimizing the probability of future introductions of harmful aquatic organisms and pathogens from ships' ballast water while protecting the safety of ships. Ballast water is considered managed if it is exchanged, treated, transferred to a reception facility once sediment has settled into tanks, or retained onboard the vessel (Transport Canada 2012). The *Ballast Water Regulations* outline a number of mandatory ballast water management procedures related to ballast water management plans, ballast water exchange and treatment, reporting requirements, compliance and enforcement, and research.

A ballast water management plan outlines the processes and procedures for the safe and effective management of ballast water. Under the *Ballast Water Regulations*, owners of Canadian and foreign vessels must ensure the preparation of the ballast water management plans and ensure that a copy of the plan is carried on board and the processes and procedures in the plan are carried out.

The *Ballast Water Regulations* outline a set of procedures for ballast water exchange or treatment prior to discharge in waters under Canadian jurisdiction. These procedures are based on the International Maritime Organization (IMO) *Guidelines for Ballast Water Management and Development of Ballast Water Management Plans* and the IMO *Guidelines for Ballast Water Exchange*. All ships entering Canadian waters must exchange ballast water outside the 200 nautical mile limit of Canada's exclusive economic zone (Transport Canada 2010). Exchange of ballast water in deep ocean areas or open seas lowers the probability that harmful aquatic organisms and pathogens be transferred in ships ballast water (Transport Canada 2012). If offshore exchange is not feasible for safety reasons such as poor weather, ballast exchange is allowed in designated alternate exchange zones (Transport Canada 2010). Loaded vessels coming from outside waters normally carry some residual ballast water onboard. Before a vessel can take on ballast in tanks containing residual ballast water and subsequently discharge it in Canadian waters, ensure that the residual ballast water has been exposed to salinity conditions equivalent to mid-ocean ballast exchange (Transport Canada 2012).

Transport Canada inspectors may inspect a vessel to determine whether the vessel is in compliance with the *Ballast Water Regulations*. The inspection process may include inspection of the ballast water record book, ballast water management plan, sampling of the vessels ballast water, and any other documentation or assistance as required by the inspector (Transport Canada 2012). Vessels may also be boarded to collect ballast water samples for scientific analysis to further research the effectiveness of ballast water management (Transport Canada 2012).

Ships can choose to treat ballast water before entering Canadian waters instead of exchanging it. Under the *Ballast Water Regulations*, treated ballast water must meet the Ballast Water Performance Standard specified in Regulation D-2 of the IMO *Regulations for the Control and Management of Ships' Ballast Water and Sediments* to be acceptable (Transport Canada 2012).

The *Ballast Water Regulations* also establish reporting requirements for ship operators. The Master of a ship destined for a Canadian port must complete a ballast water reporting form and send it to Transport Canada as soon as possible after a management process is performed (Transport Canada 2012). If a ship is unable to comply with the legislation prior to entering Canadian water, they are required to notify Transport Canada at least 96 hours before entry into Canada's territorial sea and provide an explanation as to the inability to carry out exchange, and what equivalent process the ship intends to carry out to minimize the threat of introduction of AIS (Transport Canada 2012).

Trans Mountain will encourage shippers to comply with all federal laws and legislation regarding ballast water management, including the *Canadian Shipping Act* and the *Ballast Water Control and Management Regulations*. Compliance with the *Ballast Water Regulations* will minimize the likelihood that aquatic invasive species will be introduced during ballast water exchange. Therefore, the introduction of aquatic invasive species due to ballast water discharge was not considered further in this assessment.

Behavioral Disturbance of Marine Fish and Invertebrates Due to Vessel Noise

Exposure to sound typically includes a measure of the received sound level and the duration of the sound signal (Popper and Hastings 2009a). In general, there are two types of anthropogenic sounds: short pulses of high-intensity sounds such as those from blasting, pile driving, and seismic guns; and long-lasting, low-intensity sounds that result in increased background noise such as noise from vessels (Popper and Hastings 2009b).

Several reviews on the effects of anthropogenic sounds on fish and invertebrates have concluded that there is lack of empirical data about the effects of underwater noise on marine fish and invertebrates and very little is known about the potential effects (Hastings and Popper 2005, Moriyasu *et al.* 2004, Popper and Hastings 2009a,b). Potential effects of anthropogenic sound on fish and invertebrates include physical injury or mortality and behavioural responses (Hastings and Popper 2005, Moriyasu *et al*. 2004, Popper and Hastings 2009a,b). There are no criteria or thresholds for the effects underwater noise produced by vessels on marine fish or invertebrates; however, noise from vessels is not likely to be of sufficient intensity to cause physical injury or mortality to marine fish (Popper and Hastings 2009b). Therefore, these effects were not considered further. Underwater noise from vessels berthed at the Westridge Marine Terminal could potentially trigger behavioural responses by marine fish and, therefore, this potential effect was considered for inclusion in the assessment.

The effects of short-term and long-term exposure to underwater noise from vessels on marine fish and invertebrate behaviour are unknown and studies on the effects of anthropogenic sound on fishes have largely been focused on acoustic disturbances associated with explosives, pile driving, and seismic air guns (Moriyasu *et al.* 2004, Popper and Hastings 2009a). Nearly all studies to date on behavioural responses of fish to sound have been conducted in a laboratory setting, which does not provide insight as to how animals will behave in their natural habitat (Popper and Hastings 2009a,b). Furthermore, Popper and Hastings (2009b) note that it is very difficult to extrapolate data on the effects of sound between different fish species and sound sources. Potential behavioural responses of fish to anthropogenic sounds include no change in behavior, small temporary movements for the duration of the sound, large movements that displace fish from their normal locations, and large-scale changes in migration routes (Popper and Hastings 2009b). In theory, the large-scale displacement of a fish or invertebrate population from foraging, spawning, rearing, or migration areas could potentially affect its long-term survival.

Marine fish and invertebrates located near tankers berthed at the Westridge Marine Terminal may respond to the underwater noise by moving away from the sound source for the duration of the disturbance, but there is no evidence in the literature that suggests vessel noise will result in the large-scale displacement of fish or invertebrate populations from foraging, spawning, rearing, or migration areas or otherwise affect their distribution or abundance. This conclusion is supported by the existing overlap of areas of high shipping activity and Pacific salmon migration areas, such as Haro Strait, and the Fraser and Columbia rivers; and Dungeness crab fishing areas, such as the Strait of Georgia. Therefore, behavioural disturbance to marine fish and invertebrates due to underwater noise from Project-related marine vessels was not considered further in this assessment.

Identified Potential Effects

Expansion of the Westridge Marine Terminal will involve the construction of three new loading berths capable of handling Aframax-sized tankers, two trestles, and a utility dock for small tugs and workboats (Figure 6.2-1). These structures will be supported by approximately 220 steel pipe piles (maximum size 1,500 mm) driven into the marine sediment and rock-socketed into the underlying bedrock. A small amount of dredging may be required around the inner west berth to provide underkeel clearance; however, no underwater blasting is required. The expansion of the marine infrastructure will require some onshore development, including the installation of two new 762 mm OD (NPS 30) delivery pipes, vapour recovery units, maintenance sheds and electrical sheds, and a terminal operations control building. Due to the limited space available between the existing CN rail line and the foreshore, marine reclamation (*i.e.,* infilling) will be required to accommodate the new onshore infrastructure.

Construction activities associated with the expansion of the Westridge Marine Terminal have the potential to directly and indirectly affect marine fish and fish habitat through:

- alteration or loss of marine fish habitat;
- change in productive capacity of marine fish habitat; and
- injury or mortality of marine fish.

Activities associated with routine operations at the Westridge Marine Terminal are not expected to result in measurable effects to marine fish and fish habitat. Potential effects of an accidental hydrocarbon release at the Westridge Marine Terminal are discussed in Volume 7.

The potential effects associated with construction activities at the Westridge Marine Terminal on the marine fish and fish habitat indicators are listed in Table 7.6.9-2 and were based on the results of a literature review, desktop analysis, field work, engagement with regulatory authorities and other stakeholders (Section 3.0), and the professional experience of the assessment team.

A summary of mitigation measures provided in Table 7.6.9-2 was principally developed in accordance with federal regulatory guidelines, industry best management practices, and the professional experience of the assessment team.

Section 35(1) of the federal *Fisheries Act* prohibits works or undertakings that will result in serious harm to fish that are part of a commercial, recreational or Aboriginal fishery, or fish that support such a fishery. Serious harm is defined as the death of fish or any permanent alteration to, or destruction of, fish habitat. However, section 35(2) qualifies this prohibition, in that it allows for the authorization of serious harm to fish by the Minister of Fisheries and Oceans, or through legislation.

In 2012, amendments to the *Fisheries Act* received Royal Assent. Policy and legislation have now been developed to support the new fisheries protection provisions of the *Fisheries Act*, which will focus on the sustainability and ongoing productivity of recreational, commercial and Aboriginal fisheries. In November 2013, amendments proposed to the *Fisheries Act* came in to force. New guidance and policy that accompanies these changes to the *Fisheries Act* now apply. The previous long-term policy objective of DFO was the achievement of an overall “net gain” of the productive capacity of fish habitats (DFO 1986). That policy’s objective was guided by the “no net loss” principle where DFO strived to balance unavoidable habitat losses with habitat compensation on a project-by-project basis. The management of effects to fish resulting from habitat degradation or loss remain the primary focus of DFO’s new Fisheries Protection Policy, as proponents are directed to avoid, mitigate and offset harmful impacts to fish and fish habitat (DFO 2013a).

Under DFO’s previous Policy for the Management of Fish Habitat, authorizations under section 35(2) of the *Fisheries Act* were only granted where habitat losses were unavoidable and the proponent could demonstrate that there would be no net loss of the productive capacity of fish habitat (DFO 1986). To meet DFO’s guiding principle of no net loss, habitat compensation, which involves the creation of new fish habitats or the restoration or enhancement of existing fish habitats, was typically required. Wherever possible, DFO urged proponents to pursue compensation measures that would achieve a net gain in the productive capacity of fish habitats. Although DFO’s new Fisheries Protection Policy focuses on the ‘productivity of fisheries’ rather than the ‘productive capacity of fish habitats’, the overall objective is largely the same: minimize harmful impacts to fish and fish habitats. Where impacts cannot be avoided or completely mitigated, offset measures (*i.e.*, compensation measures) are required. Since the new Fisheries Protection Policy was released only weeks before the filing date, this assessment of potential Project-related effects to marine fish and fish habitat is primarily written using language from DFO’s previous Policy for the Management of Fish Habitat (*e.g*., ‘no net loss’, ‘net gain’, ‘productive capacity’, ‘habitat compensation’). However, both the old policy and the new Fisheries Protection Policy were considered by the assessment team in developing this assessment and in determining appropriate mitigation measures.

The principal mitigation measure for marine fish and fish habitat is the implementation of a marine fish habitat compensation/offset program. A detailed marine fish habitat compensation/offset plan will be developed during the permitting phase of the Project (*i.e.,* post-regulatory review). This plan will quantify the amount of marine fish habitat affected by construction of the Westridge Marine Terminal (based on final engineering and design plans), identify and describe the compensation/offset measures that will be implemented to offset the effects to marine fish habitat (*e.g.,* creation of new habitats or enhancement/restoration of existing habitats), and discuss how the compensation/offset measures will ensure there is no net loss of productive capacity. The plan will also present a habitat effectiveness monitoring program that will be conducted to ensure the compensation/offset measures are successful. Key resources that will be used to guide the development of this program include the *Practitioners Guide to Habitat Compensation for DFO Habitat Management Staff* (DFO 2013c), the *Decision Framework for the Determination and Authorization of Harmful Alteration, Disruption or Destruction of Fish Habitat* (DFO 1998), and the new *Fisheries Protection Policy* (DFO 2013a).

To minimize the potential for injury or mortality to marine fish, all dredging and infilling works will be completed within the DFO least-risk work window for Burrard Inlet, which is from August 16 to February 28. If this becomes impractical, timing will be determined in consultation with DFO. In addition, a crab salvage program will be implemented within the dredge and fill footprint immediately prior to the commencement of dredging and infilling to reduce potential injury or mortality to Dungeness crabs. Crabs will be collected using baited traps and relocated to a nearby site, outside of the Marine Fish and Fish Habitat LSA.

Due to the time required to install the large number of piles (anticipated 2 years), it will not be possible to schedule this activity during the DFO least-risk window. However, additional mitigation measures will be applied during pile installation to minimize, if not eliminate, potential injury or mortality to marine fish. As illustrated in Table 7.6.9-5 (see assessment of *Injury or Mortality to Inshore Rockfish Due to Underwater Noise Produced During Pile Driving*, below), noise levels produced during pile driving are highly variable and situation-specific. However, use of a vibratory driver generally produces sound pressure levels (SPLs) that are roughly 25 dB lower (sound exposure levels [SELs] of 10-15 dB lower), on average, than those produced by an impact hammer in a comparable setting and does not produce the high impulse signatures of impact pile driving (Illingworth and Rodkin Inc. 2007, McCauley and Salgado Kent 2008). The preferred installation method is therefore vibratory driver, for its decreased noise production.

Where a vibratory driver cannot be used due to engineering constraints (*e.g*., unfavourable substrate conditions), an impact hammer will likely be used. If an impact or hydraulic hammer is required for pile installation, Trans Mountain will implement several mitigation measures when driving the piles. These recommendations are in accordance with Best Management Practices for Pile Driving and Related Operations (BMPs) for driving steel pipe piles with a diameter greater than 609 mm (24 inches). The BMPs were developed by the BC Marine and Pile Driving Contractors Association (2003) to minimize impacts to fish and fish habitat. Bubble curtains will be deployed over the full length of the wetted pile to assist in attenuating sound levels. A hydrophone will be used to monitor pressure levels during pile-driving, so as to reduce potential fish injury or mortality. This hydrophone will also be monitored at the onset of pile-driving to confirm the assumptions concerning source levels, potential exceedance of the interim criteria for fish harm (SPL of 208 dB re: 1µ; Popper *et al.* 2006), and effectiveness of mitigation measures.

Bubble curtains are a standard mitigation method for impact pile driving. While there are a variety of styles, they all rely on the same basic principle: surrounding the pile with air assists in attenuating the noise produced during impact. When designed and used effectively, bubble curtains have generally been shown to provide a reduction in SPLs and SELs of between 10 and 15 dB (Illingworth and Rodkin Inc. 2007). Actual attenuation values will vary depending on factors such as design of the bubble curtain, installation, current velocity, water depth, and substrate type (Koschinski 2011). Should use of a vibratory driver not be technically feasible, details concerning appropriate type and usage of bubble curtains will be discussed with DFO.

TABLE 7.6.9-2

POTENTIAL EFFECTS, MITIGATION MEASURES AND RESIDUAL EFFECTS OF CONSTRUCTION AND OPERATIONS AT THE WESTRIDGE MARINE TERMINAL ON MARINE FISH AND FISH HABITAT

Potential Effect	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
1. Marine Fish and Fish Habitat Indicator – Marine Riparian Habitat			
1.1 Loss of marine riparian habitat	Footprint	• Limit shoreline clearing to what is absolutely necessary for Project construction. • Implement a marine fish habitat compensation/offset program to ensure there is no net loss of the productive capacity of marine fish habitats.	• Loss of marine riparian habitat due to construction activities.
2. Marine Fish and Fish Habitat Indicator – Intertidal Habitat			
2.1 Loss of intertidal habitat	Footprint	• Limit the area of infill to what is absolutely necessary for Project construction. • Implement a marine fish habitat compensation/offset program to ensure there is no net loss of the productive capacity of marine fish habitats.	• Loss of intertidal habitat due to construction activities.
3. Marine Fish and Fish Habitat Indicator – Subtidal Habitat			
3.1 Loss of subtidal habitat	Footprint	• Limit the area of infill to what is absolutely necessary for Project construction. • Limit the number of piles to what is absolutely necessary for Project construction. • Implement a marine fish habitat compensation/offset program to ensure there is no net loss of the productive capacity of marine fish habitats.	• Loss of subtidal habitat due to construction activities.
4. Marine Fish and Fish Habitat Indicator – Dungeness Crab			
4.1 Decrease in productive capacity of suitable habitat for Dungeness crab	LSA	• Limit the extent of in-water works to what is absolutely necessary for Project construction. • Reduce the risk of sedimentation into areas of fish habitat by properly installing appropriate terrestrial erosion and sediment control measures and marine sediment/turbidity control measures, as required [Section 8.2]. • Implement a marine fish habitat compensation/offset program to ensure there is no net loss of the productive capacity of marine fish habitats.	• Decrease in productive capacity of suitable habitat for Dungeness crab due to construction activities.
4.2 Injury or mortality to Dungeness crab	Footprint	• Limit the extent of in-water works to what is absolutely necessary for Project construction. • Prior to the commencement of marine infilling and dredging, implement a crab salvage program to trap and relocate Dungeness crabs away from in-water construction areas [Section 8.2]. • Reduce the risk of sedimentation into areas of fish habitat by properly installing appropriate terrestrial erosion and sediment control measures and marine sediment/turbidity control measures, as required [Section 8.2]. • Conduct all dredging and infilling works within the DFO least-risk timing window for Burrard Inlet (August 16-February 28) to minimize the potential for injury or mortality of Dungeness crab. If this becomes impractical, timing will be determined in consultation with DFO [Section 8.2].	• Injury or mortality of Dungeness crab due to burial or crushing during infilling and/or dredging.
5. Marine Fish and Fish Habitat Indicator – Inshore Rockfish			
5.1 Decrease in productive capacity of suitable habitat for inshore rockfish	LSA	• See recommended mitigation measures outlined in potential effect 4.1 of this table.	• Decrease in productive capacity of suitable habitat for inshore rockfish due to construction activities.

TABLE 7.6.9-2 Cont'd

Potential Effect	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
5.2 Injury or mortality to inshore rockfish	LSA	• Limit the extent of in-water works to what is absolutely necessary for Project construction. • Use a vibratory method of pile installation, where possible [Section 8.2]. • Deploy bubble curtains during pile installation to reduce underwater noise levels where an impact hammer is required for pile installation [Section 8.2]. • Conduct an acoustic survey in order to establish the effectiveness of the bubble curtain, prior to the commencement of the pile installation activity [Section 8.2]. • Reduce the risk of sedimentation into areas of fish habitat by properly installing appropriate terrestrial erosion and sediment control measures and marine sediment/turbidity control measures, as required [Section 8.2]. • Conduct all dredging and infilling works within the DFO least-risk timing window for Burrard Inlet (August 16-February 28) to minimize the potential for injury or mortality of inshore rockfish. If this becomes impractical, timing will be determined in consultation with DFO [Section 8.2].	• Injury or mortality to inshore rockfish due to burial or crushing during infilling and/or dredging. • Injury or mortality to inshore rockfish due to underwater noise produced during pile driving.
6. Marine Fish and Fish Habitat Indicator – Pacific Salmon			
6.1 Decrease in productive capacity of suitable habitat for Pacific salmon	LSA	• See recommended mitigation measures outlined in potential effect 4.1 of this table.	• Decrease in productive capacity of suitable habitat for Pacific salmon due to construction activities.
6.2 Injury or mortality to Pacific salmon	LSA	• Limit the extent of in-water works to what is absolutely necessary for Project construction. • Use a vibratory method of pile installation, where possible [Section 8.2]. • Deploy bubble curtains during pile installation to reduce underwater noise levels where an impact hammer is required for pile installation [Section 8.2]. • Conduct an acoustic survey in order to establish the effectiveness of the bubble curtain, prior to the commencement of the pile installation activity [Section 8.2]. • Reduce the risk of sedimentation into areas of fish habitat by properly installing appropriate terrestrial erosion and sediment control measures and marine sediment/turbidity control measures, as required [Section 8.2]. • Conduct all dredging and infilling works within the DFO least-risk timing window for Burrard Inlet (August 16-February 28) to minimize the potential for injury or mortality of Pacific salmon. If this becomes impractical, timing will be determined in consultation with DFO [Section 8.2].	• Injury or mortality of Pacific salmon due to burial or crushing during infilling and/or dredging. • Injury or mortality to Pacific salmon due to underwater noise produced during pile driving.

Notes: 1 LSA = Marine Fish and Fish Habitat LSA.
2 Detailed mitigation measures are outlined in the Westridge Marine Terminal EPP (Volume 6D).

7.6.9.5 Potential Residual Effects

The potential residual environmental effects on the marine fish and fish habitat indicators associated with construction activities at the Westridge Marine Terminal (Table 7.6.9-2) are:

- loss of marine riparian habitat, intertidal habitat, and subtidal habitat due to construction activities;
- decrease in productive capacity of suitable habitat for Dungeness crab, inshore rockfish, and Pacific salmon due to construction activities;
- injury or mortality to Dungeness crab, inshore rockfish, and Pacific salmon due to crushing or burial during infilling and/or dredging; and

- injury or mortality to inshore rockfish and Pacific salmon due to underwater noise produced during pile driving.

7.6.9.6 Significance Evaluation of Potential Residual Effects

The approach used to evaluate the significance of potential residual effects on marine fish and fish habitat was both quantitative and qualitative. For the effect of habitat loss, the areal extent of habitat affected by construction of the Westridge Marine Terminal was quantified using the most recent Project engineering and design plans, while the relative importance of the habitat to each indicator species and the resultant effect on productive capacity was assessed qualitatively. For the effect of injury or mortality, the area over which benthic organisms could be crushed or buried was quantified to the extent possible, as were the source levels of underwater noise that could potentially cause harm to fish. However, given the difficulty in predicting actual numbers of marine organisms injured or killed as a result of in-water construction, the magnitude of potential losses and the resultant effect on a species' population were assessed qualitatively. In determining the significance of potential residual effects on marine fish and fish habitat, special attention was given to the provisions of the *Fisheries Act* (and associated policies) that prohibit harm to fish and fish habitat. The evaluation of significance also relied on the professional judgment of the assessment team.

Table 7.6.9-3 provides a summary of the significance evaluation of the potential residual environmental effects of construction activities at the Westridge Marine Terminal on marine fish and fish habitat. The rationale used to evaluate the significance of each of the residual environmental effects is provided below.

TABLE 7.6.9-3

SIGNIFICANCE EVALUATION OF POTENTIAL RESIDUAL EFFECTS OF CONSTRUCTION AND OPERATIONS AT THE WESTRIDGE MARINE TERMINAL ON MARINE FISH AND FISH HABITAT

Potential Residual Effects		Impact Balance	Spatial Boundary[1]	Temporal Context			Magnitude	Probability	Confidence	Significance[2]
				Duration	Frequency	Reversibility				
1.	Marine Fish and Fish Habitat Indicator – Marine Riparian Habitat									
1(a)	Loss of marine riparian habitat due to construction activities.	Negative	Footprint	Short-term	Isolated	Permanent	Low	High	High	Not significant
2.	Marine Fish and Fish Habitat Indicator – Intertidal Habitat									
2(a)	Loss of intertidal habitat due to construction activities.	Negative	Footprint	Short-term	Isolated	Permanent	Low	High	High	Not significant
3.	Marine Fish and Fish Habitat Indicator – Subtidal Habitat									
3(a)	Loss of subtidal habitat due to construction activities.	Negative	Footprint	Short-term	Isolated	Permanent	Low	High	High	Not significant
4.	Marine Fish and Fish Habitat Indicator – Dungeness Crab									
4(a)	Decrease in productive capacity of suitable habitat for Dungeness crab due to construction activities.	Negative	LSA	Short-term	Isolated	Medium-term	Low	High	High	Not significant
4(b)	Injury or mortality to Dungeness crab due to burial or crushing during infilling and/or dredging.	Negative	Footprint	Short-term	Isolated	Medium-term	Low	High	High	Not significant
4(c)	Combined effects on the Dungeness crab indicator (4[a] and 4[b]).	Negative	LSA	Short-term	Isolated	Medium-term	Low	High	High	Not significant
5.	Marine Fish and Fish Habitat Indicator – Inshore Rockfish									
5(a)	Decrease in productive capacity of suitable habitat for inshore rockfish due to construction activities.	Negative	LSA	Short-term	Isolated	Medium-term	Low	High	High	Not significant
5(b)	Injury or mortality to inshore rockfish due to burial or crushing during infilling and/or dredging.	Negative	Footprint	Short-term	Isolated	Medium-term	Low	Low	High	Not significant
5(c)	Injury or mortality to inshore rockfish due to underwater noise produced during pile driving and blasting.	Negative	LSA	Short-term	Isolated	Medium-term	Low	Low	High	Not significant
6.	Marine Fish and Fish Habitat Indicator – Pacific Salmon									
6(a)	Decrease in productive capacity of suitable habitat for Pacific salmon due to construction activities.	Negative	LSA	Short-term	Isolated	Medium-term	Low	High	High	Not significant

TABLE 7.6.9-3 Cont'd

Potential Residual Effects	Impact Balance	Spatial Boundary[1]	Temporal Context: Duration	Temporal Context: Frequency	Temporal Context: Reversibility	Magnitude	Probability	Confidence	Significance[2]
6(b) Injury or mortality to Pacific salmon due to burial or crushing during infilling and/or dredging.	Negative	Footprint	Short-term	Isolated	Medium-term	Low	Low	High	Not significant
6(c) Injury or mortality to Pacific salmon due to underwater noise produced during pile driving and blasting.	Negative	LSA	Short-term	Isolated	Medium-term	Low	Low	High	Not significant

Notes: 1 LSA = Marine Fish and Fish Habitat LSA.

2 Significant Residual Environmental Effect: A high probability of occurrence of a permanent or long-term residual effect of high magnitude that cannot be technically or economically mitigated.

Marine Fish and Fish Habitat Indicator – Marine Riparian Habitat

The following subsection provides the evaluation of significance of the potential residual effect on the marine riparian habitat indicator.

Loss of Marine Riparian Habitat Due to Construction Activities

Construction of the marine infrastructure and expansion of onshore facilities at the Westridge Marine Terminal will result in the loss of marine riparian habitat, intertidal habitat, and subtidal habitat. Marine riparian vegetation along the shoreline will be cleared to accommodate the new land-based infrastructure (*e.g.,* vapour recovery units, pipe racks) and to allow for construction of the marine trestles. Marine reclamation will result in the loss of intertidal and nearshore subtidal habitats within the existing Westridge Marine Terminal water lot. The rip rap (*i.e.,* large angular rock) used to armour the outer surface of the fill area will provide habitat for intertidal and subtidal biota, partially offsetting the losses attributed to infilling. The installation of steel pipe piles will also result in the loss of some soft sediment subtidal habitat.

The areal extent of marine fish habitat affected by construction of the Westridge Marine Terminal has been estimated based on the most current Project engineering and design plans, and is provided in Table 7.6.9-4. These values are considered to be conservative but may be adjusted following detailed terminal engineering.

TABLE 7.6.9-4

TYPE AND AMOUNT OF MARINE FISH HABITAT AFFECTED BY EXPANSION OF THE WESTRIDGE MARINE TERMINAL

Habitat Type	Effect Type	Area of Habitat Affected (m^2)	Description of Habitat
Marine riparian habitat	Loss[1]	2,685	Narrow fringe (~2-4 m wide) of small shrubs, brambles and other herbaceous plants
Intertidal habitat	Loss[1]	5,470	Primarily steep rip rap, with a small area of boulder/cobble with interspersed sand and gravel
	Creation[2]	3,770	Rip rap
Subtidal habitat	Loss[1]	17,100	Primarily soft sediment (sand and mud) with a small area of rip rap adjacent to the existing loading berth
	Creation[2]	5,550	Rip rap
Total	Loss	25,255	Marine riparian vegetation, intertidal habitat and subtidal habitat
	Creation[2]	9,320	Intertidal and subtidal rip rap

Notes: 1 Habitat permanently lost due to Project construction.

2 Habitat created as a direct result of Project construction.

Habitat lost as a result of construction of the Westridge Marine Terminal will decrease the productive capacity of marine fish habitats within the Marine Fish and Fish Habitat LSA. The degree to which a given species will be affected depends on the type and amount of habitat affected, the local and regional availability of the habitat, and the importance of the habitat for rearing, spawning or migration.

Marine riparian habitat provides a number of ecological functions including water quality and pollution abatement, wave energy absorption, terrain formation and stabilization, microclimate regulation, nutrient input, and habitat structure (Brennan and Culverwell 2004, Lemieux *et al.* 2004). As a result, marine riparian habitat contributes to the productive capacity of nearshore marine fish habitats (Lemieux *et al.* 2004, Levings and Jamieson 2001). Marine riparian habitat features and biological assemblages in the Marine Fish and Fish Habitat LSA were observed during the marine riparian survey conducted at the Westridge Marine Terminal on September 26, 2012 (see Marine Resources – Westridge Marine Terminal Technical Report of Volume 5C). Within the existing Westridge Marine Terminal water lot, marine riparian vegetation is limited to a narrow fringe of small shrubs, brambles and weeds. A total of 38 vascular plant species were identified during the survey; common species included asters, ferns, grasses, holly, horsetail, morning-glory, peas, plantains, rushes, saxifrages, and various shrubs. This habitat has been heavily altered by past development, and likely provides limited value in terms of fish habitat.

Construction of the Westridge Marine Terminal will result in the loss of approximately 2,685 m^2 of marine riparian habitat, which is considered to have a negative impact balance. While this loss will be permanent, the associated loss of productive capacity will be offset through the construction of compensation/offset habitat. Specific compensation/offset measures will be determined in consultation with DFO, Aboriginal communities, local stewardship groups and other interested parties during the permitting phase of the Project. One option that has been been implemented successfully for other marine development Projects in BC is the creation of subtidal rock reefs. The ecological benefits of constructing a subtidal reef are myriad. The solid rock foundations of a reef provide anchoring sites for algae and invertebrates, leading to increased diversity and productivity. Crevices and interstitial spaces within a reef provide habitat for a variety of commercially harvested fish and invertebrates. The open matrix of a well-constructed reef also promotes exposure to tidal flushing that increases food and oxygen availability within the reef structure itself. Fish are attracted to the structural complexity of subtidal reef structures and the algal species (*e.g.*, kelps) growing on them. Through direct herbivory and bacterial decomposition, algal detritus forms the basis of many coastal marine food webs. An increase in algal biomass results in increased primary productivity, which translates into a higher abundance of primary and secondary consumers. It is well documented that rocky reefs provide important habitat for many commercially harvested species, including salmon, rockfish, lingcod, herring, Dungeness crab and red rock crab. For the purposes of this assessment, it is assumed that compensation/offset measures will include the construction of a subtidal rock reef near the Westridge Marine Terminal; however, the this option may or may not be included in the final compensation/offset plan depending on feedback from DFO, Aboriginal communities and other interested stakeholders.

With the implementation of marine fish habitat compensation/offset measures, there will be no net loss of productive capacity of marine fish habitat. Compared to the existing riparian vegetation, which has a limited value to marine fish, the subtidal rock reef will provide direct benefits to a variety of harvested species, including rockfish, salmon and Dungeness crab. The temporary decrease in productive capacity that occurs during the time it takes for the rock reef to become fully functional habitat (anticipated 2 to 3 years) will be completely offset by the creation of high value habitat that will persist in perpetuity. As a result, the effect of loss of marine riparian habitat is considered to be of low magnitude (Table 7.6.9-3, point 1[a]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Footprint – the physical effects to marine riparian habitat will be limited to the area of overlap between marine riparian habitat and the Footprint.
- Duration: short-term – the activities and works causing the loss of marine riparian habitat will occur during construction activities on the foreshore, which is expected to take no more than 2 years.
- Frequency: isolated – the events causing the loss of marine riparian habitat will be limited to the construction phase.
- Reversibility: permanent – loss of marine riparian habitat will be permanent.

- Magnitude: low – with the implementation of a marine fish habitat compensation/offset program, there will be no net loss of productive capacity of marine fish habitat.
- Probability: high – riparian clearing will be required for construction of the expanded Westridge Marine Terminal.
- Confidence: high – based on a good understanding by the assessment team of the cause-effect relationship between construction of the Westridge Marine Terminal and the loss of marine riparian habitat, and the effectiveness of the marine fish habitat compensation/offset program.

Marine Fish and Fish Habitat Indicator – Intertidal Habitat

The following subsection provides the evaluation of significance of the potential residual effect on the intertidal habitat indicator.

Loss of Intertidal Habitat Due to Construction Activities

Intertidal habitat is present along the entire length of shoreline within the Marine Fish and Fish Habitat LSA. Based on information from BC MFLNRO (2005), three shore types are present within the Marine Fish and Fish Habitat LSA including ‘man-made’, ‘mud flat’, and ‘sand flat’. Man-made is the dominant shore type, covering approximately 1 km or 44% of the shoreline in the Marine Fish and Fish Habitat LSA (BC MFLNRO 2005). The Footprint of the in-water construction activities overlaps with the man-made shore type. Updated and extensively more detailed information on shoreline type and character within the Marine Fish and Fish Habitat LSA and all the Central Harbour of Burrard Inlet, will be available in the first quarter of 2014. This is currently being completed as a separate Trans Mountain initiative, which is developing a pre-spill SCAT database for the purpose of enhancing emergency preparedness and response capability within this area of Burrard Inlet. For additional information please refer to Volume 8C.

Intertidal habitat features and biological assemblages in the Marine Fish and Fish Habitat LSA were observed during the intertidal survey conducted at the Westridge Marine Terminal on August 18-19, 2012 (see Marine Resources – Westridge Marine Terminal Technical Report of Volume 5C). Intertidal habitat within the Marine Fish and Fish Habitat LSA is characterized by steep, boulder and cobble rip rap substrate with small areas of gravel and sand. A total of 17 marine invertebrate species and 8 marine algae species were observed in the intertidal zone.

The expansion and upgrade of the Westridge Marine Terminal will include the construction of three new tanker berths, a new utility dock, and an extension of the foreshore adjacent to the berths. The foreshore extension will effectively move the intertidal zone seaward of its current location, and the zone is expected to retain the same general physical characteristics (*i.e.,* steep, boulder and cobble rip rap). Approximately 5,470 m^2 of intertidal habitat will be lost due to infilling, and this is considered to have a negative impact balance. However, this loss will be partially offset by the creation of approximately 3,770 m^2 of new rocky intertidal habitat (rip rap) along the outer face of the fill area.

While the loss of intertidal habitat will be permanent, there will be no net loss of the productive capacity of marine fish habitat in the Marine Fish and Fish Habitat LSA. High-value marine fish habitat will be created through the marine fish habitat compensation/offset program. As currently envisaged, the habitat compensation program would involve the construction of a subtidal rock reef near the Westridge Marine Terminal. Within 2 to 3 years, a diverse community of algae, invertebrates, and fish are expected become established on the rock reef, as well as on the rip rap placed in the intertidal zone. As a result, there will be no net loss of productive capacity of marine fish habitat in the Marine Fish and Fish Habitat LSA and this effect is considered to be of low magnitude (Table 7.6.9-3, point 2[a]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Footprint – the physical effects to intertidal habitat will be limited to the area of overlap between intertidal habitat and the Footprint.
- Duration: short-term – the activities and works causing the loss of intertidal habitat will occur during the construction of in-water infrastructure, which is expected to take no more than 2 years.

- Frequency: isolated – the events causing the loss of intertidal habitat will be limited to the construction phase.
- Reversibility: permanent – loss of intertidal habitat will be permanent.
- Magnitude: low – with the implementation of a marine fish habitat compensation/offset program, there will be no net loss of productive capacity of marine fish habitat.
- Probability: high – the proposed in-water construction activities are likely to result in the loss of intertidal habitat.
- Confidence: high – based on a good understanding by the assessment team of the cause-effect relationship between construction of the Westridge Marine Terminal and the loss of intertidal habitat, and the effectiveness of the marine fish habitat compensation/offset program.

Marine Fish and Fish Habitat Indicator – Subtidal Habitat

The following subsection provides the evaluation of significance of the potential residual effect on the marine subtidal habitat indicator.

Loss of Subtidal Habitat Due to Construction Activities

Subtidal habitat is present throughout the Marine Fish and Fish Habitat LSA below the mean lower low water level. The inner portions of Burrard Inlet are predominantly shallow (<30 m) mud substrates (BC Marine Conservation Analysis 2009, Burd *et al.* 2008, Burd 1990). Subtidal habitat features and biological assemblages in the Marine Fish and Fish Habitat LSA were observed during the subtidal remotely operated vehicle (ROV) survey conducted at the Westridge Marine Terminal on September 17-20, 2012 (see Marine Resources – Westridge Marine Terminal Technical Report of Volume 5C). Subtidal habitat within the Marine Fish and Fish Habitat LSA is characterized by soft substrates (silt, mud, sand) with traces of broken shells and wood debris. A total of 32 species of marine fauna were observed during the subtidal ROV survey including 8 species of arthropods, 7 species of echinoderms, 9 species of fish, 4 species of cnidarians, 3 species of molluscs, and 1 species of tunicate. Algal diversity and density was low.

The expansion and upgrade of the Westridge Marine Terminal will include the construction of three new tanker berths, a new utility dock, and an extension of the foreshore adjacent to the new berths. The foreshore extension will involve infilling areas of subtidal habitat and the construction of the new berths and connecting trestles will involve the placement of piles in subtidal habitat. The total area of subtidal habitat lost to infill and pile placement is approximately 17,100 m^2, and this is considered to have a negative impact balance. However, this loss will be partially offset by the creation of approximately 5,550 m^2 of new rocky subtidal habitat (rip rap) along the outer face of the fill area.

While the loss of subtidal habitat will be permanent, there will be no net loss of productive capacity of marine fish habitat in the Marine Fish and Fish Habitat LSA. High-value marine fish habitat will be created through the marine fish habitat compensation/offset program. As currently envisaged, the program will involve the construction of a subtidal rock reef near the Westridge Marine Terminal. Within 2 to 3 years, a diverse community of algae, invertebrates, and fish are expected to become established on the rock reef, as well as on the rip rap placed in the subtidal zone. As a result, there will be no net loss of productive capacity of marine fish habitat in the Marine Fish and Fish Habitat LSA and this effect is considered to be of low magnitude (Table 7.6.9-3, point 3[a]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Footprint – the physical effects to subtidal habitat will be limited to the area of overlap between subtidal habitat and the Footprint.
- Duration: short-term – the activities and works causing the loss of subtidal habitat will occur during the construction of in-water infrastructure, which is expected to take no more than 2 years.
- Frequency: isolated – the events causing the loss of subtidal habitat will be limited to the construction phase.

- Reversibility: permanent – loss of subtidal habitat will be permanent.
- Magnitude: low – with the implementation of a marine fish habitat compensation/offset program, there will be no net loss of productive capacity of marine fish habitat.
- Probability: high – the proposed in-water construction activities are likely to result in the loss of subtidal habitat.
- Confidence: high – based on a good understanding by the assessment team of the cause-effect relationships between construction of the Westridge Marine Terminal and the loss of subtidal habitat, and the effectiveness of the marine fish habitat compensation/offset program.

Marine Fish and Fish Habitat Indicator – Dungeness Crab

The following subsections provide the evaluation of significance of potential residual effects on the Dungeness crab indicator.

Decrease in Productive Capacity of Suitable Habitat for Dungeness Crab

Dungeness crabs typically inhabit sand, mud, or silt substrates and eelgrass beds from the low intertidal zone to depths of 230 m (DFO 2013d). Dungeness crabs were observed in relatively high abundance during the subtidal ROV survey conducted at the Westridge Marine Terminal on September 17-20, 2012 (see Marine Resources – Westridge Marine Terminal Technical Report of Volume 5C). All crabs were observed on soft sediment habitats which was the dominant substrate type observed within the Marine Fish and Fish Habitat LSA. Although no Dungeness crabs were observed during the intertidal survey conducted on August 18-19, 2012 (see Marine Resources – Westridge Marine Terminal Technical Report of Volume 5C), sub-adults and larvae are known to occur in nearshore habitats in inlet environments and are presumed to use the intertidal habitats present within the Marine Fish and Fish Habitat LSA (DFO 2013d, McConnaughey *et al.* 1992).

The loss of intertidal and subtidal habitats (see effects assessments above) is likely to result in a temporary decrease in the productive capacity of Dungeness crab habitat within the Marine Fish and Fish Habitat LSA, which is considered to have a negative impact balance. Although the physical effects to intertidal and subtidal habitats will be limited to the Footprint, the productive capacity of surrounding habitats may be affected as a result of decreased productivity (*e.g.,* algal biomass) and decreased prey availability. This effect will be reversible in the medium-term through the creation of marine compensation/offset habitat and through the natural establishment of algae and invertebrates on the rocky habitats created as a result of infilling (*i.e.,* intertidal and subtidal rip rap). As currently envisaged, the marine fish habitat compensation/offset program will involve the construction of a of rock reef in the subtidal zone near the Westridge Marine Terminal. This reef will provide rearing habitat for recently-settled Dungeness crab larvae and foraging habitat for sub-adult and adult crabs. Algae, invertebrates, and fish are expected to become established on the rock reef and the intertidal and subtidal rip rap within a period of 2 to 3 years after their construction, providing rearing and foraging habitat for Dungeness crabs. With this mitigation, there will be no net loss of the productive capacity of Dungeness crab habitat due to Project-related construction activities in the Marine Fish and Fish Habitat LSA. As a result, this effect is considered to be low magnitude (Table 7.6.9-3, point [4a]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Marine Fish and Fish Habitat LSA – although the physical effects to intertidal and subtidal habitats will be limited to the Footprint, the productive capacity of surrounding habitats may be affected as a result of decreased productivity (*e.g.,* algal biomass) and decreased prey availability.
- Duration: short-term – the events causing the loss of productive capacity will occur during the construction of in-water infrastructure, which is expected to take no more than 2 years.
- Frequency: isolated – the events causing the loss of productive capacity will be limited to the construction phase.

- Reversibility: medium-term – it is expected to take 2 to 3 years for a fully functional biotic community to become established on the subtidal rock reef (marine compensation/offset habitat) and the intertidal and subtidal rip rap habitat.
- Magnitude: low – with the implementation of a marine fish habitat compensation/offset program, there will be no net loss of the productive capacity of Dungeness crab habitat.
- Probability: high – the proposed in-water construction activities are likely to result in the loss of marine fish habitat and subsequently a loss of productive capacity of suitable Dungeness crab habitat.
- Confidence: high – based on a good understanding by the assessment team of the cause-effect relationships between construction of the Westridge Marine Terminal and the productive capacity of marine fish habitat, and the effectiveness of the marine fish habitat compensation/offset program.

Injury or Mortality to Dungeness Crab Due to Burial or Crushing During Infilling and Dredging

Infilling of nearshore habitats will result in the direct mortality of some intertidal and subtidal organisms, primarily through burial and crushing. Sessile organisms (*e.g.,* barnacles, mussels, limpets) will be most susceptible to harm, whereas mobile species (*e.g.,* crabs, rockfish, salmon) will generally be able to avoid harm by dispersing from the work area. The installation of steel pipe piles may also result in the mortality of some sessile subtidal organisms, although the physical footprint of all 220 piles combined is expected to be only 400 m^2. Dredging, if required, will likely be performed using a clamshell bucket, which takes large scoops of sediment from the seafloor and deposits them on a barge. Benthic invertebrates living within the dredge area will be physically removed from the ocean, and will die due to crushing and/or desiccation.

Given the abundance of Dungeness crab within the Footprint, it is likely that some individuals will be harmed or killed during infilling and dredging, and this is considered to have a negative impact balance. To minimize the number of individuals affected, a crab salvage program will be conducted prior to the commencement of both infilling and dredging. Baited traps will be deployed within and adjacent to the work area, and crabs will be relocated to suitable habitat outside of the Marine Fish and Fish Habitat LSA. Because crab traps are selective for larger individuals, it will not be possible to recover sub-adult crabs. However, Dungeness crab are abundant throughout Burrard Inlet (Jamieson and Levesque 2012a,b), the loss of a small number of individuals will not affect the viability of the local population. To further mitigate potential injury or mortality to Dungeness crabs, marine infilling and dredging activities will be restricted to the DFO least-risk timing window for Burrard Inlet, which is from August 16 to February 28. If this becomes impractical, timing will be determined in consultation with DFO.

With the application of mitigation measures, injury or mortality to Dungeness crab due to burial or crushing during infilling and dredging is considered to be low magnitude (Table 7.6.9-3, point [4b]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Footprint – direct physical effects to Dungeness crab will be limited to the area of infill and the dredge footprint.
- Duration: short-term – the events causing injury or mortality to Dungeness crab will occur during the construction of in-water infrastructure, which is expected to take no more than 2 years.
- Frequency: isolated – the events causing injury or mortality of Dungeness crab will be limited to the construction phase.
- Reversibility: medium-term – Dungeness crab spawn annually and are expected to return to pre-disturbance abundance within 1 to 2 years post-construction.
- Magnitude: low – based on the abundance of Dungeness crab in the Marine Fish and Fish Habitat LSA and Marine RSA, the availability of suitable habitat, and the limited spatial extent of infilling and dredging.
- Probability: high – infilling and dredging are likely to result in the loss of a relatively small number of Dungeness crabs.

- Confidence: high – based on a good understanding by the assessment team of the cause-effect relationships between construction of the Westridge Marine Terminal and injury or mortality to Dungeness crab, and the effectiveness of the proposed mitigation.

Combined Effects on Dungeness Crab

Construction of the Westridge Marine Terminal is expected to result in a temporary loss of the productive capacity of suitable Dungeness crab habitat within the Marine Fish and Fish Habitat LSA and the injury or mortality of a relatively small number of individuals within the Footprint. The combined effects on Dungeness crab are considered to have a negative impact balance. However, these effects will be limited in spatial extent and are considered to be reversible in the medium-term. With the implementation of a marine fish habitat compensation/offset program and the establishment of algae, invertebrates, and fish on the intertidal and subtidal rip rap habitat, there will be no net loss of the productive capacity of suitable Dungeness crab habitat.

Dredging and infilling associated with construction of the Westridge Marine Terminal are expected to result in injury or mortality to Dungeness crab. The crab salvage program will greatly reduce the number of adult crabs potentially harmed or killed as a result of in-water construction activities. Given the abundance of this species in Burrard Inlet, the loss of a small number of individuals (mostly juveniles) will not affect the viability of the local population. As a result, the combined effects on Dungeness crab are expected to be of low magnitude (Table 7.6.9-3, point 4[c]). A summary of the rationale for all of the significance criteria of combined effects on Dungeness crab is provided below.

- Spatial Boundary: Marine Fish and Fish Habitat LSA – combined effects on Dungeness crab will be focused within the Footprint, but are expected to extend into the LSA.
- Duration: short-term – the events causing combined effects on Dungeness crab will occur during the construction of in-water infrastructure, which is expected to take no more than 2 years.
- Frequency: isolated – the events causing combined effects on Dungeness crab will be limited to the construction phase.
- Reversibility: medium-term – combined effects on Dungeness crab are expected to take two to three years to reverse.
- Magnitude: low – based on the abundance of Dungeness crab in the Marine Fish and Fish Habitat LSA and Marine RSA, the availability of suitable habitat, and the limited spatial extent of potential Project effects.
- Probability: high – combined effects on Dungeness crab are likely to occur as a result of construction of the Westridge Marine Terminal.
- Confidence: high – based on a good understanding by the assessment team of the cause-effect relationships between construction activities (*i.e.,* dredging and infilling) and Dungeness crab, and the effectiveness of the proposed mitigation measures.

Marine Fish and Fish Habitat Indicator – Inshore Rockfish

The following subsections provide the evaluation of significance of potential residual effects on the inshore rockfish indicator.

Decrease in Productive Capacity of Suitable Habitat for Inshore Rockfish

Inshore rockfish such as quillback and copper rockfish typically inhabit rock reefs in relatively shallow water inlets (DFO 2001, Hart 1973, Yamanaka and Lacko 2001). Pelagic larvae develop into juveniles, who then settle in rock reef areas where they typically demonstrate high site fidelity, rarely moving from the area (DFO 2001, Love *et al.* 2002). Rockfish were not observed during the subtidal ROV survey conducted at the Westridge Marine Terminal on September 17-20, 2012 (see Marine Resources – Westridge Marine Terminal Technical Report of Volume 5C) and the survey revealed that the seabed of the Marine Fish and Fish Habitat LSA consists almost entirely of soft substrates (*i.e.,* silt, mud, sand) with some small areas of rock substrate. Rock rip rap is present in the intertidal and shallow subtidal zones adjacent to the Westridge Marine Terminal. Although rockfish were not observed during the subtidal ROV survey and the predominantly soft substrates in the subtidal zone are not ideal habitat for inshore rockfish, subtidal and intertidal rock substrates and rock rip rap may provide suitable habitat for inshore rockfish and they are presumed to be present in low abundance within the Marine Fish and Fish Habitat LSA.

The loss of intertidal and subtidal habitats (see effects assessments above) is likely to result in a temporary decrease in the productive capacity of rockfish habitat within the Marine Fish and Fish Habitat LSA. Although the physical effects to intertidal and subtidal habitats will be limited to the Footprint, the productive capacity of surrounding habitats may be affected as a result of decreased productivity (*e.g.,* algal biomass) and decreased prey availability. This effect will be reversible in the medium-term through the creation of marine compensation/offset habitat and through the natural establishment of algae and invertebrates on the intertidal and subtidal rip rap habitat created as a result of infilling. As currently envisaged, the marine fish habitat compensation/offset program would involve the construction of a rock reef in the subtidal zone near the Westridge Marine Terminal. This reef will provide more suitable habitat for juvenile and adult rockfish than the soft substrates that currently dominate the Marine Fish and Fish Habitat LSA, and will support rockfish populations in the Eastern Burrard Inlet RCA. Algae, invertebrates, and fish are expected to become established on the rock reef and the intertidal and subtidal rip rap within a period of 2 to 3 years after their construction, providing foraging and spawning habitat for juvenile and adult rockfish. With this mitigation, there will be no net loss of the productive capacity of suitable inshore rockfish habitat due to Project-related construction activities in the Marine Fish and Fish Habitat LSA. As a result, this effect is considered to be of low magnitude (Table 7.6.9-3, point 5[a]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Marine Fish and Fish Habitat LSA – although the physical effects to intertidal and subtidal habitats will be limited to the Footprint, the productive capacity of surrounding habitats may be affected as a result of decreased productivity (*e.g.,* algal biomass) and decreased prey availability.
- Duration: short-term – the events causing the loss of productive capacity will occur during the construction of in-water infrastructure, which is expected to take no more than 2 years.
- Frequency: isolated – the events causing the loss of productive capacity will be limited to the construction phase.
- Reversibility: medium-term – it is expected to take 2 to 3 years for a fully functional biotic community to become established on the subtidal rock reef (marine compensation/offset habitat) and the intertidal and subtidal rip rap habitat.
- Magnitude: low – with the implementation of a marine fish habitat compensation/offset program, there will be no net loss of the productive capacity of suitable rockfish habitat.
- Probability: high – the proposed in-water construction activities are likely to result in the loss of marine fish habitat and subsequently a loss of productive capacity of suitable inshore rockfish habitat.
- Confidence: high – based on a good understanding by the assessment team of the cause-effect relationships between Terminal construction and the productive capacity of marine fish habitat, and the effectiveness of the proposed marine fish habitat compensation/offset program.

Injury or Mortality to Inshore Rockfish Due to Burial or Crushing During Infilling and Dredging

Given the potential for inshore rockfish to be present at low abundance within the Footprint, it is possible that a small number of individuals will be harmed or killed during infilling and dredging, and this is considered to have a negative impact balance. However, the subtidal ROV survey conducted within the Marine Fish and Fish Habitat LSA indicated that the majority of habitat is soft sediment, which has relatively low value for inshore rockfish. Only a small area of complex rocky habitat will be affected by Project construction, and this is a submerged rip rap embankment that was created during historical infilling at the site. During construction, any rockfish that are present within the Footprint may avoid harm by moving away from the work area to adjacent undisturbed habitats. To mitigate potential harm to inshore rockfish, marine infilling and dredging activities will be restricted to the DFO least-risk work window for Burrard Inlet, which is from August 16 to February 28. If this becomes impractical, timing will be determined in consultation with DFO.

Although several species of inshore rockfish have experienced substantial population declines in recent decades as a result of overfishing (Yamanaka and Logan 2010), nearshore species such as the copper rockfish, which is the most likely species to occur in the shallow waters of the Marine Fish and Fish Habitat LSA, are relatively common throughout shallow inlets in the Strait of Georgia (COSEWIC 2009, Hart 1973, Love *et al.* 2002) and the loss of a small number of individuals will not affect the viability of the local populations. In addition, the construction of a rock reef in the subtidal zone near the Westridge Marine Terminal as part of the marine fish habitat compensation/offset program will provide more suitable habitat for juvenile and adult rockfish than the soft substrates that currently dominate the Marine Fish and Fish Habitat LSA, and is expected to increase the abundance of inshore rockfish within the Eastern Burrard Inlet RCA. As a result, injury or mortality to inshore rockfish due to burial or crushing during infilling and dredging is considered to be low magnitude (Table 7.6.9-3, point 5[b]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Footprint – direct physical effects to rockfish will be limited to the area of infill and the dredge footprint.
- Duration: short-term - the events causing injury or mortality to rockfish will occur during the construction of in-water infrastructure, which is expected to take no more than 2 years.
- Frequency: isolated - the events causing injury or mortality rockfish will be limited to the construction phase.
- Reversibility: medium-term – in the unlikely event that a small number of inshore rockfish are killed during Project construction, it may take one to two generations (copper rockfish generation time is approximately 7 years; Love *et al.* 2002) for abundance to return to pre-disturbance levels.
- Magnitude: low – based on the low abundance of rockfish in the Marine Fish and Fish Habitat LSA and Marine RSA, the lack of high-value habitat, and the limited spatial extent of infilling and dredging.
- Probability: low – infilling and dredging are unlikely to result in injury or mortality to rockfish due to their ability to avoid disturbances by temporarily avoiding the work area and the low abundance of rockfish in the Marine Fish and Fish Habitat LSA.
- Confidence: high - based on a good understanding by the assessment team of the cause-effect relationships between construction of the Westridge Marine Terminal and injury or mortality to rockfish, and the effectiveness of the proposed mitigation.

Injury or Mortality to Inshore Rockfish Due to Underwater Noise Produced During Pile Driving

Construction of the marine loading berths will involve the installation of large diameter steel piles (*i.e.,* pile driving). Pile driving can result in the generation of high energy pressure waves that radiate outward from the sound source. If these pressure waves are of sufficient magnitude, they can result in physical injury to fish as they pass through a fish's swim bladder. The interim criteria recommended to evaluate potential harm from pile driving are a peak sound pressure level (peak SPL) of 208 dB re: 1µPa per single strike and an accumulated sound exposure level (SEL) of 187 dB re: 1µPa^2-sec (Popper *et al.* 2006). Peak SPL determines whether the swim bladder and ear are subjected to extreme mechanical stress whereas SEL describes the potential for damage from different wave lengths and energy distributions.

The intensity of sound levels that are produced during pile driving depends on a variety of factors. These typically include the following:

- method of installation (*e.g.,* vibratory or impact hammer);
- type of pile (*e.g.,* steel, concrete, or wood);
- diameter of the pile;

- size of the hammer;
- sediment type and geotechnical conditions;
- tidal and current conditions (particularly if sound attenuation systems such as non-enclosed bubble curtains are used); and
- water depth (Illingworth and Rodkin Inc. 2007).

The exact engineering details concerning the sizes and number of piles or method of installation that will be used for construction of the Westridge Marine Terminal were not known at the time of this assessment. However, noise levels produced during in-water pile installation have been recorded during past construction projects, and are available in the literature (*e.g.,* Illingworth and Rodkin Inc. 2007). SPLs (peak and root mean square [RMS]) and SELs recorded for the installation of large diameter piles of varying sizes and materials are available for both vibratory driver and impact hammer methods and some examples are provided in Table 7.6.9-5. The effects assessment has been developed based on the assumption that 220 1.4 m (1,371.6 mm [NPS 54]) vertical steel pipe piles will be installed intermittently, using an impact hammer, over the course of approximately 2 years. Therefore, the literature values presented for the 1.5 m (1,498.6 mm [NPS 59]) steel CISS (cast-in-steel shell) pile were used as surrogate source levels to assess the potential acoustic effects of pile driving.

TABLE 7.6.9-5

EXAMPLE UNMITIGATED UNDERWATER SOUND LEVELS FROM VARIOUS PILE DRIVING SOURCES

Pile Type and Size	Peak SPL (dB_{peak} re: 1µPa)	SEL (dB re: 1 $µPa^2$-s)	RMS SPL (dB_{rms} re: 1 µPa)
Impact Hammer Installation Method			
2.4 m steel CISS	220	195	205
1.5 m steel CISS	210	185	195
0.91 m steel pipe pile	210	183	193
0.61 m steel pipe pile	207	178	194
0.61 m concrete pile	188	166	176
Vibratory Driver/Extractor Installation Method			
1.8 m steel pipe pile (loudest)	195	180	180
1.8 m steel pipe pile (typical)	183	170	170
0.91 m steel pipe pile	185	175	175
0.61 m AZ steel sheet	182	165	165

Source: Sample values taken from Tables 1.2-1 and 1.2-2 of Illingworth and Rodkin Inc. 2007.

Notes: SPL = Sound Pressure Level; SEL = Sound Exposure Level; RMS = Root Mean Square; CISS = cast-in-steel shell. Sound levels provided above are for illustrative purposes only; sound levels may be highly variable from one situation to another. All sound levels were measured at 10 m from the pile. Depths varied and are presented in Illingworth and Rodkin Inc. 2007 along with further details concerning measurements and sources. Decibels re: 1 µPa are the accepted unit for measuring underwater sound as it relates to marine wildlife (Richardson *et al.* 1995, Southall *et al.* 2007), however, there are different metrics (*i.e.,* peak vs RMS) for calculating and reporting decibels. SELs are a measure of received sound energy and values presented in Table 7.6.9-5 are not M-weighted by any functional hearing groups as in Southall *et al.* 2007; however, generalized comparison to the Southall *et al.* 2007 thresholds (Table 7.6.11-2) is believed to be conservative.

Construction of the marine loading berths may require a small amount of dredging. Dredging typically produces underwater noise of lower sound levels than pile driving. A typical suction cutter dredge has a broadband source level (peak SPL) of 187 dB re: 1 µPa at 1 m, while a typical clamshell dredge has a maximum broadband source level of ~167 dB re: 1 µPa at 1 m (Richardson *et al.* 1995). The dock layout of the proposed Westridge Marine Terminal expansion was designed to reduce or eliminate the need for dredging, so it is most likely that none will be required; however, for the purposes of this assessment, the potential for a small amount of dredging over the course of the two-year construction period has been assessed. Specifications concerning which dredging equipment would be used for construction of the Westridge Marine Terminal were not known at the time of this assessment. For the purpose of the assessment, it was assumed that a small amount of dredging will be required (*i.e.,* approximately 60 days) and that this will be conducted using a clamshell dredge. Sound levels produced by the clamshell dredge are not expected to exceed those produced during pile driving activities and both of the example literature levels noted above are below the peak SPL criterion for injury to fish (208 dB re: 1µPa; Popper *et al.* 2006).

To reduce the likelihood of injury or mortality to rockfish due to exposure to sound from pile-driving, Trans Mountain will use a vibratory method of pile installation wherever technically feasible. Vibratory pile installation typically generates noise levels approximately 25 dB below those generated by impact pile installation, and does not produce the high impulse signatures of impact pile driving (McCauley and Salgado Kent 2008). If an impact or hydraulic hammer is required for pile installation, Trans Mountain will implement several mitigation measures when driving the piles. These recommendations are in concordance with the *Best Management Practices for Pile Driving and Related Operations* developed by the BC Marine and Pile Driving Contractors Association for driving steel pipe piles with a diameter greater than 609.6 mm (NPS 24). First, bubble curtains will be deployed over the full length of the wetted pile. The bubbles act as a barrier and reduce the propagation of shock waves through the water from pile-driving. Second, a hydrophone will be used to monitor the pressure levels from pile-driving. Should the sound pressure exceed 30 kPa, the work will stop immediately and the methods will be reviewed and corrected to ensure acceptable conditions.

With the mitigation measures described above, underwater noise levels produced during pile installation will not exceed the peak SPL criterion for injury to fish (208 dB re: 1µPa; Popper *et al.* 2006), except possibly within the immediate vicinity (*i.e.*, several metres) of the pile. Any rockfish within this range are expected to relocate in response to preparatory activities such as pile placement and/or installation of bubble curtains. Though unlikely, it is possible that a small number of rockfish could be harmed or killed due to underwater noise produced during pile driving; therefore, this residual effect is considered to have a negative impact balance. However, the proposed mitigation measures are expected to be effective at minimizing or eliminating potential harm to inshore rockfish. As a result, injury or mortality to inshore rockfish due to underwater noise produced during pile driving is considered to be low magnitude (Table 7.6.9-3, point 5[c]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Marine Fish and Fish Habitat LSA – although pile-driving activities will be limited to the Footprint, underwater sound generated by pile-driving is expected to propagate throughout the LSA.
- Duration: short-term – the events potentially causing injury or mortality to rockfish will occur during the construction of in-water infrastructure, which is expected to take no more than 2 years.
- Frequency: isolated – the events potentially causing injury or mortality to rockfish will be limited to the construction phase.
- Reversibility: medium-term – in the unlikely event that a small number of inshore rockfish are killed during Project construction, it may take one to two generations (copper rockfish generation time is approximately 7 years; Love *et al.* 2002) for abundance to return to pre-disturbance levels.
- Magnitude: low – based on the low abundance of rockfish in the Marine Fish and Fish Habitat LSA and Marine RSA and the effectiveness of the proposed mitigation.
- Probability: low – injury or mortality to rockfish is unlikely due to their low abundance within the Marine Fish and Fish Habitat LSA and the effectiveness of the proposed mitigation.
- Confidence: high – based on a reasonable understanding by the assessment team of the cause-effect relationships between underwater noise levels produced during pile-driving and injury or mortality to rockfish, and a good understanding of the effectiveness of the proposed mitigation.

Marine Fish and Fish Habitat Indicator – Pacific Salmon

The following subsections provide the evaluation of significance of potential residual effects on the Pacific salmon indicator.

Decrease in Productive Capacity of Suitable Habitat for Pacific Salmon Due to Construction Activities

Burrard Inlet has been identified as a DFO Important Area for Pacific salmon (Jamieson and Levesque 2012a,b) and the area provides suitable habitat for salmon during different phases of their life cycle. Pacific salmon migrate through Burrard Inlet on their way to and from spawning rivers and streams, and juvenile salmon spend time rearing and foraging in estuaries and inshore habitats before migrating offshore (DFO 2001, Hart 1973). Although Pacific salmon were not observed during the subtidal ROV survey conducted at the Westridge Marine Terminal from September 17 to 20, 2012 (see Marine Resources – Westridge Marine Terminal Technical Report of Volume 5C), salmon are presumed to be present within the Marine Fish and Fish Habitat LSA at times.

The loss of intertidal and subtidal habitats (see effects assessments above for these indicators) is likely to result in a temporary decrease in the productive capacity of Pacific salmon habitat within the Marine Fish and Fish Habitat LSA, and this is considered to have a negative impact balance. Although the physical effects to intertidal and subtidal habitats will be limited to the Footprint, the productive capacity of surrounding habitats may be affected as a result of decreased productivity (*e.g.,* algal biomass) and decreased prey availability. This effect will be reversible in the medium-term through the creation of marine compensation/offset habitat and through the natural establishment of algae and invertebrates on the intertidal and subtidal rip rap created as a result of infilling. As currently envisaged, the marine fish habitat compensation/offset program would involve the construction of a rock reef in the subtidal zone near the Westridge Marine Terminal. Algae, invertebrates, and fish are expected to become established on the rock reef and the intertidal and subtidal rip rap within a period of 2 to 3 years after their construction, providing rearing and foraging habitat for Pacific salmon.

Underwater noise produced during in-water construction activities (*e.g.*, dredging and pile installation) may cause Pacific salmon to temporarily avoid the work area, resulting in a temporary decrease in the productive capacity of habitats within the Marine Fish and Fish Habitat LSA. Although no explicit behavioural thresholds exist for fish, studies have shown that some species of fish, including salmonids, exhibit startle and avoidance responses to underwater sound (McCauley *et al.* 2000, Nedwell *et al.* 2006, Wardle *et al*. 2001). Because salmon are hearing generalists and, therefore, assumed to be relatively insensitive to underwater noise, behavioural responses are expected to be limited in spatial extent, short-lived, and unlikely to affect feeding ability (Nedwell *et al.* 2006). Shoreline habitat within the Marine Fish and Fish Habitat LSA is primarily anthropogenic and lacks structural complexity. While juvenile salmon likely use this area to some extent for rearing and foraging, it does not possess the habitat attributes that would make it high value nursery habitat for juvenile salmon (*e.g.*, kelp, eelgrass, undulating shoreline, embayments, natural substrate). While localized avoidance of nearshore habitats within the Marine Fish and Fish Habitat LSA by salmon during periods of in-water construction will decrease the productive capacity of this habitat, the effect will be temporary and is not expected to affect the viability of any local populations.

With the implementation of compensation/offset measures, there will be no net loss of productive capacity of suitable habitat for Pacific salmon within the Marine Fish and Fish Habitat LSA. As a result, this effect is considered to be low magnitude (Table 7.6.9-3, point 6[a]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Marine Fish and Fish Habitat LSA – although the physical effects to intertidal and subtidal habitats will be limited to the Footprint, the productive capacity of surrounding habitats may be affected as a result of decreased productivity (*e.g.,* algal biomass) and decreased prey availability; underwater noise produced during in-water construction activities may result in temporary behavioural responses within the Marine Fish and Fish Habitat LSA, decreasing the productive capacity of available habitat

- Duration: short-term – the events causing the loss of productive capacity will occur during the construction of in-water infrastructure, which is expected to take no more than 2 years.

- Frequency: isolated – the events causing the loss of productive capacity will be limited to the construction phase.

- Reversibility: medium-term – any behavioural changes induced by underwater noise are expected to be immediately reversible upon the cessation of in-water construction; it is expected to take two to three years for a fully functional biotic community to become established on the subtidal rock reef (marine compensation/offset habitat) and the intertidal and subtidal rip rap habitat.
- Magnitude: low – with the implementation of a marine fish habitat compensation program, there will be no net loss of the productive capacity of suitable Pacific salmon habitat.
- Probability: high – the proposed in-water construction activities are likely to result in the loss of marine fish habitat and, subsequently, a loss of productive capacity of suitable Pacific salmon habitat; underwater noise produced during in-water construction activities is likely to result in short-term behavioural responses including localized avoidance of the construction area.
- Confidence: high – based on a good understanding by the assessment team of the cause-effect relationships between construction of the Westridge Marine Terminal and the productive capacity of marine fish habitat, and the effectiveness of the marine fish habitat compensation/offset program.

Injury or Mortality to Pacific Salmon Due to Burial or Crushing During Infilling and Dredging

Given the potential for Pacific salmon to be present within the Footprint, it is possible that a small number of individuals will be harmed or killed during infilling and dredging; therefore, this residual effect is considered to have a negative impact balance. To minimize potential harm to Pacific salmon, marine infilling and dredging activities will be restricted to the DFO least-risk work window for Burrard Inlet, which is from August 16 to February 28. This will avoid the times when juvenile and adult salmon are most abundant in Burrard Inlet (late spring to summer). If this becomes impractical, timing will be determined in consultation with DFO. Pacific salmon are relatively abundant in Burrard Inlet and the Strait of Georgia (DFO 2013e) and the loss of a small number of individuals will not affect the viability of the local populations. As a result, injury or mortality to Pacific salmon due to burial or crushing during infilling and dredging is considered to be low magnitude (Table 7.6.9-3, point [6b]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Footprint – direct physical effects to Pacific salmon will be limited to the area of infill and the dredge footprint.
- Duration: short-term – the events potentially causing injury or mortality to Pacific salmon will occur during the construction of in-water infrastructure, which is expected to take no more than 2 years.
- Frequency: isolated – the events potentially causing injury or mortality to Pacific salmon will be limited to the construction phase.
- Reversibility: medium-term – with the exception of pink salmon which spawn in odd-years in Burrard Inlet, Pacific salmon spawn annually; therefore, in the unlikely event that a small number of Pacific salmon are killed during Project construction, abundance is expected to return to pre-disturbance levels within one to two years post-construction.
- Magnitude: low – based on the predicted low abundance of Pacific salmon in the Marine Fish and Fish Habitat LSA and Marine RSA, the lack of high-value Pacific salmon habitat, the timing of infilling and dredging (DFO least-risk window) and the limited spatial extent of infilling and dredging.
- Probability: low – infilling and dredging are unlikely to result in injury or mortality to Pacific salmon due to their ability to avoid harm by dispersing from the work area, and the timing of infilling and dredging to avoid periods of high salmon abundance.
- Confidence: high – based on a good understanding by the assessment team of the cause-effect relationships between construction of the Westridge Marine Terminal and injury or mortality to Pacific salmon and the effectiveness of the proposed mitigation.

Injury or Mortality to Pacific Salmon Due to Underwater Noise Produced During Pile Driving

The effects of underwater noise from pile-driving on marine fish are described above under *Injury or Mortality to Inshore Rockfish Due to Underwater Noise Produced During Pile Driving*. Potential effects on Pacific salmon are expected to be similar to those described for inshore rockfish.

To reduce the likelihood of injury or mortality to Pacific salmon due to exposure to sound from pile-driving, Trans Mountain will use a vibratory method of pile installation wherever technically feasible. If an impact or hydraulic hammer is required for pile installation, Trans Mountain will implement several mitigation measures when driving the piles, as previously discussed under the inshore rockfish indicator. This includes the installation of bubble curtains around the full wetted length of the pile and monitoring of underwater noise levels with a hydrophone to ensure they do not exceed 30 kPa, as recommended in the *Best Management Practices for Pile Driving and Related Operations*.

With the mitigation measures described above, underwater noise levels produced during pile installation will not exceed the peak SPL criterion for injury to fish (208 dB re: 1µPa; Popper *et al.* 2006), except possibly within the immediate vicinity (*i.e.*, several metres) of the pile. Any salmon within this range are expected to relocate in response to preparatory activities such as pile placement and/or installation of bubble curtains. Though unlikely, it is possible that a small number of salmon could be harmed or killed due to underwater noise produced during pile driving; therefore, this residual effect is considered to have a negative impact balance. However, the proposed mitigation measures are expected to be effective at minimizing or eliminating potential harm to Pacific salmon. As a result, injury or mortality to Pacific salmon due to underwater noise produced during pile driving is considered to be low magnitude (Table 7.6.9-3, point 6[c]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Marine Fish and Fish Habitat LSA – although pile-driving activities will be limited to the Footprint, underwater sound generated by pile-driving is expected to propagate throughout the Marine Fish and Fish Habitat LSA.
- Duration: short-term – the events potentially causing injury or mortality to Pacific salmon will occur during the construction of in-water infrastructure, which is expected to take no more than 2 years.
- Frequency: isolated – the events potentially causing injury or mortality to Pacific salmon will be limited to the construction phase.
- Reversibility: medium-term – with the exception of pink salmon which spawn in odd-years in Burrard Inlet, Pacific salmon spawn annually; therefore, in the unlikely event that a small number of Pacific salmon are killed during Project construction, abundance is expected to return to pre-disturbance levels within one to two years post-construction.
- Magnitude: low – based on the abundance of Pacific salmon in the Marine Fish and Fish Habitat LSA and Marine RSA and the effectiveness of the proposed mitigation.
- Probability: low – injury or mortality to Pacific salmon is unlikely given the effectiveness of the proposed mitigation and the expectation that individuals in close proximity of the piles will relocate during preparatory activities such as pile placement and installation of the bubble curtain.
- Confidence: high – based on a reasonable understanding by the assessment team of the cause-effect relationships between underwater noise levels produced during pile-driving and injury or mortality to Pacific salmon, and the effectiveness of the proposed mitigation.

7.6.9.7 Summary

As identified in Table 7.6.9-3, there are no situations where there is a high probability of occurrence of a permanent or long-term residual environmental effect on marine fish or fish habitat indicators of high magnitude that cannot be technically or economically mitigated. Consequently, it is concluded that the residual environmental effects of construction and operations activities at the Westridge Marine Terminal on marine fish and fish habitat will be not significant.

7.6.10 Wildlife and Wildlife Habitat

The Westridge Marine Terminal is an existing industrial site and all onshore work will be conducted within the existing fenced area. There are residual patches of vegetation that will be affected by Project activities. However, given that the site is highly disturbed and all work will occur within the existing fenced area, wildlife and wildlife habitat value at the Westridge Marine Terminal is considered to be low. Wildlife indicators that may be affected by Project activities at the Westridge Marine Terminal include coastal riparian small mammals, bats, mature/old forest birds, early seral forest birds, riparian and wetland birds, rusty blackbird, western screech-owl, great blue heron, bald eagle, common nighthawk, northern goshawk, olive-sided flycatcher, and pond-dwelling amphibians.

The assessment of effects on wildlife and wildlife habitat has been conducted considering all the Project components in an integrated manner (*e.g.,* pipeline, temporary facilities, pump stations [including power lines], tanks, other ancillary facilities, and the Westridge Marine Terminal), since the components will have similar effect pathways (*i.e.,* change in habitat movement and mortality risk) on wildlife indicators and disaggregation of effects by Project component is not meaningful at an individual or population level for wildlife indicators.

The assessment of effects on wildlife and wildlife habitat for the Project as a whole is presented in Section 7.2.10. Table 7.2.10-6 and accompanying discussion in Section 7.2.10.9 provide the evaluation of potential residual effects of the construction and operations of the Westridge Marine Terminal on mammal indicators, Table 7.2.10-9 and accompanying discussion in Section 7.2.10.10 provide the evaluation of potential residual effects of the construction and operations of the Westridge Marine Terminal on bird indicators, and Table 7.2.10-12 and accompanying discussion in Section 7.2.10.11 provide the evaluation of potential residual effects of the construction and operations of the Westridge Marine Terminal on amphibian indicators.

7.6.11 Marine Mammals

Marine mammals have high ecological value and play key roles in marine food webs, both as top predators and as prey. They also have high cultural and socio-economic importance to Aboriginal communities, British Columbians, Canadians, and visitors from abroad and are often the focal point of whale-watching and tourism activities on the coast of BC.

7.6.11.1 Assessment Indicators and Measurement Endpoints

The assessment indicators for marine mammals were selected from a list of all marine mammal species known to occur in Burrard Inlet with preference for species likely to occur with regularity in the Marine Mammal LSA. The only species that met this criterion was the Pacific harbour seal (‘harbour seal’; *Phoca vitulina richardsi*). Therefore, the harbour seal was selected as the assessment indicator for marine mammals. While the assessment focuses on effects to harbour seals, mitigation will also be applied to reduce potential adverse environmental effects on less common marine mammal species.

Feedback on marine mammal indicator selection was solicited from Environment Canada at a meeting held on April 16, 2013. Environment Canada did not raise any concerns with the selection of the harbour seal, but did suggest that the river otter be considered for possible inclusion. Although river otters in Burrard Inlet forage in intertidal and shallow subtidal habitats, they dwell in burrows on land and are generally classified as a terrestrial mammal. For this reason, the harbour seal was considered a more appropriate indicator for assessing potential Project effects on marine mammals. Mitigation measures developed to reduce effects of marine construction activities on marine mammals are assumed to also reduce potential effects to river otters.

No issues were raised concerning selection of the harbour seal indicator at any of the open houses or ESA Workshops.

No pathways of effects to marine mammals associated with Project operations were identified. For an assessment of the effects of marine transportation on marine mammals, see Section 4.3.7 of Volume 8A.

Table 7.6.11-1 lists the indicator used to assess potential effects on marine mammals, the measurement endpoints used and the rationale for their selection.

TABLE 7.6.11-1

ASSESSMENT INDICATOR AND MEASUREMENT ENDPOINTS FOR MARINE MAMMALS

Marine Mammal Indicator	Measurement Endpoints	Rationale for Indicator Selection
Pacific harbour seal (*Phoca vitulina richardsi*)	• Potential for (1) injury, and (2) sensory disturbance due to in-water Project construction activities (evaluated qualitatively) • Relative importance and quality of marine mammal habitat affected	• Could be affected by the Westridge Marine Terminal construction. • Most common and abundant marine mammal in the Marine Mammal LSA and Marine RSA.

7.6.11.2 Spatial Boundaries

Spatial boundaries for the assessment of potential Project effects on marine mammals are defined as follows.

- Project Footprint: the area directly affected by construction of the Westridge Marine Terminal.
- Marine Mammal LSA: the ZOI likely to be affected by construction and operations of the Westridge Marine Terminal, defined as the area within 500 m of the proposed water lease expansion.
- Marine RSA: the area where the direct and indirect influence of other activities could overlap with Project-specific effects and cause cumulative effects on marine mammals. This includes the area of Burrard Inlet east of the First Narrows, including Indian Arm and Port Moody Arm.

The ZOI for the Marine Mammals LSA corresponds to the exclusion zone that will be monitored for cetaceans and marine mammal species at risk during pile installation activities. The 500 m radius has been applied for numerous other marine terminal development projects in BC.

Study area boundaries for marine mammals are shown on Figures 6.2-1 and 6.2-2.

7.6.11.3 Marine Mammal Context

Marine Mammal Presence

Marine mammal diversity and abundance in Burrard Inlet is generally considered low. Up until the late nineteenth century, whales, including the humpback whale, were a common sight in Burrard Inlet (BIEAP 1995). Even fin whales, generally more common to offshore and exposed coastal waters, were historically seen on occasion in the more protected waters of the nearby Strait of Georgia (Pike and MacAskie 1969 *in* Gregr *et al.* 2006). At least 95 humpback whales were commercially hunted and killed in the Strait of Georgia and Queen Charlotte Strait between 1866 and 1873 (Nichol *et al.* 2002). A whaling station was even established at Page's Lagoon near Nanaimo from 1907 to 1909 to hunt humpback whales that overwintered in the Strait of Georgia (Merilees 1985 *in* Nichol *et al.* 2002). Whaling-related BC coastal geographical names in the Strait of Georgia, such as Whaling Station Bay (Hornby Island), Blubber Bay (Texada Island), and Whaletown (Cortes Island) attest to previous whale presence in this region (Merilees 1985 *in* Nichol *et al.* 2002).

The most abundant and common marine mammal species currently observed in Burrard Inlet is the Pacific harbour seal, which is a year-round resident within the Inlet and throughout the coastal waters of BC (DFO 2010, Hanrahan 1994 *in* Haggarty 2001). Historically, harbour seals (in addition to salmon and eulachon) were a major source of food for Aboriginal communities of Burrard Inlet (BIEAP 1995). Currently the seals are a viewing attraction for tourists and local residents, and can be found basking in the sun on rocks or piers along the seawall, or surfacing in the water beside boats and kayaks.

There are occasional, though relatively rare, sightings of other marine mammal species in Burrard Inlet, including Steller (*Eumetopias jubatus monteriensis*) and California (*Zalophus californianus*) sea lions, northern fur seal (*Callorhinus ursinus*) and harbour porpoise (*Phocoena phocoena*) (Marine Mammal Research Unit 2012). Killer whale (*Orcinus orca*), Pacific white-sided dolphin (*Lagenorhynchus* *obliquidens*), false killer whale (*Pseudorca crassidens*), grey whale (*Eschrichtius robustus*), humpback whale (*Megaptera novaeangliae*) and minke whale (*Balaenoptera acutorostrata*) have also made the occasional appearance in Burrard Inlet or nearby waters (BC Cetacean Sightings Network 2013), though their use of this habitat is limited and sightings are relatively uncommon. At this time, there is no officially designated critical habitat or DFO Important Areas (Jamieson and Levesque 2012a,b) for marine mammal species at risk in the Marine RSA.

Injury Criteria and Disturbance Thresholds

Noise-induced auditory injury (*i.e.,* permanent or temporary threshold shifts [PTS and TTS, respectively]), avoidance and sensory disturbance may compromise marine mammal feeding efficiency, predator detection, and/or migratory success, and can lead to reduced health and possibly death (Richardson *et al.* 1995). DFO does not have any formal guidance or thresholds for assessing the potential effects of underwater noise on marine mammals (with the exception of seismic surveys, for which it has a statement of Canadian practice; DFO 2013f). In the absence of Canadian legislation or guidelines, the assessment considered two alternative sets of commonly-applied thresholds, described in the following text.

The first set of criteria, developed by Southall *et al.* (2007), is used primarily to evaluate the potential for injury (*i.e.,* PTS or TTS). Sound levels capable of inducing PTS and TTS in marine mammals are not well established; PTS has not been observed in any marine mammal, and TTS has only been observed in a few species of pinnipeds and small toothed whales (Southall *et al.* 2007). Estimates of sound levels capable of inducing auditory injury are therefore developed by extrapolating from known or predicted marine mammal auditory thresholds (Richardson *et al.* 1995, Southall *et al.* 2007). The injury criteria proposed by Southall *et al.* in 2007 are the most recent generalized estimates of TTS- and PTS-inducing sound pressure levels (SPLs) and sound exposure levels (SELs), and are based on a comprehensive analysis of existing research. Southall *et al.*'s (2007) proposed injury criteria for SELs and peak SPLs of single pulse, multiple pulse and non-pulse sound sources are summarized in Table 7.6.11-2 for cetaceans (*i.e.,* whales, dolphins, and porpoises) and pinnipeds (*i.e.,* seals and sea lions).

The second set of thresholds is that currently used by the National Oceanic and Atmospheric Administration (NOAA) to issue *Marine Mammal Protection Act* permits and conduct *Endangered Species Act* Section 7 consultations. These are considered interim conservative thresholds to be used until formal guidance is available. The NOAA criteria are frequently used to evaluate behavioural disruption because Southall *et al*. (2007) did not recommend specific numeric criteria (distinct from TTS-onset) for the onset of behavioural disturbance from multiple or non-pulse sound sources. The NOAA criteria also set thresholds for SPLs for impulsive noises deemed capable of potentially causing PTS or TTS. The Southall *et al.* (2007) metrics (*i.e.,* peak SPL and SEL) are generally considered more appropriate metrics for assessing potential effects of impulsive sounds such as pile driving; however, since the NOAA criteria may be more conservative, both metrics are used in the assessment of potential injury. The NOAA criteria are summarized alongside Southall *et al.*'s (2007) in Table 7.6.11-2. Different thresholds are proposed for impulsive (*e.g.,* pile driving) noise versus non-pulse (*e.g.,* vibratory pile driving, pile drilling, and dredging) sound sources, and for pinnipeds versus cetaceans. While NOAA is currently revising its criteria, with specific reference to different sound sources (*e.g.,* explosives; Finneran and Jenkins 2012), criteria specific to pile driving and/or dredging are not yet available.

The term "auditory injury" as used by NOAA or Southall *et al.* is intended to refer strictly to permanent auditory damage (*i.e.,* PTS; as per the three columns of injury criteria presented in Table 7.6.11-2). However, the terms 'permanent auditory injury' and 'temporary auditory injury' are used in this assessment interchangeably with the terms PTS and TTS, respectively (*i.e.,* this assessment considers TTS to be a form of injury, even if only temporary in nature).

Southall *et al.* (2007) developed their proposed PTS criteria based on sound levels predicted to cause TTS. The SEL thresholds used by Southall *et al.* for TTS onset were 183 dB re: 1 μPa^2-s for cetaceans and 171 dB re: 1 μPa^2-s for pinnipeds (PTS onset was predicted by adding an additional 15 dB exposure to pulsed sounds). For peak broadband SPLs, TTS onset was set at 224 dB re: 1 μPa for cetaceans and 212 dB re: 1 μPa for pinnipeds (values used to assess PTS were determined by adding 6 dB; Southall *et al.* 2007). Threshold values capable of causing temporary auditory damage are not addressed by the NOAA proposed criteria, nor are PTS or TTS thresholds from non-pulse sound sources (NOAA Fisheries 2013a).

TABLE 7.6.11-2

MARINE MAMMAL INJURY CRITERIA AND SENSORY DISTURBANCE THRESHOLDS USED IN THE ASSESSMENT OF UNDERWATER NOISE

Species Group	Southall *et al.* and NOAA Injury Criteria (PTS)			Southall *et al.* 'Behavioural Disturbance' Criteria (same for TTS)		NOAA 'Behavioural Disruption' Thresholds
	Peak SPL[a] (dB_{peak} re: 1μPa)	SEL[a] (dB re: 1 μPa^2-s)	RMS SPL[b] (dB_{RMS} re: 1 μPa)	Peak SPL[a] (dB_{peak} re: 1μPa)	SEL[a] (dB re: 1 μPa^2-s)	RMS SPL[b] (dB_{RMS} re: 1 μPa)
Pinnipeds	218 (single, multiple, and non-pulse)	186 (pulse); 203 (non-pulse)	190 (pulse)	212 (single pulse)	171 (single pulse)	160 (pulse); 120 (non-pulse)
Cetaceans	230 (single, multiple, and non-pulse)	198 (pulse); 215 (non-pulse)	180 (pulse)	224 (single pulse)	183 (single pulse)	160 (pulse); 120 (non-pulse)

Sources: a. Values taken from Southall *et al.* 2007. b Values taken from NOAA Fisheries 2013a.

Notes:
- SPL = Sound Pressure Level; SEL = Sound Exposure Level; RMS = Root Mean Square; PTS = Permanent Threshold Shift
- Impact pile driving is an example of a multiple pulse noise, while vibratory pile driving is an example of a non-pulse noise.
- Decibels re: 1 μPa are the accepted unit for measuring underwater sound as it relates to marine mammals (Richardson *et al.* 1995, Southall *et al.* 2007); however, there are different metrics (*i.e.,* peak vs RMS) for measuring and reporting decibels. SELs are a measure of received sound energy and values presented in Table 7.6.11-2 were developed to reflect M-weighted SELs by functional hearing group (see Southall *et al.* 2007); however, only unweighted values are discussed in this assessment. Comparison of unweighted source levels and M-weighted thresholds is expected to be conservative.
- The three columns of injury criteria above reflect only the onset levels for permanent auditory damage, or PTS (not TTS). The Southall *et al.* proposed behavioural disturbance criteria are the same as the estimated TTS onset values.

7.6.11.4 Potential Effects and Mitigation Measures

Identified Potential Effects

The potential effects associated with construction at the Westridge Marine Terminal are listed in Table 7.6.11-3. Identification of effects was based on the results of a literature review, desktop analysis, engagement with regulatory authorities and other stakeholders (Section 3.0), and the professional experience of the assessment team. There are no identified pathways of effects for marine mammals associated with operational activities of the Westridge Marine Terminal. For the assessment of effects associated with increases in Project-related marine traffic, see Volume 8A.

Construction of the marine loading berths will involve the installation of large diameter steel piles (*i.e.,* pile driving) and may involve a small amount of dredging. Pile driving can result in the generation of high energy pressure waves that radiate outward from the sound source. While mobile marine organisms such as marine mammals are generally expected to avoid very loud in-water construction activities, noise from these activities could still result in temporary or permanent auditory damage (*i.e.,* TTS or PTS) to individuals in close proximity to pile driving (Richardson *et al.* 1995). Predicted underwater noise source levels associated with pile driving were presented in Table 7.6.9-5. Source levels for pile driving and dredging are discussed in Section 7.6.9.6 Marine Fish and Fish Habitat. Noise levels associated with dredging are typically lower than pile driving (Richardson *et al*. 1995) and are not expected to cause either PTS or TTS.

The production of loud underwater construction noise (*i.e.,* from pile driving, pile drilling, or dredging) could also cause sensory disturbance to marine mammals. This may result in behavioural responses such as habitat avoidance, changes in activity state (*e.g.,* feeding, resting, or travelling) and/or interference with communication and perception of sounds (*i.e.,* masking; Richardson *et al.* 1995). The extent of sensory disturbance depends on a number of factors, including: the source level, frequency, and duration of the underwater noise, the context and the species in question.

To determine potential effects of construction-related underwater noise on marine mammals, source sound levels (based on literature values) were contrasted with the Southall *et al.* (2007) and NOAA threshold sound levels predicted to cause auditory harm or induce behavioural responses.

The summary of mitigation measures provided in Table 7.6.11-3 was principally developed in accordance with industry best management practices, NOAA Fisheries' Guidance for Developing a Marine Mammal

Monitoring Plan (NOAA Fisheries 2013b), and the professional experience of the assessment team. Further details on potential residual effects and the key mitigation measures are provided in the following subsections.

TABLE 7.6.11-3

POTENTIAL EFFECTS, MITIGATION MEASURES AND RESIDUAL EFFECTS OF CONSTRUCTION AT THE WESTRIDGE MARINE TERMINAL ON MARINE MAMMALS

Potential Effect	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
1. Marine Mammal Indicator – Harbour Seal			
1.1 Permanent or temporary auditory injury	LSA	• Use a vibratory method of pile installation instead of an impact hammer, if feasible [Section 8.2]. • Deploy bubble curtains during pile installation to reduce underwater noise levels where an impact hammer is required for pile installation [Section 8.2]. • Conduct an acoustic survey in order to establish the effectiveness of the bubble curtain, prior to the commencement of the pile installation activity [Section 8.2]. • Complete a marine mammal survey prior to any marine activities (*i.e.,* dredging of the marine environment from onshore and/or in the marine environment, drilling, pile installation, infilling), by trained personnel to determine the presence of marine mammals within the area. If any cetaceans or species at risk are observed in or within close proximity to the predetermined exclusion zone, all marine operations will be temporarily suspended (or rescheduled if deemed necessary) until the marine mammal(s) has left the exclusion zone and does not reappear within 30 minutes [Section 8.2]. • Sound levels will be monitored by qualified personnel both onshore and in-water, during loud underwater construction activities (*e.g.,* pile installation activities) in order to allow for adjustments to the radius of the exclusion zone based on changes in field conditions. The number of personnel required for monitoring will depend on the size and extent of the pre-determined exclusion zone. Monitoring will take place for 30 minutes prior to and during marine construction activities. In the event that cetaceans or species at risk are observed within or near the exclusion zone, temporarily suspend or reschedule all construction activity if deemed necessary. Resume activities once the observed marine mammal(s) has left the exclusion zone and does not reappear within 30 minutes [Section 8.2].	• No residual effect identified related to permanent auditory injury (see Section 7.6.11.5). • Temporary auditory injury of harbour seals or other marine mammals due to underwater noise produced during pile driving.
1.2 Sensory disturbance	RSA	• Use a vibratory method of pile installation instead of an impact hammer, if feasible [Section 8.2]. • Deploy bubble curtains during pile installation to reduce underwater noise levels where an impact hammer is required for pile installation [Section 8.2]. • Conduct an acoustic survey in order to establish the effectiveness of the bubble curtain, prior to the commencement of the pile installation activity [Section 8.2].	• Sensory disturbance of harbour seals or other marine mammals due to underwater noise produced during pile driving or dredging.

Notes: 1 LSA = Marine Mammal LSA; RSA = Marine RSA.
2 Detailed mitigation measures are outlined in the Westridge Marine Terminal EPP (Volume 6D).

Mitigation Measures

As noted above, and as illustrated in Table 7.6.9-5, noise levels produced during pile driving are highly variable and situation-specific. However, use of a vibratory driver generally produces SPLs that are roughly 25 dB lower (SELs of 10-15 dB lower), on average, than those produced by an impact hammer in a comparable setting and vibratory drivers do not produce the high impulse signatures of impact pile driving (Illingworth and Rodkin Inc. 2007, McCauley and Salgado Kent 2008). The preferred installation method is therefore vibratory driver, for its decreased noise production.

Where a vibratory driver cannot be used due to engineering constraints (*e.g.,* unfavourable substrate conditions), an impact hammer will likely be used. If an impact or hydraulic hammer is required for pile installation, Trans Mountain will implement several mitigation measures when driving the piles. These recommendations are in accordance with *Best Management Practices for Pile Driving and Related Operations* (BMPs) for driving steel pipe piles with a diameter greater than 61 cm (24 inches). The BMPs were developed by the BC Marine and Pile Driving Contractors Association (2003) to minimize impact to fish habitat. Bubble curtains will be deployed over the full length of the wetted pile to assist in attenuating sound levels. A hydrophone will be used to monitor pressure levels during pile-driving, so as to reduce potential fish injury or mortality (see Section 7.6.9). This hydrophone will also be monitored at the onset of pile-driving to confirm the assumptions concerning source levels, potential exceedance of marine mammal auditory injury levels, and effectiveness of mitigation measures.

Bubble curtains are a potential mitigation method for impact pile driving. While there are a variety of styles, they all rely on the same basic principle: surrounding the pile with air assists in attenuating the noise produced during impact. When designed and used effectively, bubble curtains have generally been shown to provide a reduction in SPLs and SELs of between 10 and 15 dB (Illingworth and Rodkin Inc. 2007). Actual attenuation values will vary depending on factors such as design of the bubble curtain, installation, current velocity, water depth, and substrate type (Koschinski 2011). Lucke *et al.* (2011) showed that installation of a bubble curtain during pile driving of wooden piles reduced mean SEL values (over a continuous sequence of 95 strikes) by 13 dB (standard deviation 2.5 dB), and resulted in the termination of avoidance reactions by harbour porpoises. Should use of a vibratory driver not be technically feasible, details concerning appropriate type and usage of bubble curtains will be discussed with DFO.

A marine mammal monitoring program will be implemented to enforce a pre-determined exclusion zone during pile driving operations. The area of the exclusion zone (generally set at 500 m from the sound source) will be confirmed through discussion with DFO, and may involve acoustic modelling if deemed necessary. Trained observers will monitor the Marine Mammal LSA and surrounding waters for all marine mammals during loud underwater construction activities. Pile driving will only occur during daylight hours to ensure that marine mammals can be seen if they approach or enter the exclusion zone. If cetaceans or species at risk are detected within the exclusion zone, the underwater construction activity will be immediately stopped until the marine mammal has been observed to exit the exclusion zone, or has not been re-sighted for 30 minutes. This additional mitigation measure is expected to reduce potential residual effects for all species of marine mammals in the Marine Mammal LSA with the exception of harbour seals. While the marine mammal monitoring program has been designed as an additional safeguard to protect cetaceans and species of conservation concern, current Canadian practice (*e.g.,* the Statement of Canadian Practice with respect to the Mitigation of Seismic Sound in the Marine Environment; DFO 2013f) does not generally mitigate for effects of loud underwater noise for non-listed pinnipeds.

7.6.11.5 Potential Residual Effects

The potential residual environmental effects on harbour seals associated with construction activities at the Westridge Marine Terminal (Table 7.6.10-3) are:

- temporary auditory injury of harbour seals or other marine mammals due to underwater noise produced during pile driving; and
- sensory disturbance of harbour seals or other marine mammals due to underwater noise produced during pile driving or dredging.

Potential effects on the marine mammal indicator related to permanent auditory injury as a result of construction activities at the Westridge Marine Terminal was assessed but determined to not constitute a likely residual effect and, consequently, no residual effect is anticipated (Table 7.6.10-3). The rationale for this conclusion is presented below.

<u>Permanent Auditory Injury</u>

Should the Project be approved, pile driving and dredging are assumed to take place intermittently over the course of approximately 2 years. Based on typical maximum broadband source levels for a clamshell dredge (*i.e.,* 167 dB_{peak} re: 1 μPa at 1 m) presented in Richardson *et al.* (1995), underwater noise produced during dredging is not expected to reach levels capable of causing TTS or PTS. As such, the assessment of auditory injury focuses on noise produced during pile driving activities.

Based on sound levels measured during other construction projects (*i.e.,* Illingworth and Rodkin Inc. 2007), and assuming the Project uses steel piles up to 1.5 m in diameter installed using an impact hammer, peak SPLs and SELs predicted for construction of the Westridge Marine Terminal are expected to approach, but not exceed Southall *et al.*'s auditory injury criteria, even in the absence of mitigation (see Tables 7.6.9-5 and 7.6.11-2 above). Based on these criteria, no permanent auditory injury to marine mammals is expected. However, using NOAA's more conservative RMS SPL thresholds of 190 and 180 dB re: 1 μPa (for pinnipeds and cetaceans, respectively), unmitigated noise from pile driving would be expected to exceed those thresholds by 5 and 15 dB, respectively. The likelihood of permanent physical injury for marine mammals associated with the construction of the Westridge Marine Terminal will be greatly reduced or predicted to be eliminated through the implementation of mitigation measures (Table 7.6.11-3).

Trans Mountain has committed to implementing several mitigation measures when driving the piles. If technically feasible, a vibratory driver would be used in lieu of an impact hammer. Based on the conservative use of surrogate literature values for a typical 1.8 m steel pile installed using a vibratory driver (Table 7.6.9-5; 1.4 m steel pile source level not available), this form of mitigation would lower RMS sound pressure levels at 10 m from the source to 170 dB re: 1 μPa. Although NOAA does not have injury thresholds for continuous sound sources such as vibratory driving, the SEL and peak SPL values for use of this vibratory driver far well below Southall *et al.* injury criteria (*i.e.,* SELs from the literature are 33 dB below auditory injury level for pinnipeds, and 45 dB below for cetaceans, while peak SPLs are 35 dB and 47 dB below, respectively). Use of a vibratory driver is therefore the preferred option, and if used, residual effects of permanent auditory damage would not be expected for marine mammals in the LSA.

In the case where use of an impact hammer is deemed necessary for engineering reasons, Trans Mountain will implement use of bubble curtains. Assuming a conservative value of 10 dB of attenuation, the use of an appropriately-designed bubble curtain during the assumed Project pile driving installation scenario would reduce SELs to 175 dB re: 1 μPa^2-s and $SPLs_{RMS}$ to 185 dB re: 1 μPa (at 10 m from the pile). While these values fall below Southall *et al.*'s criteria, and below NOAA's criteria for pinnipeds, they remain above NOAA's criteria for cetaceans. Noise associated with pile driving activities is therefore not expected to cause permanent auditory damage to pinnipeds (including the harbour seal indicator) in the Marine Mammal LSA, regardless of the mitigation measure ultimately applied.

The Marine Mammal LSA is not considered to be high quality habitat for marine mammals and the predominant species is the common harbour seal. However, cetaceans (including species at risk) may be exposed to sound levels capable of causing permanent auditory damage if they are present in the Marine Mammal LSA during construction. As such, the marine mammal monitoring program (as detailed above) will be implemented as an additional mitigation measure to ensure that should cetaceans or marine mammal species of conservation concern make the occasional appearance in the Marine Mammal LSA, these individuals will not be permanently injured by loud underwater noise.

The above suite of mitigation measures is predicted to eliminate the risk of PTS to marine mammals. The potential for permanent auditory injury is therefore not carried forward into the assessment of potential residual effects, as no residual effects are predicted.

7.6.11.6 Significance Evaluation of Potential Residual Effects

A combination of quantitative and qualitative assessments of marine mammals was determined to be the most appropriate approach to evaluate the significance of potential residual environmental effects. While there are thresholds for auditory injury and sensory disturbance, and the source levels of in-water construction activities can be estimated with reasonable confidence (in a conservative fashion), the responses of marine mammals to underwater noise vary considerably among species and even among individuals of the same species. Consequently, the evaluation of significance of the potential residual effects relies on both the application of standards and guidelines and the professional judgment of the assessment team.

Table 7.6.11-4 provides a summary of the significance evaluation of the potential residual environmental effects of construction activities at the Westridge Marine Terminal on marine mammals. As previously noted, no residual effects associated with operations activities of the Westridge Marine Terminal are expected. The rationale used to evaluate the significance of each of the residual environmental effects is provided below.

TABLE 7.6.11-4

SIGNIFICANCE EVALUATION OF POTENTIAL RESIDUAL EFFECTS OF CONSTRUCTION AT THE WESTRIDGE MARINE TERMINAL ON MARINE MAMMALS

Potential Residual Effects		Impact Balance	Spatial Boundary[1]	Temporal Context			Magnitude	Probability	Confidence	Significance[2]
				Duration	Frequency	Reversibility				
1.	Marine Mammal Indicator – Harbour Seal									
1(a)	Temporary auditory injury of harbour seals or other marine mammals due to underwater noise produced during pile driving.	Negative	LSA	Short-term	Isolated	Medium-term	Medium	Low	High	Not significant
1(b)	Sensory disturbance of harbour seals or other marine mammals due to underwater noise produced during pile driving or dredging.	Negative	RSA	Short-term	Isolated	Medium-term	Medium	High	High	Not significant

Notes: 1 LSA = Marine Mammal LSA; RSA = Marine RSA.

2 Significant Residual Environmental Effect: A high probability of occurrence of a permanent or long-term residual effect of high magnitude that cannot be technically or economically mitigated.

Marine Mammal Indicator – Harbour Seal

The following subsections provide the evaluation of significance of potential residual effects on the harbour seal indicator and other marine mammals.

Temporary Auditory Injury of Harbour Seals or Other Marine Mammals Due to Underwater Noise Produced During Pile Driving

A comprehensive mitigation program has been developed to reduce or eliminate potential harm to marine mammals during construction of the Westridge Marine Terminal. Use of mitigation measures (*i.e.,* vibratory driver or bubble curtains) is generally expected to reduce underwater noise levels to below levels likely to cause TTS. However, sound levels capable of causing the onset of TTS are still not well understood, empirical evidence is limited, and results can vary dramatically between species or even individuals (*e.g.,* Kastelein *et al.* 2012a). For example, harbour porpoises are thought to be one of the most sensitive species to construction noise, and TTS has been found to occur in harbour porpoises at sound exposure levels approximately 20 dB below the threshold for which they occurred in harbour seals (Kastelein *et al.* 2011). In a study of TTS in harbour porpoise by Kastelein *et al.* (2012b), the lowest SEL (151 dB re: 1 μPa^2-s) found to cause statistically significant TTS occurred following exposure to an SPL_{RMS} of 124 dB re: 1 μPa for 7.5 minutes. In this same study, recovery time following TTS varied between 4 and 96 minutes, depending on the exposure level, duration, and the degree of TTS induced (Kastelein *et al.* 2012b).

While mitigation measures are expected to be effective at reducing the occurrence of TTS, a small number of marine mammals in the vicinity of pile driving may still experience TTS. Harbour seals are the most likely species to be affected, as they are the most common species in the area, and they will not have the additional protection associated with the marine mammal monitoring program. These individuals are expected to vacate the area should underwater noise exceed TTS levels, thereby reducing their length of exposure. Effects will be, by definition, temporary in nature, and are expected to dissipate within a manner of minutes to hours following exposure. The likelihood of noise levels capable of causing TTS will decrease with distance from the source. The potential for TTS is therefore considered more likely within the Project Footprint itself and is not expected to extend beyond the Marine Mammal LSA. To be exposed to sound levels capable of causing TTS, marine mammals therefore need to be in close proximity to the piles at the time of pile-installation. The Marine Mammal LSA is not considered high quality marine mammal habitat, and while harbour seals are expected to be regularly observed in the area, they are also expected to move away from areas where SPLs exceed TTS or PTS levels. Sightings of other species of marine mammal are expected to be uncommon, but even rare occurrences will be mitigated by the additional measures in place for cetaceans and species at risk. Based on the above assessment, the effects of temporary auditory injury of harbour seals or other marine mammals due to underwater noise produced during pile driving are determined to be not significant.

At the time of this assessment, exact engineering details concerning the nature of the pile driving activities were not available, although relevant examples from other projects are known from the literature. There is also some uncertainty regarding the type of mitigation measures that will be used (*e.g.,* if vibratory pile installation is feasible) and the sound levels that will ultimately be produced. However, determination of confidence has been based on the engineering assumptions made, and the presumed use of appropriate mitigation measures. Additionally, while a variety of thresholds and criteria exist for assessing PTS, further research is warranted in developing a clear understanding of SPLs or SELs capable of causing auditory injury (permanent or temporary) in marine mammals. Whether SPLs produced actually result in auditory damage will also depend in large part on the species and individuals exposed, the exact nature of the sound, and the context and duration of exposure. A limited number and diversity of marine mammals are expected to use the Marine Mammal LSA on a regular basis, and despite the above uncertainties, the comprehensive mitigation program detailed above (including additional measures for species at risk) is expected to reduce or eliminate potential harm to marine mammals. As such, confidence in the significance conclusion is rated as high (Table 7.6.11-4, point 1[a]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Marine Mammal LSA – should underwater SPLs exceed thresholds for causing TTS even after mitigation, these levels are likely to dissipate within a relatively short distance from the source. Potential residual effects associated with temporary auditory injury are, therefore, expected to be confined to the LSA.
- Duration: short-term – underwater SPLs potentially capable of causing TTS will only be associated with pile-driving activities (*i.e.,* approximately 2 years). While potential effects may extend for a brief duration into the operations phase, the actual event associated with the effect (*i.e.,* production of loud underwater noise during pile driving) will be restricted to the construction phase.
- Frequency: isolated – underwater SPLs potentially capable of causing TTS will only be associated with intermittent pile-driving activities during construction (*i.e.,* on and off for approximately 2 years). While potential effects may extend into the operations phase, the actual event associated with the effect (*i.e.,* production of loud underwater noise during pile driving) will be restricted to the construction phase.
- Reversibility: medium-term – the potential for repeated exposure over the length of the construction phase means that the overall effect is likely to be reversible in the medium-term (*i.e.,* greater than 2 years).
- Magnitude: medium – mitigated sound levels are not expected to exceed PTS thresholds, and while they may exceed TTS thresholds for pinnipeds, cetaceans and species at risk will receive additional protection through monitoring.
- Probability: low – a comprehensive mitigation program is expected to reduce or eliminate potential auditory injury to marine mammals.
- Confidence: high – determination of confidence is based on the engineering assumptions made, the limited number and diversity of marine mammals in the Marine Mammal LSA, and the presumed use of appropriate mitigation measures.

Sensory Disturbance of Harbour Seals or Other Marine Mammals Due to Underwater Noise Produced During Pile Driving or Dredging

Sound levels produced during typical mitigated pile driving and dredging activities that are below PTS or TTS levels of concern may continue to elicit behavioural responses that affect the health of marine mammals (Richardson *et al.* 1995, Nowacek *et al.* 2007, Southall *et al.* 2007). The extent of sensory disturbance depends on numerous factors, including the source level, frequency, and attenuation rate of the underwater sound, as well as the species, proximity, activity state, and individual marine mammal in question (Richardson *et al.* 1995, Southall *et al.* 2007). The form of sensory disturbance may also vary widely and can range from non-observable physiological responses, such as increases in stress hormones and heart rate or decreases in ability to detect other sounds in the environment (*i.e.,* masking) to overt physical reactions such as startle responses. Habitat avoidance is among the most severe forms of behavioural responses, as displaced animals may be excluded from important foraging or breeding areas (Richardson *et al.* 1995, Southall *et al.* 2007).

Southall *et al*.'s initial proposed behavioural disturbance criteria are also the estimated TTS onset values and apply only to single pulses (*i.e.,* would not apply to the multiple pulses that occur during pile driving). As such, only the NOAA behavioural disruption criteria are considered here (see Table 7.6.11-2). This assessment further assumes that sound levels capable of causing injury (as discussed above) will also result in sensory disturbance; therefore, the following discussion focuses only on responses to underwater noise at levels below those capable of causing injury.

Noise levels within the Marine Mammal LSA and potentially in portions of the Marine RSA are expected to exceed the NOAA threshold for behavioural disruption (*i.e.,* 160 dB_{RMS} re: 1 μPa for both cetaceans and pinnipeds). However, based on a review of limited data concerning exposure of pinnipeds to multiple underwater pulses, Southall *et al.* (2007) generally found that exposures in the ~150 to 180 dB_{RMS} re: 1 μPa range had limited potential to induce avoidance behavior in pinnipeds. Ringed seals (close relatives to harbour seals) in Prudhoe Bay, Alaska exhibited little or no reaction to mean underwater SPLs from terrestrial impact pipe-driving pulses of 151 dB_{RMS} re: 1 μPa (Blackwell *et al.* 2004). SPLs near the bottom of the water column may have approached 160 dB_{RMS} re: 1 μPa, yet there was no observed change in diving behaviour and one seal actually approached to within 3 m of shore (46 m from the pipe installation activities). The authors hypothesized that the seals in this region were habituated to industrial sounds (Blackwell *et al.* 2004). While harbour seals in the Marine Mammal LSA and portions of the Marine RSA will be able to detect pile driving activity, it remains possible that they habituate to these sounds over the course of the construction phase.

Most studies report that marine mammal behaviour returns to normal after sound production ceases (Richardson *et al.* 1995, Southall *et al.* 2007); however, the length of time can vary. A study by Brandt *et al.* (2011) showed that harbour porpoise acoustic activity was reduced by 100% during the first hour after pile driving activities, at a distance of 2.6 km from the construction site (*i.e.,* the porpoise were likely displaced from within this area). Acoustic activity within 2.6 km remained below normal levels for 24 to 72 hours. The length of time to recover gradually decreased with increasing distance; however, a negative effect was detectable out to a mean distance of 17.8 km (Brandt *et al.* 2011). These results are comparable to those of Tougaard *et al.* (2009) who detected harbour porpoise responsiveness to pile driving at a distance of 20 km. Both of these studies involved harbour porpoises (which are expected to be more sensitive to construction sounds than harbour seals) and installation of steel monopile foundations (*i.e.,* 4 m diameter) for offshore wind turbines. Mitigation measures such as bubble curtains have proved successful at reducing effects of smaller operations, as captive harbour porpoises that showed avoidance reactions during unmitigated piling were observed to return to normal behaviour when a bubble curtain was activated. Piling activity in this case involved 40 cm wood piles installed at a distance of between 100 and 175 m from a porpoise enclosure (Lucke *et al.* 2011).

It is difficult to predict with certainty how different species, or even individuals, will respond to underwater noise associated with construction of the Westridge Marine Terminal. While certain species (*e.g.,* harbour porpoise) appear more likely to display adverse reactions than others (*e.g.,* harbour seals), the Marine RSA is not considered prime marine mammal habitat, and it is likely that the primary species to experience exposure is the harbour seal. Pile driving will be intermittent but will not occur continuously over the two-year construction phase, and it is expected that the time between pile driving activities will allow harbour seals to recover, or potentially even habituate to the activity. While startle responses and small-scale avoidance reactions remain possible, these are expected to be temporary and of short duration (*i.e.,* immediately upon onset of pile driving) and recovery is expected to be rapid. Likewise, while there may be temporary interruption of foraging or resting, normal activities are expected to resume once the immediate perceived threat has passed. Underwater noise from construction may result in an unknown degree of communication masking, and may reduce harbour seals' ability to detect predators or detect and communicate with conspecifics. As with other aspects of sensory disturbance, this effect will decrease with increasing distance from the Marine Mammal LSA.

The comprehensive mitigation program discussed above will also be effective at reducing the degree of sensory disturbance to marine mammals during construction of the Westridge Marine Terminal. While noise levels are likely to exceed NOAA's threshold for behavioural disruption within the Marine Mammal LSA and potentially small portions of the Marine RSA, the literature suggests that pinnipeds may habituate to these sounds. The Marine Mammal LSA is not considered high quality marine mammal habitat, and sightings of other species of marine mammal are expected to be uncommon. Rare occurrences of more sensitive species such as harbour porpoises may result in temporary avoidance responses to construction activities. Based on the above assessment, the effects of sensory disturbance of harbour seals or other marine mammals due to underwater noise produced during pile driving are determined to be not significant.

At the time of this assessment, exact engineering details concerning the nature of the pile driving activities were not available, although relevant examples from other projects are known from the literature. There is also some uncertainty regarding the type of mitigation measures that will be used (*e.g.,* if vibratory pile installation is feasible) and the sound levels that will ultimately be produced. However, determination of confidence has been based on the engineering assumptions made, and the presumed use of appropriate mitigation measures. Behavioural responses to underwater noise vary widely within and between species, and to what degree SPLs produced will actually result in sensory disturbance will depend in large part on the species and individuals exposed, the exact nature of the sound, and the context and duration of exposure. A limited number and diversity of marine mammals are expected to use the Marine Mammal LSA on a regular basis, and despite the above uncertainties, the comprehensive mitigation program (including additional measures for species at risk) is expected to reduce the degree of sensory disturbance to marine mammals. As such, confidence in the significance conclusion is rated as high (Table 7.6.11-4, point 1[b]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Marine RSA – loud underwater construction activities at the Westridge Marine Terminal will be detectable beyond the boundaries of the Marine Mammal LSA and may temporarily displace sensitive species such as harbour porpoise from within the LSA; however, effects are not expected to extend beyond the Marine RSA.
- Duration: short-term – while potential effects may extend briefly into the operations phase of the Project, the actual event (*i.e.,* production of loud underwater noise) will be restricted to the construction phase.
- Frequency: isolated – while potential effects may extend briefly into the operations phase of the Project, the actual event (*i.e.,* production of loud underwater noise) will be intermittent throughout the construction phase, but restricted to that phase.
- Reversibility: medium-term – residual effects will occur primarily during the construction phase and are expected to be reversible within a few hours to a few months after the end of construction.
- Magnitude: medium – since mitigation measures will be applied to reduce this potential disturbance to the extent practical, and there is no officially designated critical habitat or DFO Important Areas for marine mammals in the Marine RSA, the magnitude of this effect is determined to be medium.
- Probability: high – it is considered likely that marine mammals in the vicinity of loud underwater construction activities at the Westridge Marine Terminal will experience some degree of sensory disturbance.
- Confidence: high – determination of confidence is based on the engineering assumptions made, the limited number and diversity of marine mammals in the Marine Mammal LSA, and the presumed use of appropriate mitigation measures.

7.6.11.7 Summary

As identified in Table 7.6.11-4, there are no situations where there is a high probability of occurrence of a permanent or long-term residual environmental effect on the marine mammal indicator of high magnitude that cannot be technically or economically mitigated. Consequently, it is concluded that the residual environmental effects of construction activities at the Westridge Marine Terminal on marine mammals will be not significant.

7.6.12 Marine Birds

Key issues for the marine birds element were identified through discussions with senior regulatory authorities including Environment Canada, and the professional judgment of the assessment team. Project-related issues include:

- a change in habitat quality or availability due to terminal site clearing and construction activities;
- sensory disturbance causing stress or avoidance of marine habitats at or near the Westridge Marine Terminal area due to Project-related activities; and
- injury or mortality due to collisions with terminal or vessel infrastructure, or nest abandonment as a result of sensory disturbances.

The assessment of potential effects to marine birds from the Westridge Marine Terminal expansion has particular objectives which include, but are not limited to, ensuring there is:

- compliance with the BC *Wildlife Act, Migratory Birds Convention Act* (*MBCA*), and other provincial and federal legislative guidelines (Milko 1998, NEB 2013a), with respect to harassment, harm or destruction of nests and nesting birds;
- protection for species at risk, consistent with the objectives of *SARA*, and provincial and local policies related to biodiversity conservation (*e.g.,* provincial Best Management Practices (BMPs) and the BIEAP);
- management of marine bird species within the context of the ecological values in Burrard Inlet; and
- special attention to species of importance to the culture and traditional harvest of Aboriginal communities.

7.6.12.1 Assessment Indicators and Measurement Endpoints

Indicator Species

It is important to consider potential Project-related effects on all marine bird species within the study area; however, it is impractical to assess every species present. A suite of marine bird indicators can be selected to characterize the effects to all bird species, each indicator representing an ecological guild using a similar foraging strategy or ecological niche (Lindenmayer *et al.* 2000). The process for selecting indicators for the assessment of effects to marine birds began with a review of existing marine habitats, consultation with stakeholders and senior authorities, and knowledge of bird species known to be present seasonally in Burrard Inlet. The candidate list of indicators was narrowed by focusing on those species that fit all or most of the following criteria:

- they seasonally utilize habitats within the Marine Birds LSA or Marine RSA for foraging and/or breeding;
- they have life requisites shared by a broad group of other marine bird species;
- they are a species of conservation concern, are considered restricted in range, or associated with a confined or sensitive ecological community;

- there is an established baseline of information on their biology, population abundance and distribution;
- they have been documented as a species susceptible to anthropogenic disturbances;
- they are a species whose extirpation could alter or disrupt the function of the ecosystem;
- they have been identified as important to some coastal Aboriginal communities; and
- they have previously been used as indicators in regional effects-based assessments and, therefore, have been the focus of academic and regulatory studies within the Marine RSA.

Based on these criteria, six indicator species were selected to assess potential effects of the construction and operation of the Westridge Marine Terminal on marine birds: bald eagle (*Haliaeetus leucocephalus*), great blue heron (*Ardea herodias fannini*), pelagic cormorant (*Phalacrocorax pelagicus)*, Barrow's goldeneye *(Bucephala islandica)*, glaucous-winged gull *(Larus glaucescens)* and spotted sandpiper (*Actitis macularius*). These six species represent an overall diverse group of resident and migrant marine bird species that utilize distinct niches within the matrix of marine and coastal habitats present within the Marine Birds LSA and Marine RSA.

The selection of a suite of marine bird indicators was discussed with Environment Canada, more specifically the Canadian Wildlife Service, at a meeting held on April 17, 2013. The final selection of indicators took into consideration feedback from this meeting, input from other regulators, stakeholders, Aboriginal communities, and the professional judgment of the assessment team that have extensive experience on other marine development projects with similar ecological conditions and potential issues. Suggestions provided for the selection of indicators at the ESA Workshops on May 22 and 23, 2013 included marine birds that were species at risk, or uncommon and sensitive, including western grebe, purple martin and marbled murrelet. The judgment of Project assessment team was that these suggested species were too low in abundance or seasonal presence for effective monitoring and that they were adequately represented by the selected indicator species presented here.

The following subsections provide a brief description of biology and relevance of the six marine bird indicator species selected for this assessment. More detailed information on these species and their habitats in the Marine RSA can be found in the Marine Birds – Westridge Marine Terminal Technical Report of Volume 5C.

Bald eagles may be affected by direct alteration or loss of trees for terrestrial perching and nesting habitat, and by sensory disturbances from noise, light and activity associated with the construction and future operations of the Westridge Marine Terminal expansion. These effects may cause them to avoid preferred roosts or feeding sites. There is also minimal potential for injury or mortality to bald eagles during inclement weather as a result of their accidental collision with infrastructure at the terminal, berthed vessels or large construction equipment temporarily present during terminal expansion. The bald eagle is a year-round resident and recent breeding records indicate there are nests at approximately 15 sites within the Marine RSA. The population is stable and abundant in BC. It has similar habitat requirements to other raptor species that occasionally use the marine foreshore and open water areas to fish or scavenge, such as osprey, vulture and Cooper's hawk. It is considered a top predator and local flagship species, having special cultural importance to Aboriginal communities.

Great blue herons may potentially be affected by sensory disturbances caused by noise, light and activity associated with the construction and operation of the expanded Westridge Marine Terminal. Clearing of the foreshore and upland terrestrial vegetation could result in alteration to, or loss of, preferred shoreline foraging sites and tree roosts. Great blue herons are woodland colonial nesters with strong nest site fidelity. Local breeding colonies are located in Stanley Park at the western edge of the Marine RSA and several kilometers upstream of the terminal on Heron Creek, therefore, they are unlikely to seek alternate nest sites within the Project LSA. There is minimal potential for injury or mortality from collisions with large equipment or terminal infrastructure due to disorientation caused by night-lighting, or during periods of low visibility, fog or inclement weather. The great blue heron is a resident species of conservation concern (provincial list status – Blue; federal *SARA* status – Special Concern). Direct threats to local populations include disturbance and mortality from predators and humans, limited food resources, and environmental contamination (COSEWIC 2008f, Vennesland 2004). The great blue heron has similar requirements to other species that rely on intertidal, foreshore and coastal terrestrial habitats, such as sandpipers and kingfishers.

Pelagic cormorants may be disturbed by in-air noise and activity associated with the construction and operation of the Westridge Marine Terminal and Project-related vessel activity. In addition, the cormorant's foraging behaviour of diving within the foreshore areas for small fish may expose them to underwater noise from vessels operating vessels, or loud in-water construction and pile-driving. Although cormorants typically roost in trees, there is a tendency to use artificial structures in developed areas such as cranes, bridges and wharfs. The risk of injury or mortality from bird collisions with infrastructure as a result of night-lighting or low visibility during fog or inclement weather is minimal. Injury could result from their perching or moving within unstable or unfamiliar, large construction equipment present temporarily during terminal expansion. The pelagic cormorant is a resident species and locally breeds at several colonies seasonally active within Burrard Inlet. BC populations are declining and, consequently, the pelagic cormorant is a species of conservation concern (provincial list status – Red). It has similar foraging habitat requirements to other diving piscivorous birds using littoral zones within the Marine RSA, such as the common merganser.

Barrow's goldeneyes may be affected by sensory disturbances resulting from noise and activity associated with the construction and operation of the expanded Westridge Marine Terminal and Project-related vessel activity. Potential injury or mortality could result from collisions with terminal infrastructure if bird become disoriented during night-lighting of the terminal, or during periods of fog or inclement weather, especially during seasonal migrations. The Barrow's goldeneye is a seasonally resident seabird (fall, winter, and early spring) which breeds on inland freshwater lakes. The Inlet provides important staging and overwintering forage and refuge habitat during non-breeding periods (Boyd *et al.* 2011). It has similar requirements to other migrating and resident seabirds and waterfowl that feed on nearshore invertebrates, bivalves and intertidal vegetation. Large flocks of Barrow's goldeneye congregate to forage during winter, often in rafts with other seabird species and, therefore, can be vulnerable to localized environmental effects.

Glaucous-winged gulls have a strong association with urban developed areas, and consequently there is an assumption that they are familiar with structures at this and other local sites, especially if reared in Burrard Inlet. However, under particular circumstances, individuals may be affected by sensory disturbances from noise and activity associated with the construction and operation of the expanded Westridge Marine Terminal and Project-related vessel activity. Injury or mortality from collisions with infrastructure and construction equipment associated with the terminal expansion is possible but unlikely. The glaucous-winged gull is an abundant resident species breeding annually at several colonies within Burrard Inlet. Nesting habitat is typically flat, rocky, or gravel substrates, but also includes human-built structures, and floating platforms along the shore. Within Puget Sound, glaucous-winged gull colonies are most often located in human-altered habitats (Seattle Audubon Society 2013). This species feeds opportunistically on a range of available natural and urban resources and has similar resource and habitat requirements to many marine birds as a generalist adapted to the current context of disturbed environments in the Marine RSA, such as northwestern crows and killdeer.

Spotted sandpipers typically forage along shorelines with other sandpiper and passerine species species, all which tend to flush easily when disrupted by human activity. They may be affected by sensory disturbances from noise and activity associated with the construction and operation of the expanded Westridge Marine Terminal and Project-related vessel activity. Effects from vegetation clearing of the Project footprint may include the alteration or loss of upland shoreline breeding habitat for spotted sandpipers using the security and thermal cover of low shrubs and forbs. Suitable nest sites are typically on shorelines with abundant ground cover and are selected near intertidal shores and mudflats to take advantage of foraging opportunities for invertebrate prey (Seattle Audubon Society 2013). There is a potential for events of injury or mortality from one or more birds colliding with terminal infrastructure as a result of disorientation from terminal night-lighting, or periods of low visibility during fog or inclement weather. The spotted sandpiper is a breeding species and primarily resident; some individuals are migratory. It has similar habitat requirements to other resident and seasonally present shorebirds or passerines that rely on the intertidal and upland coastal terrains for nesting and foraging.

Rationale for the selection of each of the indicators is summarized in Table 7.6.12-1.

Measurement Endpoints

The Project has the potential to affect marine birds through direct change in habitat availability or quality, sensory disturbance, and risk of injury or mortality from Project-related activities. Measurement endpoints (parameters) associated with these effects have been identified for each indicator (Table 7.6.12-1) and include both quantitative and qualitative measurements. The quantitative measurements include the area of suitable foraging or breeding habitat that will be altered or lost as a result of Westridge Marine Terminal clearing and construction calculated from the most current Westridge Marine Terminal engineering and design plans. The effect of sensory disturbance was qualitatively assessed for each indicator species based on potential changes in suitable habitat use, stress, behavioural alterations or habitat avoidance as a result of Terminal construction or operations. The potential for marine bird injury or mortality was qualitatively assessed for each of the indicators based on the known behavioural tendencies during movement or migration, sensitivity to night-lighting of the terminal or berthed vessels, anticipated level of risk or familiarity, and seasonal use of the species relative to the anticipated changes to Westridge Marine Terminal facilities and structures during Project construction and operations. The degree of change in these endpoints was used to characterize, and determine the significance of, potential direct and cumulative environmental effects from the Project on marine birds.

TABLE 7.6.12-1

ASSESSMENT INDICATORS AND MEASUREMENT ENDPOINTS FOR MARINE BIRDS

Marine Bird Indicator	Measurement Endpoints	Rationale for Indicator Selection
Bald eagle	• Quantitative measure of area of coastal habitat altered or lost due to Project activities • Qualitative potential for sensory disturbance from Project activities • Qualitative potential for injury or mortality from collisions with terminal infrastructure	• Breeding resident. • Established baseline of bird biology, population abundance and distribution • Sensitive to anthropogenic changes in habitat. • Top predator, keystone and flagship species. • Culturally important to Aboriginal communities. • Similar requirements to other raptors.
Great blue heron	• Quantitative measure of area of coastal habitat altered or lost due to Project activities • Qualitative potential for sensory disturbance from Project activities • Qualitative potential for injury or mortality from collisions with terminal infrastructure	• Breeding resident. • Species of conservation concern. • Declining in population abundance. • Established baseline of bird biology, population abundance and distribution. • Sensitive to anthropogenic and predator disturbances, and changes in shoreline and forested habitats. • Similar requirements to other foreshore waders.
Pelagic cormorant	• Quantitative measure of area of coastal habitat altered or lost due to Project activities • Qualitative potential for sensory disturbance from Project activities • Qualitative potential for injury or mortality from collisions with terminal infrastructure	• Breeding resident. • Species of conservation concern. • Declining in population abundance. • Established baseline of bird biology, population abundance and distribution. • Sensitive to anthropogenic and eagle disturbances. • Similar requirements to other littoral zone piscivores.
Barrow's goldeneye	• Quantitative measure of area of coastal habitat altered or lost due to Project activities • Qualitative potential for sensory disturbance from Project activities • Qualitative potential for injury or mortality from collisions with terminal infrastructure	• Winter resident, spring/fall migrant. • Congregates in large flocks to feed. • Established baseline of bird biology, population abundance and distribution. • Sensitive to anthropogenic disturbances and habitat alteration. • Similar requirements to other seabirds and waterfowl.
Glaucous-winged gull	• Quantitative measure of area of coastal habitat altered or lost due to Project activities • Qualitative potential for sensory disturbance from Project activities • Qualitative potential for injury or mortality from collisions with terminal infrastructure	• Breeding resident. • Abundant population as a generalist in natural and anthropogenically disturbed environments. • Established baseline of bird biology, population abundance and distribution. • Traditionally important to Aboriginal communities. • Similar requirements to a wide range of marine birds.

TABLE 7.6.12-1 Cont'd

Marine Bird Indicator	Measurement Endpoints	Rationale for Indicator Selection
Spotted sandpiper	• Quantitative measure of area of coastal habitat altered or lost due to Project activities • Qualitative potential for sensory disturbance from Project activities • Qualitative potential for injury or mortality from collisions with terminal infrastructure	• Breeding resident. • Established baseline of bird biology, population abundance and distribution, • Sensitive to anthropogenic disturbances. • Similar requirements to other foraging and nesting shorebirds.

7.6.12.2 Spatial Boundaries

Spatial boundaries for the assessment of potential Project effects on marine birds are defined as follows.

- Project Footprint: the area directly affected by construction of the Westridge Marine Terminal.
- Marine Birds LSA: the ZOI for marine birds likely to be affected by construction and operations of the Westridge Marine Terminal, defined as the area within 300 m of the proposed water lease expansion.
- Marine RSA: the area where the direct and indirect influence of other activities could overlap with Project-specific effects and cause cumulative effects on marine birds. This includes the area of Burrard Inlet east of the First Narrows, including Indian Arm and Port Moody Arm.

This ZOI used to define the Marine Birds LSA is a reasonable estimate of the thresholds of disturbance for sensitive species of marine birds as indicated in scientific literature (Hentze 2006, Ruddock and Whitfield 2007). It is a standard observation distance for marine bird surveys in various sea conditions (Resources Information Standards Committee [RISC] 1997) and has been applied as a threshold of disturbance for marine birds in similar marine projects in BC (*e.g.,* NGPLP 2006) using the professional judgment and expertise of the assessment team.

The spatial extent of the Marine RSA represents a rational balance between a large conservative assessment area where effects may not be detectable and a smaller area where the assessment of effects on populations of special concern may not be biologically meaningful. The Marine RSA is also bounded by developed shorelines which naturally limit the assessment of potential marine effects. There is an abundance of information for this spatial area including local studies, available research literature, and input from regulators.

Study area boundaries for marine birds are shown on Figures 6.2-1 and 6.2-2.

7.6.12.3 Marine Bird Context

The original dock at the Westridge Marine Terminal was constructed in 1957 using wood piles and decking. At that time, the shoreline south and west of the dock was extended seaward using rock and sediment fill. Over the course of the last few decades, the dock has been upgraded several times. The original wood piles have been replaced by steel piles, the wood decking with a steel and concrete trestle and loading platform, and concrete caissons to support the infrastructure. Large rip rap was added to reinforce the infill along the shoreline. As a result of the historic development at the Westridge Marine Terminal, approximately 480 m of the 710 m (68%) of shoreline within the Westridge Marine Terminal water lot has been replaced with fill material. To the east of the trestle, the upper intertidal zone has been infilled to support the CN rail line. The existing Westridge Marine Terminal currently has one loading berth which accommodates one Aframax tanker or barge.

Marine birds require marine and coastal habitats during all or a part of their life cycle (Croxall *et al*. 2012). They are an important component of BC marine ecosystems because of their high abundance and species diversity (Milko *et al*. 2003). This particular group of bird species uses coastal terrestrial habitats (above high-water mark); foreshore (shoreline from high-water to low-water tide mark); nearshore (low-water mark to water extending 10 m seaward); and offshore areas (nearshore to the continental shelf). The BC south coast supports large year-round and seasonal bird populations, often referred to in broad groups: geese and swans; shorebirds; dabbling and diving ducks; gulls, jaegars, skuas and terns; loons and grebes; murres, murrelets, guillemots and auklets; cormorants; kingfishers; wading birds; corvids; and coastal raptors. These groups occur within the Marine RSA. Marine birds are long-lived species, often living more than 20 years (Clapp *et al.* 1982) that produce few offspring, often only one per year, and provide a large amount of parental care compared to most marine species. Therefore, marine bird individuals and populations can, at certain times, be vulnerable and slow to rebound from adverse human and environmental impacts.

Burrard Inlet has been designated within an Important Bird Area (IBA020 - English Bay and Burrard Inlet) by BirdLife International (2013), a partnership of Bird Studies Canada and Nature Canada. Approximately 110 of the 307 species recorded in the IBA across seasons are marine birds and waterfowl (BIEAP 2002). The area attracts tens of thousands of migratory birds using the Pacific Flyway, is globally important habitat for western grebes, Barrow's goldeneye, and surf scoter, and is nationally important habitat for great blue herons (BIEAP 2002, BirdLife International 2013). Bird abundance in the inlet has been recorded at more than 24,000 birds during peak spring months (BIEAP 2002, Breault and Watts 1996). The marine areas of Central Harbour have the greatest abundance of waterbirds recorded here. The highest diversity of non-waterfowl marine birds (9 to 11 species) have been recorded near Port Moody, First Narrows Bridge and Second Narrows Bridge (Breault and Watts 1996).

The Marine RSA contains approximately 17 bird breeding colonies of 5 species; glaucous-winged gulls, pelagic cormorant, pigeon guillemot, great blue heron and purple martin (see Marine Birds – Westridge Marine Terminal Technical Report of Volume 5C for details and locations), and 25 species of conservation concern with seasonally required foraging, nesting and moulting habitats. Many of those species have been documented as sensitive to disturbance to varying degrees. The south coast, including Burrard Inlet and associated watercourses, are an important movement corridor and staging area for, often millions of, migrating birds, especially shorebirds and waterfowl (Butler 1992, Collins *et al*. 2011, Donaldson *et al*. 2000).

In terms of marine species, seabirds offer many advantages for study. They are highly visible and easily enumerated as they travel and forage in marine areas where most other plants and animals are underwater. Most are colonial and congregate annually in large numbers at relatively few locations to reproduce and forage. This allows the measurement and monitoring of population, distribution and behavioural parameters. Some species tend to travel or forage at night. Many species groups tend to particularly vulnerable to human activity and development. For these reasons, marine birds are frequently identified as useful indicators of marine-ecosystem health (Croxall *et al*. 2012, Mallory *et al*. 2010, Parrish *et al*. 2007, Piatt *et al*. 2007).

7.6.12.4 Potential Effects and Mitigation Measures

The Westridge Marine Terminal construction and operations activities are anticipated to have the potential to adversely affect marine birds through changes in habitat, sensory disturbance and risk of injury or mortality during the construction and operational phases of the Project. Environmental effects to marine birds are assessed within the context of habitat presently available within the Marine Birds LSA prior to construction (*i.e.,* existing conditions) which will change during and after construction.

Identified Potential Effects

Potential effects associated with construction and operations of the Westridge Marine Terminal on marine bird indicators are listed in Table 7.6.12-2. These effects were identified through a literature review, field studies, desktop analyses and the professional expertise and experience of the assessment team. Consultation with senior regulatory authorities (primarily Environment Canada) and other relevant stakeholders provided additional information on potential effects and mitigation measures.

Change in Habitat Quality or Availability

Change in habitat quality or availability can occur from land clearing, siltation during dredging, construction and temporary structures. Clearing for additional terminal infrastructure and buildings will include 2,685 m^2 (0.27 ha) of marine riparian habitat that will not be available for the operational life of the Westridge Marine Terminal. Removal of any large trees or shrub habitat could adversely affect nesting opportunities for bald eagle, great blue heron and spotted sandpiper. Anticipated minor changes in foreshore and shoreline habitats may affect preferred habitats used by marine birds to forage, roost/perch and nest. Construction activities could result in a temporary reduction in littoral-benthic zones available for foraging seabirds, although, there are abundant sites in adjacent channels and bays. After construction and during operations; however, new terminal and berth structures could provide roosting sites for some species, such as eagles, cormorants and herons. The degree to which each species may be affected depends on the type and amount of landscape and structures altered, seasonal species-specific use, the known sensitivities and vulnerabilities of these species, and the adaptability of some species to altered habitats.

Sensory Disturbance

The highest sound level due to terrestrial construction activities at the closest affected human receptor was predicted by noise modelling (Section 7.6.6 Acoustic Environment) to be approximately 70 dBA; however, detailed construction planning required to fully assess urban sound levels is not available at this stage of project planning. Noise levels as a result of night time construction, in-water dredging and pile driving have not yet been assessed; however, potentially high magnitude sound levels could be mitigated with additional noise management planning. During operations the spatial extent of the operating sounds (*e.g.,* pumps, ship loading, ship berthing and support equipment, ship idling at the berth, and tug operations) are expected to be limited to the Marine Birds LSA. The predicted sound levels created by the terminal, including the proposed expansion operations, is approximately 49 dBA at the nearest homes west of the site, and during the more stringent nighttime period. The duration of the terminal sound is long-term for the operational life of the Westridge Marine Terminal with a continuous frequency, because the Westridge terminal will operate 24 hours per day, 7 days per week. The effects will be reversible after terminal decommissioning.

Sensory disturbances to marine birds are associated with in-air and underwater noise and activities during Westridge Marine Terminal construction and operational activities. In-air noise and human activities during site clearing, in-air and underwater noise during dredging and pile driving, and an increase in noise and activity during Westridge Marine Terminal operations, could result in the alteration of normal dispersal patterns to avoid these foreshore sites near the Westridge Marine. High magnitude noise levels, such as during impact pile driving, could result in flushing behaviour, individual distress and avoidance from important habitats (*i.e.,* reduced habitat effectiveness). Previous research indicates that birds are disturbed by in-air noise levels greater than 90 dBA (90 dB re: 20 µPa) (Gladwin *et al.* 1988). Given the context of industrial activity and marine vessel traffic in Burrard Inlet, marine birds may habituate to operational and low level construction noise, and other types of sensory disturbances, that are predictable and not associated with negative consequences (Grubb *et al*. 2002, Steidl and Anthony 2000, Ward and Stehn 1989). Although known to be sensitive to human disturbance (Smith 2000), there are no studies from the local area to determine the extent of habituation or effects; however, it would be difficult to separate effects related directly to Project activities from the effects of other human activities in the Inlet.

Sources of underwater noise disturbance are pile-driving, and to a lesser degree, dredging, during terminal construction. Engineering information regarding the type and method of pile-driving, and the method and extent of dredging, that will be used for expansion of the Westridge Marine Terminal were not available at the time of this assessment. However, detailed assumptions and literature-sourced data on various types, sizes and methods, with resulting noise assessments, have been provided for marine mammals in Section 7.6.11.4. In this subsection, impact dredging is reported to have a potential broadband source level (peak SPL) of 187 dB re: 1 µPa at 1 m, and a clamshell dredge has a maximum broadband source level of approximately 167 dB re: 1 µPa at 1 m (Richardson *et al*. 1995). Vibratory drivers produce less noise impact, approximately 25 dB lower than that of impact driving. Guidance from the Project engineers to date has indicated that pile driving is to be conducted irregularly but relatively consistently over a period of approximately 2 years. Therefore, with regard to mitigating effects to marine wildlife, vibratory drivers are the preferred method of pile driving. Only a small amount of dredging will likely be required (*i.e.,* approximately 60 days) using a clamshell dredge.

Although there is considerable information on noise disturbance to marine mammals, little information is available on the hearing capabilities and thresholds of disturbance of birds underwater. The harm from, or avoidance of, events of underwater noise could adversely affect feeding effectiveness, nest provisioning, or the energetics critical to staging and migration periods. Variation in response to disturbance events is associated with the level of source-noise to that of the ambient, degree of naiveté of the animals to the source-noise, ongoing activity at the time of exposure and, to an uncertain degree, the species involved (Myrberg 1990). The most recent information is from a study of the hearing of the Blackfooted penguin (*Sphenikcus demersus*), the results of which indicate an underwater sensitivity measured at 1-4 kHz (McCauley and Salgado Kent 2008). Although there is no formal guidance on the assessment of disturbance to birds from underwater noise, there are general principles that can be used to indicate the potential for a level of disturbance, Nedwell *et al.* (2004) suggest that a behavioural response in a marine bird on the surface would be elicited if the in-air noise level was greater than 90 dB re: 20 µPa. At this noise level, individuals have been found to show an avoidance reaction, typically swimming away from the source of noise. Using guidance provided in Slabberkoorn *et al*. (2010), an airborne sound pressure level of 90 dB re: 20 µPa is comparable to an underwater 151.5 dB re: 1 µPa, with sound level adjustments for the higher acoustic impedance in water, and that sound travels much greater distances at higher amplitude levels in water. During impact piling installation, noise levels 187 dB re: 1 µPa could be reached and; therefore, diving birds in proximity to the in-water construction could be disturbed. Without local baseline studies, the threshold of underwater noise disturbance for particular bird species it is difficult to assess; however, it is reasonable to assume that marine birds, specifically diving species, could be disturbed during loud underwater construction events.

Potentially high suspended sediment levels may affect marine bird visibility of prey and the abundance of food immediately around the construction site; however, this would be a temporary condition. Construction of the new berths have the potential for minimal adverse effects to water quality, visual acuity and prey availability in foreshore or intertidal areas to foraging marine birds. Operations are less likely to have substantial effects on marine birds considering the context of high vessel activity and adjacent industry within their current habitats.

Injury or Mortality

Injury or mortality may occur as a result of pre-construction activities to remove marine riparian substrates and vegetation. If it were necessary to clear vegetation at the shoreline during the breeding season, there is the potential to accidentally injure or kill ground and shrub nesting birds, eggs and nestlings. Substantial sensory disturbance events, such as unusual human activity or persistent loud noises could, in some cases, cause nest abandonment and the consequent mortality of exposed young nestlings.

Mortality may occur during rare events of birds colliding with Westridge Marine Terminal or vessel infrastructures, large construction-related equipment or motorized vehicles, primarily as a result of disorientation by night lighting of the Westridge Marine Terminal area or lack of visibility during weather events. Major sources of artificial light in the marine environment include vessels, marine terminals, and local shoreline industry and developments. Seabirds are highly visually oriented and known to become disoriented at night, especially during migration, in the presence of artificial light (Bruderer *et al*. 1999, LeCorre *et al*. 2002). Night lighting of the Westridge Marine Terminal or docked vessels can attract some species groups that are more responsive to or confused by night-lights and susceptible to collisions with terminal structures. The risk of injury or mortality increases when visibility is reduced during inclement weather (Greer 2010, BirdLife International 2003). Variables that influence the level of risk include weather conditions, season, species, age of birds, and the lunar phase (Montevecchi 2006). Bird strikes or collisions have been documented at various shipping areas around the world (Black 2005, Merkel and Johansen 2011, Montevecchi 2006). The Westridge Marine Terminal expansion will require a marginal increase in lighting from existing light levels which could result in rare collision events. Resident birds may be acclimated to night-lighting at this and proximal locations and information on bird strikes is lacking for the Marine RSA. Consequently, no specific thresholds for evaluation of this effect have been identified.

A summary of mitigation measures provided in Table 7.6.12-2 was principally developed in accordance with the professional experience of the assessment team, as well as applicable measures in accordance with Trans Mountain professional operating standards.

TABLE 7.6.12-2

POTENTIAL EFFECTS, MITIGATION MEASURES AND RESIDUAL EFFECTS OF CONSTRUCTION AND OPERATIONS AT THE WESTRIDGE MARINE TERMINAL ON MARINE BIRDS

Potential Effect	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
1. Marine Bird Indicator – Bald Eagle			
1.1 Change in habitat quality or availability	LSA	• Adhere to an established Environmental Protection Plan (EPP) and monitor in an adaptive framework. • Confine all clearing and associated activities within the staked/flagged Westridge Marine Terminal construction boundaries. Adhere to clearing restrictions associated with special environmental features (*i.e.,* nesting birds) as outlined in the Wildlife and Wildlife Habitat Specific Protection and Management Measures table [Section 8.1]. • Ensure that any potential mitigation measures concerning marine wildlife species at risk are communicated to the Contractor and enforced by the Lead Activity Inspector and the Environmental Inspector [Section 8.1]. • Clear shrubs with limited habitat potential within the appropriate timing windows for breeding birds to discourage nesting on the Westridge Marine Terminal site prior to construction, if construction is scheduled to occur during the spring/summer period [Section 8.1]. • Direct that a breeding bird nest survey be conducted by a qualified marine avian biologist at least seven days prior to initiating activities in areas where clearing activities have not been completed prior to the start of the bird nesting period. In the event that a nest is discovered, or found incidentally during other Project-related activities, an appropriate mitigation strategy will be established by Trans Mountain's Environmental Inspector or Wildlife Resources Specialists as described in the Onshore or Marine Wildlife Species of Concern Discovery Contingency Plan [Section 8.1]. • The Environmental Inspector will ensure the brushing Contractor clears shrubby vegetation from the Westridge Marine Terminal prior to the onset of the bird nesting season. See the Environmental Facility Drawings of Westridge Marine Terminal for locations to be pre-cleared. Any clearing within the migratory restricted activity period (RAP) will only be allowed if a nest survey has been conducted within seven days of the commencement of clearing and no nesting activity was observed [Section 8.1]. • Apply species-specific buffers, provided by wildlife resource specialists, at all active bird nest sites [Section 8.1]. • Install sediment fences at the base of cut/fill areas to reduce sediment discharge into the marine environment, where warranted [Section 8.1]. • Maintain sediment fences in place at the base of cut/fill areas, where warranted, until revegetation is stable [Section 8.1]. • Ensure that watering of roads and work surfaces does not generate excessive formation of surface water accumulation (*i.e.* puddles or excessive mud generation), or result in overland water flow or sedimentation of the marine environment. [Section 8.1]. • Implement appropriate marine sediment/turbidity control measures within the surrounding area, prior to marine construction activities, to contain sedimentation to the marine work area (*e.g.,* turbidity curtains) [Section 8.2].	• Loss of foraging, nesting and roosting habitat, which may adversely affect species fitness and population sustainability.

TABLE 7.6.12-2 Cont'd

Potential Effect	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
1.2 Sensory disturbance	RSA	• Initiate pre-construction environmental monitoring, where warranted, prior to the commencement of construction or, if appropriate, prior to the commencement of a specific activity (*e.g.*, pile installation). At some locations, monitoring will be necessary to assess the effects on specific environmental features (*e.g.,* nesting birds). If, required, ensure that applicable permits/approvals/authorizations are in place to allow monitoring to be conducted [Section 6.0]. • Noise abatement and construction scheduling will be considered during noise-sensitive periods, to limit disruption to sensitive receptors (*e.g.,* nesting birds) [Section 7.0]. • Prevent sky-lighting which may lead to bird disorientation/collisions, where feasible, by: using low level and low intensity lighting; using no lighting in areas where no work is planned; using downturned shaded fixtures in light standards; and using a higher lumen/watt (light out to power in) ratio, such as metal halide lighting [Section 7.0]. • Operate all Project-related vessels at slow speeds during marine construction in order to limit the intensity of acoustic emissions. Vessel operators will avoid rapid acceleration to control noise [Section 8.2]. • Propellers of all Project-related vessels will be well maintained in order to reduce underwater noise [Section 8,2]. • Use a vibratory method of pile installation instead of an impact hammer, if feasible [Section 8.2] • Deploy bubble curtains during pile installation to reduce underwater noise levels where an impact hammer is required for pile installation [Section 8.1].	• Stress, behavioural changes or avoidance of preferred or important habitats, which may adversely affect species fitness and population sustainability.
1.3 Injury or mortality	RSA	• Prevent sky-lighting which may lead to bird disorientation/collisions, where feasible, by: using low level and low intensity lighting; using no lighting in areas where no work is planned; using downturned shaded fixtures in light standards; and using a higher lumen/watt (light out to power in) ratio, such as metal halide lighting [Section 7.0]. • During migratory bird periods and/or during extreme weather events, bird strike warnings will be issued to berthed vessels with a request to reduce deck lighting [Section 7.0]. • Inform all operators of Project-related vessels of the hazards regarding bird strikes occurring at night because of deck lighting or inclement weather and bird collisions with Westridge Marine Terminal structures. Report all bird strikes/collisions immediately to Trans Mountain's Lead Activity Inspector and the Environmental Inspector Section 8.2]. • Ensure construction activities located within offshore or marine wildlife setback distances will be scheduled to occur within least risk windows or proceed with the approval of the appropriate regulatory authority [Section 7.0]. • Implement the Onshore or Marine Wildlife Species of Concern Discovery Contingency Plan in the event that potentially rare and endangered wildlife species and/or their habitats are discovered during construction [Section 8.0]. •	• Injury or mortality events, which may adversely affect population abundance.
2. Marine Bird Indicators – Great Blue Heron			
2.1 Change in habitat quality or availability	Footprint	• See recommended mitigation measures from potential effect 1.1 of this table.	• Loss of foraging, nesting and roosting habitat, which may adversely affect species fitness and population sustainability.
2.2 Sensory disturbance	RSA	• See recommended mitigation measures from potential effect 1.2 of this table.	• Stress, behavioural changes or avoidance of preferred or important habitats, which may adversely affect species fitness and population sustainability.
2.3 Injury or mortality	RSA	• See recommended mitigation measures from potential effect 1.3 of this table.	• Injury or mortality events, which may adversely affect population abundance.

TABLE 7.6.12-2 Cont'd

Potential Effect	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
3. Marine Bird Indicators – Pelagic Cormorant			
3.1 Change in habitat quality or availability	LSA	• See recommended mitigation measures from potential effect 1.1 of this table.	• Loss of foraging, nesting and roosting habitat, which may adversely affect species fitness and population sustainability.
3.2 Sensory disturbance	RSA	• See recommended mitigation measures from potential effect 1.2 of this table.	• Stress, behavioural changes or avoidance of preferred or important habitats, which may adversely affect species fitness and population sustainability.
3.3 Injury or mortality	RSA	• See recommended mitigation measures from potential effect 1.3 of this table.	• Injury or mortality events, which may adversely affect population abundance.
4. Marine Bird Indicators – Barrow's Goldeneye			
4.1 Change in habitat quality or availability	LSA	• See recommended mitigation measures from potential effect 1.1 of this table.	• Loss of foraging, nesting and roosting habitat, which may adversely affect species fitness and population sustainability.
4.2 Sensory disturbance	RSA	• See recommended mitigation measures from potential effect 1.2 of this table.	• Stress, behavioural changes or avoidance of preferred or important habitats, which may adversely affect species fitness and population sustainability.
4.3 Injury or mortality	LSA	• See recommended mitigation measures from potential effect 1.3 of this table.	• Injury or mortality events, which may adversely affect population abundance.
5. Marine Bird Indicators – Glaucous-winged Gull			
5.1 Change in habitat quality or availability	LSA	• See recommended mitigation measures from potential effect 1.1 of this table.	• Loss of foraging, nesting and roosting habitat, which may adversely affect species fitness and population sustainability.
5.2 Sensory disturbance	RSA	• See recommended mitigation measures from potential effect 1.2 of this table.	• Stress, behavioural changes or avoidance of preferred or important habitats, which may adversely affect species fitness and population sustainability.
5.3 Injury or mortality	RSA	• See recommended mitigation measures from potential effect 1.3 of this table.	• Injury or mortality events, which may adversely affect population abundance.
6. Marine Bird Indicators – Spotted Sandpiper			
6.1 Change in habitat quality or availability	Footprint	• See recommended mitigation measures from potential effect 1.1 of this table.	• Loss of foraging, nesting and roosting habitat, which may adversely affect species fitness and population sustainability.
6.2 Sensory disturbance	RSA	• See recommended mitigation measures from potential effect 1.2 of this table.	• Stress, behavioural changes or avoidance of preferred or important habitats, which may adversely affect species fitness and population sustainability.
6.3 Injury or mortality	RSA	• See recommended mitigation measures from potential effect 1.3 of this table.	• Injury or mortality events, which may adversely affect population abundance.

Notes: 1 LSA = Marine Birds LSA; RSA = Marine RSA.
2 Detailed mitigation measures are provided in the Westridge Marine Terminal EPP (Volume 6D).

7.6.12.5 Potential Residual Effects

The potential residual environmental effects on the marine bird indicators associated with construction and operations activities at the Westridge Marine Terminal (Table 7.6.12-2) are:

- alteration or loss or of foraging, nesting and roosting habitat, which may adversely affect species habitat effectiveness, altered energy budgets, reduced individual fitness, or effects to the abundance of local breeding populations;
- sensory disturbances causing stress, behavioural changes or avoidance of preferred or important habitats, which may adversely affect individual fitness and local population sustainability; and
- events of accidental injury or mortality, which may adversely affect local population abundance.

7.6.12.6 Significance Evaluation of Potential Residual Effects

The significance of the effects from habitat loss were assessed quantitatively as changes to the baseline data from proposed clearing limits at the shoreline of the terminal and the area of marine disturbance from construction of additional berths. A qualitative assessment was the most appropriate approach to evaluate the significance of the potential residual effects of disturbance and injury or mortality due to a lack of scientific and regulatory thresholds to define rating criteria for marine bird indicators. The evaluation of significance of these potential residual effects relied on recent available research literature for other areas or marine species, many years of related field experience, and the professional expertise and judgment of the marine environmental assessment team.

Table 7.6.12-3 provides a summary of the significance evaluation of potential residual effects on marine bird indicators from construction and operation of the expanded Westridge Marine Terminal. The rationale used to evaluate the significance of each of the residual environmental effects is provided below.

TABLE 7.6.12-3

SIGNIFICANCE EVALUATION OF POTENTIAL RESIDUAL EFFECTS OF CONSTRUCTION AND OPERATIONS AT THE WESTRIDGE MARINE TERMINAL ON MARINE BIRDS

				Temporal Context						
	Potential Residual Effects	Impact Balance	Spatial Boundary[1]	Duration	Frequency	Reversibility	Magnitude	Probability	Confidence	Significance[2]
1.	Marine Bird Indicator – Bald Eagle									
1(a)	Loss or alteration of foraging, nesting and roosting habitat adversely affecting habitat effectiveness and individual fitness, or sustainability of local breeding populations.	Negative	LSA	Short-term	Isolated	Medium-term	Low	High	High	Not significant
1(b)	Sensory disturbances causing stress, behavioural changes or avoidance of preferred or important habitats, which may adversely affect individual fitness and local population sustainability.	Negative	RSA	Long-term	Periodic	Short-term	Low	High	High	Not significant
1(c)	Events of accidental injury or mortality, which may adversely affect local population abundance.	Negative	RSA	Long-term	Accidental	Medium-term	Low	Low	High	Not significant
1(d)	Combined effects on the bald eagle indicator (1[a] and 1[b]).	Negative	RSA	Long-term	Periodic	Medium-term	Low	High	High	Not significant
2.	Marine Bird Indicator – Great Blue Heron									
2(a)	Loss or alteration of foraging, nesting and roosting habitat adversely affecting habitat effectiveness and individual fitness, or sustainability of local breeding populations.	Negative	Footprint	Short-term	Isolated	Medium-term	Low	High	High	Not significant
2(b)	Sensory disturbances causing stress, behavioural changes or avoidance of preferred or important habitats, which may adversely affect individual fitness and local population sustainability.	Negative	RSA	Long-term	Periodic	Short-term	Medium	High	High	Not significant
2(c)	Events of accidental injury or mortality, which may adversely affect local population abundance.	Negative	RSA	Long-term	Accidental	Medium-term	Low	Low	High	Not significant

TABLE 7.6.12-3 Cont'd

Potential Residual Effects		Impact Balance	Spatial Boundary[1]	Temporal Context			Magnitude	Probability	Confidence	Significance[2]
				Duration	Frequency	Reversibility				
2(d)	Combined effects on the great blue heron indicator (2[a] and 2[b]).	Negative	RSA	Long-term	Periodic	Medium-term	Low	High	High	Not significant
3.	Marine Bird Indicator – Pelagic Cormorant									
3(a)	Loss or alteration of foraging, nesting and roosting habitat adversely affecting habitat effectiveness and individual fitness, or sustainability of local breeding populations.	Negative	LSA	Short-term	Isolated	Medium-term	Low	High	High	Not significant
3(b)	Sensory disturbances causing stress, behavioural changes or avoidance of preferred or important habitats, which may adversely affect individual fitness and local population sustainability.	Negative	RSA	Long-term	Periodic	Short-term	Medium	High	Moderate	Not significant
3(c)	Events of accidental injury or mortality, which may adversely affect local population abundance.	Negative	RSA	Long-term	Accidental	Medium-term	Low	Low	High	Not significant
3(d)	Combined effects on the pelagic cormorant indicator (3[a] and 3[b]).	Negative	RSA	Long-term	Periodic	Medium-term	Low	High	High	Not significant
4.	Marine Bird Indicator – Barrow's Goldeneye									
4(a)	Loss or alteration of foraging, nesting and roosting habitat adversely affecting habitat effectiveness and individual fitness, or sustainability of local breeding populations.	Negative	LSA	Short-term	Isolated	Medium-term	Low	High	High	Not significant
4(b)	Sensory disturbances causing stress, behavioural changes or avoidance of preferred or important habitats, which may adversely affect individual fitness and local population sustainability.	Negative	RSA	Long-term	Periodic	Short-term	Medium	High	High	Not significant
4(c)	Events of accidental injury or mortality, which may adversely affect local population abundance.	Negative	RSA	Long-term	Accidental	Medium-term	Low	Low	High	Not significant
4(d)	Combined effects on the Barrow's goldeneye indicator (4[a] and 4[b]).	Negative	RSA	Long-term	Periodic	Medium-term	Low	High	High	Not significant
5.	Marine Bird Indicator – Glaucous-winged Gull									
5(a)	Loss or alteration of foraging, nesting and roosting habitat adversely affecting habitat effectiveness and individual fitness, or sustainability of local breeding population.	Negative	LSA	Short-term	Isolated	Medium-term	Low	High	High	Not significant
5(b)	Sensory disturbances causing stress, behavioural changes or avoidance of preferred or important habitats, which may adversely affect individual fitness and local population sustainability.	Neutral	RSA	Long-term	Occasional	Short-term	Low	High	High	Not significant
5(c)	Events of accidental injury or mortality, which may adversely affect local population abundance.	Negative	RSA	Long-term	Accidental	Medium-term	Low	Low	High	Not significant
5(d)	Combined effects on the glaucous-winged gull indicator (5[a] and 5[b]).	Negative	RSA	Long-term	Occasional	Medium-term	Low	High	High	Not significant
6.	Marine Bird Indicator – Spotted Sandpiper									
6(a)	Loss or alteration of foraging, nesting and roosting habitat adversely affecting habitat effectiveness and individual fitness, or sustainability of local breeding populations.	Negative	Footprint	Short-term	Isolated	Medium-term	Low	High	High	Not significant
6(b)	Sensory disturbances causing stress, behavioural changes or avoidance of preferred or important habitats, which may adversely affect individual fitness and local population sustainability.	Negative	RSA	Long-term	Periodic	Short-term	Medium	High	Moderate	Not significant
6(c)	Events of accidental injury or mortality, which may adversely affect local population abundance.	Negative	RSA	Long-term	Accidental	Medium-term	Low	Low	High	Not significant
6(d)	Combined effects on the spotted sandpiper indicator (6[a] and 6[b]).	Negative	RSA	Long-term	Periodic	Medium-term	Low	High	High	Not significant

Notes: 1 LSA = Marine Birds LSA; RSA = Marine RSA.

2 Significant Residual Environmental Effect: A high probability of occurrence of a permanent or long-term residual effect of high magnitude that cannot be technically or economically mitigated.

Marine Birds Indicator – Bald Eagle

The following subsections provide the evaluation of significance of potential residual effects on the bald eagle indicator.

Loss or Alteration of Foraging, Nesting and Roosting Habitat

There will be 2,685 m^2 (0.27 ha) of marine shoreline and riparian habitat lost due to Westridge Marine Terminal construction, a portion of which is suitable bald eagle habitat (Anthony *et al.* 1982). This may adversely affect the availability of raptor nesting, perching or foraging habitat in the Marine Birds LSA. Bald eagle predation is opportunistic and occurs in shallow aquatic zones or shorelines. They feed primarily on live and dead fish, ducks and other waterbirds, and small mammals. Large stick nests are built and used year after year in tall trees or on cliffs. Historic bald eagle nesting sites are at approximately 15 locations throughout the Marine RSA, with consideration for their tendency to build one or two alternate nests at different sites within their breeding range (Cook 2008). The Marine Birds LSA has limited value as foraging and nesting habitat for this species due to existing terrestrial disturbance and terminal activities; however, the Marine RSA offers other opportunities for these requirements which could potentially offset any effects from terminal expansion. After construction and during operations; vegetation in some perimeter areas of the site will be allowed to recover and regrowth could provide perching or nesting sites. The bald eagle represents other raptor species which may also be using these shoreline and foreshore habitats and this recovery is true for other tree-dwelling marine bird species as well, such as osprey, cormorants and herons. The existing Westridge Marine Terminal pilings and berth that provide roosting habitat for these species will be removed; however, the additional larger berths may enhance the availability of roosting opportunities. Therefore, the magnitude of the effect of lost or altered perching/roosting or nesting habitat is low, and the reversibility is anticipated to be medium-term in view of the length of time it will take to recovery tree canopy where it might have previously provided suitable habitat (Table 7.6.12-3, point 1[a]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Marine Birds LSA – effects are confined to the area of ground disturbance and construction directly associated with the terminal Footprint and potentially includes intertidal zones and shorelines within a portion of the Marine Birds LSA.
- Duration: short-term – the events that will result in habitat loss or alteration will occur during the construction phase of the Project.
- Frequency: isolated – the events causing habitat loss or alteration is confined to the construction phase of the Project.
- Reversibility: medium-term – some cleared areas with associated bald eagle capability habitat are expected to recover in less than 10 years providing opportunities for future habitat use.
- Magnitude: low – effects will be detectable in the short-term but suitable tree cover will recover over time post-construction, and may potentially be enhanced by additional roosting sites provided by terminal infrastructure.
- Probability: high – the Project is likely to alter or destroy suitable bald eagle roosting or nesting habitat during construction.
- Confidence: high – based on a good understanding by the assessment team of cause-effect relationships between the Project activities and bald eagles, and data pertinent to the Project area.

Sensory Disturbance Causing Stress, Behavioural Changes or Avoidance of Important Habitats

Temporary sediment releases in marine waters surrounding the in-water construction sites could alter prey abundance or impede prey visibility. Increased in-air noise and activity at the Westridge Marine Terminal may result in the stress of individuals using preferred and/or important habitats or, alternatively, an alteration of normal movement patterns through avoidance of those preferred foreshore and shoreline areas. Substantial noise levels during construction, dredging and pile driving are expected to have some detectable effect on adult eagles with territories that overlap with the Marine Birds LSA and Marine RSA.

Bald eagles are known to habituate to noise and human activity in developed areas (Grubb *et al.* 2002, McGarigal *et al*. 1991); however, this is difficult to assess. It is reasonable to assume bald eagle persistence is related to some level of anthropogenic tolerance, and this can be said for other raptor or foreshore species that the bald eagle, as an indicator, is representative of, such as vultures, osprey, Cooper's hawk, owls, or great blue herons. Although constraints to obtaining life history requirements can adversely affect habitat effectiveness and individual fitness, the local bald eagle population sustainability is unlikely to be affected assuming some habituation by bald eagles within the context of dense marine activity within the Marine Birds LSA and Marine RSA where many breeding pairs currently reside. The magnitude of the effect of sensory disturbance is anticipated to be low acting periodically over the life of terminal operations (Table 7.6.12-3, point 1[b]); however, reversibility after each event will be short-term. A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Marine Birds RSA – effects may extend into the Marine RSA and beyond the ZOI specific to the visual and noise disturbance threshold of the bald eagle (approximately 200 m).
- Duration: long-term – the events causing sensory disturbances to bald eagles will be initiated during construction and extend throughout terminal operations for the operational life of the Westridge Marine Terminal.
- Frequency: periodic – the events causing a sensory disturbance effects will occur intermittently but repeatedly for the operational life of the Westridge Marine Terminal.
- Reversibility: short-term – although bald eagles may habituate to a particular level of noise and human activity from temporary construction and long-term operations of the terminal, recovery from the effects of some disturbance events may be interrupted by subsequent marine activities.
- Magnitude: low – effects will be detectable at the individual level but will not likely be detectable at the population level with consideration for the context of abundant industrial development and activity in the Marine RSA and the potential for some level of individual habituation to disturbance.
- Probability: high – the effect of Project–related sensory disturbances to bald eagles is likely to occur.
- Confidence: high – based on a good understanding by the assessment team of cause-effect relationships between the Project activities and bald eagles, and data relevant to the Marine RSA.

Events of Accidental Injury or Mortality

Bald eagles could potentially be injured or suffer mortality from colliding with vessel or terminal infrastructure while in flight, or if they are perched on moving or unstable equipment. This is most likely to occur if birds are flying through fog or bad weather; however, these events would be accidental and rarely occurring (Table 7.6.12-3, point 1[c]) for adults that have resided long-term in the area of Burrard Inlet. The incremental change in structure and equipment that will occur during and after the construction of the Westridge Marine Terminal should not impose a substantial risk since it is reasonable to assume that there is some familiarity with existing opportunities to perch on similar structures at and around this site. Because bald eagles are known to habituate to human activity, they may return to favoured roosts at or near the terminal within a short time after construction. Long periods of relatively loud noise associated with pile installation could potentially cause sufficient stress to cause nest abandonment, if a nest was near enough to the Westridge Marine Terminal (approximately 200 m) but had not been detected by Inspectors (Volume 6D, Westridge Marine Terminal EPP). Abandonment would result in subsequent mortality of eggs or hatchlings from exposure. The probability of this effect occurring is low considering presence of Environmental Inspectors during construction and that bald eagles currently nest near many commercial and industrial areas in Burrard Inlet. The effect to individuals would be accidental and of low magnitude. A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Marine Birds RSA – effects could extend to outside the direct area of disturbance from construction and operational facilities associated with the terminal expansion.

- Duration: long-term – the effect of bird injury or mortality from collisions with terminal infrastructure could occur during construction and throughout the operations phase for the operational life of the Westridge Marine Terminal. The effect of bird mortality from nest abandonment would be limited to the construction phase.
- Frequency: accidental – the events causing potential injury or mortality to bald eagles would occur rarely over the operational life of the Westridge Marine Terminal.
- Reversibility: medium-term – each event of mortality would be restored within one generation of breeding and maturity of an individual.
- Magnitude: low – effects from rare events will be detectable at the individual level but with mitigation are unlikely to be detectable at the population level.
- Probability: low – mortality would be a rare event and unlikely to occur as a result of the Project.
- Confidence: high – based on a good understanding by the assessment team of cause-effect relationships between the Project activities and bald eagles, and data relevant to the Marine RSA.

Combined Effects on Bald Eagle

Combined effects consider those residual effects that are likely to occur (*i.e.,* habitat loss and sensory disturbance) which, in this section, applies to all indicators. No nests are currently active within or adjacent to the Westridge Marine Terminal and abundant shoreline habitat is available within the Marine RSA for foraging and perching. A comprehensive Westridge Marine Terminal EPP (Volume 6D) has been developed to reduce or eliminate potential harm to marine life during construction of the Westridge Marine Terminal, to include noise baffles, bubble curtains and working windows (September 1 to January 31) that consider sensitive breeding (February 1 to August 31 during 2 years of construction) and bird migration periods. The likelihood of noise levels capable of sensory disturbance events will decrease with distance from the source, for example, noise during construction within the terminal footprint or during in-water pile driving. The effects of noise and activity are not expected to extend beyond the Marine Birds LSA under most construction and operating conditions but may occur intermittently during this period when particular activities are scheduled to occur. To be exposed to sound levels capable of causing disturbance or harm, marine birds would need to be in relatively close proximity to the upland terminal and in-water pile-driving. At the time of this assessment, detailed engineering and parameters of noise and activity associated with pile-driving were not available. However, Trans Mountain will comply with mitigation set out in the Westridge Marine Terminal EPP (Volume 6D), which may be technically supplemented, depending on the conditions at the time, to avoid harm or disturbance to marine life. A summary of the rationale for all of the significance criteria for combined effects on bald eagle is provided below (Table 7.6.12-3, point 1[c]).

- Spatial Boundary: Marine Birds RSA – combined effects from construction and operations could potentially occur within all spatial scales of the assessment area.
- Duration: long-term – the events causing combined effects on bald eagles may occur during construction and throughout the operations phase for the operational life of the Westridge Marine Terminal.
- Frequency: periodic – the events causing the combined effects on bald eagles have the potential to occur intermittently but repeatedly over the operational life of the Westridge Marine Terminal.
- Reversibility: medium-term – potential combined effects of sensory disturbance, and habitat alteration or loss are expected to recover in less than 10 years.
- Magnitude: low – effects will be detectable at the individual level but are unlikely to be detectable at the population level.
- Probability: high – combined effects on the bald eagle arising from the Project are likely to occur.
- Confidence: high – based on a good understanding by the assessment team of cause-effect relationships between the Project activities and the bird indicator species, bald eagle.

Marine Bird Indicator – Great Blue Heron

The following subsections provide the evaluation of significance of potential residual effects on the great blue heron indicator.

Loss or Alteration of Foraging, Nesting and Roosting Habitat

Effects to great blue herons are expected to be associated with the potential loss or alteration of nesting/roosting and foraging habitat in the Marine Birds LSA. There will be 2,685 m^2 (0.27 ha) of marine riparian habitat lost due to terminal construction, a portion of which is suitable great blue heron habitat. Foraging by great blue herons is opportunistic with regard to what prey is available and is primarily focused within the littoral-benthic zone (COSEWIC 2008f). The indicator, great blue heron forages opportunistically on fish, amphibians, small mammal and invertebrate prey primarily taken at shorelines and within the intertidal zone and, as such, represent the many species of intertidal foragers that occur within the Marine RSA (*e.g.,* sandpiper species, waterfowl species, common raven, migrating birds). Herons nest colonially in woodland forest. The Marine Birds LSA has limited value as foraging and nesting habitat for this species; however, the Marine Birds RSA does offer those opportunities. Stanley Park, which extends to the shoreline in the RSA has an active great blue heron nesting colony and a small colony of a few breeding pairs is located upstream of the Terminal site in the riparian zone of Heron Creek. Herons have strong nest site fidelity and established sites within Burrard Inlet are likely to remain viable. Therefore, the magnitude of effect from loss of nesting and foraging habitat is low (Table 7.6.12-3, point 2[a]). After construction and during operations; vegetation in some perimeter areas of the site will be allowed to recover and new structures could provide roosting or nesting sites for some species, such as eagles, cormorants and herons. The existing Westridge Marine Terminal pilings and berth that currently provide roosting habitat will be removed; however, the additional larger berths may provide enhanced roosting opportunities. Therefore, the reversibility of habitat lost or disturbed is anticipated to be medium-term. A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Footprint – effects are confined to the area of disturbance and construction associated with the terminal expansion.
- Duration: short-term – the event causing habitat alteration or loss will occur during the construction phase.
- Frequency: isolated – the event causing habitat alteration or loss is confined to the construction phase of the Project.
- Reversibility: medium-term – suitable tree roosting habitat is expected to recover in less than 10 years along with the associated habitat use by great blue herons.
- Magnitude: low – effects will be detectable in the short-term but will begin to recover and potentially be enhanced post-construction with the additional structure provided by new berths.
- Probability: high – the Project is likely to alter foreshore habitat during construction.
- Confidence: high – based on a good understanding by the assessment team of cause-effect relationships between the Project activities and great blue heron, and data specific to the Marine RSA.

Sensory Disturbance Causing Stress, Behavioural Changes or Avoidance of Important Habitats

Increased in-air noise and activity at the Westridge Marine Terminal may result in the stress of individuals (Gebauer and Moul 2001, Vennesland 2000) using preferred and/or important habitats or, alternatively, an alteration of normal movement patterns to avoid those preferred but active foreshore areas. Substantial noise levels during dredging and pile-driving are expected to have some measureable effect on herons. Temporary sediment releases in marine waters surrounding the in-water construction sites could alter prey abundance or impede bird visibility while attempting to catch prey. Constraints from obtaining life history requirements can adversely affect habitat effectiveness, individual fitness and population sustainability. Although, habituation is known to occur in some population groups (Vennesland 2000) depending on local conditions; this is difficult to assess. With consideration for the context of existing high-volume marine traffic and local industry, the magnitude of the effect of disturbance is anticipated to be medium but long-term acting periodically over the life of terminal operations (Table 7.6.12-3, point 2[b]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Marine Birds RSA – effects may extend into the Marine RSA and beyond the ZOI specific to the visual and noise disturbance threshold (approximately 200 m) of the great blue heron.
- Duration: long-term – the events causing sensory disturbance will be initiated during construction and extend throughout operations for the operational life of the Westridge Marine Terminal.
- Frequency: periodic – the events causing sensory disturbance (*i.e.,* noise and activity during construction and operations) will occur intermittently but repeatedly for the operational life of the Westridge Marine Terminal.
- Reversibility: short-term – although great blue herons may habituate to a particular level of noise and human activity from temporary construction and long-term operation of the terminal, recovery from the effects from some disturbance events may be interrupted by subsequent marine activity.
- Magnitude: medium – effects will be detectable at the individual level but with mitigation may not be detectable at the population level with consideration for the known sensitivities of this species to disturbance.
- Probability: high – the Project is likely to cause sensory disturbances to great blue heron.
- Confidence: high – based on a good understanding by the assessment team of cause-effect relationships between the Project activities and great blue herons, and data relevant to the Marine RSA.

Events of Accidental Injury or Mortality

Great blue herons could potentially collide in flight, or be injured, by vessel or terminal infrastructure if they are perched and it is moving, or unstable, or in they are flying through bad weather; however, these events would be accidental and rare (Table 7.6.12-3, point 2[c]) for adults that have resided long-term in the area of Burrard Inlet. The incremental change in structure and equipment that will occur during and after the construction and expansion of the Westridge Marine Terminal expansion should not impose a safety threat since it is reasonable to assume that there is some familiarity with the existing opportunities to perch on similar structures at and around this site. Relatively long periods of sensory disturbances from noise levels during pile installation could potentially cause adult herons to abandon nests, if a nest was near enough to the terminal, and had not been observed by Inspectors (Volume 6D, Westridge Marine Terminal EPP). This would result in the subsequent mortality of eggs or hatchlings. However, the probability of this effect occurring is low considering the current established nest sites in Burrard Inlet, nest site fidelity, and the presence of Inspectors during construction. A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Marine Birds RSA – effects could extend to outside the direct area of disturbance from construction and operational facilities associated with the terminal expansion.
- Duration: long-term – the effect of bird injury or mortality from collisions with terminal infrastructure could occur during construction and throughout the operational phase for the operational life of the Westridge Marine Terminal. The effect of bird mortality from nest abandonment would be limited to the construction phase.
- Frequency: accidental – effects have the potential to occur rarely and accidentally for the operational life of the Westridge Marine Terminal.
- Reversibility: medium term – each event of mortality would be restored within one generation of breeding and maturity of an individual.

- Magnitude: low – effects from rare events will be detectable at the individual level but if mitigated are unlikely to be detectable at the population level.
- Probability: low – mortality is possible but will be rare and unlikely to occur as a result of the Project.
- Confidence: high – based on a good understanding by the assessment team of cause-effect relationships between the Project activities and great blue herons.

Combined Effects on Great Blue Heron

No great blue heron nests are currently active within or adjacent to the Westridge Marine Terminal and abundant shoreline is available within the Marine RSA for foraging and perching. A comprehensive environmental protection program has been developed to reduce or eliminate potential harm to marine life during construction of the terminal, to include noise baffles, bubble curtains and timing windows that consider sensitive wildlife periods (Westridge Marine Terminal EPP of Volume 6D). The likelihood of noise levels capable of causing disturbances will decrease with distance from the source (*e.g.,* during construction or in-water pile driving). Noise and activity are not expected be substantial to any extent beyond the Marine Bird LSA. To be exposed to sound levels capable of causing disturbance or harm, marine birds would need to be in close proximity to the site of the upland terminal and in-water pile-driving. At the time of this assessment, detailed engineering and parameters of noise and activity associated with pile-driving were not available. However, Trans Mountain will comply with mitigation measures set out in the Westridge Marine Terminal EPP (Volume 6D). A summary of the rationale for all of the significance criteria for combined effects on great blue heron is provided below (Table 7.6.12-3, point 2[d]).

- Spatial Boundary: Marine Birds RSA – combined effects from construction and operations could potentially occur within all spatial scales of the assessment area.
- Duration: long-term – the events causing combined effects on great blue heron may occur during construction and throughout the operations phase for the operational life of the Westridge Marine Terminal.
- Frequency: periodic – the events causing combined effects have the potential to occur intermittently but repeatedly for the operational life of the Westridge Marine Terminal.
- Reversibility: medium-term – potential combined effects of sensory disturbance, and habitat alteration or loss are expected to recover in less than 10 years.
- Magnitude: low – effects will be detectable at the individual level but are unlikely to be detectable at the population level.
- Probability: high – the combined effects on the great blue heron arising from the Project are likely to occur.
- Confidence: high – based on a good understanding by the assessment team of cause-effect relationships between the Project activities and great blue herons, and data relevant to the Marine RSA.

Marine Bird Indicator – Pelagic Cormorant

The following subsections provide the evaluation of significance of potential residual effects on the pelagic cormorant indicator.

Loss or Alteration of Foraging, Nesting and Roosting Habitat

Effects to pelagic cormorants are expected to be associated with the potential loss or alteration of nesting/roosting and foraging habitat in the Marine Birds LSA. Several breeding colonies are located within the Marine RSA on rocky islets and bridge structures (Moul and Gebauer 2002). Cormorants often roost in large trees and on boulder substrate in more natural shoreline habitats. There will be 2,685 m^2 (0.27 ha) of marine riparian habitat lost due to terminal construction, a marginal portion of which is suitable cormorant perching and preening habitat. Pelagic cormorants are opportunistic foragers using primarily the littoral-benthic zone and nearshore areas of the terminal (Ainley *et al.* 1981). Pelagic cormorants feed primarily on solitary prey in rocky reef substrates present at and around the existing terminal, and within smaller watercourses entering the inlet. This species, as an indicator, represents other larger piscivorous and typically sensitive marine birds that occur within the Marine RSA, such as western grebes, common loons and merganser species. The Marine Birds LSA has limited moderate to low value habitat for foraging and nesting due to existing structure, vessel activity and nearshore habitat disturbance; however, the Marine RSA does offer those opportunities. Therefore, the magnitude of effect from loss of nesting and foraging habitat in the Marine Bird LSA is low (Table 7.6.12-3, point 3[a]). The existing Westridge Marine Terminal pilings and berth that currently provide roosting habitat will be removed; however, the additional larger berths may provide enhanced nesting and roosting opportunities. The reversibility of habitat lost or disturbed is anticipated to be medium-term because altered habitats may recover or be enhanced to provide roosting and foraging during operations. A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Marine Birds LSA – effects are confined to the area of disturbance and construction associated with the terminal expansion and potentially includes marine protective structures within a portion of the Marine Birds LSA.
- Duration: short-term – the event will occur during the construction phase.
- Frequency: isolated – the event is confined to the construction phase of the Project.
- Reversibility: medium-term – habitat and habitat use is expected to recover in less than 10 years.
- Magnitude: low – effects will be detectable in the short-term but will begin to recover and potentially enhance post-construction.
- Probability: high – the Project is likely to alter habitat during construction.
- Confidence: high – based on a good understanding by the assessment team of cause-effect relationships between the Project activities and pelagic cormorants.

Sensory Disturbance Causing Stress, Behavioural Changes or Avoidance of Important Habitats

Increased in-air noise and activity at the terminal may result in the stress of individuals using preferred and/or important habitats near the terminal (the closest breeding colony is approximately 5 km from the terminal) or, alternatively, an alteration of normal movement patterns to avoid those preferred foreshore areas. The effects of underwater noise are difficult to assess without an established body of literature to inform thresholds for disturbance in birds. Substantial noise levels during pile-driving that may affect other marine animals, including fish and mammals, are expected to have some detectable behavioural effect on diving marine birds as well. Temporary sediment releases in marine waters surrounding the in-water construction sites could alter prey abundance or impede the bird’s ability to see and catch prey. Habituation to disturbance is known to occur in some marine bird species under some conditions. Constraints to obtaining life history requirements can adversely affect habitat effectiveness, individual fitness and population sustainability. With consideration for the context of existing volume of marine traffic and local industry, and the application of mitigation measures to prevent substantial noise disturbances to marine wildlife, the magnitude of the effect of disturbance is anticipated to be medium but long-term acting periodically over the life of terminal operations (Table 7.6.12-3, point 3[b]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Marine Birds RSA – effects may extend into the RSA and beyond the ZOI specific to the visual and noise disturbance threshold (approximately 200 m) of the pelagic cormorant.
- Duration: long-term – the events causing sensory disturbance will be initiated during construction and extend throughout operations for the operational life of the Westridge Marine Terminal.

- Frequency: periodic – the events causing sensory disturbance (*i.e.,* noise and activity during construction and operations) will occur intermittently but repeatedly for the operational life of the Westridge Marine Terminal.
- Reversibility: short-term – although pelagic cormorants may habituate to a particular level of noise and human activity from temporary construction and long-term operations of the terminal, recovery from the effects from disturbances may be interrupted by subsequent marine activities.
- Magnitude: medium – effects will be detectable at the individual level but with mitigation may not be detectable at the population level with consideration for the context of abundant industry in the Marine RSA.
- Probability: high – the Project is likely to pose sensory disturbances to pelagic cormorant.
- Confidence: moderate – based on a good understanding by the assessment team of cause-effect relationships between Project activities and marine birds; however, data is lacking for the Project area.

Events of Accidental Injury or Mortality

Many species of marine birds are documented as sensitive to night lighting at marine terminals and on ships and which have resulted in rare events of harmful or fatal collisions with vessel or terminal infrastructure (Black 2005, ConocoPhillips 2011). In the context of the existing industrially developed environment of the Marine Birds LSA, these events would be accidental and rare for adults that have resided long-term in the area of Burrard Inlet. Considering the degree of lighting that currently exists both at the existing terminal and within the Vancouver Port area at night, it would be difficult to isolate the incremental effects of additional lighting that will be in place for the terminal expansion and vessels positioned at berths. Relatively long periods of sensory and in-air noise disturbances during pile-driving could potentially cause stress, or foraging habitat avoidance, in adult cormorants leading to nest abandonment or poor provisioning and, consequently, the mortality of eggs or hatchlings. However, the probability of this effect occurring is low considering the current location of established nest sites in Burrard Inlet and the presence of Environmental Inspectors during construction (Table 7.6.12-3, point 3[c]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Marine RSA – effects could extend to outside the direct area of disturbance, construction and operational facilities associated with the terminal expansion.
- Duration: long-term – the events causing potential injury or mortality to pelagic cormorants may occur during construction and throughout the operations phase for the operational life of the Westridge Marine Terminal.
- Frequency: accidental – the events causing potential injury or mortality to pelagic cormorants will occur rarely and accidentally over the operational life of the Westridge Marine Terminal.
- Reversibility: medium-term – each event of mortality would be restored within one generation of breeding and maturity of an individual.
- Magnitude: low – effects from rare events will be detectable at the individual level but with mitigation are unlikely to be detectable at the population level.
- Probability: low – mortality is possible but would be rare and unlikely to occur as a result of the Project.
- Confidence: high – based on a good understanding by the assessment team of cause-effect relationships between the Project activities and pelagic cormorants.

Combined Effects on Pelagic Cormorant

No pelagic cormorant nests are currently active within or near to the Westridge Marine Terminal and abundant shoreline habitat is available within the Marine RSA for foraging and roosting. A comprehensive environmental protection program (Westridge Marine Terminal EPP of Volume 6D) has been developed to reduce or eliminate potential harm to marine life during construction of the Westridge Marine Terminal, to include noise baffles, bubble curtains and timing windows (September 1 to January 31), and consider sensitive breeding (February 1 to August 31) and bird migration periods. The likelihood of noise levels capable of disturbances will decrease with distance from the source, for example during construction within the terminal Footprint or during in-water pile driving. Noise and activity are not expected be substantial to any extent beyond the Marine Bird LSA. To be exposed to sound levels capable of causing disturbance or harm, marine birds would need to be in close proximity to the site of the upland terminal and in-water pile-driving. At the time of this assessment, detailed engineering and parameters of noise and activity associated with pile-driving were not available. However, Trans Mountain will comply with mitigation measures set out in the Westridge Marine Terminal EPP (Volume 6D). A summary of the rationale for all of the significance criteria for combined effects on pelagic cormorant is provided below (Table 7.6.12-3, point 3[d]).

- Spatial Boundary: Marine Birds RSA – combined effects from construction and operations could potentially occur within all spatial scales of the assessment area.
- Duration: long-term – the events causing combined effects on pelagic cormorant may occur during construction and throughout the operations phase for the operational life of the Westridge Marine Terminal.
- Frequency: periodic – the events causing combined effects have the potential to occur intermittently but regularly for the operational life of the Westridge Marine Terminal.
- Reversibility: medium-term – potential combined effects of sensory disturbance, and habitat alteration or loss are expected to recover in less than 10 years.
- Magnitude: low – effects will be detectable at the individual level but are unlikely to be detectable at the population level.
- Probability: high – combined effects on the pelagic cormorant arising from the Project are likely to occur.
- Confidence: high – based on a good understanding by the assessment team of cause-effect relationships between the Project activities and pelagic cormorants.

Marine Bird Indicator – Barrow’s Goldeneye

The following subsections provide the evaluation of significance of potential residual effects on the Barrow’s goldeneye indicator.

Loss or Alteration of Foraging, Nesting and Roosting Habitat

Effects to Barrow’s goldeneyes are expected to be associated with the potential loss or alteration of nearshore marine foraging habitat in the Marine Birds LSA. Barrow’s goldeneyes are closely tied to intertidal zones where they forage for invertebrate species (Eadie *et al.* 2000). They winter mostly in marine habitats including bays, inlets, harbours and rocky shores. Feeding in shallow water, they primarily consume mussels but also clams, crustaceans, and fish eggs. As such, they are indicators representing other resident and migrating marine birds that are benthic and invertebrate foragers within the Marine RSA, such as, surf scoters, common goldeneye and some waterfowl species. The Marine Birds LSA has limited foraging habitat for this species in nearshore waters at the terminal; however, the larger Marine RSA does provide more suitable foraging and loafing opportunities. The existing terminal pilings provide minimal foraging opportunities for invertebrate prey; however, it is anticipated that this will be enhanced by the additional in-water structures of new berths. Invertebrate populations have been shown to establish on artificial marine structures within 2 to 3 years which can be utilized at times by foraging birds. Therefore, the magnitude of effects of habitat loss is anticipated to be low and have medium-term reversibility with consideration for the potential re-establishment of invertebrate communities at the new terminal site (Table 7.6.12-3, point 4[a]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Marine Birds LSA – effects are confined to the area of disturbance and construction associated with the terminal expansion and potentially includes marine protective and berth infrastructures within a portion of the Marine Birds LSA.
- Duration: short-term – the event will occur during the construction phase.
- Frequency: isolated – the event is confined to the construction phase of the Project.
- Reversibility: medium-term – habitat and subsequent habitat use by Barrow's goldeneye is expected to recover in approximately 3 years years post-construction.
- Magnitude: low – effects will be detectable in the short-term but will begin to recover and potentially enhance post-construction.
- Probability: high – the Project is likely to alter habitat during construction.
- Confidence: high – based on a good understanding by the assessment team of cause-effect relationships between the Project activities and Barrow's goldeneyes, and data pertinent to the Marine RSA.

Sensory Disturbance Causing Stress, Behavioural Changes or Avoidance of Important Habitats

Increased in-air noise and activity at the Westridge Marine Terminal may result in the stress of individuals using preferred and/or seasonally important habitats near the terminal or, alternatively, an alteration of normal movement patterns to avoid those preferred but active intertidal zones. The effects of underwater noise are difficult to assess without an adequate body of literature to inform thresholds for disturbance in birds. Substantial noise levels during pile-driving that may affect other marine animals, including fish and mammals, are expected to have some detectable behavioural effect on diving marine birds as well. Temporary sediment releases in marine waters surrounding the in-water construction sites could alter prey abundance or impede the bird's ability to see and catch prey. Habituation is known to occur in some species in some conditions; however, this is difficult to assess. Goldeneyes use the inlet seasonally, flying inland to breed, and so have less time to become familiar with typical operational noises or other disturbance events. Constraints to obtaining life history requirements can adversely affect habitat effectiveness, individual fitness and population sustainability. With consideration for the context of the existing high-volume of marine traffic and local industry, and the application of mitigation measures to prevent substantial noise disturbances to marine wildlife, the magnitude of the effect of disturbance is anticipated to be medium but long-term acting periodically over the life of terminal operations (Table 7.6.12-3, point 4[b]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Marine Birds RSA – effects may extend into the RSA and beyond the ZOI specific to the visual and noise disturbance threshold (approximately 100 m) of the Barrow's goldeneye.
- Duration: long-term – the events causing sensory disturbance will be initiated during construction and extend throughout operations for the operational life of the Westridge Marine Terminal.
- Frequency: periodic – the events causing sensory disturbance (*i.e.,* noise and activity during construction and operations) will occur intermittently but repeatedly for the operational life of the Westridge Marine Terminal.
- Reversibility: short-term – although Barrow's goldeneye may habituate to a particular level of noise and human activity from temporary construction and long-term operations of the terminal, recovery from the effects of disturbance events may be interrupted by subsequent marine activities.
- Magnitude: medium – effects will be detectable at the individual level but with mitigation may not be detectable at the population level with consideration for the potential for familiarity with the context of abundant industrial development and activity in the Marine RSA.
- Probability: high – the Project is likely to cause sensory disturbances to Barrow's goldeneye.

- Confidence: high – based on a good understanding by the assessment team of cause-effect relationships between the Project activities and Barrow's goldeneyes.

Events of Accidental Injury or Mortality

Goldeneyes are associated with marine bird species that are documented as sensitive to night-lighting (Black 2005, Merkel and Johansen 2011) at marine terminals and on ships and which have resulted in rare events of harmful or fatal collisions with vessel or terminal infrastructure. In the context of the existing industrially developed environment of the Marine Birds LSA, these events would be accidental and rare (Table 7.6.12-3, point 4[c]) for adults that regularly use habitats to overwinter in the area of Burrard Inlet. Considering the degree of lighting that currently exists both at the existing terminal and within the Vancouver Port area at night, it would be difficult to isolate the incremental effects of additional lighting that will be in place for the terminal expansion and vessels positioned at berths. Relatively long periods of sensory disturbances during pile-driving or operations could potentially cause abandonment of important foraging opportunities during staging. Populations are considered stable in western Canada, although, there is potential for mortality of some young individuals who may not survive overwintering or predator disturbance events. Other local watercourses associated with the Burrard Inlet are rich in seasonal foraging habitats and exposure to potential harmful events at the terminal is anticipated to be of low probability for the operational life of the Westridge Marine Terminal (Table 7.6.12-3, point 4[c]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Marine Birds RSA – effects could extend to outside the direct area of disturbance, construction and operational facilities associated with the terminal expansion.
- Duration: long-term – the events causing potential injury or mortality to Barrow's goldeneyes may occur during construction and throughout the operations phase for the operational life of the Westridge Marine Terminal.
- Frequency: accidental – the events causing potential injury or mortality to Barrow's goldeneyes will occur rarely over the operational life of the Westridge Marine Terminal.
- Reversibility: medium-term – each event of mortality would be restored within one generation of breeding and maturity of an individual.
- Magnitude: low – effects will be detectable at the individual level but with mitigation are unlikely detectable at the population level.
- Probability: low – mortality is possible but will be rare and unlikely to occur as a result of the Project.
- Confidence: high – based on a good understanding by the assessment team of cause-effect relationships between the Project activities and Barrow's goldeneyes.

Combined Effects on Barrow's Goldeneye

Abundant nearshore and rocky shoreline areas are available within the Marine RSA for foraging and resting. A comprehensive environmental protection program (Westridge Marine Terminal EPP of Volume 6D) has been developed to reduce or eliminate potential harm to marine life during construction of the Westridge Marine Terminal, to include noise baffles, bubble curtains and timing windows with consideration for sensitive spring and fall migration periods. The likelihood of noise levels capable of disturbances will decrease with distance from the source, for example during construction within the terminal footprint or during in-water pile driving. Noise and activity are not expected be substantial to any extent beyond the Marine Bird LSA. To be exposed to sound levels capable of causing disturbance or harm, marine birds would need to be in close proximity to the site of the upland terminal and in-water pile-driving. At the time of this assessment, detailed engineering and parameters of noise and activity associated with pile-driving were not available. However, Trans Mountain will comply with mitigation measures set out in the Westridge Marine Terminal EPP (Volume 6D). A summary of the rationale for all of the significance criteria for combined effects on Barrow's goldeneye is provided below (Table 7.6.12-3, point 4[d]).

- Spatial Boundary: Marine Birds RSA – combined effects from construction and operations could potentially occur within all spatial scales of the assessment area.
- Duration: long-term – the events causing combined effects on pelagic cormorant may occur during construction and throughout the operations phase for the operational life of the Westridge Marine Terminal.
- Frequency: periodic – the events causing combined effects have the potential to occur intermittently but regularly for the operational life of the Westridge Marine Terminal.
- Reversibility: medium-term – potential combined effects of sensory disturbance, and habitat alteration or loss are expected to recover in less than 10 years.
- Magnitude: low – combined effects will be detectable at the individual level but are unlikely to be detectable at the population level.
- Probability: high – combined effects on the Barrow's goldeneye arising from the Project are likely to occur.
- Confidence: high – based on a good understanding by the assessment team of cause-effect relationships between the Project activities and Barrow's goldeneyes.

Marine Bird Indicator – Glaucous-winged Gull

The following subsections provide the evaluation of significance of potential residual effects on the glaucous-winged gull indicator.

Loss or Alteration of Foraging, Nesting and Roosting Habitat

Effects to glaucous-winged gulls are expected to be associated with the potential loss or alteration of nesting, roosting and foraging habitat in the Marine Birds LSA. Gulls fish and scavenge opportunistically and are abundant generalists in the natural and anthropogenic environments of the Maine RSA. They are indicators of a wide range of other marine birds that forage and nest within the Marine RSA due their versatile habitat use and strong-association with human-influenced environments, and as in other species, their sensitivity during the breeding cycle, particularly during egg-laying and incubation. As such they also overlap with representativeness provided by some other marine bird indicators, for example, locally breeding cormorants and herons, scavenging raptors and fish-eating seabird species. There are several breeding colonies within the Marine RSA, including one colony site within 1 km of the terminal on the south shore of Port Moody Arm, and abundant roosting areas throughout the Marine Birds LSA and Marine RSA (Suraci and Dill 2011). The population is healthy with many natural and anthropogenically altered sites available for foraging, roosting and breeding. The existing Westridge Marine Terminal pilings and berth that currently provide roosting habitat will be removed; however, the additional larger berths may provide enhanced nesting and roosting opportunities. Therefore, the magnitude habitat loss is anticipated to be low with a medium-term reversibility with consideration for the potential re-establishment of invertebrate communities at the new terminal site (Table 7.6.12-3, point 5[a]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Marine Birds LSA – effects are confined to the area of disturbance and construction associated with the Terminal expansion and potentially includes marine protective structures within a portion of the Marine Birds LSA.
- Duration: short-term – the event will occur during the construction phase.
- Frequency: isolated – the event is confined to the construction phase of the Project.
- Reversibility: medium-term – habitat and habitat use is expected to recover in less than 10 years.
- Magnitude: low – effects will be detectable in the short-term but will begin to recover and potentially be enhanced post-construction by new wharf infrastructure.

- Probability: high – the Project is likely to alter habitat during construction.
- Confidence: high – based on a good understanding by the assessment team of cause-effect relationships between the Project activities and marine birds and data pertinent to the Marine RSA.

Sensory Disturbance Causing Stress, Behavioural Changes or Avoidance of Important Habitats

Increased in-air noise and activity at the Westridge Marine Terminal may result in the disturbance of some individuals using preferred habitats or, an avoidance of preferred foreshore areas. Substantial noise levels during dredging and pile-driving are expected to have some detectable effect on individual gulls; however, some proportion of the population is assumed to be familiar with the noise and activity at abundant local industrial sites. Temporary sediment releases in marine waters surrounding the in-water construction sites could alter prey abundance or prey capture. The habituation of gulls to anthropogenic disturbances and urban environments is known to occur; however, constraints from obtaining life history requirements can result in adverse effects to habitat effectiveness, and individual fitness. With consideration for the context of existing marine traffic and local industry, the association of gulls with human developments, and the application of mitigation measures to prevent disturbance to sensitive nesting colonies, the magnitude of the effect of disturbance is anticipated to be low but long-term acting occasionally over the life of terminal operations (Table 7.6.12-3, point 5[b]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Marine RSA – effects will extend beyond the Footprint into a ZOI specific to the visual and noise disturbance threshold of the glaucous-winged gull.
- Duration: long-term – effects will be initiated during construction and extend throughout operations for the operational life of the Westridge Marine Terminal.
- Frequency: occasional – effect is expected to occur intermittently and sporadically for the operational life of the Westridge Marine Terminal with consideration for the known tendency of glaucous-winged gulls for habituation and adaptiveness to urban environments.
- Reversibility: short-term – although glaucous-winged gulls commonly habituate to a particular level of noise and human activity, recovery from substantial persistent disturbances during temporary construction and long-term operations of the terminal may be interrupted by subsequent marine activities.
- Magnitude: low – effects may be detectable at the individual level but are not likely to be detectable at the population level with consideration for likely habituation to the context of abundant industry in the Marine RSA.
- Probability: high – the Project is likely to cause sensory disturbances to glaucous-winged gulls.
- Confidence: high – based on a good understanding by the assessment team of cause-effect relationships between the Project activities and glaucous-winged gulls.

Events of Accidental Injury or Mortality

The risk of gull collisions with terminal infrastructure is very unlikely given the large local population, their affinity for human-influenced sites and marine structures, and their tendency to habituate to urban and industrial settings; however, this could potentially occur during events of high wind and inclement weather. In the context of the existing industrially developed Marine Bird LSA, these events would be considered accidental and rare for adults that regularly use the area of Burrard Inlet. Breeding colonies are highly sensitive, and relatively long periods of sensory disturbances (*i.e.,* during pile-driving could potentially cause adult gulls to abandon nests at the nearby colony during the breeding season). This would cause the subsequent mortality of exposed eggs or hatchlings. However, mitigation measures will be established to avoid such an event and reduce disturbance during this sensitive period. In addition an Environmental Inspector will be made aware of the location, timing and sensitivity of the breeding site prior to onset of construction activities. A summary of the rationale for all of the significance criteria is provided below (Table 7.6.12-3, point 5[c]).

- Spatial Boundary: Marine RSA – effects could extend to outside the direct area of disturbance, construction and operational facilities associated with the terminal expansion.
- Duration: long-term – the events causing potential injury or mortality to glaucous-winged gulls may occur during construction and throughout the operations phase for the operational life of the Westridge Marine Terminal.
- Frequency: accidental – the events causing potential injury or mortality to glaucous-winged gulls will occur rarely and accidentally over the operational life of the Westridge Marine Terminal.
- Reversibility: medium-term – each event of mortality would be restored within one generation of breeding and maturity of an individual.
- Magnitude: low – effects from rare events will be detectable at the individual level but with mitigation are unlikely to be detectable at the population level.
- Probability: low – mortality is possible but will be rare and unlikely to occur as a result of the Project.
- Confidence: high – based on a good understanding by the assessment team of cause-effect relationships between the Project activities and glaucous-winged gulls.

Combined Effects on Glaucous-winged Gulls

One breeding colony is active near the Westridge Marine Terminal. The sensitive breeding period is from early May (egg-laying) extending often into late August (fledging). A comprehensive environmental protection program (Westridge Marine Terminal EPP of Volume 6D) has been developed to reduce or eliminate potential harm to marine life during construction of the Westridge Marine Terminal, to include noise baffles, bubble curtains and timing windows that consider sensitive breeding periods (February 1 to August 31 during each of the projected 2 years of construction). The likelihood of noise levels capable of disturbances will decrease with distance from the source, for example during construction within the terminal Footprint or during in-water pile driving. Noise and activity are not expected be substantial to any extent beyond the Marine Birds LSA. To be exposed to sound levels capable of causing disturbance or harm, marine birds would need to be in close proximity to the site of the upland terminal and in-water pile-driving. At the time of this assessment, detailed engineering and parameters of noise and activity associated with pile-driving were not available. However, Trans Mountain will comply with mitigation measures set out in the Westridge Marine Terminal EPP (Volume 6D). A summary of the rationale for all of the significance criteria for combined effects on glaucous-winged gulls is provided below (Table 7.6.12-3, point 5[d]).

- Spatial Boundary: Marine RSA – combined effects from construction and operations could potentially occur within all spatial scales of the assessment area.
- Duration: long-term – the events causing combined effects on glaucous-winged gull may occur during construction and throughout the operations phase for the operational life of the Westridge Marine Terminal.
- Frequency: occasional – the events causing combined effects are expected to occur intermittently and sporadically for the operational life of the Westridge Marine Terminal with consideration for glaucous-winged gulls to habituate and adapt in urban environments.
- Reversibility: medium-term – potential combined effects of sensory disturbance, and habitat alteration or loss are expected to recover in less than 10 years.
- Magnitude: low – combined effects will be detectable at the individual level but are unlikely to be detectable at the population level.
- Probability: high – combined effects on the glaucous-winged gull arising from the Project are likely to occur.

- Confidence: high – based on a good understanding by the assessment team of cause-effect relationships between the Project activities and glaucous-winged gulls, and data relevant to the Marine RSA.

Marine Bird Indicator – Spotted Sandpiper

The following subsections provide the evaluation of significance of potential residual effects on the spotted sandpiper indicator.

Loss or Alteration of Foraging, Nesting and Roosting Habitat

Effects to the spotted sandpiper are expected to be associated with the potential loss or alteration of nesting and foraging habitat at the foreshore of the Marine Birds LSA. There will be 2,685 m^2 (0.27 ha) of marine riparian habitat lost due to terminal construction, a small portion of which is suitable sandpiper spotted sandpiper shoreline foraging and nesting habitat. Spotted sandpipers use a variety of aquatic habitats; nesting at shores, near streams and lakes, and require herbaceous vegetation at these sites as ground cover for their nests. During migration periods and in winter, they can be found at mudflats, beaches, breakwaters, and sewage ponds foraging exclusively on invertebrates. Spotted sandpipers are indicators of a diversity of small and large migratory sandpiper species, and resident passerines (such as song sparrows), which use the intertidal and foreshore areas seasonally to forage on insects and other invertebrates, and to nest in shoreline vegetation, nest boxes (such as purple martin) and debris. The Marine Birds LSA has limited foreshore value for foraging and nesting habitat for this species; however, the Marine RSA does contain abundant suitable habitat, especially at Maplewood Conservation Area. Therefore, the magnitude of effect from loss of nesting and foraging habitat in the Marine Bird LSA is low (Table 7.6.12-3, point 6[a]). The reversibility of habitat lost or disturbed is anticipated to be medium-term because altered habitats may recover during operations. A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Footprint – effects are confined to the area of disturbance and construction associated with the terminal expansion.
- Duration: short-term – the event causing habitat alteration or loss will occur during the construction phase.
- Frequency: isolated – the event causing habitat alteration or loss is confined to the construction phase of the Project.
- Reversibility: medium-term – habitat and habitat use is expected to recover in less than 10 years.
- Magnitude: low – effects will be detectable in the short-term but will begin to recover post-construction.
- Probability: high – the Project is likely to alter habitat during construction.
- Confidence: high – based on a good understanding by the assessment team of cause-effect relationships between the Project activities and spotted sandpiper, and data relevant to the Project area.

Sensory Disturbance Causing Stress, Behavioural Changes or Avoidance of Important Habitats

Increased in-air noise and activity at the Westridge Marine Terminal may result in the stress of groups or individuals using preferred and/or important habitats or, alternatively, an alteration of normal movement patterns through avoidance of those preferred foreshore and shoreline foraging areas. Substantial noise levels during dredging and pile-driving are expected to have some detectable effect on sandpipers. Like other sandpipers, they tend to flush easily during human disturbance events. Levels of habituation are not well known in this species; however, sandpipers are known to be reactive in a relatively short threshold distance during human disturbances. Constraints from obtaining life history requirements can result in adverse effects to habitat effectiveness, changes in critical energy budgets, reduced individual fitness, and the potential for minimal effects to local population sustainability. With consideration for the context of existing local industry, and the application of mitigation measures to prevent substantial noise disturbances to marine wildlife, the magnitude of the effect of disturbance is anticipated to be medium for the long-term acting periodically over the life of terminal operations (Table 7.6.12-3, point 6[b]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Marine RSA – effects will extend beyond the Footprint into a ZOI specific to the visual and noise disturbance threshold (approximately 50 m) of the sandpiper.
- Duration: long-term – the events causing sensory disturbance will be initiated during construction and extend throughout operations for the operational life of the Westridge Marine Terminal.
- Frequency: periodic – the events causing sensory disturbance (*i.e.,* noise and activity during construction and operations) will occur intermittently but repeatedly for the operational life of the Westridge Marine Terminal.
- Reversibility: short-term – although spotted sandpipers may habituate to a particular level of noise and human activity from temporary construction and long-term operations of the terminal, recovery from the effects from disturbances may be interrupted by subsequent marine activity.
- Magnitude: medium – effects will be detectable at the individual level but with mitigation may not be detectable at the population level with consideration for the potential for some level of habituation to the context of abundant industry in the Marine RSA.
- Probability: high – the Project is likely to create sensory disturbances to spotted sandpiper.
- Confidence: moderate – based on a good understanding by the assessment team of cause-effect relationships between Project activities and spotted sandpiper; however, data is lacking for the Project area.

Events of Accidental Injury or Mortality

Spotted sandpipers are among marine bird species that are documented as sensitive to night lighting at marine terminals and on ships and which have resulted in rare events of harmful or fatal collisions with vessel or terminal infrastructure. Sandpipers could potentially collide in flight, or be injured, by vessel or terminal infrastructure during migration or if they are flying through bad weather; however, these events would be accidental and rare (Table 7.6.12-3, point 6[c]). Considering the degree of lighting that currently exists both at the existing terminal and within the Vancouver Port area at night, it would be difficult to isolate the incremental effects of additional lighting that will be in place for the Terminal expansion and vessels positioned at berths. A small amount of breeding and foraging habitat is available near the terminal expansion site. Relatively long periods of sensory disturbances during pile-driving could potentially cause adult sandpipers to abandon nests located near the terminal, and not previously detected by Environmental Inspectors. This could result in subsequent mortality of exposed eggs or hatchlings. However, the probability of this effect occurring is low considering the minimal nesting habitat available now and in future, and the current level of noise and activity that currently takes place, which may deter sandpipers from using these lower suitability habitats near the terminal. A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Marine Birds RSA – effects could extend to outside the direct area of disturbance, construction and operational facilities associated with the Terminal expansion.
- Duration: long-term – the effect of bird injury or mortality from collisions with terminal infrastructure could occur during construction and throughout the operations phase for the operational life of the Westridge Marine Terminal. The effect of bird mortality from nest abandonment would be limited to the construction phase.
- Frequency: accidental – effects have the potential to occur rarely over the operational life of the Westridge Marine Terminal.
- Reversibility: medium-term – each event of mortality would be restored within one generation of breeding and maturity of an individual.

- Magnitude: low – effects from rare events will be detectable at the individual level but if mitigated are unlikely to be detectable at the population level.
- Probability: low – mortality is possible but will be rare and unlikely to occur as a result of the Project.
- Confidence: high – based on a good understanding by the assessment team of cause-effect relationships between the Project activities and marine birds.

Combined Effects on Spotted Sandpiper

No spotted sandpiper nests have been documented at the shoreline or within the terminal Footprint. Abundant shoreline is available within the Marine RSA for foraging and perching. A comprehensive environmental protection program (Westridge Marine Terminal EPP of Volume 6D) has been developed to reduce or eliminate potential harm to marine life during construction of the Westridge Marine Terminal, to include noise baffles, bubble curtains and timing windows that consider sensitive breeding (February 1 to August 31) and migration periods. The likelihood of noise levels capable of disturbances will decrease with distance from the source, for example during construction within the terminal footprint or during in-water pile driving. Noise and activity are not expected be substantial to any extent beyond the Marine Birds LSA. To be exposed to sound levels capable of causing disturbance or harm, marine birds would need to be in close proximity to the site of the upland terminal and in-water pile-driving. At the time of this assessment, detailed engineering and parameters of noise and activity associated with pile-driving were not available. However, Trans Mountain will comply with the mitigation measures set out in the Westridge Marine Terminal EPP (Volume 6D). A summary of the rationale for all of the significance criteria for combined effects on spotted sandpiper is provided below (Table 7.6.12-3, point 6[d]).

- Spatial Boundary: Marine Birds RSA – combined effects from construction and operations could potentially occur within all spatial scales of the assessment area.
- Duration: long-term – the events causing combined effects on spotted sandpiper may occur during construction and throughout the operations phase for the operational life of the Westridge Marine Terminal.
- Frequency: periodic – the events causing combined effects have the potential to occur intermittently but repeatedly for the operational life of the Westridge Marine Terminal.
- Reversibility: medium-term – potential combined effects of sensory disturbance, and habitat alteration or loss are expected to recover in less than 10 years.
- Magnitude: low – effects will be detectable at the individual level but are unlikely to be detectable at the population level.
- Probability: high – the combined effects on the spotted sandpiper arising from the Project are likely to occur.
- Confidence: high – based on a good understanding by the assessment team of cause-effect relationships between the Project activities and spotted sandpiper.

7.6.12.7 Summary

As identified in Table 7.6.12-3, there are no situations where there is a high probability of the occurrence of a permanent long-term residual effect on marine bird indicators of high magnitude from Project-related activities that cannot be technically mitigated. Consequently, it is concluded that the residual environmental effects of construction and operation activities at the Westridge Marine Terminal on marine bird indicators will be not significant.

7.6.13 Species at Risk

The construction and operations of Project activities at the Westridge Marine Terminal may affect wildlife, marine fish, marine mammals and marine bird species at risk. Section 7.2.11 provides a discussion of the wildlife species used as indicators for species at risk. Although not all species at risk are discussed explicitly under each indicator, potential Project effects were assessed in consideration of all species at risk. The indicators used to represent wildlife and wildlife habitat, marine fish and fish habitat, marine mammals and marine birds were carefully selected to ensure that the full range of potential Project effects on species at risk was addressed and mitigation measures to reduce these effects will apply to all species at risk, not just the indicators. Section 7.2.10 Wildlife and Wildlife Habitat, Section 7.6.9 Marine Fish and Fish Habitat, Section 7.6.11 Marine Mammals and Section 7.6.12 Marine Birds provide the significance rationale for applicable indicator species. No significant adverse effects on species at risk have been identified as a result of the pipeline and facilities component of the Project.

7.7 Effects Assessment – Pipeline Reactivation Activities

Using the assessment methodology described in Section 7.1, the following subsection evaluates the potential environmental effects associated with the reactivation of the existing pipeline segments from Hinton to Hargreaves and Darfield to Black Pines, as well as associated activities such as the installation of automated valves.

Environmental elements potentially interacting with the pipeline reactivation include:

- physical elements such as soil and soil productivity, water quality and quantity, air emissions, GHG emissions and acoustic environment; and
- biological elements such as fish and fish habitat, vegetation, wildlife and wildlife habitat, and species at risk.

Environmental elements which are not considered to interact with the reactivation of the Hinton to Hargreaves or the Darfield to Black Pines segments are summarized in Table 7.7-1. Spatial boundaries for the assessment of the reactivation of the existing pipeline segments are the same as in the applicable subsection of Section 7.2 unless otherwise noted.

TABLE 7.7-1

ELEMENTS NOT INTERACTING WITH PIPELINE REACTIVATION AND ASSOCIATED ACTIVITIES

Element	Justification
Physical and Meteorological Environment	There are no potential effects associated with physical environment indicators anticipated to result from pipeline reactivation activities.
Wetland Loss or Alteration	Wetlands are not expected to be disturbed along any of the reactivated pipeline segments.
Wildlife and Wildlife Habitat	The pipeline reactivation activities are not expected to have a measurable impact on wildlife and wildlife habitat. Habitat disturbance will be limited to a similar level of sensory disturbance as would occur during pipeline maintenance activities. Any potential effects will be short-term and of low magnitude.

7.7.1 Soil and Soil Productivity

Sections 7.2.2.1, 7.2.2.2 and 7.2.2.3 provides the assessment indicators, measurement endpoints, spatial boundaries and ecological assessment for the assessment of potential effects of Project activities at pump station facilities on soil and soil productivity.

7.7.1.1 Potential Effects and Mitigation Measures

<u>Identified Potential Effects</u>

Potential effects associated with pipeline reactivation activities on soil and soil productivity indicators are listed in Table 7.7.1-1. These interactions were based on the results of the literature review, desktop analysis and the professional experience of the assessment team.

A summary of mitigation measures provided in Table 7.7.1-1 was principally developed in accordance with Trans Mountain standards as well as industry and provincial regulatory guidelines as described in Section 7.2.2.4. Pipeline reactivation activities in Jasper National Park along the Hinton to Hargreaves Segment will follow the Jasper National Park Operations and Maintenance Environmental Protection Plan (TERA 2009).

TABLE 7.7.1-1

POTENTIAL EFFECTS, MITIGATION MEASURES AND RESIDUAL EFFECTS OF PIPELINE REACTIVATION AND ASSOCIATED ACTIVITIES ON SOIL AND SOIL PRODUCTIVITY

Potential Effect	Pipeline Reactivation Segment(s)	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
1. Soil Indicator – Soil Productivity				
1.1 Decreased topsoil/root zone material productivity during topsoil/root zone material salvaging	All	Footprint	• See recommended mitigation measures outlined in Table 7.2.2-2 Soil and Soil Productivity.	• Mixing of topsoil/root zone material and subsoil.
1.2 Decreased soil productivity from flooding of soil as a result of release of hydrostatic test water on land	All	LSA	• See recommended mitigation measures outlined in Table 7.2.2-2 Soil and Soil Productivity.	• No residual effect identified.
1.3 Decreased soil productivity from soil diseases (*i.e.,* clubroot disease and potato cyst nematode)	All	LSA	• See recommended mitigation measures outlined in Table 7.2.2-2 Soil and Soil Productivity.	• Clubroot disease introduction and spread. Potato cyst nematode introduction and spread.
2. Soil Indicator – Soil Degradation				
2.1 Degradation of soil structure due to compaction and rutting	All	Footprint	• See recommended mitigation measures outlined in Table 7.2.2-2 Soil and Soil Productivity.	• Degradation of soil structure and impairment of rooting zone due to compaction and rutting.
2.2 Loss of topsoil/root zone material through wind and water erosion.	All	Footprint	• See recommended mitigation measures outlined in Table 7.2.2-2 Soil and Soil Productivity.	• Surface erosion of topsoil/root zone material can be expected until a vegetative cover is established.
2.3 Degradation of soil structure due to pulverization of soil and sod	All	Footprint	• See recommended mitigation measures outlined in Table 7.2.2-2 Soil and Soil Productivity.	• Pulverization resulting in fugitive dust and loss of soil structure can be expected during dry conditions.
2.4 Erosion of soil as a result of release of hydrostatic test water on land	All	LSA	• See recommended mitigation measures outlined in Table 7.2.2-2 Soil and Soil Productivity.	• No residual effect identified.
3. Soil Indicator – Soil Contamination				
3.1 Disturbance of previously contaminated soil	All	Footprint	• See recommended mitigation measures outlined in Table 7.2.2-2 Soil and Soil Productivity.	• No residual effect identified.
3.2 Contamination of soil as a result of release of hydrostatic test water on land	All	LSA	• See recommended mitigation measures outlined in Table 7.2.2-2 Soil and Soil Productivity.	• No residual effect identified.
3.3 Soil contamination due to spot spills during construction	All	Footprint	• See recommended mitigation measures outlined in Table 7.2.2-2 Soil and Soil Productivity.	• No residual effect identified.

Notes: 1 LSA = Soil LSA.
2 Detailed mitigation measures are outlined in the Pipeline EPP (Volume 6B).

7.7.1.2 Potential Residual Effects

The potential residual environmental effects of pipeline reactivation and associated activities on soil and soil productivity indicators (Table 7.7.1-1) are:

- mixing of topsoil/root zone material and subsoil;
- clubroot disease and potato cyst nematode introduction and spread;
- degradation of soil structure and impairment of rooting zone due to compaction and rutting;
- surface erosion of topsoil/root zone material can be expected until a vegetative cover is established; and

- pulverization resulting in fugitive dust and loss of soil structure can be expected during dry conditions.

Some of the potential effects on element indicators associated with pipeline reactivation and associated activities are predicted to be eliminated through the implementation of mitigation measures (Table 7.7.1-1). The potential effects determined not to have a residual effect are:

- decreased soil productivity from flooding of soil as a result of release of hydrostatic test water on land;
- erosion of soil as a result of release of hydrostatic test water on land;
- disturbance of previously contaminated soil;
- contamination of soil as a result of hydrostatic test water on land; and
- soil contamination due to spot spills during construction.

7.7.1.3 Significance Evaluation of Potential Residual Effects

Table 7.7.1-2 provides a summary of the significance evaluation of the potential residual environmental effects on soil and soil productivity indicators associated with pipeline reactivation and associated activities.

TABLE 7.7.1-2

SIGNIFICANCE EVALUATION OF POTENTIAL RESIDUAL EFFECTS OF PIPELINE REACTIVATION AND ASSOCIATED ACTIVITIES ON SOIL AND SOIL PRODUCTIVITY

Potential Residual Effects		Impact Balance	Spatial Boundary[1]	Temporal Context			Magnitude	Probability	Confidence	Significance[2]
				Duration	Frequency	Reversibility				
1.	Soil Indicator – Soil Productivity									
1(a)	Mixing of topsoil/root zone material and subsoil.	Negative	Footprint	Short-term	Periodic	Medium-term	Low	High	High	Not significant
1(b)	Clubroot disease and potato cyst nematode introduction and spread.	Negative	LSA	Short-term	Accidental	Long-term	High	Low	Moderate	Not significant
2.	Soil Indicator – Soil Degradation									
2(a)	Degradation of soil structure and impairment of rooting zone due to compaction and rutting.	Negative	Footprint	Short-term	Periodic	Short to medium-term	Low	High	High	Not significant
2(b)	Surface erosion of topsoil/root zone material can be expected until a vegetative cover is established.	Negative	Footprint	Short-term	Periodic	Medium-term	Low	High	High	Not significant
2(c)	Pulverization resulting in fugitive dust and loss of soil structure can be expected during dry conditions.	Negative	Footprint	Short-term	Isolated	Short to medium-term	Low	Low to high	High	Not significant
2(d)	Combined effects on the soil degradation indicator (2[a] to 2[c]).	Negative	Footprint	Short-term	Periodic	Short to medium-term	Low	High	High	Not significant

Notes: 1 LSA = Soil LSA.

2 Significant Residual Environmental Effect: A high probability of occurrence of a permanent or long-term residual effect of high magnitude that cannot be technically or economically mitigated.

The significance evaluation of the potential residual effects on the soil productivity indicator and soil degradation indicator was determined to be the same for pipeline reactivation and associated activities as for pipeline construction and operations (Table 7.7.1-2, points 1[a], 1[b] and 2[a] to 2[d]). The exception is the frequency of the event (*i.e.*, hydrostatic testing) which is limited to a specific phase of the assessment.

Table 7.2.2-3 and the accompanying discussion in Section 7.2.2.6 provide an evaluation of potential residual effects of reactivation activities and their significance on the applicable soil and soil productivity indicator.

7.7.1.4 Summary

As identified in Table 7.7.1-2, there are no situations where there is a high probability of occurrence of a permanent or long-term residual environmental effect on soil and soil productivity indicators of high magnitude that cannot be technically or economically mitigated. Consequently, it is concluded that the residual environmental effects associated with pipeline reactivation and associated activities on soil and soil productivity will be not significant.

7.7.2 Water Quality and Quantity

Sections 7.2.3.1 and 7.2.3.2 provide the assessment indicators, measurement endpoints and spatial boundaries for the assessment of potential effects of pipeline reactivation and associated activities on water quality and quantity.

7.7.2.1 Water Quality and Quantity Context

The Hinton to Hargreaves reactivated pipeline segment is located within the Athabasca River Basin in Alberta and the Fraser River Basin in BC. The Darfield to Black Pines reactivated pipeline segment is located within the Lower North Thompson River Watershed of the Fraser River Basin.

Reactivation of the Hinton to Hargreaves and Darfield to Black Pines pipeline segments will require hydrostatic testing. Source test water for the Hinton to Hargreaves Segment is likely to be withdrawn from the Athabasca, Snaring, Miette and Fraser rivers, as well as Moose Lake. Source test water for the Darfield to Black Pines Segment is likely to be drawn from the North Thompson River.

Section 5.13 provides additional setting information related to water quality and quantity along the reactivated pipeline segments.

7.7.2.2 Potential Effects and Mitigation Measures

Identified Potential effects

Potential effects associated with pipeline reactivation activities on the water quality and quantity indicators listed in Table 7.7.2-1 were based on the results of the literature review, desktop analysis and the professional experience of the assessment team.

A summary of mitigation measures provided in Table 7.7.2-1 was principally developed in accordance with Trans Mountain standards and industry and provincial regulatory guidelines as described in Section 7.2.3.4. Pipeline reactivation activities in Jasper National Park along the Hinton to Hargreaves Segment will follow the Jasper National Park Operations and Maintenance Environmental Protection Plan (TERA 2009).

TABLE 7.7.2-1

POTENTIAL EFFECTS, MITIGATION MEASURES AND RESIDUAL EFFECTS OF PIPELINE REACTIVATION AND ASSOCIATED ACTIVITIES ON WATER QUALITY AND QUANTITY

Potential Effect	Pipeline Reactivation Segment(s)	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
1. Water Quality and Quantity Indicator – Surface Water Quality				
1.1 Alteration or contamination of aquatic environment as a result of withdrawal and release of hydrostatic test water	Hinton to Hargreaves Athabasca River Snaring River Miette River Fraser River Moose Lake Darfield to Black Pines North Thompson River	LSA	• Assess reactivated segments using in-line inspection tools. Specific locations along the pipeline will be physically inspected and repaired, if required, as determined necessary to ensure structural integrity. Following inspection, in-line cleaning tools will be used to scrub the pipe walls and remove residual hydrocarbon products and debris. • See recommended mitigation measures outlined in Table 7.2.3-2 Water Quality and Quantity.	• Alteration or contamination of aquatic environment as a result of withdrawal and release of hydrostatic test water.
1.2 Reduction of surface water quality from small spill during reactivation activities	Hinton to Hargreaves Darfield to Black Pines	LSA	• See recommended mitigation measures outlined in Table 7.2.3-2 Water Quality and Quantity.	• Contamination of surface water due to a small spill during construction at valve sites.
2. Water Quality and Quantity Indicator – Surface Water Quantity				
2.1 Localized alteration of natural surface drainage patterns during reactivation activities	Hinton to Hargreaves Darfield to Black Pines	LSA	• See recommended mitigation measures outlined in Table 7.2.3-2 Water Quality and Quantity.	• Localized alteration of natural surface drainage patterns at valve sites.
2.2 Alteration of streamflow volumes as a result of withdrawal and release of hydrostatic test water	Hinton to Hargreaves Athabasca River Snaring River Miette River Fraser River Moose Lake Darfield to Black Pines North Thompson River	LSA	• See recommended mitigation measures outlined in Table 7.2.3-2 Water Quality and Quantity.	• No residual effect identified.

Notes: 1 LSA = Water Quality and Quantity LSA.
2 Detailed mitigation measures are outlined in the Pipeline EPP (Volume 6B).

7.7.2.3 Potential Residual Effects

The potential residual environmental effects of pipeline reactivation and associated activities on water quality and quantity indicators (Table 7.7.2-1) are:

- alteration or contamination of aquatic environment as a result of withdrawal and release of hydrostatic test water;
- contamination of surface water due to a small spill during construction at valve sites; and
- localized alteration of natural surface drainage patterns at valve sites.

Alteration of streamflow volumes is concluded to not be a residual effect associated with reactivation activities following implementation of mitigation measures (Table 7.7.2-1).

7.7.2.4 Significance Evaluation of Potential Residual Effects

Table 7.7.2-2 provides a summary of the significance evaluation of the potential residual environmental effects of the reactivation activities on water quality and quantity.

TABLE 7.7.2-2

SIGNIFICANCE EVALUATION OF POTENTIAL RESIDUAL EFFECTS OF PIPELINE REACTIVATION AND ASSOCIATED ACTIVITIES ON WATER QUALITY AND QUANTITY

	Potential Residual Effects	Impact Balance	Spatial Boundary[1]	Temporal Context			Magnitude	Probability	Confidence	Significance[2]
				Duration	Frequency	Reversibility				
1.	Water Quality and Quantity Indicator – Surface Water Quality									
1(a)	Alteration or contamination of aquatic environment as a result of withdrawal and release of hydrostatic test water.	Negative	LSA	Short-term	Isolated	Immediate to short-term	Low	Low	High	Not significant
1(b)	Contamination of surface water due to a small spill during construction at valve sites.	Negative	LSA	Immediate	Accidental	Short to medium-term	Low to high	Low	Moderate	Not significant
2.	Water Quality and Quantity Indicator – Surface Water Quantity									
2(a)	Localized alteration of natural surface drainage patterns at valve sites.	Negative	LSA	Short-term	Isolated	Short to medium-term	Low to medium	High	High	Not significant

Notes: 1 LSA = Water Quality and Quantity LSA.

2 Significant Residual Environmental Effect: A high probability of occurrence of a permanent or long-term residual effect of high magnitude that cannot be technically or economically mitigated.

The significance evaluation of the potential residual effects for the surface water quality and surface water quantity indicators was determined to be the same as for the construction and operations of the pipeline. Table 7.2.3-3 and the accompanying discussion in Section 7.2.3.6 provide an evaluation of these potential residual effects of reactivation activities and their significance on the applicable water quality and quantity indicator.

7.7.2.5 Summary

As identified in Table 7.7.2-2, there are no situations where there is a high probability of occurrence of a permanent or long-term residual environmental effect on the water quality and quantity indicators of high magnitude that cannot be technically or economically mitigated. Consequently, it is concluded that the residual environmental effects associated with pipeline reactivation and associated activities on water quality and quantity will be not significant.

7.7.3 Air Emissions

Sections 7.2.4.1 and 7.2.4.2 provide the assessment indicators, measurement endpoints and spatial boundaries for the assessment of potential effects of pipeline reactivation and associated activities on air emissions.

Air emissions associated with pipeline reactivation activities (*e.g.*, hydrostatic testing, use of equipment) is anticipated to be minor in comparison to the construction of other Project components and pipeline operations of the reactivated segments are expected to be negligible.

7.7.3.1 Potential Effects and Mitigation Measures

Identified Potential Effects

The potential effects on the air emissions indicators associated with pipeline reactivation activities and listed in Table 7.7.4-1 were based on the results of the desktop analysis and the professional experience of the assessment team.

A summary of the mitigation measures provided in Table 7.7.4-1 was principally developed in accordance with Trans Mountain standards and accepted pipeline construction methods for construction-related activities.

TABLE 7.7.4-1

POTENTIAL EFFECTS, MITIGATION MEASURES AND RESIDUAL EFFECTS OF PIPELINE REACTIVATION AND ASSOCIATED ACTIVITIES ON AIR EMISSIONS

Potential Effect	Pipeline Reactivated Segments	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
1. Air Emissions Indicator – Primary Emissions of Criteria Air Contaminants and Volatile Organic Compounds				
1.1 Project contribution to emissions	All	RSA	• See recommended mitigation measures outlined in Table 7.2.4-3, Air Emissions.	• Increase in air emissions during pipeline reactivation activities.

Notes: 1 RSA = Air Quality RSA.
2 Detailed mitigation measures are outlined in the Pipeline EPP (Volume 6B).

7.7.3.2 Potential Residual Effects

The potential residual environmental effects on the air emissions indicator associated with pipeline reactivation and associated activities (Table 7.7.4-1) is an increase in air emissions during pipeline reactivation activities.

7.7.3.3 Significance Evaluation of Potential Residual Effects

Table 7.7.4-2 provides a summary of the significance evaluation of the potential residual environmental effects of pipeline reactivation and associated activities on air emissions.

TABLE 7.7.4-2

SIGNIFICANCE EVALUATION OF POTENTIAL RESIDUAL EFFECTS OF PIPELINE REACTIVATION AND ASSOCIATED ACTIVITIES ON AIR EMISSIONS

Potential Residual Effects	Impact Balance	Spatial Boundary[1]	Temporal Context			Magnitude	Probability	Confidence	Significance[2]
			Duration	Frequency	Reversibility				
1. Air Emissions Indicator – Primary Emissions of Criteria Air Contaminants and Volatile Organic Compounds									
1(a) Increase in air emissions during pipeline reactivation activities.	Negative	RSA	Short-term	Isolated	Short-term	Low	High	Moderate	Not significant

Notes: 1 RSA = Air Quality RSA.
2 Significant Residual Environmental Effect: A high probability of occurrence of a permanent or long-term residual effect of high magnitude that cannot be technically or economically mitigated.

The significance evaluation of the potential residual effects on the primary emissions of CACs and VOCs indicator (Table 7.7.4-2, point 1[a]) was determined to be the same for the pipeline reactivation activities as for pipeline construction and operations. The exceptions are the frequency which is limited to the construction phase (isolated) and the magnitude which is low given the extent of activities associated with reactivation. Table 7.2.4-4 and the accompanying discussion in Section 7.2.4.6 provide an evaluation of the potential residual effects of pipeline reactivation and associated activities and their significance on the primary emissions of CACs and VOCs indicator.

7.7.3.4 Summary

As identified in Table 7.7.4-2, there are no situations where there is a high probability of occurrence of a permanent or long-term residual environmental effect on the air emissions indicator of high magnitude that cannot be technically or economically mitigated. Consequently, it is concluded that the residual environmental effects of pipeline reactivation and associated activities on air emissions will be not significant.

7.7.4 Greenhouse Gas Emissions

As discussed in Section 7.2.5.3, during operation of the reactivated pipeline segments, the main sources of GHG emissions will be regular transportation and equipment use during maintenance activities. Pipeline reactivation related GHG emissions are summarized in Table 7.2.5-6.

The assessment of effects on GHG emissions has been conducted considering all the Project components in an integrated manner (*e.g.,* pipeline, temporary facilities, pump stations [including power lines], tanks, Westridge Marine Terminal and pipeline reactivation), since GHG emissions associated with the construction and operation of each Project component are aggregated for the Project as a whole and then compared to provincial and federal GHG inventory totals.

The assessment of effects on GHG emissions for the Project as a whole is presented in Section 7.2.5. Table 7.2.5-8 and accompanying discussion in Section 7.2.5.3 provide an evaluation of potential residual effects of pipeline reactivation and associated activities on GHG indicators.

7.7.5 Acoustic Environment

Sections 7.2.6.1, 7.2.6.2 and 7.4.6 provide the assessment indicators, measurement endpoints, spatial boundaries and acoustic environment context for the assessment of potential effects of pipeline reactivation and associated activities on the acoustic environment.

7.7.5.1 Potential Effects and Mitigation Measures

Potential effects associated with pipeline reactivation activities on the acoustic environment indicators listed in Table 7.7.5-1 were based on the results of the desktop analysis and the professional experience of the assessment team.

A summary of mitigation measures provided in Table 7.7.5-1 was principally developed in accordance with Trans Mountain standards and industry and provincial regulatory guidelines as described in Section 7.2.6.4.

TABLE 7.7.5-1

POTENTIAL EFFECTS, MITIGATION MEASURES AND RESIDUAL EFFECTS OF PIPELINE REACTIVATION AND ASSOCIATED ACTIVITIES ON THE ACOUSTIC ENVIRONMENT

Potential Effect	Pipeline Reactivated Segment(s)	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
1. Acoustic Environment Indicator – Sound Levels				
1.1 Changes in sound levels during reactivation activities	All	LSA	• See recommended mitigation measures in Table 7.2.6-2 Acoustic Environment.	• Increase in sound levels during pipeline reactivation activities.
1.2 Changes in sound levels during operation	All	LSA	• See recommended mitigation measures in Table 7.2.6-2 Acoustic Environment.	• Periodic noise events due to maintenance and inspections.

Notes: 1 LSA = Acoustic Environment LSA.
2 Detailed mitigation measures are outlined in the Pipeline EPP (Volume 6B).

7.7.5.2 Residual Effects

The potential residual environmental effects of pipeline reactivation and associated activities on acoustic environment indicators (Table 7.7.5-1) are:

- increase in sound levels during pipeline reactivation activities; and
- noise events due to maintenance and inspections.

7.7.5.3 Significance of Residual Effects

Table 7.7.5-2 provides a summary of the significance evaluation of the potential residual environmental effects of the reactivation activities on the acoustic environment.

TABLE 7.7.5-2

SIGNIFICANCE EVALUATION OF POTENTIAL RESIDUAL EFFECTS OF PIPELINE REACTIVATION AND ASSOCIATED ACTIVITIES ON THE ACOUSTIC ENVIRONMENT

Potential Residual Effects	Impact Balance	Spatial Boundary[1]	Temporal Context			Magnitude	Probability	Confidence	Significance[2]
			Duration	Frequency	Reversibility				
1. Acoustic Environment – Sound Levels									
1(a) Increase in sound levels during pipeline reactivation activities.	Negative	LSA	Short-term	Isolated	Short-term	Low to medium	High	Moderate	Not significant
1(b) Periodic noise events due to maintenance and inspections.	Negative	LSA	Short-term	Periodic	Immediate to short-term	Negligible to medium	High	Moderate	Not significant
1(c) Combined effects on the sound levels indicator (1[a]) and 1[b]).	Negative	LSA	Short-term	Isolated	Short-term	Low to medium	High	Moderate	Not significant

Notes: 1 LSA = Acoustic Environment LSA.

2 Significant Residual Environmental Effect: A high probability of occurrence of a permanent or long-term residual effect of high magnitude that cannot be technically or economically mitigated.

The significance evaluation of the potential residual effects on the sound levels indicator was determined to be the same for pipeline reactivation and associated activities as for pipeline construction and operations (Table 7.7.5-2, points 1[a] to 1[c]). Table 7.2.6-3 and the accompanying discussion in Section 7.2.6.6 provide an evaluation of potential residual effects of reactivation activities and their significance on the applicable sound levels indicator.

7.7.5.4 Summary

As identified in Table 7.7.5-2, there are no situations where there is a high probability of occurrence of a permanent or long-term residual environmental effect on acoustic environment indicators of high magnitude. Consequently, is it concluded that the residual environmental effects associated with pipeline reactivation and associated activities on the acoustic environment will be not significant.

7.7.6 Fish and Fish Habitat

Reactivation of the Hinton to Hargreaves and Darfield to Black Pines pipeline segments will require hydrostatic testing. Source test water for the Hinton to Hargreaves Segment is likely to be drawn from the Athabasca, Snaring, Miette and Fraser rivers, as well as Moose Lake. Source test water for the Darfield to Black Pines Segment is likely to be drawn from the North Thompson River.

The Hinton to Hargreaves Segment is located within the Athabasca River Basin, and all six Alberta indicator species are known to occur within this basin. The Darfield to Black Pines Segment is located within the Lower North Thompson River Watershed, which is known to contain four of the BC indicator species (*i.e.,* bull trout/Dolly Varden, Chinook salmon, coho salmon and rainbow trout/steelhead). Hydrostatic testing will cause an interaction with fish and fish habitat indicators (riparian habitat, instream habitat and the indicator species found in the watershed from which test water is withdrawn).

The assessment of effects on fish and fish habitat has been conducted considering all the Project components in an integrated manner (*e.g.,* pipeline, temporary facilities, pump stations [including power lines], tanks and pipeline reactivation), since the components will have similar effect pathways (*i.e.,* riparian habitat, instream habitat and fish mortality and injury) on fish indicators and disaggregation of effects by Project component is not meaningful at an individual or population level for fish indicators.

The assessment of effects on fish and fish habitat for the Project as a whole is presented in Section 7.2.7. Table 7.2.7-3 and accompanying discussion in Section 7.2.7.6 provide an evaluation of potential residual effects of pipeline reactivation activities on fish indicators. Pipeline reactivation activities in Jasper National Park along the Hinton to Hargreaves Segment will follow the Jasper National Park Operations and Maintenance Environmental Protection Plan (TERA 2009).

7.7.7 Vegetation

Sections 7.2.9.1 and 7.2.9.2 provides the assessment indicators, measurement endpoints and spatial boundaries for the assessment of potential effects of pipeline reactivation activities on vegetation.

7.7.7.1 Ecological Context

Activities that may require clearing of land have the potential to affect vegetation. The pipeline reactivation includes MLBV locations that may require clearing of previously disturbed land. MLBV locations on the Hinton to Hargreaves Segment may be on the reclaimed TMX Anchor Loop right-of-way which was reclaimed and seeded with a native seed mix more than 5 years ago. The MLBV locations on the Darfield to Black Pines Segment may be on a right-of-way reclaimed decades earlier. Therefore, native vegetation is likely to have revegetated the right-of-way and may provide potential habitat for rare plant and lichen species. The introduction and spread of weeds has the potential to occur during any anthropogenic disturbance and, therefore, must be considered with the reactivated segments.

Section 7.2.9.3 provides further details on ecological context.

7.7.7.2 Potential Effects and Mitigation Measures

Identified Potential Effects

Potential effects associated with the reactivation of pipeline segments on vegetation are listed in Table 7.7.7-1. These interactions are based on the results of the literature review and desktop analysis as well as the professional experience of the assessment team.

A summary of mitigation measures provided in Table 7.7.7-1 was principally developed in accordance with Trans Mountain standards as well as industry and provincial regulatory guidelines as described in Section 7.2.9.4. Pipeline reactivation activities in Jasper National Park along the Hinton to Hargreaves Segment will follow the Jasper National Park Operations and Maintenance Environmental Protection Plan (TERA 2009).

TABLE 7.7.7-1

POTENTIAL EFFECTS, MITIGATION MEASURES AND RESIDUAL EFFECTS OF PIPELINE REACTIVATION AND ASSOCIATED ACTIVITIES ON VEGETATION

Potential Effect	Pipeline Reactivation Segment(s)	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
1. Vegetation Indicator – Vegetation Communities of Concern				
1.1 Alteration of native vegetation	All	Footprint	• See recommended mitigation measures outlined in Table 7.2.9-3 Vegetation.	• Incremental alteration of the composition of native vegetation.

TABLE 7.7.7-1 Cont'd

Potential Effect	Pipeline Reactivation Segment(s)	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
2. Vegetation Indicator – Plant and Lichen Species of Concern				
2.1 Loss or alteration of rare plant and lichen occurrences	All	LSA	• See recommended mitigation measures outlined in Table 7.2.9-3 Vegetation.	• Some disturbance or alteration of a rare plant or lichen occurrence, if avoidance is not practical and mitigation measures do not completely protect a site. • If rare plant or lichen sub-populations are located near the MLBV installation/automation location they may be affected by changes in hydrology or light levels.
3. Vegetation Indicator – Presence of Infestations of Provincial Weed Species and Other Invasive Non-native Species Identified as a Concern				
3.1 Weed introduction and spread	All	RSA	• See recommended mitigation measures outlined in Table 7.2.9-3 Vegetation.	• Weed introduction and spread.

Notes: 1 LSA = Vegetation LSA; RSA = Vegetation RSA.
2 Detailed mitigation measures are outlined in the Pipeline EPP (Volume 6B).

7.7.7.3 Potential Residual Effects

The potential residual environmental effects on vegetation indicators as a result of pipeline reactivation activities (Table 7.7.7-1) are:

- incremental alteration of the composition of native vegetation;
- some disturbance or alteration of a rare plant or lichen occurrence, if avoidance is not practical and mitigation measures do not completely protect a site;
- if rare plant and lichen sub-populations are located near a MLBV location they may be affected by changes in hydrology or light levels; and
- weed introduction and spread.

7.7.7.4 Significance Evaluation of Potential Residual Effects

Table 7.7.7-2 provides a summary of the significance evaluation of the potential residual environmental effects of pipeline reactivation activities on vegetation. The rationale used to evaluate the significance of each of the residual environmental effects is provided below.

TABLE 7.7.7-2

SIGNIFICANCE EVALUATION OF POTENTIAL RESIDUAL EFFECTS OF PIPELINE REACTIVATION AND ASSOCIATED ACTIVITIES ON VEGETATION

Potential Residual Effects	Impact Balance	Spatial Boundary[1]	Temporal Context			Magnitude	Probability	Confidence	Significance[2]
			Duration	Frequency	Reversibility				
1. Vegetation Indicator – Vegetation Communities of Concern									
1(a) Incremental alteration of the composition of native vegetation.	Negative	Footprint	Short-term	Isolated	Short to medium-term	Low	High	High	Not significant
2. Vegetation Indicator – Plant and Lichen Species of Concern									
2(a) Some disturbance or alteration of a rare plant or lichen occurrence, if avoidance is not practical and mitigation measures do not completely protect a site.	Negative	Footprint	Short-term	Isolated	Medium to long-term	Medium	Low	High	Not significant

TABLE 7.7.7-2 Cont'd

Potential Residual Effects		Impact Balance	Spatial Boundary[1]	Temporal Context: Duration	Temporal Context: Frequency	Temporal Context: Reversibility	Magnitude	Probability	Confidence	Significance[2]
2(b)	If rare plant and lichen sub-populations are located near a MLBV location they may be affected by changes in hydrology or light levels.	Negative	LSA	Short-term	Isolated	Short to medium-term	Low	Low	High	Not significant
3.	Vegetation Indicator – Presence of Infestations of Provincial Weed Species and Other Invasive Non-native Species Identified as a Concern									
3(a)	Weed introduction and spread.	Negative	RSA	Short-term	Isolated	Short to medium-term	Low to medium	High	High	Not significant

Notes: 1 LSA = Vegetation LSA; RSA = Vegetation RSA.

2 Significant Residual Environmental Effect: A high probability of occurrence of a permanent or long-term residual effect of high magnitude that cannot be technically or economically mitigated.

The significance evaluation of the potential residual effects vegetation communities of concern, the rare plant and lichen species of concern and the presence of infestations of Provincial weed species and other invasive non-native species identified as a concern indicators were determined to be generally the same for pipeline reactivation activities as for the construction and operation of pipelines (Section 7.2.9.6) (Table 7.7.7-2, points 1[a], 2[a], 2[b], 3[a]). The exceptions are the frequency of the events which is isolated, reversibility of alteration of native vegetation which is considered to be of short to medium-term and low magnitude given the disturbed areas will be very small and likely located in previously disturbed areas. In addition, the probability of effects on plant and lichen species of concern is low for the reactivated segments because the probability of rare plant or lichen species revegetating the previously disturbed right-of-way is low. Table 7.4.9-2 and the accompanying discussion in Section 7.4.9.4 provide an evaluation of potential residual effects of the pipeline reactivation activities and their significance on the applicable vegetation indicator.

7.7.7.5 Summary

As identified in Table 7.7.7-2, there are no situations where there is a high probability of occurrence of a permanent or long-term residual environmental effect on the vegetation indicators of high magnitude that cannot be technically or economically mitigated. Consequently, is it concluded that the residual environmental effects arising from the pipeline reactivation and associated activities on vegetation will be not significant.

7.7.8 Species at Risk

The reactivation of pipeline segments may affect fish, vegetation and wildlife species at risk. Section 7.2.11 provides a discussion of the fish and wildlife species used as indicators for species at risk. Vegetation species at risk are considered under the plant and lichen species of concern indicator. Although not all species at risk are discussed explicitly under each indicator, potential Project effects were assessed in consideration of all species at risk. The indicators used to represent fish and fish habitat, vegetation and wildlife and wildlife habitat were carefully selected to ensure that the full range of potential Project effects on species at risk was addressed and mitigation measures to reduce these effects will apply to all species at risk, not just the indicators. Section 7.2.7 Fish and Fish Habitat, Section 7.2.9 Vegetation and Section 7.2.10 Wildlife and Wildlife Habitat provide the significance rationale for applicable indicator species. No significant adverse effect on species at risk has been identified as a result of the pipeline and facilities component of the Project.

7.8 Effects Assessment - Decommissioning and Abandonment

The NEB defines decommissioning as the permanent cessation of the operations of a pipeline without discontinuance of service, abandonment as the permanent cessation of the operation of a pipeline which results in the discontinuance of service and deactivation as to remove temporarily from service. The abandonment of a facility requires an application to the NEB under Section 74 of the *NEB Act*, as described in Guide B of the NEB *Filing Manual*.

It is difficult at this time to predict when or how the pipeline and facilities will be decommissioned or abandoned at the end of the Project's useful life. However, it can be anticipated that any of the following three scenarios may occur during pipeline decommissioning or abandonment: pipeline removal, abandonment-in-place or a combination of abandonment-in-place and pipeline removal. The existing TMPL has been successfully operating for 60 years and will be safe and reliable for many more years as a result of continuing proactive maintenance and integrity programs. The useful life of the Project will be as long or longer.

Trans Mountain is participating in and will comply with the process established by Stream 3 of the NEB Land Matters Consultation Initiative and Reasons for Decision [RH-2-2008]. In addition, a Preliminary Abandonment Plan is provided in Section 12.0 of Volume 4C, providing a discussion of the abandonment planning strategy for the pipelines and facilities to be constructed for TMEP. The plan discusses general activities for the types of facilities that would be abandoned in place, abandoned in place with special treatment or removed. The plan also discusses general reclamation objectives and principles that would be applied during abandonment to return the right-of-way and facility sites to a state comparable with the surrounding environment.

Current and future land use for the Project will be one of the most important factors in the determination of pipeline abandonment rationale. It is unlikely that any one abandonment technique will be appropriate for all land uses and as per consultation with affected parties, the decision to abandon or remove the pipeline and any associated infrastructure, including facilities and access roads, will be made on a site-specific basis and at the time of abandonment.

The methods of abandonment that will ultimately be implemented for the pipeline segments and facilities constructed for the Project will be determined at the time of the planning for abandonment and will be based on the most current body of scientific knowledge and accepted industry practices. It is expected that most of the pipeline will be abandoned in place; however, land use considerations and other factors may lead to pipeline segments being removed.

Current and future land use will be one of the most important factors in the determination of pipeline abandonment rationale. It is unlikely that any one abandonment technique will be appropriate for all land uses and the decision to abandon in place, abandon in place with special measures, or remove pipeline segments will be made on a site-specific basis and after consultation with affected parties and at the time of abandonment.

Environmental issues associated with potential abandonment methodologies such as ground subsidence, soil erosion and soil and water contamination may be regarded on a site-specific basis in determining the most appropriate abandonment methodology. Additionally, an assessment will be conducted to determine if there is any contamination of the associated land and, if warranted, special soil handling and remediation procedures would be implemented. Any lands disturbed by physical activities will be reclaimed to the appropriate land use at that time. For the Project, which is not expected to be abandoned for another 50-70 years, mitigation to address the environmental issues associated with pipeline abandonment and the determination of significance for any of the potential remaining effects cannot be meaningfully or realistically assessed at this time. The significance of any effects remaining following mitigation, including the significance of cumulative effects, will be determined and provided at the time Trans Mountain files for abandonment.

The reclamation objectives or principles to be applied to abandonment of the pipeline segments and facilities constructed for the Project will be in accordance with legislative and regulatory requirements in place at that time and likely similar to those required for Project construction. The primary goal of the reclamation is to stabilize and revegetate affected lands such that they will, in time, achieve productivity equivalent to the adjacent land use, ensuring the ability of the land to support various land uses.

The process of reclamation post-abandonment will likely involve a combination of measures such as: topsoil and root zone material salvage; subsoil conditioning and grade and drainage re-establishment; topsoil and root zone material replacement; installation and maintenance of temporary and permanent erosion and sediment control measures; and revegetation. Parameters such as vegetation, soil and landscape will be used as criteria to measure the degree of reclamation success, ensuring that land productivity is equivalent to the adjacent lands. Where no known or visible limitations to normal management, access, soil productivity and ecosystem function are evident during the evaluation, land reclamation will be determined to be successful.

Future decommissioning or abandonment activities will require prior approval by the NEB and other applicable regulatory authorities. Information regarding abandonment costs are provided in Section 2.0 of Volume 2. Volume 4C, Project Design and Execution – Operations and Maintenance, Section 12.0 provides additional details on abandonment plans.

7.9 Accidents and Malfunctions

Accidents and malfunctions are unplanned events that could result in significant adverse effects to human health, property or the environment, but are unlikely to occur. While accidents and malfunctions are predicted to be unlikely for the Project, the potential consequences are evaluated so that emergency response and contingency planning can be identified to ensure the risk is further mitigated.

7.9.1 Assessment Indicators and Measurement Endpoints

Indicators considered in the assessment of accidents and malfunctions include those indicators previously described for the environmental elements in Sections 7.2 to 7.7. The measurement endpoints for accidents and malfunctions consist of qualitative assessment of potential residual effects of accidents and malfunctions.

7.9.2 Spatial Boundaries

The spatial boundaries used in the effects assessment of accidents and malfunctions considered the applicable environmental element LSAs and RSAs as described in Sections 7.2 to 7.7. In general, the LSA is the ZOI in which environmental indicators are most likely to be affected by the construction and operations of the Project. The RSA is considered the area where the direct and indirect influence of other land uses and activities could overlap with Project effects and cause cumulative effects on the environmental indicator.

7.9.3 Potential Effects and Mitigation Measures

<u>Identified Potential Effects</u>

As stated in the NEB *Filing Manual* (NEB 2013a), an ESA must identify and assess the effects on workers, the public and biophysical and socio-economic elements of all potential accidents and malfunctions. Events causing accidents and malfunctions could include pipeline and equipment failure; human error; natural perils such as tornadoes, floods, hurricanes or earthquakes, and terrorism or other criminal activities.

Trans Mountain is committed to keeping their pipelines safe, and protecting their employees, the public and the environment. Trans Mountain strives to safeguard their facilities and to meet or exceed all applicable federal, provincial and local safety legislation.

Pipelines are a safe and efficient method of transporting large volumes of liquid products over long distances (Canadian Energy Pipeline Association 2013). However, incidents such as damage to the pipeline, operator error and vandalism could occur. To ensure the continued safe and reliable operation of its pipelines, Trans Mountain uses a multi-layered approach to pipeline safety that encompasses integrity management, damage prevention and emergency response programs.

The potential effects associated with accidents and malfunctions on socio-economic elements are provided in Volume 5B. The potential effects associated with accidents and malfunctions during marine transportation are provided in Volume 8A. The potential direct and indirect effects of an operational pipeline or marine spill are evaluated in Volumes 7 and 8A, respectively, including the risk of a spill, the anticipated spill response and the potential effects for various spill scenarios. Events causing accidents and malfunctions from natural perils such as tornadoes, floods, hurricanes and earthquakes are discussed in Section 7.10 Changes to the Project Caused by the Environment. The potential effects associated with a large spill reaching the Fraser River and estuary and a small spill during loading at the Westridge Marine Terminal are provided in Volume 7.

Potential effects associated with the construction and operations of the proposed pipeline and facilities on the environmental indicators are listed in Table 7.9-2. These interactions are based on the results of the literature review, desktop analysis, engagement with Aboriginal communities, consultation with landowners, regulatory authorities, stakeholders and the general public (Section 3.0), and the professional experience of the assessment team.

A summary of mitigation measures provided in Table 7.9-2 was principally developed in accordance with Trans Mountain standards as well as industry and provincial regulatory guidelines including AENV (1988, 1994a), BC OGC (2010a), CAPP (1999, 2001) and NEB (2011). In addition, these measures have been considered acceptable by the NEB for past pipeline projects for Spectra Energy (NEB 2008), Terasen Pipelines (NEB 2006) and NOVA Gas Transmission Ltd. (NEB 2010a-f).

Industry best practice technology, safety measures and contingency plans will also be used to reduce the probability and magnitude of accidents occurring and having substantial adverse effects. However, if an accident or malfunction does occur, an effective response plan will reduce the effects and associated risks. Trans Mountain adopts KMC's plans and policies for the purposes of the Project. Management systems and programs required under the *National Energy Board Onshore Pipeline Regulations* (*NEB OPR)* are listed below in Table 7.9-1.

TABLE 7.9-1

MANAGEMENT SYSTEMS AND PROGRAMS REQUIRED UNDER THE *NEB OPR*

Program	*NEB OPR* Section	Purpose of Program	Equivalent Trans Mountain Document
Emergency Management Program	Section 32	To ensure appropriate emergency preparedness and response.	• KMC Emergency Response Plan (on file with the NEB) • KMC Incident Command System (ICS) Guide • KMC Terminal Emergency Response Plan • KMC Westridge Marine Terminal Emergency Response Plan
Integrity Management Program	Section 40	To ensure the pipeline system continually operates within its design parameters.	• KMC Canadian Integrity Management Program (on file with the NEB) • KMC Facility Integrity Management Program (on file with the NEB)
Safety Management Program	Section 47	To protect workers and the public from occupational and process standards.	• KMC Contractor (Environmental/Safety) Manual (on file with the NEB) • KMC Health and Safety Standards Manual (on file with the NEB) • KMC Knowledge and Experience Enhancement Program (KEEP Canada Practice) (on file with the NEB)
Security Management Program	Section 47.1	To protect people, property and the environment from malicious damage.	• KMC has in place a Kinder Morgan Canadian Operations Facilities Security Plan that will be implemented for the Project (as per the NEB *Filing Manual*, companies are not to file their security documents electronically, although they need to be available for examination by the NEB during audits, inspections or other NEB regulatory activities) • KMC has in place site specific security plans for each district and terminal • KMC Emergency Response Program (on file with the NEB)
Environmental Protection Program	Section 48	To avoid or reduce adverse effects on the environment.	• Pipeline EPP (Volume 6B) • Facilities EPP (Volume 6C) • Westridge Marine Terminal EPP (Volume 6D) • KMC Contractor (Environmental/Safety) Manual (on file with the NEB) • KMC Environmental Standards and Guidelines

TABLE 7.9-2

POTENTIAL EFFECTS, MITIGATION MEASURES AND RESIDUAL EFFECTS OF ACCIDENTS AND MALFUNCTIONS DURING PIPELINE AND FACILITIES CONSTRUCTION AND OPERATIONS

Potential Effect	Project Component	Spatial Boundary	Key Recommendations/Mitigation Measures [EPP Reference][1]	Potential Residual Effect(s)
1. Small spill of hazardous materials during construction and maintenance activities	All	Wildlife LSA and Aquatics LSA	<u>Spill Prevention</u> • Follow spill prevention measures provided in Section 43: Environmental Requirements – General and Section 45: Environmental – Spill Prevention and Control of the KMC Contractor (Environmental/Safety) Manual, on file with the NEB. • Do not store fuel, oil or hazardous material within 300 m of a watercourse/wetland/lake [Section 7.0]. • Maintain all appropriate spill equipment at all work sites. Assess the risk of resource-specific spills to determine the appropriate type and quantity of spill response equipment and materials to be stored on-site and a suitable location for storage (see Emergency Response Plan in Section 3.5 of Volume 4C) [Section 7.0]. • Store all hazardous substances and fuels in proper containment systems, to prevent release to the environment. Handle all hazardous materials in accordance with applicable WHMIS protocols [Section 7.0]. • Ensure that during construction no fuel, lubricating fluids, hydraulic fluids, methanol, antifreeze, herbicides, biocides, or other chemicals are dumped on the ground or into watercourses/wetlands/lakes. In the event of a spill, implement the Spill Contingency Plan [Section 7.0]. • Place an impervious tarp or drip tray underneath equipment/vehicles when servicing equipment/vehicles with the potential for accidental spills (*e.g.,* oil changes, servicing of hydraulic systems) [Section 7.0]. • Ensure that bulk fuel trucks, service vehicles and pick-up trucks equipped with box-mounted fuel tanks carry spill prevention, containment and clean-up materials that are suitable for the volume of fuels or oils carried. Carry spill response supplies on bulk fuel and service vehicles that are suitable for use on land and water (*i.e.,* sorbent pads, sorbent boom and rope) [Section 7.0]. • Ensure that operators and on-site construction foremen are trained to contain spills or leakage from equipment [Section 7.0]. The KMC Knowledge and Experience Enhancement Program (KEEP Canada Practice), on file with the NEB, is designed to ensure Trans Mountain employees are competent in their work and can work safely to protect themselves, the public and the environment. • Employ the following measures to limit the risk of fuel spills in water. Where equipment refuelling is necessary within 100 m of a watercourse/wetland/lake [Section 7.0]: - all containers, hoses, nozzles are free of leaks; - all fuel nozzles are equipped with automatic shut-offs; - operators are stationed at both ends of the hose during fuelling unless the ends are visible and readily accessible by one operator; and - fuel remaining in the hose is returned to the storage facility. • Do not wash equipment or machinery in watercourses/wetlands/lakes. Control wastewater from construction activities, such as equipment washing or concrete mixing, to avoid discharge directly into any body of water [Section 7.0].	• Inadvertent small spills could result in contamination or alteration of: - surface or groundwater quality (Section 7.2.3 Water Quality and Quantity); - instream or riparian habitat and fish mortality or injury (Section 7.2.7 Fish and Fish Habitat); - wetland function (Section 7.2.8 Wetland Loss or Alteration); - plants and ecological communities (Section 7.2.9 Vegetation); and - wildlife and wildlife habitat (Section 7.2.10 Wildlife and Wildlife Habitat). • No residual effects identified for soil and soil productivity due to effectiveness of clean up measures.

TABLE 7.9-2 Cont'd

Potential Effect	Project Component	Spatial Boundary	Key Recommendations/Mitigation Measures [EPP Reference][1]	Potential Residual Effect(s)
1. Spill of hazardous materials during construction and maintenance activities (cont'd)	All	Wildlife LSA and Aquatics LSA	In the Event of a Spill • Implement the Contamination Discovery Contingency Plan in the event contaminated soils are encountered during construction [Appendix B]. • In the event of a spill, implement the Spill Contingency Plan [Appendix B]. • Report spills immediately to the Inspector(s) who will, if warranted, notify Trans Mountain for reporting to the appropriate regulatory authorities in accordance with the Spill Contingency Plan [Section 7.0 and Appendix B]. • Clean up and document spill in accordance with the *NEB Remediation Process Guide* (NEB 2011).	• See above.
2. Fire during construction and operations	All	Wildlife RSA	Fire Prevention • An environmental education program (Level II and III training) will be developed and implemented by the Trans Mountain Environmental Team to ensure that all Trans Mountain staff and contractors will be informed of the environmental and socio-economic requirements and sensitivities regarding the Project prior to arrival on the pipeline construction right-of-way, ancillary sites or associated component sites [Section 3.0]. • Apply the KEEP Canada Practice to ensure Trans Mountain employees are competent in their work and can work safely to protect themselves, the public and the environment. • Notify the appropriate regulatory authority prior to commencement of burning slash. When the fire risk is varying and when required, obtain and record the fire ratings daily to determine whether it is safe to burn. During slash disposal activities, maintain communication on a daily basis regarding time of ignition, location, extent and anticipated duration of burning activities [Section 8.1]. Slash burning will not be conducted in the Lower Mainland or at the Westridge Marine Terminal. • Comply with local government bylaws, the *Forest and Prairie Protection Act* (Alberta), the *Open Burning Smoke Control Regulation* (BC) and the *Forest Fire Prevention and Suppression Regulation* (BC) when burning slash [Section 7.0]. • Avoid locating burn piles on peat-rich soils in order to limit the risk of residual fires after construction. Locate burn piles on exposed soils (*i.e.*, where topsoil/root zone material salvage has occurred) [Section 8.1]. • Burn only when the fire hazard is at acceptable levels. No burning is to be conducted during high winds [Section 8.1]. • Monitor burning at all times and prevent fire from spreading off the construction right-of-way. Extinguish burning embers before leaving the site and monitor burn sites to ensure no smouldering debris remains. Push unburned stumps along the edge of the construction right-of-way after attempting to burn them [Section 8.1]. • Firefighting equipment and a Fire Watch must be supplied by the contractor and must be present while performing any hot work (Section 13: Fire Prevention and Protection of the KMC Contractor [Environmental/Safety] Manual). • Implement the fire prevention measures in Section 6.1.1 of KMC's Emergency Response Plan, on file with the NEB. • Ensure that slash burning crews have firefighting equipment on hand that is capable of controlling any fire that may occur as a result of their activities [Section 8.1].	• Despite vigilance, fires may adversely affect adjacent vegetation and in very rare situations, affect wildlife.

TABLE 7.9-2 Cont'd

Potential Effect	Project Component	Spatial Boundary	Key Recommendations/Mitigation Measures [EPP Reference][1]	Potential Residual Effect(s)
2. Fire during construction and operations (cont'd)	All	Wildlife RSA	Fire Prevention (cont'd) • Burn piles must be spread and mixed with water or snow to ensure they are properly extinguished [Section 8.1]. • Conduct infrared scanning of burn piles to locate any hot spots [Section 8.1]. • Smoking is allowed in designated areas only. Designated smoking areas will be identified during the pre-job construction meeting or work permitting process (Section 13: Fire Prevention and Protection of the KMC Contractor [Environmental/Safety] Manual). • All activity inspectors and contractors' vehicles will carry firefighting equipment such as pulaskis, shovels, backpack pumps or components of a water delivery system (pump and hose) in sufficient quantities so that each worker has access to at minimum, one hand tool with which to carry out fire suppression work. In addition, all motorized equipment must carry a fully charged fire extinguisher. The Safety Manager or Safety Coordinator will ensure that fire extinguishers are present and fully charged [Appendix B]. Fire During Construction • Follow the fire suppression measures of the Fire Contingency Plan [Appendix B]. • Implement the Emergency Response Plan and Fire Contingency Plan in Section 3.5 of Volume 4C. Fire During Operations • Implement the above procedures, as applicable, to operations and maintenance activities.	• See above.
3. Damage to foreign utilities during construction and operations	All	Aquatics RSA	• Notify applicable companies for road, power line and foreign pipeline crossings, if required, by crossing and road use agreements [Section 4.0]. • Locate and flag all existing buried utility lines and cables to be crossed by the pipeline prior to the commencement of ground disturbance activities by using "one call" services or direct contact with utility owners [Section 7.0]. • Ensure construction personnel are properly trained in ground disturbance techniques. Apply the KEEP Canada Practice to ensure Trans Mountain employees are competent in their work and can work safely to protect themselves, the public and the environment. • Use flagging and signage at overhead line crossings to alert equipment operators of hazards. • Conduct construction activities near adjacent pipelines in compliance with all requirements of CSA Z662-11 and the *NEB OPR* for work close to an operating pipeline. • Prior to any equipment working on, or crossing over, an adjacent pipeline, first obtain a crossing permit from the operator for each specific location, detailing the conditions and limitations for each crossing. • During Project construction, maintain minimum separations between the pipe trench and adjacent pipes needed to protect the existing pipeline during construction of the Project, and allow for future remedial excavation work on either pipeline without affecting the other pipeline.	• Damage to utility lines could lead to contamination of soil or water depending on the location and severity of the rupture, and fires in the case of gas.
4. Release of drilling mud during HDD	New pipeline	Aquatics LSA	• Plan for and use the procedures for a HDD or other trenchless crossing in accordance with those provided in the Horizontal Directional Drilling/Trenchless Planning and Procedures Management Plan (see Appendix C) [Section 8.7.3]. • Cease trenchless crossing work immediately and refer to the Drilling Mud Release Contingency Plan (see Appendix B) in the event that an inadvertent release of drilling mud has occurred and the material is or may enter the watercourse or affect other sensitive environmental or land use features [Section 8.7.3].	• Release of drilling mud on land may affect soil productivity.

TABLE 7.9-2 Cont'd

Potential Effect	Project Component	Spatial Boundary	Key Recommendations/Mitigation Measures [EPP Reference][1]	Potential Residual Effect(s)
4. Release of drilling mud during HDD (cont'd)	New pipeline	Aquatics LSA	• Follow the drilling mud frac-out monitoring and other measures outlined in the Drilling Mud Release Contingency Plan (see Appendix B) during horizontal directional drilling [Section 8.7.3]. • Assign the Inspector(s), Qualified Aquatic Environmental Specialist (QAES) or Qualified Environmental Professional (QEP) with expertise in the containment of inadvertent release of drilling mud and clean up to HDDs under a watercourse (see Drilling Mud Release Contingency Plan in Appendix B) [Section 8.7.1].	• Disturbance of vegetation or habitat could result during clean up and reclamation efforts following an HDD mud release on land or riparian areas. • Depending on the volume and location of a release, a release of HDD mud into a watercourse may affect aquatic ecosystems.
5. Transportation accidents	All	Wildlife RSA	• Establish speed limits, approved by Trans Mountain, on the construction right-of-way and access roads. Post signs stating the applicable speed limits for construction traffic to avoid wildlife injury and mortality, maintain soil structure and reduce dust [Section 7.0]. • An environmental education program (Level II and III training) will be developed and implemented by the Trans Mountain Environmental Team to ensure that all Trans Mountain staff and contractors will be informed of the environmental and socio-economic requirements and sensitivities regarding the Project prior to arrival on the pipeline construction right-of-way, ancillary sites or associated component sites. Environmental training at a minimum will include, at a minimum, the following: - the identification of sensitive features and valuable environmental components; - the process to follow should sensitive environmental features be located and/or disturbed during construction; - the expectation that speed limits and signage, flagging and/or fences delineating the environmental features shall be respected at all times; and - the established protocol for wildlife encounters. [Section 3.0]. • Use multi-passenger vehicles for the transportation of crews to and from the job sites, where feasible [Section 7.0]. • Follow recommendations in the Traffic and Access Control Management Plan [Appendix C of Volume 6B] and the Traffic Control Management Plan in Section 3.5 of Volume 4B, as well as the Public Traffic Control Plan to be developed by the contractor.	• A transportation accident may cause injury to wildlife or may result in fire or contamination of lands and water depending on the location and severity of the accident.
6. Use of explosives	New pipeline	Wildlife RSA	• Review safety protocols and procedures with construction workers working in the fly rock zone prior to commencement of blasting activity. Reduce the potential for injury from flying rock, by using sound warning calls and visually scan for wildlife in the blasting area. If wildlife is spotted within the blasting area, use measures recommended by the Wildlife Resource Specialist to displace wildlife prior to blasting [Section 8.3]. • Apply the KEEP Canada Practice to ensure Trans Mountain employees are competent in their work and can work safely to protect themselves, the public and the environment. • Utilize warning sirens, blasting mats, blasting controls and monitoring to reduce potential injury to wildlife [Section 8.3]. • Implement measures in the Blasting Management Plan in Section 3.5 of Volume 4B. • Transport explosives in accordance with the *Transport of Dangerous Goods Act* and other applicable provincial or federal legislation.	• Fly rock from blasting may cause injury to wildlife, while unintentional detonation of explosives could affect wildlife or aquatic ecosystems depending on the proximity to the detonated area.

TABLE 7.9-2 Cont'd

Potential Effect	Project Component	Spatial Boundary	Key Recommendations/Mitigation Measures [EPP Reference][1]	Potential Residual Effect(s)
6. Use of explosives (cont'd)	See above	See above	• Store explosives on-site in compliance with permits and provincial or federal legislation. Ensure that explosives are stored in a secured container to minimize accessibility to wildlife and the public. • Handle the explosives in accordance with permits, certificates and provincial and federal legislation. • Use blast mats to minimize the risk of damage to property within the fly rock zone.	• See above.
7. Security risk	All	Wildlife LSA	<u>Construction</u> • Install locked gates at locations noted on the Environmental Alignment Sheets (Volume 6E) to block unauthorized travel along the construction right-of-way following clearing. Keep gates locked and assign security personnel, if warranted, to block access [Section 8.1]. • Install temporary fencing around construction camps and borrow sites to reduce the attraction of wildlife and to provide security for the site [Sections 10.0 and 11.0]. • During construction, Trans Mountain will implement the Security Program in Section 3.5 of Volume 4B. During operations, follow Section 10.0 Pipeline Security of Volume 4C. • In the event of a bomb threat, Trans Mountain will follow the Bomb Threat Action Checklist in Section 6.6 of KMC's Emergency Response Plan. • For any other breaches of security, Trans Mountain will follow the Breach of Security Action Checklist in Section 6.7 of KMC's Emergency Response Plan. <u>Operations</u> • Right-of-way surveillance is conducted in the form of aerial patrols and ground patrols to monitor for visible threats to pipeline integrity. Aerial patrol can prevent incidents by reporting unauthorized ground disturbance activities, as discussed in the KMC Canadian Integrity Management Program, on file with the NEB. • Ensure all facility sites are secured with locked fencing and are equipped with signage warning of the hazards related to the products on the site. Ensure all valves in remote facilities are locked or mechanically plugged and the local push buttons on motor operated valves are rendered inactive unless activated by secured switches (Section 6 of the KMC Facility Integrity Management Program, on file with the NEB). • During construction, Trans Mountain will implement the Security Program in Section 3.5 of Volume 4B. During operations, follow Section 10.0 Pipeline Security of Volume 4C. • In the event of a bomb threat, Trans Mountain will follow the Bomb Threat Action Checklist in Section 6.6 of KMC's Emergency Response Plan. • For any other breaches of security, Trans Mountain will follow the Breach of Security Action Checklist in Section 6.7 of KMC's Emergency Response Plan.	• Damage from criminal activity.

Note: 1 Detailed mitigation measures noted are outlined in the Pipeline EPP (Volume 6B). Similar measures appear in the Facilities EPP (Volume 6C) and Westridge Marine Terminal EPP (Volume 6D) but cross references have not been provided.

7.9.4 Potential Residual Effects

The potential residual environmental effects that could occur as a result of accidents and malfunctions during construction and operations of the pipeline and facilities (Table 7.9-2) are:

- contamination or alteration of surface or groundwater quality, riparian or instream habitat, fish mortality or injury, wetland function, plants and ecological communities, and wildlife and wildlife habitat due to small spills during construction;

- despite vigilance, fires may adversely affect adjacent vegetation and in very rare situations, affect wildlife;
- damage to utility lines could lead to contamination of soil or water depending on the location and severity of the rupture, and fires in the case of gas;
- release of drilling mud on land may affect soil productivity;
- disturbance of vegetation or habitat could result during clean up and reclamation efforts following an HDD mud release on land or riparian areas;
- depending on the volume and location of a release, a release of HDD mud into a watercourse may affect aquatic ecosystems;
- a transportation accident may cause injury to wildlife or may result in fire or contamination of lands and water depending on the location and severity of the accident;
- fly rock from blasting may cause injury to wildlife, while unintentional detonation of explosives could affect wildlife or aquatic ecosystems depending on the proximity to the detonated area; and
- damage from criminal activity.

7.9.5 Significance Evaluation of Potential Residual Effects

Where there are no standards, guidelines, objectives or other established and accepted ecological thresholds to define quantitative rating criteria or where quantitative thresholds are not appropriate, the qualitative method that is considered to be the appropriate method. Consequently, a qualitative assessment for accidents and malfunctions was determined to be the most appropriate method with the evaluation of significance of each of the potential residual effects relying on the professional judgment of the assessment team.

Table 7.9-3 provides a summary of the significance evaluation of the potential residual environmental effects associated with accidents and malfunctions during the construction and operations of the Project. The rationale used to evaluate the significance of each of the residual environmental effects is provided below.

TABLE 7.9-3

SIGNIFICANCE EVALUATION OF POTENTIAL RESIDUAL EFFECTS OF ACCIDENTS AND MALFUNCTIONS DURING PROJECT CONSTRUCTION AND OPERATIONS

	Potential Residual Effects	Impact Balance	Spatial Boundary	Temporal Context			Magnitude	Probability	Confidence	Significance[1]
				Duration	Frequency	Reversibility				
(a)	Contamination of surface or groundwater due to small spills during construction.	Negative	Water Quality and Quantity LSA	Immediate	Accidental	Short to medium-term	Low to high	Low	Moderate	Not significant
(b)	Contamination or alteration of habitat and fish mortality or injury due to small spills during construction.	Negative	Wildlife LSA and Aquatics LSA	Immediate	Accidental	Short to long-term	Low to high	Low	Moderate	Not significant
(c)	Despite vigilance, fires may adversely affect adjacent vegetation and in very rare situations, affect wildlife.	Negative	Wildlife RSA	Immediate	Accidental	Medium to long-term	Low to high	Low	Moderate	Not significant

TABLE 7.9-3 Cont'd

	Potential Residual Effects	Impact Balance	Spatial Boundary	Temporal Context: Duration	Temporal Context: Frequency	Temporal Context: Reversibility	Magnitude	Probability	Confidence	Significance[1]
(d)	Damage to utility lines could lead to contamination of soil or water depending on the location and severity of the rupture, and fires in the case of gas.	Negative	Aquatics RSA	Immediate	Accidental	Immediate to short-term	Low to high	Low	Moderate	Not significant
(e)	Disturbance of vegetation/habitat could result during clean up and reclamation efforts following an HDD mud release on land or riparian areas.	Negative	Wildlife LSA	Immediate	Accidental	Medium to long-term	Low to high	Low	Moderate	Not significant
(f)	Depending on the volume and location of the release, a release of HDD mud on land may affect soil productivity or into a watercourse may affect aquatic ecosystems.	Negative	Water Quality and Quantity LSA	Immediate	Accidental	Immediate to medium-term	Low to high	Low	Moderate	Not significant
(g)	A transportation accident may cause injury to wildlife or may result in fire or contamination of lands and water depending on the location and severity of the accident.	Negative	Wildlife RSA	Immediate	Accidental	Short to medium-term	Low to high	Low	Moderate	Not significant
(h)	Fly rock from blasting may cause injury to wildlife, while unintentional detonation of explosives could affect wildlife or aquatic ecosystems depending on the proximity to the detonated area.	Negative	Wildlife RSA	Immediate	Accidental	Short to medium-term	Low to high	Low	Moderate	Not significant
(i)	Damage from criminal activity.	Negative	Wildlife LSA	Immediate	Accidental	Short to long-term	Low to high	Low	Moderate	Not significant

Note: 1 Significant Residual Environmental Effect: A high probability of occurrence of a permanent or long-term residual effect of high magnitude that cannot be technically or economically mitigated.

Spills During Construction

Concerns regarding spills were raised during Aboriginal engagement and during most of the public information sessions, ESA Workshops and Community Workshops during public consultation. Many people engaged noted that the potential effects of spills, spill prevention and spill response were top concerns. While the effects of large spills during operations are discussed in Volume 7, this discussion focuses on small spills during construction and the potential impact on the environment. For the purposes of this assessment, a small spill is defined by Kinder Morgan's North American Standard as a spill under 5 gallons (18.9 L) which would not cause a significant environmental effect (*i.e.,* not into a watercourse). It should be noted that spills of all sizes and commodities are logged.

Companies regulated by the NEB are required to report on spills that could have a significant adverse effect on the environment regardless of size. An example of this is would be any release of hydrocarbons into a water body. of all reportable liquid spill incidents recorded by industry between 2008 and April 2013, less than one incident per year was a liquid release into a waterway, illustrating that spills potentially altering surface or groundwater are rare but not exceptionally uncommon (NEB 2013b).

Surface water or groundwater quality could be affected from a spill during construction. The severity of the effect would depend on the size and location of the spill. However, pipeline spill statistics demonstrate that the probability of a significant adverse residual effect is low. As discussed in Section 7.2.3.4, contamination of an aquifer may result if the spilled material migrates through the developed soil near the surface through the surficial materials into the first water-bearing unit. The rate of migration is dependent upon the permeability of the materials, presence or absence of fractures, the properties of the spilled contaminant (density, viscosity) and the vertical hydraulic gradients. A spill during the construction phase of the Project is likely to be noted quickly and be of small volume, and evidence suggests that the effects of most minor spills are localized. With the implementation of the spill prevention (*i.e.,* not storing fuel, oil or other hazardous materials within 300 m of a watercourse or waterbody) and response measures (*e.g.,* Spill Contingency Plan in Appendix B of the Pipeline EPP in Volume 6B) recommended in Table 7.9-2 and clean up and remediation measures, a spill potentially affecting surface or groundwater are considered to be of low to high magnitude and reversible in the short to medium-term. The probability of a spill contaminating groundwater or surface water is low (Table 7.9-3, point [a]). This adverse residual effect relates to the indicators of surface water and groundwater quality and quantity under Section 7.2.3 Water Quality and Quantity. A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Water Quality and Quantity LSA – contaminants released into surface water or groundwater resulting from an accidental spill during construction can be transported before the contaminants are either diluted to a safe level or remediated.
- Duration: immediate – the event causing contamination of surface or groundwater is a spill, the period of which is less than one day.
- Frequency: accidental – a spill causing contamination of surface or groundwater is rare during construction.
- Reversibility: short to medium-term – depending on the size of the spill.
- Magnitude: low to high – depending on the volume, location and contaminants released.
- Probability: low – due to mitigation measures in place to reduce the potential for spills and the emergency response measures to contain and clean up product.
- Confidence: moderate – based on the professional experience of the assessment team.

Spills during construction could potentially contaminate or otherwise alter aquatic habitat (*i.e.,* instream fish habitat, wetlands) or terrestrial habitat (*i.e.,* riparian fish and wildlife habitat, upland wildlife habitat, vegetation habitat, wetland habitat). Depending on the severity and location of the spill, residual effects are expected to be reversible in the short-term (*e.g.,* small terrestrial spill that affects only herbaceous vegetation) to long-term (*e.g.,* spill affecting forested wildlife habitat and may require clearing to effectively clean up and reclaim the site; cleared habitat can regenerate in the long-term). Similarly, the magnitude of residual effects of spills on habitat varies depending on the severity of the event and the habitat affected. For example, in the event of a spill such as a fuel truck rollover in a stream with high quality fish habitat, the adverse residual effects could be of high magnitude with long lasting ramifications to the health of the stream. With the implementation of spill prevention and response measures, events such as this rarely occur and even more rarely occur instream or where other sensitive habitats exist (*e.g.,* rare plant populations or habitat features important for wildlife species of concern). Therefore, the probability of the effect is low (Table 7.9-3, point [b]).

This adverse residual effect relates to the indicators of instream and riparian habitat, and fish mortality or injury under Section 7.2.7 Fish and Fish Habitat, wetland function under Section 7.2.8 Wetland Loss or Alteration, vegetation communities of concern and plant and lichen species of concern under Section 7.2.9 Vegetation, and indicator species under Section 7.2.10 Wildlife and Wildlife Habitat. A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Wildlife LSA and Aquatics LSA – contaminants resulting from accidental spills may be confined to the location of the incident within terrestrial habitat or released into aquatic habitat and subsequently transported.
- Duration: immediate – the event causing contamination of aquatic or terrestrial habitat is a spill, the period of which is less than or one day.
- Frequency: accidental – a spill causing contamination or otherwise alter aquatic habitat is rare during construction.
- Reversibility: short to long-term – depending on the size of the spill.
- Magnitude: low to high – depending on the volume, location and contaminants released.

- Probability: low – due to mitigation measures in place to reduce the potential for spills and the emergency response measures to contain and clean up product.
- Confidence: moderate – based on the professional experience of the assessment team.

Fire During Construction

Restricting burning in areas with high fire hazard will be especially important during summer construction in the interior BC area, particularly if it is a dry year. Participants at the Blue River Community Workshop noted that a forest fire in the area could potentially shut down construction work, even if exemptions to burning restrictions are obtained. Participants at the Blue River Community Workshop also advised that emergency response capacity may be limited in the event of an accident due to capacity constraints. This may be the case with other small communities along the proposed pipeline corridor; however, Trans Mountain will work with emergency services to ensure that there is sufficient capacity to respond to a fire during construction and operations.

The significance of a fire will depend to a large extent on the location (*e.g.,* forest versus agricultural lands), size and what it consumes. Since small fires within the Footprint and off of the Footprint are of minor and moderate concern respectively, and can be extinguished quickly, they are not likely to cause a significant adverse residual effect. Large fires that spread off the Footprint and result in loss of vegetation or wildlife habitat are likely to be considered of high magnitude. With the implementation of mitigation measures (*e.g.,* construction crews having firefighting equipment and training) and the development of a Fire Contingency Plan (Appendix B of the Pipeline EPP in Volume 6B), the probability of large fires developing during pipeline construction is low (Table 7.9-3, point [c]).

This adverse residual effect relates to the indicators of vegetation communities of concern and plant and lichen species of concern under Section 7.2.9 Vegetation, and indicator species under Section 7.2.19 Wildlife and Wildlife Habitat. A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Wildlife RSA – accidental fires could vary in size depending on the circumstances (*e.g.,* location, weather, level of preparation) and would generally be confined to the Wildlife LSA but in exceptional circumstances (grassland) could extend beyond the LSA to the RSA.
- Duration: immediate – the event causing effects on adjacent habitat is a fire, the period of which is generally less than or equal to two days.
- Frequency: accidental – fires resulting from construction or operations activities are rare.
- Reversibility: medium to long-term – affected habitat may take up to or longer than 10 years to recover from a fire depending on the species composition (*i.e.,* shorter for shrubs and grasses, longer for trees).
- Magnitude: low to high – depending on the size and location of the fire, and the sensitivity of the habitat affected.
- Probability: low – it is unlikely that a fire will occur.
- Confidence: moderate – based on the professional experience of the assessment team.

Damage to Utility Lines Could Lead to Interruption of Services and Fires in the Case of Gas

In the event of a rupture of a high-pressure gas line, the risk of explosion and risk to habitat could be considered of medium magnitude. Since high-pressure pipelines are easily located (as opposed to some low-pressure plastic distribution lines) and are of sufficient size and strength that rupture is extremely unlikely, the probability of an explosion of existing gas pipelines is low. Rupture of the existing Trans Mountain pipeline or another foreign pipeline during construction resulting in severe contamination to air or water could be considered a significant adverse effect. Trans Mountain will adhere to industry standards, legislation (*e.g.,* CSA Z662-11 and the *NEB OPR*) and company protocols and, therefore, the probability of a rupture of the existing Trans Mountain pipeline or another foreign pipeline is unlikely and, therefore, the potential for a significant adverse effect resulting from working in the vicinity of foreign pipelines is low (Table 7.9-3, point [d]). The potential effects of a large rupture on air or water are discussed further in Volume 7. This adverse residual effect relates to the indicators of soil productivity and soil contamination under Section 7.2.2 Soil and Soil Productivity, surface and groundwater quality under Section 7.2.3 Water Quality and Quantity, vegetation communities of concern and plant and lichen species of concern under Section 7.2.9 Vegetation and indicator species under Section 7.2.10 Wildlife and Wildlife Habitat. A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Aquatics RSA – the effects resulting from accidental ruptures of water lines or foreign pipelines range from small terrestrial spills (Footprint) to contamination of surface or groundwater (Aquatics RSA) to large fires (Wildlife RSA), depending on the product in the line.
- Duration: immediate – the event causing a rupture or damage to utility lines is an accident, the period of which is less than or equal to two days.
- Frequency: accidental – rupture of or damage to utility lines during construction is rare.
- Reversibility: immediate to short-term – depending on the length of time needed for clean up and reclamation of the residual effect caused by damage to or rupture of a utility line.
- Magnitude: low to high – depending on the type and location of the utility line as well as the sensitivity of habitats affected by the ruptured utility line.
- Probability: low – it is unlikely that a rupture or damage to a utility line will occur.
- Confidence: moderate – based on the professional experience of the assessment team.

Inadvertent Release of Drilling Mud During Horizontal Directional Drilling

A release of drilling mud during an HDD onto land could potentially alter upland or riparian habitat. A drilling mud release is relatively benign since the bentonite clay is inert and can often be cleaned up and the areas affected by the release readily reclaimed. In the event that a drilling mud release on to land occurs during a trenchless crossing, the Drilling Mud Release Contingency Plan of the Pipeline EPP will be implemented which includes measures for clean up of the site. Schmidt *et al.* (2001) evaluated the effect of a release of mud during HDD on wetlands at five sites and determined that none displayed significant long-term effects as a result of bentonite discharge and further noted that the level of observed effect was in part related to the nature of clean up procedures. The reversibility of the adverse residual effect of a terrestrial (upland or riparian area) HDD release will depend on the length of time it takes vegetation to recolonize the area disturbed by the mud and clean up activities and varies from medium to long-term (Table 7.9-3, point [e]).

Instream releases of drilling mud occur less frequently than terrestrial releases. This is primarily due to the layout of directional drill paths which are commonly much longer than the width of the watercourse and have shallower depths of cover near the upland drill entry and exit locations. The depth of cover along an HDD path often reaches its maximum directly under the watercourse. The introduction of a clay-based drilling mud into the environment will have variable effects depending on the location, volume released and the level of clean up that is appropriate. Monitoring throughout an HDD program allows detection of a release of drilling mud soon after a release occurs. The ability to stop the flow of mud quickly also aids in limiting the total volume of drilling mud that could be released. Since the total volumes of drilling mud released during an inadvertent release are generally limited, drilling mud released into a watercourse will dissipate into a watercourse in a short period. An instream drilling mud release is reversible in the immediate to medium-term, depending on the volume of the release and flow rates of the watercourse (Table 7.9-3, point [f]).

These adverse residual effects relates to the indicators of surface and groundwater quality under Section 7.2.3 Water Quality and Quantity; instream habitat, injury and mortality, and fish indicator species under Section 7.2.7 Fish and Fish Habitat; vegetation communities of concern under Section 7.2.9 Vegetation; and wildlife indicator species under Section 7.2.10 Wildlife and Wildlife Habitat. A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Wildlife LSA - drilling mud releases may be confined to land (point [e]); Water Quality and Quantity LSA – drilling mud releases may be transported via surface water or groundwater.
- Duration: immediate – the event causing the residual effect is an inadvertent release of drilling mud during HDD, the period of which is less than or equal to two days.
- Frequency: accidental – the release of drilling mud is relatively rare, being confined to segments of pipeline construction requiring HDD.
- Reversibility: medium to long-term (terrestrial mud release, point [e]) – depending on the length of time it takes for vegetation to recolonize the area disturbed by the mud; immediate to medium-term (instream release, point [f]) – depending on the volume of the release and flow rates of the watercourse.
- Magnitude: low to high – depending on the location and quantity of drilling mud released.
- Probability: low – Trans Mountain will implement mitigation measures during HDD operations to prevent drilling mud release.
- Confidence: moderate – based on the professional experience of the assessment team.

Transportation Accident During Construction

Public safety during construction was noted as a concern during the Chilliwack Community Workshop. Increased traffic congestion during construction that may lead to an increased risk of traffic accidents was also raised during the Valemount Community Workshop. Transportation accidents arising from increased traffic on major roads associated with Project construction will be mitigated by implementing the measures in Table 7.9-2, including the use of a Traffic and Access Control Management Plan (Appendix C of the Pipeline EPP in Volume 6B). The availability and capacity of emergency services (*e.g.,* fire, ground and air ambulance) in the Project area are described in Section 5.5.6 and Section 5.8.6.3 of Volume 5B.

This adverse residual effect relates to the indicators of soil productivity and soil contamination under Section 7.2.2 Soil and Soil Productivity, surface water quality under Section 7.2.3 Water Quality and Quantity, vegetation communities of concern and plant and lichen species of concern under Section 7.2.9 Vegetation and wildlife indicator species under Section 7.2.10 Wildlife and Wildlife Habitat.

A transportation accident arising from increased traffic on major roads associated with Project construction activities would likely be considered of high magnitude if the accident resulted in death to a wildlife species of concern, damage to critical habitat or severe contamination of lands or water. However, the probability of a vehicle accident having a significant effect is low (Table 7.9-3, point [g]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Wildlife RSA – transportation accidents during construction activities may result from commuting to and from the work site.
- Duration: immediate – the event causing potential injury to wildlife is a transportation accident, the period of which is less than two days.
- Frequency: accidental – transportation accidents during construction and any associated residual effects are rare.
- Reversibility: short to medium – some accidents affecting wildlife may result in minor injuries from which the individual can readily recover; however, in situations where the individual succumbs to its injuries, it will take more than one year to replace the individual within the species population.
- Magnitude: low to high – depending on the type and severity of effects associated with the outcome of a transportation accident.

- Probability: low – it is unlikely that a transportation accident will occur.
- Confidence: moderate – based on the professional experience of the assessment team.

Blasting During Construction

Blasting will be required at certain places along the proposed pipeline corridor to install the new pipe. Mitigation measures in Table 7.9-2 will be implemented to reduce the risk of injury from fly rock or accidental detonation. Emergency response plans will respond in the unlikely event of an injury. The availability and capacity of emergency services (*e.g.,* fire, ground and air ambulance) in the Project area are described in Section 5.5.6 and Section 5.8.6.3 of Volume 5B. This adverse residual effect is relevant to the indicators of surface water quality under Section 7.2.3 Water Quality and Quantity, fish mortality or injury and fish indicator species under Section 7.2.7 Fish and Fish Habitat, and indicator species under Section 7.2.10 Wildlife and Wildlife Habitat.

Typically, fly rock from the detonation of explosives during blasting will not result in a significant adverse residual effect if safety measures and protocols are adhered to, including the use of blasting mats to reduce or eliminate fly rock. Noise associated with general construction activity in the vicinity of the blasting area coupled with the warning calls prior to detonation will likely displace wildlife from the fly rock zone. The probability of serious injury or death of wildlife is low. Blasting activities were conducted during construction of the TMX Anchor Loop Project and no adverse effects to the environment were noted (TERA 2009a).

The significance of an unintentional detonation of explosives will depend on the location of the detonation and its proximity to sensitive wildlife and sensitive aquatic ecosystems. An accidental detonation of explosives in areas devoid of fish-bearing watercourses and habitat for wildlife species at risk is not likely to cause a significant adverse residual effect. Given the proper implementation of mitigation measures during the transport, storage and handling of explosives, the probability of an unintentional detonation is low (Table 7.9-3, point [h]).

The use of explosives during blasting along the proposed pipeline corridor will not affect the operations or integrity of the existing Trans Mountain pipeline or other infrastructure. Small scale test blasts will be conducted to demonstrate the blast performed as per plan and complies with allowable vibration levels measured at the infrastructure of concern. Additional detail on blasting is provided in Volume 4A. A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Wildlife RSA – fly rock or unintentional detonation could cause injury or damage to habitat beyond the Footprint.
- Duration: immediate – the event causing injury or damage to habitat from fly rock from blasting or an unintentional detonation is an accident, the period of which is less than two days.
- Frequency: accidental – injury from blasting fly rock or an unintentional detonation of explosives is rare.
- Reversibility: short to medium – an accident from fly rock or unintentional detonation may result in minor injuries to wildlife from which the individual can readily recover; however, in situations where the individual succumbs to its injuries, it will take more than one year to replace the individual within the species population.
- Magnitude: low to high – depending on the type and severity of effects associated with the outcome of an accident associated with explosives.
- Probability: low – it is unlikely that an accident associated with explosives will occur.
- Confidence: moderate – based on the professional experience of the assessment team.

Damage from Criminal Activity

The issue of security risks related to criminal activity was raised during consultation at the Edmonton West, Edson, Chilliwack and Burnaby Community Workshops. Participants in these workshops were concerned that opponents of the Project may pose a security risk to the existing TMPL system and/or the Project.

KMC has in place a Kinder Morgan Canadian Operations Facilities Security Plan as required by Section 47.1 "Security Management Program" of the *NEB OPR* and in compliance with CSA Z246.1-09 which will be supplemented with a TMEP-specific Security Program. Additional mitigation measures (*e.g.,* the Traffic and Access Control Management Plan in Appendix C of the Pipeline EPP [Volume 6B]) are provided in Table 7.9-2 to prevent vandalism, theft and damage to the existing and proposed infrastructure.

Despite security measures currently in place and proposed for the Project, it is possible that a security incident could still occur during construction or operations. A security incident such as a bomb threat which could cause a rupture of the pipeline and a product release, injury or mortality of wildlife, fire or severe contamination of aquatic ecosystems, could potentially be considered a significant adverse residual effect. The probability of such an incident occurring is low (Table 7.9-3, point [i]). The potential effects of a product release during operations are discussed further in Volume 7. Other security incidents such as theft or minor vandalism, while illegal, would likely be of low magnitude and reversible in the immediate to short-term if repair or replacement is relatively easy.

Engagement with communities along the proposed pipeline corridor will be ongoing, including discussions about how Trans Mountain addresses pipeline safety and how the community may assist, such as reporting suspicious behaviour around the pipeline or facilities, if observed. Trans Mountain will work with emergency services (*e.g.,* fire and police) to ensure that there are resources available to respond to a major security incident such as a bombing or fire, should it occur during construction or over the lifetime of the Project.

This adverse residual effect is relevant to the indicators of surface water quality under Section 7.2.3 Water Quality and Quantity, fish mortality or injury and fish indicator species under Section 7.2.7 Fish and Fish Habitat, and wildlife indicator species under Section 7.2.10 Wildlife and Wildlife Habitat. A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Wildlife LSA – the effects of a security incident could be confined to the Footprint or extend into the Wildlife LSA.
- Duration: immediate – acts of criminal activity would likely be conducted as quickly as possible in order to avoid being seen by a worker or the general public (*i.e.,* less than or equal to two days).
- Frequency: accidental – although the act of a security incident such as vandalism, theft, damage to the proposed or existing pipeline and facilities, or fire would be deliberate, it is expected to occur rarely, if at all.
- Reversibility: short to long-term – an act of vandalism resulting in minor disturbance to the environment may be remediated during the construction phase or within any one year during the operations phase (short-term), while other acts (*e.g.,* a bombing) resulting in injury or death to wildlife may take several years to replace the individual within the species population, depending on the species (medium-term). Damage to habitat from a fire would be reversible in the long-term.
- Magnitude: low to high – depending on the type and severity of effects caused by the security incident.
- Probability: low – the probability of a security incident occurring is based on actual location.
- Confidence: moderate – based on the professional experience of the assessment team.

7.9.6 Summary

As identified in Table 7.9-3, the probability of a significant residual environmental effect arising from accidents and malfunctions as a result of the construction and operations of the Project is low.

7.10 Changes to the Project Caused by the Environment

Trans Mountain has been operating a pipeline system and associated facilities in Canada for over 60 years and is aware of the typical, as well as the range of atypical, environmental conditions experienced along their system. This knowledge is reflected in the engineering design and mitigation measures proposed to address these environmental conditions. In particular, Trans Mountain's Natural Hazard's Management Program was designed to mitigate and avoid many of these potential effects such that they will have little, if any effect on the Project.

7.10.1 Environmental Conditions Not Considered

The following environmental conditions were not considered to have the potential to adversely affect the Project either during construction or operations or both:

- severe weather events including high wind speeds, heavy/persistent precipitation, extreme temperatures and lightning;
- permafrost degradation;
- acid rock drainage (ARD);
- snow avalanche;
- volcanic eruption; and
- tsunami.

7.10.1.1 Severe Weather

High winds could result in the suspension of some construction activities such as topsoil/root zone material salvage, clearing, slash burning and welding. Although this could temporarily delay construction activities, the buried pipeline and above ground facilities will not be adversely affected by high winds. Consequently, no adverse effects on the Project are anticipated due to wind, regardless of wind direction.

Heavy or persistent precipitation could result in the delay of pipeline construction if topsoil/root zone material salvage activities have not been completed or if wet soil conditions create safety or traffic-related problems. Delays in construction due to severe weather conditions are expected to be short in duration, and heavy precipitation will not adversely affect the buried pipeline or above ground facilities. Trans Mountain will monitor the condition of the right-of-way in a timely manner after any heavy rainfall events to look for erosion or washout areas and remediate any damage to protect the integrity of the pipeline. Although it is unlikely, severe persistent precipitation could affect access to above ground facilities during operations.

Extremely cold temperatures create safety hazards for workers. However, delays in construction due to severe weather conditions are expected to be short in duration. Equipment and instruments will be constructed of materials suitable for climate conditions along the corridor, including unusually extreme temperatures, without any risk to pipeline integrity or facility operation. As a result, no adverse effects on the Project are anticipated to result from inclement weather.

Lightning has the potential to affect the power supply and damage buildings or above ground equipment (*i.e.,* block valves, cathodic protection equipment), and ignite wildfires (Section 7.10.4). Buildings and above ground equipment will be grounded in accordance with provincial and National Building Codes to minimize the risk of damage due to lightning. Consequently, the risk of damage to the pipeline and above ground facilities is considered to be low and no changes to the Project are anticipated to result from lightning.

7.10.1.2 Permafrost Degradation

As stated in Section 5.1.1, the proposed pipeline corridor does not encounter any areas of permafrost along any of the proposed pipeline segments in Alberta or BC. No changes to the Project are anticipated to result from permafrost degradation.

7.10.1.3 Acid Rock Drainage

Exposing, excavating or reusing rock during construction can increase the likelihood of ARD from sulphide-bearing rocks due to increased interaction with water and oxygen and larger surface areas relative to undisturbed rock. The effects of the Project on ARD are discussed in Section 7.2.1 Physical and Meteorological Environment. Undisturbed PAG rock is not expected to cause adverse effects on the Project since the pipeline coating will prevent any damage caused by ARD or metal leaching. Further information is provided in the Acid Rock Drainage and Metal Leaching Potential Technical Report of Volume 5C.

7.10.1.4 Snow Avalanche

A snow avalanche is not likely to affect a buried pipeline. One area along the proposed pipeline corridor near the Coquihalla Summit was identified as a potential snow avalanche area; further work related to avalanche zone evaluation is ongoing for construction and operational safety. The additional weight of snow and debris from an avalanche are not anticipated to compromise the structural integrity of the pipe.

7.10.1.5 Volcanic Eruption

The risk of volcanic eruption was brought up as a concern by a participant of the Chilliwack Community Workshop. Ash from volcanoes would not affect the buried pipeline or the structural integrity of above ground facilities, but would likely require some clean up at facilities. of more concern is the seismic activity associated with an eruption. A discussion on seismic hazards is provided in Section 7.10.4.

7.10.1.6 Tsunami

A study of tsunami hazards to the shorelines of North and West Vancouver was conducted in 2005. Computer models of large subaqueous block slides on the western foreslope of the Fraser delta indicate that waves about 2 m high would strike adjacent shorelines shortly after the landslide (Clague and Orwin 2005). Such waves could also occur in the event of seismic activity. However, no evidence of such waves was detected in the geological record, suggesting these large waves, if they occur, are extremely rare. Project design has taken into account a potential tsunami wave occurring at the Westridge Marine Terminal. Waves of this size (*i.e.*, approximately 2 m high) would not adversely affect tankers travelling to and from the terminal, and waves of a size that would affect tankers are considered extremely rare and unlikely. In addition, the location of the Westridge Marine Terminal, being sheltered within Burrard Inlet, lessens the chance of any adverse effects from large waves in the unlikely event of a Pacific tsunami.

7.10.2 Potential Effects and Mitigation Measures

Environmental conditions may have adverse effects on the Project. Natural hazards are naturally occurring events that may have a negative effect on people, the environment or in this case, the Project. Geohazards are a subset of natural hazards which can present severe threats to people, property and natural and built environments, and are generally divided into two classes, slope processes and fluvial processes. Geohazards pose potential threats to pipeline projects during construction with respect to worker safety, and during operations with respect to potential damage to infrastructure and the safety of operating personnel (see Terrain Mapping and Geohazard Inventory Report of Volume 4A). The following environmental conditions were identified by the assessment team as having the potential to adversely affect the Project either during construction or operations or both:

- hydrotechnical hazards (*i.e.,* flooding, scour, bank erosion, debris floods, debris flows and avulsion);
- geotechnical hazards (*i.e.,* rock slope hazards and soil slope hazards);

- seismic hazards (*i.e.,* liquefaction, fault displacement, strong shaking and historic faults);
- wildfires;
- changing climate; and
- sea level rise.

Table 7.10-1 summarizes these potential environmental conditions and provides mitigation measures to reduce the potential effects on the Project.

TABLE 7.10-1

POTENTIAL EFFECTS, MITIGATION MEASURES AND RESIDUAL EFFECTS OF CHANGES TO THE PROJECT CAUSED BY THE ENVIRONMENT

Potential Effect	Project Component	Spatial Boundary	Key Recommendations/Mitigation Measures [EPP Reference][1]	Potential Residual Effect(s)
1. Hydrotechnical hazards – flooding and erosion caused by hydrotechnical hazards	New pipeline segments Reactivated pipeline segments	Water Quality and Quantity LSA	• Postpone instream water crossing construction if excessive flows or flood conditions are present or anticipated. Ensure that all spoil piles are moved above the anticipated flood line. Resume activities when water levels have subsided or equipment/techniques suitable for conditions are deployed [Section 8.7.1]. • Implement KMC's Emergency Response Plan as well as the Flood and Excessive Flow Contingency Plan in the event of a flood or excessive stream flow (*i.e.,* greater than the seasonally expected normal range based on existing and predicted flow data) during construction [Appendix B]. See also the Soil Erosion and Sediment Control Contingency Plan [Appendix B]. • Implement the Natural Hazards Management Program in KMC's Canadian Integrity Management Program in the event of a hydrotechnical hazard. • Ensure pipeline burial depths at watercourses have taken into consideration flood events and scouring of the bed so that risk to the integrity of the pipeline due to such events is minimal. • Monitor the pipeline depth of cover within watercourses, when warranted, throughout the life of the pipeline. Complete remedial work where warranted to protect pipeline integrity. • Weight the pipeline to prevent buoyancy if poor soils/organic soils are encountered with water in the trench. • Avoid known problem areas. • Employ trenchless crossing techniques. • Use of thicker walled pipe to prevent damage from scouring and erosion.	• Loss of cover over the pipeline may occur at localized areas as a result of an extreme flood and, in rare occasions, result in damage to the pipeline. • Pipeline may become buoyant and float to the surface in flooded areas.
2. Geotechnical hazards – movement of soil and surficial materials	New pipeline segments Reactivated pipeline segments	Soil LSA	• Replace grade material to a stable contour that will approximate the pre-construction contour, except where it is not practical or safe to do so. When replacing sidehill or other graded areas is not practical due to the risk of slope failure, the Lead Activity Inspector, the Lead Environmental Inspector, the Inspector(s), the Construction Manager and a Geotechnical Engineer will discuss to determine an appropriate grade [Section 8.4]. • Assess the erosion hazard prior to the commencement of rough and final clean-up. This assessment, to be conducted by Trans Mountain's Inspector(s) in consultation with the Construction Manager, will consider topography, degree of disturbance, soil erodibility, snow depth, access limitations, timing constraints, and the likely schedule for rough clean-up, final clean-up and seeding. Request assistance in conducting the assessment, if warranted, from Trans Mountain's Environmental Manager, or the Geotechnical, Soil or Reclamation Resource Specialist [Section 8.6.1]. • Implement the Natural Hazards Management Program in KMC's Canadian Integrity Management Program in the event of a geotechnical hazard. • Areas of potential geotechnical instability will be monitored through regular aerial patrols during pipeline operations and remedial action will be promptly conducted, where warranted.	• Rock and soil slope hazards may result in movement of soil and surficial materials over the pipeline that may expose or damage the pipeline.

TABLE 7.10-1 Cont'd

Potential Effect	Project Component	Spatial Boundary	Key Recommendations/Mitigation Measures [EPP Reference][1]	Potential Residual Effect(s)
2. Geotechnical hazards – movement of soil and surficial materials (cont'd)	See above	See above	• Select geotechnically stable route over potentially unstable ones. • Employ shoreline dredging as required to ensure geotechnical stability at the Westridge Marine Terminal.	• See above.
3. Seismic hazards	All	Soil LSA	• Suspend work immediately in the event of a seismic event. Refer to Volume 4B, Section 5.4 for the Emergency Response Plan for further response measures to be taken in the event of seismic activity occurring during construction [Section 7.0]. • Implement KMC's Natural Hazards Management Program. • Further assessments will be conducted along the proposed pipeline corridor to assess site-specific seismic potential. • Pump stations will be equipped with vibration monitoring equipment.	• Seismic activity may damage the pipeline or facilities.
4. Wildfire	All	Wildlife LSA	• Follow the fire suppression measures of the Fire Contingency Plan [Appendix B]. • Implement the Emergency Response Plan and Fire Contingency Plan in Section 3.5 of Volume 4B, as well as KMC's Emergency Response Plan. • See Section 7.9 Accidents and Malfunctions for mitigation measures in the unlikely event that a fire is caused by Project construction activities.	• Depending on the severity, a wildfire could affect the construction schedule or the scheduling of maintenance activities. • Loss of pipeline cover may occur from soil ignition during fire and, in rare occasions, result in pipeline damage.
5. Changing climate	All	Water Quality and Quantity LSA Soil LSA Air Quality RSA / LFV	• Consider the changes to weather trends (*e.g.,* snow pack conditions, timing and intensity of runoff and discharge within watercourses, amount of rainfall) within the Project area when scheduling maintenance activities along the proposed pipeline corridor. • Be prepared for changes in construction plans to accommodate shifts in seasons (*e.g.*, earlier or enhanced snow melt, early thaw, late freezing). • See recommended mitigation measures outlined in potential effects 1 and 4 of this table for potential effects that are potentially exacerbated by changing climate (*e.g.*, altered temperature / hydrologic regimes and wildfires).	• Depending on the type and severity of the change in weather trends, the scheduling of maintenance activities may be affected. • Loss of cover over the pipeline may occur at localized areas as a result of an extreme flood event (see potential effect 1 of this table). • Pipeline may become buoyant and float to the surface in flooded areas (see potential effect 1 of this table). • Loss of pipeline cover may occur from soil ignition during fire, or from wind erosion in areas experiencing drought and, in rare occasions, result in pipeline damage.
6. Sea level rise	Westridge Marine Terminal	Marine Sediment and Water Quality LSA	• Engineering has considered sea level rise in design. • Implement KMC's Natural Hazards Management Program. • Employ shoreline dredging as required to ensure geotechnical stability at the Westridge Marine Terminal.	• Waves over-topping the dock leading to safety hazards, terminal downtime or damage to infrastructure.

Note: 1 Detailed mitigation measures are outlined in the Pipeline EPP (Volume 6B).

7.10.3 Potential Residual Effects

The potential residual effects of the changes to the Project caused by the environment (Table 7.10-1) are:

- loss of cover over the pipeline may occur at localized areas as a result of an extreme flood and, in rare occasions, result in damage to the pipeline;
- pipeline may become buoyant and float to the surface in flooded areas;
- rock and soil slope hazards may result in movement of soil and surficial materials over the pipeline that may expose or damage the pipeline;
- seismic activity may damage the pipeline or facilities;
- depending on the severity, a wildfire could affect the construction schedule or the scheduling of maintenance activities;
- depending on the type and severity of the change in weather trends, the scheduling of maintenance activities may be affected;
- loss of pipeline cover may occur from soil ignition during fire, or from wind erosion in areas experiencing drought and, in rare occasions, result in pipeline damage; and
- waves over-topping the dock leading to safety hazards, terminal downtime or damage to infrastructure.

7.10.4 Significance Evaluation of Potential Residual Effects

Table 7.10-2 provides a summary of the significance evaluation of potential residual effects of the changes to the Project caused by the environment. The rationale used to evaluate the significance of each of the residual effects is provided below.

TABLE 7.10-2

SIGNIFICANCE EVALUATION OF POTENTIAL RESIDUAL EFFECTS OF CHANGES TO THE PROJECT CAUSED BY THE ENVIRONMENT

Potential Residual Effects	Impact Balance	Spatial Boundary	Temporal Context			Magnitude	Probability	Confidence	Significance[1]
			Duration	Frequency	Reversibility				
(a) Loss of cover over the pipeline may occur at localized areas as a result of an extreme flood and, in rare occasions, result in damage to the pipeline.	Negative	Water Quality and Quantity LSA	Immediate to short-term	Accidental	Short to long-term	Low to high	Low	Moderate	Not significant
(b) Pipeline may become buoyant and float to the surface in flooded areas.	Negative	Water Quality and Quantity LSA	Immediate to short-term	Accidental	Short-term	Low to medium	Low	Moderate	Not significant
(c) Rock and soil slope hazards may result in movement of soil and surficial materials over the pipeline that may expose or damage the pipeline.	Negative	Soil LSA	Immediate	Accidental	Short to long-term	Low to high	Low	Moderate	Not significant
(d) Seismic activity may damage the pipeline or facilities.	Negative	Soil LSA	Immediate	Accidental	Short to long-term	Low to high	Low	Moderate	Not significant
(e) Depending on the severity, a wildfire could affect the construction schedule or the scheduling of maintenance activities.	Negative	Wildlife LSA	Immediate to short-term	Accidental	Short-term	Low	Low	High	Not significant

TABLE 7.10-2 Cont'd

Potential Residual Effects	Impact Balance	Spatial Boundary	Temporal Context: Duration	Temporal Context: Frequency	Temporal Context: Reversibility	Magnitude	Probability	Confidence	Significance[1]
(f) Loss of cover over the pipeline may occur at localized areas as a result of an extreme flood and, in rare occasions, result in damage to the pipeline.	Negative	Water Quality and Quantity LSA	Immediate to short-term	Accidental	Short to long-term	Low to high	Low	Moderate	Not significant
(g) Depending on the type and severity of the change in climate trends, the scheduling of maintenance activities may be affected.	Negative	Water Quality and Quantity LSA	Immediate to short-term	Accidental	Short-term	Low	Low	High	Not significant
(h) Loss of pipeline cover may occur from soil ignition during fire, or from wind erosion in areas experiencing drought and, in rare occasions, result in pipeline damage.	Negative	Footprint	Immediate to short-term	Accidental	Short to long-term	Low to high	Low	Moderate	Not significant
(i) Waves over-topping the dock leading to safety hazards, terminal downtime or damage to infrastructure.	Negative	Marine Sediment and Water Quality LSA	Immediate	Occasional	Short-term	Low	Low	Moderate	Not significant

Note: 1 Significant Residual Environmental Effect: A high probability of occurrence of a permanent or long-term residual effect of high magnitude that cannot be technically or economically mitigated.

Loss of Cover Over the Pipeline or Pipe Buoyancy as a Result of an Extreme Flood Event

An assessment of hydrotechnical hazards along the proposed pipeline corridor was conducted by BGC Engineering Inc. (see the Terrain Mapping and Geohazard Inventory Report of Volume 4A). Types of hydrotechnical hazards identified in the inventory include flooding, scour, bank erosion, debris floods, debris flows and avulsion. Hydrotechnical hazards are present throughout the proposed pipeline corridor, but most were observed in the Interior Plateau (Shuswap) Physiographic Region along the Hargreaves to Darfield Segment.

Concerns regarding flooding were raised in BC by participants of the Abbotsford, Surrey, Coquitlam, Kamloops, Langley, Merritt and Hope Community Workshops, as well as at the Surrey ESA Workshop. Locations where flooding and other hydrotechnical hazards were identified by participants included the Westsyde area near Kamloops, the Nicola River (prone to changing course), the Coquihalla River and Coquihalla Canyon near Hope, Sumas prairie near Abbotsford, the area north of the Fraser River near Coquitlam, and Dewdney Creek near Surrey. Participants at the Surrey ESA Workshop and Langley Community Workshop also raised concerns about the pipe floating to the surface in areas of the Lower Mainland where there could be prolonged flooding.

An extreme flood event, either during construction or operations, could result in a loss of cover over the pipeline along floodplains and in watercourses along the proposed pipeline corridor. Since the proposed pipeline will be carrying oil and will be buried at sufficient depth, the pipeline will not float to the surface even in areas with prolonged flooding. The pipeline will be designed to withstand a 200 year flood event and will have deeper cover in locations with high erosion risk. The potential effects of flooding and associated mitigation vary depending on the timing, location and magnitude of the event. A flood event that occurs immediately prior to the commencement of instream construction at a water crossing could delay construction activities and, in extreme cases, threaten the integrity of the temporary vehicle crossing.

Should flooding occur during construction of a trenched watercourse crossing, the increased flows could exceed the capability of the dams, pumps or flumes used to isolate the construction area or erode onshore spoil piles. In the unlikely event that flooding occurs during instream construction, water quality would likely be somewhat reduced due to an incremental increase in TSS over the slightly elevated TSS levels that are commonly associated with instream construction. The Flood and Excessive Flow Contingency Plan outlined in Appendix B of the Pipeline EPP (Volume 6B) would be implemented to reduce the effects of high water levels during instream construction. The risk of a flood occurring during instream construction is considered to be low since construction is scheduled to avoid peak flows, or if scheduling during peak flows cannot be avoided, a trenchless crossing method would be considered. Specifications for the different methods to be used for buoyancy control will be developed during the detailed engineering and design phase of the Project. In addition, the weather forecast applicable to the watershed for the anticipated crossing construction period can be reviewed immediately prior to commencement of crossing construction enabling the timely implementation of measures to mitigate any concerns.

Instream watercourse crossing construction is proposed after peak flows and the pipeline will be buried deep enough to reduce the potential effects of flooding, as well as associated erosion and scouring. Site-specific design will determine if the pipeline will be weighted down in certain floodplain areas to prevent buoyancy of the pipe. Nevertheless, line patrols during operations will pay particular attention to the bed and banks of watercourse crossings following floods to further ensure the integrity of the pipeline and reduce the potential effects on the aquatic environment. Remedial measures will be taken immediately, where warranted, following receipt of applicable approvals.

In the 60 years that the existing TMPL has been operating, extreme flood events have occurred that resulted in exposure of the pipe that required restoration and the implementation of KMC's Natural Hazards Management Program. River bed cover is monitored after extreme flood events and inspected every 2 years at all crossings regardless of whether a flood event has occurred or not. Trans Mountain uses its Natural Hazards Management Program to monitor and protect against damage to the pipeline from unstable slopes. Established in 1998, this program uses a custom database to document inspections and preventative maintenance work at more than 600 sites along the existing TMPL right-of-way and to schedule future inspection frequency based on risk. Consequently, the probability of a flood affecting the Project and resulting in a significant adverse environmental effect is low. This residual effect is considered to be reversible in the short to long-term and is of low to high magnitude (Table 7.10-2, points [a] and [b]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Water Quality and Quantity LSA – effects associated with the loss of cover or pipeline buoyancy as a result of an extreme flood event may extend beyond the construction right-of-way.
- Duration: immediate to short-term – the event causing the loss of cover (*i.e.,* an extreme flood event) or the pipeline to potentially float to the surface is prolonged flooding in floodplain areas, which could last less than two days, or more than two days but less than one year.
- Frequency: accidental – an extreme flood event is rare.
- Reversibility: short to long-term – the effects associated with flooding may take greater than two days but less than one year to reverse the effect. However, in the event of an extreme flooding event where damage to the pipeline may cause a spill, the effects on the environment may take greater than 10 years to reverse, depending on the location.
- Magnitude: low to high – depending on the timing, location and magnitude of the flood event. For most events, damage to the pipe is negligible or minimal (low) whereas if damage was extensive and resulted in a spill, the magnitude of environmental effects could be high depending on the volume of the spill sensitivity of the receiving environment.
- Probability: low – it is unlikely that an extreme flood event will occur that would result in a loss of cover or depth of cover over the proposed pipeline, damage the pipeline or cause the pipe to float to the surface, or exceed the capacity of isolation equipment or erode onshore spoil piles during construction.
- Confidence: moderate – based on the professional experience of the assessment team.

Rock and Soil Slope Hazards May Result in Exposure or Damage to the Pipeline

An assessment of geotechnical hazards along the proposed pipeline corridor was conducted by BGC Engineering Inc. (see the Terrain Mapping and Geohazard Inventory Report of Volume 4A). Types of geotechnical hazards identified in the inventory include rock slope hazards (*e.g.,* rockfall, extremely rapid rockslides, rock debris, rock slumps) and soil slope hazards (*e.g.,* slow earth slides, rapid earth slides, soil raveling [cut slopes] and slow earthflows). Geotechnical hazards are focused in the mountainous regions along the proposed pipeline corridor (*i.e.,* the Interior Plateau [Thompson] and Cascade Mountains Physiographic Regions along the Black Pines to Hope Segment) where there are narrow valleys. The most common type of geotechnical hazard identified is rockfall (natural and cut slopes).

Depending on the location and size of the event, a geotechnical hazard could cause movement of soil and surficial materials in the vicinity of the buried pipeline, which could result in exposure of the pipe or damage to the pipe's integrity. Engineering and design of the pipeline has taken into consideration the potential for geotechnical hazards along the proposed pipeline corridor. In addition, implementation of the mitigation measures (Table 7.10-1) will reduce the risk of a geotechnical hazard adversely affecting the pipeline. Additional information on the potential for an extreme geotechnical event that could damage the pipeline and result in a spill is provided in Volume 7. Areas of potential geotechnical instability will be avoided where practical and monitored through regular aerial patrols during pipeline operations and remedial action will be promptly conducted, where warranted. Through Trans Mountain's Pipeline Integrity Program, aerial surveillances are conducted to monitor for geotechnical events such as landslides at least once a month for every section of the existing TMPL right-of-way and the proposed pipeline will be integrated into this program. Consequently, the probability of a geotechnical hazard affecting the Project and resulting in a significant adverse environmental effect is low. This residual effect is considered to be reversible in the short to long-term and is of low to high magnitude (Table 7.10-2, point [c]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Soil LSA – effects associated with rock or soil slope hazards causing exposure or damage to the pipeline may extend beyond the construction right-of-way.
- Duration: immediate – the event causing exposure or damage to the pipeline (*i.e.,* rock or soil slope hazards) is expected to last less than two days.
- Frequency: accidental – rock or soil slope hazards causing movement of soil or surficial material over the buried pipeline is rare.
- Reversibility: short to long-term – effects associated with exposure or damage to the pipeline as a result of a geotechnical hazard event may take greater than two days but less than one year to reverse the effect. For extreme events where damage to the pipeline results in a spill, the potential environmental effects could take more than 10 years to reverse (*e.g.,* mature vegetation communities).
- Magnitude: low to high – depending on the location and magnitude of the geotechnical hazard event. For some events, the damage to the pipeline may be minimal (low) whereas if damage was extensive and resulted in a spill, the magnitude of environmental effects could be high depending on the volume of the spill and sensitivity of the receiving environment.
- Probability: low – it is unlikely that a rock or soil slope hazard will occur that would result in movement of soil or surficial material in the vicinity of the buried pipeline causing exposure or damage to the pipe.
- Confidence: moderate – based on the professional experience of the assessment team.

Seismic Activity May Damage the Pipeline or Facilities

A desktop study of seismic hazards along the proposed pipeline corridor was conducted by BGC Engineering Inc. (see the Terrain Mapping and Geohazard Inventory Report and Seismic Assessment Desktop Study of Volume 4A). Types of seismic hazards identified in the inventory include liquefaction, seismically induced landsliding, strong shaking and surface fault rupture. The strongest ground motions and largest liquefaction potential are anticipated in the Georgia Depression physiographic region (Hope to

Burnaby Segment). Most seismically induced landslide potential occurs around steep terrain in the Columbia Mountains, Interior Plateau, Cascade Mountains and Georgia Basin (Hargreaves to Darfield and Black Pines to Hope segments). Surface fault rupture may present a hazard in the Georgia Basin and Rocky Mountain Trench regions (between Hargreaves and Rearguard pump stations and in the Hope to Burnaby Segment).

Seismic activity has the potential to affect the integrity of the pipeline and other facilities during the operations phase of the Project. Concerns regarding earthquakes and liquefaction in the Lower Mainland were raised by participants of the Burnaby, Chilliwack, Coquitlam and Surrey Community Workshops. In addition, questions regarding design of the Project and how it will withstand an earthquake were posted in the online forum on Trans Mountain's website.

The commitment of Trans Mountain to reduce the earthquake risk to the existing TMPL is ongoing and includes several investigations and major construction mitigation measures. Further seismic assessments along the proposed pipeline corridor and existing TMPL will include site-specific assessment of: ground-shaking amplification; the potential and anticipated displacement due to liquefaction and landsliding triggered by shaking; and the location, likelihood and anticipated displacement at fault crossings (see Volume 4A for further details).

Through its experience with managing pipelines in the varied terrain of North America, Trans Mountain is very aware of the effect of geologic processes on its pipeline infrastructure. Trans Mountain's Natural Hazards Management Program is one of the key tools for managing geohazard risk to pipeline infrastructure. Trans Mountain is committed to reducing the earthquake risks to the existing TMPL and proactively assess earthquake hazards with consideration of advancements in understanding how pipelines perform during seismic events. Where the pipeline or facilities are determined to be at risk of failure from an earthquake, pipeline infrastructure improvement projects are completed to reduce the risk. Trans Mountain has also prepared an Earthquake Action Protocol to rapidly prioritize locations for pipeline inspection following an earthquake. This protocol includes shutting down and isolating the pipeline in the event of a serious earthquake.

If a seismic event occurs, work will be suspended immediately and the Emergency Response Plan for the Project and KMC's Emergency Response Plan will be implemented for further response measures. The probability of a seismic event affecting the Project and resulting in a significant adverse environmental effect is low. This residual effect is considered to be reversible in the short to long-term and is of low to high magnitude (Table 7.10-2, point [d]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Soil LSA – effects associated with a seismic event may extend beyond the construction right-of-way.
- Duration: immediate – a seismic event lasts less than two days.
- Frequency: accidental – seismic events that have the potential to cause damage to the pipeline resulting in adverse effects on the environment or facilities are rare.
- Reversibility: short to long-term – the effects on the environment resulting from damage to the pipeline or facilities as a result of a seismic event may take greater than two days but less than one year to reverse the effect. For extreme seismic events where the pipeline or facility damage could result in a spill, the potential environmental effects may take more than 10 years to reverse depending on the volume of spill and the sensitivity of the receiving environment.
- Magnitude: low to high – depending on the type, location and severity of the seismic event.
- Probability: low – it is unlikely that a seismic event will occur that would result in damage to the pipeline or facilities.
- Confidence: moderate – based on the professional experience of the assessment team.

Wildfire

A wildfire in the immediate vicinity of the proposed pipeline corridor during the construction phase, although unlikely, could delay construction activities along the affected portions of the proposed pipeline corridor. Participants of the Merritt and Blue River Community Workshops noted that the fire hazard in interior BC can be high in the summer and burning restrictions may be implemented. Construction activities and/or construction-related traffic would be suspended in potentially affected areas if conditions were considered to be unsafe by Trans Mountain's Construction Manager or if requested by the appropriate authority (*i.e.,* AESRD or BC MFLNRO). Contingency measures identified in the Fire Contingency Plan (Appendix B of the Pipeline EPP of Volume 6B) have been prepared to ensure that appropriate and effective procedures and materials are in place in the event of a wildfire during construction of the Project. The short delay of construction activities due to wildfire generally would be considered as having a minor effect on the Project, with the exception of a severe wildfire, which could affect large portions of the proposed pipeline corridor and could delay the resumption of construction activities into another season.

During the operations phase, forest fires are unlikely to adversely affect the buried pipeline other than potential loss of cover from soil combustion or structural changes (point [g] discussed below). However, wildfires could affect above ground facilities and maintenance activities. KMC's Emergency Response Program will be implemented in the event of a wildfire potentially affecting Trans Mountain facilities. The probability of a fire resulting in a significant adverse environmental effect is low (Table 7.10-2, point [e]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Wildlife LSA – a wildfire in the Wildlife LSA could affect access to the construction right-of-way and, consequently, the construction schedule.
- Duration: immediate to short-term – the event affecting the construction schedule (*i.e.,* wildfire) may take more than two days to control depending on the severity of the fire.
- Frequency: accidental – a wildfire affecting aboveground facilities is rare in the Project area.
- Reversibility: short-term – it is likely that construction activities, should they shut-down due to a wildfire, would resume within a year.
- Magnitude: low – the location of the Project is accessible for construction throughout the year and, therefore, could accommodate a delay into another season.
- Probability: low – it is unlikely that a wildfire will occur.
- Confidence: high – based on the professional experience of the assessment team.

Changing Climate – Alteration of Scheduling of Maintenance Activities

Changes to climate during operations of the pipeline may manifest in several ways (*e.g.*, in a long-term increase of annual average temperatures or in the increased occurrence of extreme events). Trans Mountain has been operating for 60 years, over which they have encountered a variety of environmental conditions. It is understood that past environmental conditions may not be representative of conditions under future climate change. For example, extreme events that have occurred only every few decades over the last 60 years might occur more frequently or with greater magnitude during future Project operation. Therefore, Trans Mountain will adaptively manage potential residual effects associated with changing climate through the Natural Hazards Management Program.

Increased snow pack in winter and extended warm temperatures in spring may intensify runoff and alter hydrologic regimes within watercourses, including timing and duration of peak flows. Changes in summer temperatures and rainfall patterns could lead to an increase in wildfires or drought. During operations of the Project, it is expected that Trans Mountain will be adaptive in their management of the pipeline and schedule maintenance activities to accommodate local environmental conditions (*e.g.,* conducting activity in riparian areas during periods of low flow and least risk) and implement the appropriate protection measures to suit local environmental conditions thereby reducing the potential environmental effects. By utilizing adaptive management practices that are responsive to changing conditions, this residual effect is considered to be reversible in the short-term and of low magnitude (Table 7.10-2, point [f]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Water Quality and Quantity LSA – changing weather trends in the Water Quality and Quantity LSA could affect the maintenance schedule.
- Duration: immediate to short-term – the event affecting the maintenance schedule (*i.e.,* increased intensity and duration of peak flows, wildfires) may last more than two days depending on the severity.
- Frequency: accidental – events causing the change in maintenance schedule (*i.e.,* increased intensity and duration of peak flows, wildfires) are rare in the Project area.
- Reversibility: short-term – it is likely that maintenance activities affected by changes in weather trends could be rescheduled within a year.
- Magnitude: low – most maintenance activities are routine and, consequently, can accommodate a change in schedule.
- Probability: low – Trans Mountain's adaptive management practices would accommodate local ground conditions in light of changing weather trends.
- Confidence: high – based on the professional experience of the assessment team.

Concerns were brought up by participants of the Coquitlam Community Workshop and Surrey ESA Workshop regarding increasing storms, streamflows, and increasing flood intensity and frequency attributed to climate change, and asked how the Project would be designed to withstand such conditions. Project design and engineering of the proposed pipeline is considering climate change and the conditions the pipeline will experience over the length of the operations phase. If an extreme flood event were to occur during construction or operations of the pipeline, mitigation measures would be implemented as discussed in Table 7.10-1. Potential residual effects associated with loss of cover over the pipeline and pipe buoyancy caused by an extreme flood event are discussed above (Table 7.10-2, points [a] and [b]).

Loss of Pipeline Cover From Fire or Drought

In addition to the combustion of woody and plant materials, wildfires may also cause soil to burn. In extreme cases, this could result in a loss of pipeline cover and exposure of the pipeline to damage in a similar manner to flooding described above (Table 7.10-2, point [a]). However, fires can also alter the chemical and structural properties of soil. In particular, increased hydrophobocity can occur, which results in decreased infiltration and increased runoff which can lead to erosion and soil loss (BC Ministry of Agriculture 2013). Similarly, increased drought in dry areas (*e.g.*, Kamloops) associated with climate change contributes to making soil more vulnerable to wind erosion and, therefore, a loss of pipeline cover. However, Trans Mountain's regularly scheduled maintenance and aerial patrols, as well as adaptive management will ensure that these effects are reversible in the short to long-term. A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: Footprint – a wildfire or drought in the construction right-of-way will affect the soil cover immediately over the pipeline.
- Duration: immediate to short-term – the event affecting the soil cover and pipeline integrity is a wildfire or drought event, which could last less than two days, or more than two days but less than one year.
- Frequency: accidental – a wildfire or drought affecting soil cover is rare in the Project area.
- Reversibility: short to long-term – should the pipeline be exposed or damaged due to soil loss from drought or fire, the effect should be reversed within a year. However, in the rare and extreme case where such exposure causes damage to the pipeline and results in a spill, it may take longer than 10 years to reverse the environmental effect.

- Magnitude: low to high – depending on the timing, location and severity of the event, damage to the pipe may be negligible or non-existent, whereas if damage were extensive and resulted in a spill, the effects could be high depending on the amount spilled and the location of occurrence.
- Probability: low – it is unlikely that a wildfire or severe drought will occur that causes exposure or damage to the pipeline.
- Confidence: moderate – based on the professional experience of the assessment team and available literature; however, there are still substantial difficulties in modelling regional future changes in precipitation and the effects on wildfires and droughts.

Waves Over-topping the Dock Leading to Safety Hazards, Terminal Downtime and Damage to Infrastructure

Westridge Marine Terminal dock elevation will be designed to withstand a predicted 0.5 m increase in sea level (as of 2100). Waves associated with this increase as well as associated changes in sediment transport and coastal geomorphology in Burrard Inlet over the next 90 years are difficult to predict. Model parameters required to make such predictions would be highly speculative, and as a result, detailed modelling was not conducted.

Changing weather patterns are also difficult to predict with accuracy and are not expected to have the potential to adversely affect the Project on their own. However, when combined with sea level rise, changing weather patterns could result in larger and more frequent waves. These waves could overtop the dock and lead to short duration adverse effects as a result. The negative effects associated with waves over-topping the dock could include financial losses associated with terminal downtime, ship standby time and increased maintenance and replacement of dock infrastructure.

Based on Trans Mountain's 60 year operating history at the Westridge Marine Terminal within the relatively well protected waters of Burrard Inlet, the engineering considerations related to sea level rise leads to a low probability of waves over-topping the dock. Section 3.4 of Volume 4A includes a description of dock elevation and Figure 3.4.17 of Volume 4A displays the Typical Dolphin and Pile Foundation including elevation above the high water level. Wave energy is expected to dissipate within short-term reversibility. A summary of the rationale for all of the significance criteria is provided below (Table 7.10-2, point [h]).

- Spatial Boundary: Marine Sediment and Water Quality LSA – sea level rise could lead to waves over-topping the dock.
- Duration: immediate – waves from storms would not be expected to continue for more than two days.
- Frequency: occasional – events causing waves to overtop the dock would be sporadic and dependent on weather patterns.
- Reversibility: short-term – it is likely that any dock downtime could be rescheduled within a year.
- Magnitude: low – financial losses caused by terminal downtime or damage to infrastructure are expected to be recoverable.
- Probability: low – design of the dock has taken into consideration 0.5 m sea level rise.
- Confidence: moderate – based on the professional experience of the assessment team.

7.10.5 Summary

As identified in Table 7.10-2, the environmental effects resulting from the environment affecting the Project range from short to long-term reversibility and from low to high magnitude. However, the probability of effects is low. Consequently, it is concluded that the residual effects of the changes to the Project caused by the environment will be not significant.

7.11 Summary of Environmental Effects Assessment

7.11.1 Summary of the Assessment of Potential Effects of the Project on the Environment

This subsection provides an evaluation of combined adverse residual effects and is conducted for those indicators where more than one identified potential adverse residual effect may occur. A discussion of combined effects is included to clarify the overall effect of the Project on the environmental indicator in question and the overall effect of the Project on the environmental element. In addition, the overall effects of the Project on the element are evaluated in consideration of the objectives or goals of applicable land and resource use management plans, municipal development plans (MDPs) and government policies. A summary of the plans considered is provided in Appendix 7.1 and is not considered to be exhaustive.

7.11.1.1 Physical and Meteorological Environment

The evaluation of the effects of the Project on the physical environment element considers the combined effect of applicable Project components on each of the following physical environment indicators: terrain instability; topography; and acid generating and metal leaching rock.

Combined Effects on the Terrain Instability Indicator

The components of the Project which affect the terrain instability indicator include the construction and operations of the proposed pipeline, temporary facilities, pump stations and storage tanks, as well as construction and operations activities associated with the Westridge Marine Terminal. No potential effects were identified for terrain instability resulting from pipeline reactivation activities along the reactivated pipeline segments of Hinton to Hargreaves and Darfield to Black Pines. Furthermore, through the implementation of mitigation measures, no potential residual effects were identified for terrain instability at pump stations, storage tanks and the Westridge Marine Terminal. Therefore, the significance of the combined effects on terrain instability considers the construction and operations of new pipeline segments and temporary facilities and is summarized in Table 7.11.1-1.

The evaluation of the combined effects of the Project on the terrain instability indicator considers collectively the assessment of the combined effects on this indicator from construction and operations of all applicable Project components. Overall, the Project has the potential to cause terrain instability as a result of construction and operations activities along new pipeline segments and associated temporary facilities (*i.e.,* temporary access roads and borrow pits) at steep slopes, side hills, trenched watercourse crossings, where blasting is required and where excavation is required at borrow pits, which is considered to have a negative impact balance. Through implementation of industry standard and provincially recommended mitigation measures during the construction and operations phases of the Project, the combined effects of the Project on the terrain instability indicator are considered to be of low magnitude (Table 7.11.1-1, point 1[g]). A summary of the rationale for all of the significance criteria of combined effects on terrain instability is provided below.

- Spatial Boundary: Physical Environment LSA – combined effects of the Project on the terrain instability indicator as a result of construction activities may extend beyond the construction workspace.
- Duration: short-term – the event causing combined effects on the terrain instability indicator is construction of the pipeline (*e.g.,* grading and rough clean-up) and temporary facilities (*i.e.,* temporary access roads and borrow sites).
- Frequency: isolated – the event causing combined effects on the terrain instability indicator (*i.e.,* construction of the pipeline and temporary facilities) is confined to a specific period.
- Reversibility: short to medium-term – most areas of terrain instability will be remediated within a year, however, some areas may require a second or third year of remedial effort to fully stabilize.
- Magnitude: low – the implementation of the proposed mitigation measures in addition to detailed engineering design is expected to effectively reduce the severity and extent of combined effects on terrain instability.

- Probability: high – combined effects on terrain instability will likely occur.
- Confidence: high – based on data pertinent to the Project area and the professional experience of the assessment team.

Combined Effects on the Topography Indicator

The components of the Project which affect the topography indicator include the construction and operations of the proposed pipeline, temporary facilities, pump stations and storage tanks, as well as construction and operations activities associated with the Westridge Marine Terminal. No potential effects were identified for topography resulting from pipeline reactivation activities.

The evaluation of the combined effects of the Project on the topography indicator considers collectively the assessment of the combined effects on this indicator from construction and operations of all applicable Project components (Table 7.11.1-1). Overall, the Project has the potential to alter topography as a result of construction and operations activities along new pipeline segments, at associated temporary facilities (*i.e.,* temporary access roads and borrow pits), pump stations, storage tanks and the Westridge Marine Terminal where grading, blasting or cut slopes are required, which is considered to have a negative impact balance. Through implementation of industry standard and provincially and federally recommended mitigation measures during the construction and operations phases of the Project, the combined effects of the Project on the topography indicator are considered to be of low to medium magnitude (Table 7.11.1-1, point 2[g]). A summary of the rationale for all of the significance criteria of combined effects on topography is provided below.

- Spatial Boundary: Physical Environment LSA – combined effects on the topography indicator may extend beyond the construction workspace.
- Duration: short-term – the event causing the combined effects on the topography indicator is construction of Project components.
- Frequency: isolated – the event causing the combined effects on the topography indicator is confined to a specific period (*i.e.,* construction of the various Project components).
- Reversibility: permanent – combined effects on the topography indicator cannot be reversed.
- Magnitude: low to medium – combined effects on the topography indicator are anticipated to be largely mitigated during construction.
- Probability: high – combined effects on topography will likely occur.
- Confidence: high – based on data pertinent to the Project area and the professional experience of the assessment team.

Combined Effects on the Acid Generating and Metal Leaching Rock Indicator

The components of the Project which affect the acid generating and metal leaching rock indicator include the construction and operations of the proposed pipeline and temporary facilities. No potential effects were identified for generating and metal leaching rock resulting from construction and operations activities at pump stations, terminals and the Westridge Marine Terminal or pipeline reactivation activities.

The evaluation of the combined effects of the Project on the acid generating and metal leaching rock indicator considers collectively the assessment of the combined effects on this indicator from construction and operations of all applicable Project components (Table 7.11.1-1). Overall, the Project has the potential to cause acidification/contamination of the terrestrial and/or aquatic environment from ARD or metal leaching as a result of construction and operations activities along new pipeline segments and at associated temporary facilities (*i.e.,* temporary access roads and borrow pits) where fresh rock cut surfaces are exposed, which is considered to have a negative impact balance. Through implementation of industry standard recommended mitigation measures during the construction and operations phases of the Project, the combined effects of the Project on the acid generating and metal leaching rock indicator are considered to be of low magnitude (Table 7.11.1-1, point 3[g]). A summary of the rationale for all of the significance criteria of combined effects on acid generating and metal leaching rock is provided below.

- Spatial Boundary: Physical Environment LSA – any ARD or metal leaching may extend beyond the construction workspace.
- Duration: short-term – the event causing short-term ARD or metal leaching is exposure of bedrock material during construction until mitigation measures are implemented (*e.g.,* covering fresh surfaces, proper storage) or material is removed from site and properly disposed of.
- Frequency: isolated – ARD or metal leaching may be confined to exposed construction materials until covered or removed from site.
- Reversibility: short to medium-term – acidification/contamination of the terrestrial and/or aquatic environment from ARD or metal leaching may result in localized changes to the surrounding environment, which may take longer than one year to fully remediate.
- Magnitude: low – given implementation of the proposed mitigation measures to effectively reduce the potential effect and based on the material composition of identified PAG sites and the limited volume of materials being disturbed and exposed from construction.
- Probability: low – given implementation of the proposed mitigation measures to effectively reduce the potential effect and given the limited volume of materials being disturbed and exposed from construction.
- Confidence: high – based on data pertinent to the Project area and the professional experience of the assessment team.

Combined Effects of the Project on Physical Environment

The evaluation of the combined effects of the Project on the physical environment element considers collectively the assessment of the likely combined effects of the Project on the physical environment indicators. of the physical environment indicators, only two, terrain instability and topography have residual effects that are likely to occur and, consequently, are considered in the evaluation of combined effects of the Project on the physical environment element. The residual effects related to the acid generating and metal leaching rock indicator are of low probability and, therefore, do not form part of the evaluation of the overall effect of the Project on the physical environment.

Local and regional management plans with goals and objectives applicable to the physical environment aid in the assessment of Project-related effects on the physical environment element and influenced the kinds of mitigation strategies developed to reduce or avoid adverse effects. Goals and objectives in the various local and regional management plans relevant to physical environment are listed in Appendix 7.1 and include reducing alteration of topography and natural features, protecting areas of steep slopes, reducing erosion, and avoiding hazardous terrain. Other management plans listed in Appendix 7.1 were reviewed and determined to have no specific goals or objectives related to the physical environment element. With the successful implementation of the mitigation measures, and since Project activities will be conducted in accordance with all applicable federal, provincial and municipal legislation, the Project is not expected to interfere with goals and objectives of the various management plans relevant to the physical environment as listed in Appendix 7.1.

The combined effects of the Project on physical environment indicators are considered to be of low magnitude with the implementation of the proposed mitigation measures to reduce effects on terrain instability and alteration of topography (Table 7.11.1-1, point 4[a]). A summary of the rationale for all of the significance criteria of combined effects on the physical environment indicators is provided below.

- Spatial Boundary: Physical Environment LSA – combined effects of the Project on the physical environment indicators may extend beyond the construction workspace.
- Duration: short-term – the event causing the combined effects of the Project on physical environment indicators is construction of the various Project components.

- Frequency: isolated – the event causing the combined effects of the Project on the physical environment indicators is confined to a specific period (*i.e.,* construction of the pipeline and temporary facilities).
- Reversibility: short-term to permanent – combined effects of the Project on the physical environment indicators may be reversed following reclamation or remediation or may not be reversed where permanent alteration or environmental damage has occurred.
- Magnitude: low – combined effects of the Project on the physical environment indicators are not expected to interfere with goals and objectives of management plans relevant to the physical environment indicators.
- Probability: high – based on data pertinent to the Project area and the professional experience of the assessment team.
- Confidence: high – based on data pertinent to the Project area and the professional experience of the assessment team.

<u>Summary</u>

As identified in Table 7.11.1-1, there are no situations where there is a high probability of occurrence of a permanent or long-term environmental effect on physical environment of high magnitude that cannot be technically or economically mitigated. Consequently, it is concluded that the environmental effects of the Project on physical environment indicators will be not significant.

TABLE 7.11.1-1

SIGNIFICANCE EVALUATION OF THE PROJECT ON PHYSICAL ENVIRONMENT

	Potential Effect	Impact Balance	Spatial Boundary[1]	Temporal Context: Duration	Temporal Context: Frequency	Temporal Context: Reversibility	Magnitude	Probability	Confidence	Significance[2]
1.	Physical Environment – Terrain Instability									
1(a)	Combined effects from pipeline.	Negative	LSA	Short-term	Isolated	Short to medium-term	Low	High	High	Not significant
1(b)	Combined effects from temporary facilities.	Negative	LSA	Short-term	Isolated	Short to medium-term	Low	Low	High	Not significant
1(c)	Combined effects from pump station activities.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1(d)	Combined effects from tanks.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1(e)	Combined effects from Westridge Marine Terminal.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1(f)	Combined effects from pipeline reactivation.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1(g)	Combined effects of the Project on the terrain instability indicator (1[a]).	Negative	LSA	Short-term	Isolated	Short to medium-term	Low	High	High	Not significant
2.	Physical Environment – Topography									
2(a)	Combined effects from pipeline.	Negative	LSA	Short-term	Isolated	Permanent	Low to medium	High	High	Not significant
2(b)	Combined effects from temporary facilities.	Negative	LSA	Short-term	Isolated	Permanent	Low to medium	High	High	Not significant
2(c)	Combined effects from pump station activities.	Negative	Footprint	Short-term	Isolated	Permanent	Low	High	High	Not significant
2(d)	Combined effects from tanks.	Negative	Footprint	Short-term	Isolated	Permanent	Low	High	High	Not significant

TABLE 7.11.1-1 Cont'd

Potential Effect		Impact Balance	Spatial Boundary[1]	Temporal Context			Magnitude	Probability	Confidence	Significance[2]
				Duration	Frequency	Reversibility				
2(e)	Combined effects from Westridge Marine Terminal.	Negative	Footprint	Short -term	Isolated	Permanent	Low	High	High	Not significant
2(f)	Combined effects from pipeline reactivation.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2(g)	Combined effects of the Project on the topography indicator (2[a] to 2[e]).	Negative	LSA	Short-term	Isolated	Permanent	Low to medium	High	High	Not significant
3.	Physical Environment – Acid Generating and Metal Leaching Rock									
3(a)	Combined effects from pipeline.	Negative	LSA	Short-term	Isolated	Short to medium-term	Low	Low	High	Not significant
3(b)	Combined effects from temporary facilities.	Negative	LSA	Short-term	Isolated	Short to medium-term	Low	Low	High	Not significant
3(c)	Combined effects from pump station activities.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3(d)	Combined effects from tanks.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3(e)	Combined effects from Westridge Marine Terminal.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3(f)	Combined effects from pipeline reactivation.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3(g)	Combined effects of the Project on the acid generating and metal leaching rock indicator (3[a] to 3[b]).	Negative	LSA	Short-term	Isolated	Short to medium-term	Low	Low	High	Not significant
4.	Combined Effects of the Project on Physical Environment									
4(a)	Combined effects of the Project on the physical environment indicators (1[g] and 2[g]).	Negative	LSA	Short	Isolated	Short-term to permanent	Low	High	High	Not significant

Notes: 1 LSA = Physical Environment LSA.

2 Significant Residual Environmental Effect: A high probability of occurrence of a permanent or long-term residual effect of high magnitude that cannot be technically or economically mitigated.

7.11.1.2 Soil and Soil Productivity

The evaluation of the effects of the Project on soil and soil productivity considers the combined effect of applicable Project components on each of the following indicators: soil productivity; soil degradation; bedrock and stone disposal; and soil contamination.

Combined Effects on the Soil Productivity Indicator

The components of the Project which affect the soil productivity indicator include the construction and operations of the proposed pipeline, temporary facilities, pump stations and storage tanks, the Westridge Marine Terminal and pipeline reactivation activities.

The evaluation of the combined effects of the Project on the soil productivity indicator considers collectively the assessment of the combined effects on this indicator from construction and operations of all Project components (Table 7.11.1-2). Overall, the Project has the potential to decrease soil productivity through admixing of topsoil/root zone material and subsoil caused by disturbance to soil, including grading, topsoil/root zone material salvage, trenching, backfilling and storage activities. The combined effect is considered to have a negative impact balance. Through implementation of industry standard and provincially recommended mitigation measures during the construction and operations phases of the Project, the combined effects of the Project on the soil productivity indicator are considered to be of low magnitude and reversible in the short to long-term (Table 7.11.1-2, point 1[g]). A summary of the rationale for all of the significance criteria of combined effects on soil productivity is provided below.

- Spatial Boundary: Footprint – combined effects on the soil productivity indicator are confined to the area of disturbance associated with each Project component.
- Duration: short-term – the events causing combined effects on the soil productivity indicator are construction and operations (*i.e.,* maintenance activities) of the various Project components which are limited to any one year during the operations phase.
- Frequency: periodic – the events causing combined effects on the soil productivity indicator (*i.e.,* construction and maintenance-related activities) will occur intermittently but repeatedly over the assessment period.
- Reversibility: short to long-term – combined effects on the soil productivity indicator are anticipated to take less than 10 years to reverse but could take more than 10 years to reverse where there is admixing of undesirable lower subsoils with upper subsoils during construction of the proposed pipeline.
- Magnitude: low – the implementation of the proposed mitigation measures is expected to effectively reduce the combined effects on soil productivity.
- Probability: high – the construction and operations of the Project will disturb soils and affect soil productivity.
- Confidence: high – based on a good understanding by the assessment team of cause-effect relationships between pipeline construction and soil productivity.

Combined Effects on the Soil Degradation Indicator

The components of the Project which affect the soil degradation indicator include the construction and operations of the proposed pipeline, temporary facilities, pump stations, storage tanks, Westridge Marine Terminal and pipeline reactivation activities.

The evaluation of the combined effects of the Project on the soil degradation indicator considers collectively the assessment of the combined effects on this indicator from construction and operations of all Project components (Table 7.11.1-2). Overall, the Project has the potential to degrade soil structure through compaction and rutting, erosion and pulverization caused by disturbance to soil, including grading, topsoil/root zone material salvage, trenching, backfilling and storage activities. The combined effect is considered to have a negative impact balance. Through implementation of industry standard and provincially recommended mitigation measures during the construction and operations phases of the Project, the combined effects of the Project on the soil degradation indicator are considered to be of low magnitude and reversible in the short to medium-term (Table 7.11.1-2, point 2[g]). A summary of the rationale for all of the significance criteria of combined effects on soil degradation is provided below.

- Spatial Boundary: Footprint – combined effects on the soil degradation indicator are confined to the area of disturbance associated with each Project component.
- Duration: short-term – the events causing combined effects on the soil degradation indicator are construction of the various Project components; and maintenance-related activities which are limited to any one year during the operations phase.
- Frequency: periodic – the events causing combined effects on the soil degradation indicator (*i.e.,* construction and maintenance-related activities) will occur intermittently but repeatedly over the assessment period.
- Reversibility: short to medium-term – given the implementation of mitigation measures during construction and, if necessary, the application of soil amendments post-construction, some effects contributing to combined effects on the soil degradation indicator are expected to reverse over the short-term (*e.g.,* degradation of soil structure due to compaction and rutting or pulverization), while other effects such as surface erosion and deep compaction may take a few years to reverse.

- Magnitude: low – the implementation of the proposed mitigation measures is expected to effectively reduce the combined effects on the soil degradation indicator.
- Probability: high – the construction and operations of the Project will disturb soils and potentially affect soil structure resulting in soil degradation.
- Confidence: high – based on a good understanding by the assessment team of cause-effect relationships between pipeline construction and soil degradation.

Combined Effects on the Bedrock and Stone Disposal Indicator

The bedrock and stone disposal indicator will only be affected by construction and operations of the pipeline and, therefore, the combined effects of the pipeline on bedrock and stone disposal is considered to represent the combined effects of the Project on this indicator. The significance evaluation for bedrock and stone disposal is provided in Section 7.2.2.6 and summarized in Table 7.11.1-2, point 3(g).

Combined Effects on the Soil Contamination Indicator

No potential residual effects associated with any Project components were identified related to the soil contamination indicator. Consequently, no further assessment is warranted.

Combined Effects of the Project on Soil and Soil Productivity

The evaluation of the combined effects of the Project on the soil and soil productivity indicators considers collectively the assessment of the combined effects of the Project on the soil productivity, soil degradation and bedrock and stone disposal indicators.

Local and regional management plans containing goals and objectives applicable to soil and soil productivity aid in the assessment of Project-related effects on the soil and soil productivity indicators. Goals and objectives contained within the various local and regional management plans relevant to soil and soil productivity are listed in Appendix 7.1. For example, through the implementation of the mitigation measures for each soil and soil productivity indicator, it is believed that the Project meets the goal of the Parkland County Municipal Development Plan, Bylaw No. 37-2007 (Parkland County 2007) to conserve agricultural lands for agricultural and related uses. Through the implementation of mitigation measures, the Project also aligns with the goal of the Regional Growth Strategy for the FVRD to promote the reclamation of lands back to agricultural use, where appropriate (FVRD 2004). Other management plans listed in Appendix 7.1 were reviewed and determined to have no specific goals or objectives related to the soil and soil productivity indicators.

Effects on soils resulting from pipeline projects are well understood. Results of post-construction environmental monitoring programs of large pipelines in western Canada demonstrate that the effects on soil productivity can be effectively mitigated (TERA 2009a,b, 2011a,b,c, 2012a, 2013a,b). Mitigation based on land use, construction season, soil characterization and contingency plans are in place for wet/thawed soil conditions, soil erosion and soil/sod pulverization (Volumes 6B, 6C and 6D). With the successful implementation of the mitigation measures, and since Project activities will be conducted in accordance with all applicable provincial and municipal legislation (including those related to the Agricultural Land Reserve), the Project is not expected to interfere with goals and objectives of the various management plans relevant to soil and soil productivity as listed in Appendix 7.1.

The combined effects of the Project on soil and soil productivity are considered to be low and reversible in the short to long-term (Table 7.11.1-2, point 5[a]). A summary of the rationale for all of the significance criteria of combined effects on the soil and soil productivity indicators is provided below.

- Spatial Boundary: Footprint – combined effects of the Project on the soil and soil productivity indicators are confined to the area of disturbance associated with each Project component.
- Duration: short-term – the events causing combined effects of the Project on the soil and soil productivity indicators are construction of the various Project components; and maintenance-related activities which are limited to any one year during the operations phase.

- Frequency: periodic – the events causing combined effects of the Project on the soil and soil productivity indicators (*i.e.,* construction and maintenance-related activities) occur intermittently but repeatedly over the assessment period.
- Reversibility: short to long-term – combined effects of the Project on the soil and soil productivity indicators are generally expected to reverse in the short to medium-term for effects associated with soil degradation and bedrock and stone disposal for most of the Project components; however, long-term effects on soil productivity are anticipated at pump stations, storage tanks and Westridge Marine Terminal where topsoil/root zone material will be stored for the life of the operational pipeline.
- Magnitude: low – the implementation of the proposed mitigation measures is expected to effectively reduce the combined effects of the Project on soil and soil productivity.
- Probability: high – each Project component is predicted to affect one or more soil indicators.
- Confidence: high – based on a good understanding by the assessment team of cause-effect relationships between pipeline construction and soil productivity.

Summary

As identified in Table 7.11.1-2, there are no situations where there is a high probability of occurrence of a permanent or long-term environmental effect on soil and soil productivity of high magnitude that cannot be technically or economically mitigated. Consequently, it is concluded that the environmental effects of the Project on soil and soil productivity indicators will be not significant.

TABLE 7.11.1-2

SIGNIFICANCE EVALUATION OF THE PROJECT ON SOIL AND SOIL PRODUCTIVITY

				Temporal Context					
Potential Effect	Impact Balance	Spatial Boundary[1]	Duration	Frequency	Reversibility	Magnitude	Probability	Confidence	Significance[2]
1. Soil Indicator – Soil Productivity									
1(a) Combined effects from pipeline.	Negative	Footprint	Short-term	Periodic	Short to long-term	Low	High	High	Not significant
1(b) Combined effects from temporary facilities.	Negative	Footprint	Short-term	Isolated	Medium-term	Low	High	High	Not significant
1(c) Combined effects from pump station activities.	Negative	Footprint	Short-term	Isolated	Medium to long-term	Low	High	High	Not significant
1(d) Combined effects from tanks.	Negative	Footprint	Short-term	Isolated to occasional	Long-term	Low	High	High	Not significant
1(e) Combined effects from Westridge Marine Terminal.	Negative	Footprint	Short-term	Isolated	Long-term	Low	High	High	Not significant
1(f) Combined effects from pipeline reactivation.	Negative	Footprint	Short-term	Periodic	Medium-term	Low	High	High	Not significant
1(g) Combined effects of the Project on the soil productivity indicator (1[a] to 1[f]).	Negative	Footprint	Short-term	Periodic	Short to long-term	Low	High	High	Not significant
2. Soil Indicator – Soil Degradation									
2(a) Combined effects from pipeline.	Negative	Footprint	Short-term	Periodic	Short to medium-term	Low	High	High	Not significant
2(b) Combined effects from temporary facilities.	Negative	Footprint	Short-term	Isolated	Short to medium-term	Low	High	High	Not significant
2(c) Combined effects from pump station activities.	Negative	Footprint	Short-term	Isolated to occasional	Short to medium-term	Low	High	High	Not significant
2(d) Combined effects from tanks.	Negative	Footprint	Short-term	Isolated	Short to medium-term	Low	High	High	Not significant
2(e) Combined effects from Westridge Marine Terminal.	Negative	Footprint	Short-term	Isolated	Short to medium-term	Low	High	High	Not significant

TABLE 11.1-2 Cont'd

	Potential Effect	Impact Balance	Spatial Boundary[1]	Temporal Context: Duration	Temporal Context: Frequency	Temporal Context: Reversibility	Magnitude	Probability	Confidence	Significance[2]
1.	Soil Indicator – Soil Productivity									
2(f)	Combined effects from pipeline reactivation.	Negative	Footprint	Short-term	Periodic	Short to medium-term	Low	High	High	Not significant
2(g)	Combined effects of the Project on the soil degradation indicator (2[a] to 2[f]).	Negative	Footprint	Short-term	Periodic	Short to medium-term	Low	High	High	Not significant
3.	Soil Indicator – Bedrock and Stone Disposal									
3(a)	Combined effects from pipeline.	Negative	LSA	Short-term	Isolated	Short to medium-term	Low	High	High	Not significant
3(b)	Combined effects from temporary facilities.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3(c)	Combined effects from pump station activities.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3(d)	Combined effects from tanks.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3(e)	Combined effects from Westridge Marine Terminal.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3(f)	Combined effects from pipeline reactivation.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3(g)	Combined effects of the Project on the bedrock and stone disposal indicator (3[a]).	Negative	LSA	Short-term	Isolated	Short to medium-term	Low	High	High	Not significant
4.	Soil Indicator – Soil Contamination									
	No residual effects identified.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5.	Combined Effects of the Project on Soil and Soil Productivity									
5(a)	Combined effects of the Project on the soil and soil productivity indicators (1[g], 2[g] and 3[g]).	Negative	Footprint	Short-term	Periodic	Short to long-term	Low	High	High	Not significant

Notes: 1 LSA = Soil LSA.

2 Significant Residual Environmental Effect: A high probability of occurrence of a permanent or long-term residual effect of high magnitude that cannot be technically or economically mitigated.

7.11.1.3 Water Quality and Quantity

The evaluation of the effects of the Project on the water quality and quantity indicators considers the combined effect of applicable Project components on each of the following water quality and quantity indicators: surface water quality; surface water quantity; groundwater quality; and groundwater quantity.

Combined Effects on the Surface Water Quality Indicator

The components of the Project which affect the surface water quality indicator include the construction and operations of the proposed pipeline, temporary facilities, pump stations and storage tanks. No potential effects were identified for surface water quality resulting from construction and operations activities at the Westridge Marine Terminal. In addition, although combined effects on surface water quality from pipeline reactivation were identified, they are considered to be unlikely to occur and, consequently, are not included in the evaluation of combined effects of the Project on the surface water quality indicator.

The evaluation of the combined effects of the Project on the surface water quality indicator considers collectively the assessment of the likely combined effects on this indicator from construction and operations of all applicable Project components (Table 7.11.1-3). Overall, the Project has the potential to reduce surface water quality as a result of construction and operations activities in and around waterbodies and watercourses due to increased suspended sediment and erosion of banks and approach slopes, which is considered to have a negative impact balance. Through implementation of industry standard and provincially recommended mitigation measures during the construction and operations phases of the Project, the combined effects of the Project on the surface water quality indicator are considered to be of low to medium magnitude (Table 7.11.1-3, point 1[g]). A summary of the rationale for all of the significance criteria of combined effects on surface water quality is provided below.

- Spatial Boundary: Water Quality and Quantity LSA – combined effects on the surface water quality indicator may extend beyond the construction or operations workspace to the predicted ZOI.
- Duration: short-term – the events causing the combined effects on the surface water quality indicator are construction and operations (*e.g.,* maintenance activities) of various Project components.
- Frequency: isolated to occasional – the events causing the combined effects on the surface water quality indicator are generally confined to the construction period but may occur intermittently and sporadically during the operations phase.
- Reversibility: immediate to medium-term – the events causing combined effects on the surface water quality indicator may be reversible immediately (*e.g.,* increased suspended sediment due to upstream construction at select watercourses) or may take more than a year to return to existing conditions (*e.g.,* to re-establish vegetation on approach slopes and banks).
- Magnitude: low to medium – combined effects on the surface water quality indicator are anticipated to be largely mitigated during construction.
- Probability: high – based on data pertinent to the Project area and the professional experience of the assessment team.
- Confidence: high – based on data pertinent to the Project area and the professional experience of the assessment team.

Combined Effects on the Surface Water Quantity Indicator

The components of the Project which affect the surface water quantity indicator include the construction and operations of the proposed pipeline, temporary facilities, pump stations and storage tanks, Westridge Marine Terminal, as well as pipeline reactivation activities.

The evaluation of the combined effects of the Project on the surface water quantity indicator considers collectively the assessment of the combined effects on this indicator from construction and operations of all Project components (Table 7.11.1-3). Overall, the Project has the potential to reduce surface water quantity as a result of construction and operations activities in and around waterbodies and watercourses through alteration of natural surface drainage patterns and disruption of natural streamflow from instream activities, which is considered to have a negative impact balance. Through implementation of industry standard and provincially recommended mitigation measures during the construction and operations phases of the Project, the combined effects of the Project on the surface water quantity indicator are considered to be of low to medium magnitude (Table 7.11.1-3, point 2[g]). A summary of the rationale for all of the significance criteria of combined effects on surface water quality is provided below.

- Spatial Boundary: Water Quality and Quantity LSA – combined effects on the surface water quantity indicator may extend beyond the construction or operations workspace to the predicted ZOI.
- Duration: short-term – the events causing the combined effects on the surface water quantity indicator are construction and operations (*e.g.,* maintenance activities) of various Project components.
- Frequency: isolated to occasional – the events causing the combined effects on the surface water quantity indicator are generally confined to the construction period but may occur intermittently and sporadically during into the operations phase.
- Reversibility: short-term to permanent – the events causing combined effects on the surface water quantity indicator may be reversible in the short to medium-term for the pipeline, temporary facilities and power lines where it may take more than one year to restore natural drainage patterns and long-term (*i.e.,* greater than 10 years) to permanent for above ground facilities depending whether natural drainage patterns can be restored following decommissioning and abandonment.
- Magnitude: low to medium – combined effects on the surface water quantity indicator are anticipated to be largely mitigated during construction.

- Probability: high – based on data pertinent to the Project area and the professional experience of the assessment team.
- Confidence: high – based on data pertinent to the Project area and the professional experience of the assessment team.

Combined Effects on the Groundwater Quality Indicator

An evaluation of the combined effects of the Project on the groundwater quality indicator considers collectively the assessment of the likely combined effects on this indicator from construction and operations of all applicable Project components. Although residual effects related to groundwater quality were identified for the pipeline, pump stations and proposed tanks components only, none of the effects were considered likely to occur. Consequently, an evaluation of combined effects of the Project on the groundwater quality indicator is not warranted.

Combined Effects on the Groundwater Quantity Indicator

An evaluation of the combined effects of the Project on the groundwater quantity indicator considers collectively the assessment of the likely combined effects on this indicator from construction and operations of all applicable Project components. Although residual effects related to groundwater quantity were identified for the pipeline and the Westridge Marine Terminal components only, none of the effects were considered likely to occur. Consequently, an evaluation of combined effects of the Project on the groundwater quality indicator is not warranted.

Combined Effects of the Project on Water Quality and Quantity

The evaluation of the combined effects of the Project on the water quality and quantity indicators considers collectively the assessment of the combined effects of the Project that are likely to occur (*i.e.,* surface water quality and surface water quantity). Since no potential effects were identified for the groundwater quality or quantity indicators, these were not considered in the overall effects of the Project on water quality and quantity.

Local and regional management plans containing goals and objectives applicable to water quality and quantity aided in the assessment of Project-related effects on the water quality and quantity indicators and influenced the mitigation developed to reduce or avoid adverse effects. For example, through the implementation of the mitigation measures for each water quality and quantity indicator, it is believed that the Project meets the goals of both the Parkland County Integrated Community Sustainability Plan (Parkland County 2011) to minimize water use and contamination, and the Strathcona County Municipal Development Plan (Strathcona County 2007) to reduce consumption of fresh water resources from lakes, rivers and aquifers. Through implementation of mitigation measures, the Project also aligns with the policy of the Thompson-Nicola Regional District (TNRD) Regional Growth Strategy (TNRD 2000) to protect the quality and quantity of water of the region's lakes, rivers, streams and groundwater sources, as well as an action of the FVRD Regional Growth Strategy to protect the region’s potable surface and groundwater resources by supporting water conservation and stormwater management measures (FVRD 2004). Additional goals and objectives contained in the various local and regional management plans relevant to water quality and quantity are listed in Appendix 7.1. Other management plans listed in Appendix 7.1 were reviewed and determined to have no specific goals or objectives related to the water quality and quantity indicators.

The results of the post-construction environmental monitoring programs of large pipeline projects in western Canada demonstrate that the effects of pipeline and facility construction on surface water quality can be effectively mitigated (TERA 2009a,b, 2011a,b,c, 2012a, 2013a,b). With the successful implementation of the mitigation measures in Volumes 6B, 6C and 6D, and since Project activities will be conducted in accordance with all applicable federal, provincial and municipal legislation, the combined effects of the Project on water quality and quantity are considered to be of low to medium magnitude (Table 7.11.1-3, point 5[a]) and, furthermore, are not expected to interfere with goals and objectives of the various management plans relevant to water quality and quantity as listed in Appendix 7.1. A summary of the rationale for all of the significance criteria of combined effects of the Project on the water quality and quantity indicators is provided below.

- Spatial Boundary: Water Quality and Quantity LSA – the combined effects of the Project on the water quality and quantity indicators may extend beyond the construction or operations workspace to the predicted ZOI.
- Duration: short-term - the events causing the combined effects of the Project on the water quality and quantity indicators are construction and operations (*e.g.,* maintenance activities) of various Project components.
- Frequency: isolated to occasional - the events causing the combined effects of the Project on the water quality and quantity indicators are generally confined to the construction period but may occur intermittently and sporadically during into the operations phase.
- Reversibility: short-term to permanent – the events causing combined effects on the water quality and quantity indicators will vary, where certain residual effects may be reversed shortly after construction, while others may not fully be reversed until reclamation and post-construction environmental monitoring or, in some cases, decommissioning and abandonment. At certain aboveground facilities, such as the Burnaby Terminal, full restoration of natural drainage patterns may not be possible following decommissioning and abandonment.
- Magnitude: low to medium – the combined effects of the Project on the water quality and quantity indicators are anticipated to be largely mitigated during construction and operations.
- Probability: high – based on data pertinent to the Project area and the professional experience of the assessment team.
- Confidence: high – based on data pertinent to the Project area and the professional experience of the assessment team.

Summary

As identified in Table 7.11.1-3, there are no situations where there is a high probability of occurrence of a permanent or long-term environmental effect on water quality and quantity of high magnitude that cannot be technically or economically mitigated. Consequently, it is concluded that the environmental effects of the Project on water quality and quantity indicators will be not significant.

TABLE 7.11.1-3

SIGNIFICANCE EVALUATION OF THE PROJECT ON WATER QUALITY AND QUANTITY

Potential Effect	Impact Balance	Spatial Boundary[1]	Temporal Context			Magnitude	Probability	Confidence	Significance[2]
			Duration	Frequency	Reversibility				
1. Water Quality and Quantity – Surface Water Quality									
1(a) Combined effects from pipeline.	Negative	LSA	Short-term	Isolated to occasional	Immediate to medium-term	Low to medium	High	High	Not significant
1(b) Combined effects from temporary facilities.	Negative	LSA	Immediate to short-term	Isolated	Immediate to short-term	Low	High	High	Not significant
1(c) Combined effects from pump station activities.	Negative	LSA	Immediate to short-term	Isolated to occasional	Immediate to short-term	Low	High	High	Not significant
1(d) Combined effects from tanks.	Negative	LSA	Short-term	Isolated	Immediate to short-term	Low	High	High	Not significant
1(e) Combined effects from Westridge Marine Terminal.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1(f) Combined effects from pipeline reactivation.	Negative	LSA	Short-term	Isolated	Immediate to short-term	Low	Low	High	Not significant

TABLE 7.11.1-3 Cont'd

	Potential Effect	Impact Balance	Spatial Boundary[1]	Temporal Context – Duration	Temporal Context – Frequency	Temporal Context – Reversibility	Magnitude	Probability	Confidence	Significance[2]
1(g)	Combined effects of the Project on the surface water quality indicator (1[a] to 1[d], 1[f]).	Negative	LSA	Short-term	Isolated to occasional	Immediate to medium-term	Low to medium	High	High	Not significant
2.	Water Quality and Quantity – Surface Water Quantity									
2(a)	Combined effects from pipeline.	Negative	LSA	Short-term	Isolated to occasional	Short to medium-term	Low to medium	High	High	Not significant
2(b)	Combined effects from temporary facilities.	Negative	LSA	Short-term	Isolated	Short to medium-term	Low to medium	High	High	Not significant
2(c)	Combined effects from pump station activities.	Negative	LSA	Short-term	Isolated	Short to long-term	Low	High	High	Not significant
2(d)	Combined effects from tanks.	Negative	LSA	Short-term	Isolated	Short-term to permanent	Low to medium	High	High	Not significant
2(e)	Combined effects from Westridge Marine Terminal.	Negative	LSA	Short-term	Isolated	Long-term	Low	High	High	Not significant
2(f)	Combined effects from pipeline reactivation.	Negative	LSA	Short-term	Isolated	Short to medium-term	Low to medium	High	High	Not significant
2(g)	Combined effects of the Project on the surface water quantity indicator (2[a] to 2[f]).	Negative	LSA	Short-term	Isolated to occasional	Short-term to permanent	Low to medium	High	High	Not significant
3.	Water Quality and Quantity – Groundwater Quality									
3(a)	Combined effects from pipeline.	Although residual effects were identified, none were considered to be likely, therefore, an evaluation of combined effects was not deemed necessary.								
3(b)	Combined effects from temporary facilities.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3(c)	Combined effects from pump station activities.	Although residual effects were identified, none were considered to be likely, therefore, an evaluation of combined effects was not deemed necessary.								
3(d)	Combined effects from tanks.	Although residual effects were identified, none were considered to be likely, therefore, an evaluation of combined effects was not deemed necessary.								
3(e)	Combined effects from Westridge Marine Terminal.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3(f)	Combined effects from pipeline reactivation.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3(g)	Combined effects of the Project on the groundwater quality indicator.	Although residual effects were identified for select Project components, none were considered to be likely, therefore, an evaluation of combined effects was not deemed necessary.								
4.	Water Quality and Quantity – Groundwater Quantity									
4(a)	Combined effects from pipeline.	Although residual effects were identified, none were considered to be likely, therefore, an evaluation of combined effects was not deemed necessary.								
4(b)	Combined effects from temporary facilities.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4(c)	Combined effects from pump station activities.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4(d)	Combined effects from tanks.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4(e)	Combined effects from Westridge Marine Terminal.	Although residual effects were identified, none were considered to be likely, therefore, an evaluation of combined effects was not deemed necessary.								
4(f)	Combined effects from pipeline reactivation.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4(g)	Combined effects of the Project on the groundwater quantity indicator.	Although residual effects were identified for select Project components, none were considered to be likely, therefore, an evaluation of combined effects was not deemed necessary.								
5.	Combined Effects of the Project on Water Quality and Quantity									
5(a)	Combined effects of the Project on the water quality and quantity indicators (1[g] and 2[g]).	Negative	LSA	Short-term	Isolated to occasional	Short-term to permanent	Low to medium	High	High	Not significant

Notes: 1 LSA = Water Quality and Quantity LSA.

2 <u>Significant Residual Environmental Effect</u>: A high probability of occurrence of a permanent or long-term residual effect of high magnitude that cannot be technically or economically mitigated.

7.11.1.4 Air Emissions

The evaluation of the effects of the Project on the air emissions indicators considers the combined effect of applicable Project components on each of the following air emissions indicators: CACs and VOCs; formation of secondary particulate matter and ozone; and H_2S and mercaptans.

Combined Effects on the Primary Emissions of CACs and VOCs Indicator

The components of the Project, which affect the primary emissions of CACs and VOCs indicator, include the construction and operations of the proposed pipeline, temporary facilities, pump stations and storage tanks, the Westridge Marine Terminal and pipeline reactivation. Residual effects varied between the construction and operations phases and were dependent on the type of activities. The significance of the combined effects on CACs and VOCs from construction and operations of the Project is summarized in Table 7.11.1-4.

The evaluation of the combined effects of the Project on the primary emissions of CACs and VOCs indicator considers collectively the assessment of the combined effects on this indicator from construction and operations of all Project components. Overall, the Project has the potential to cause CACs and VOCs increases during construction and operations, which are considered to have a negative impact balance. Through implementation of industry standard recommended mitigation measures during the construction and operations phases of the Project, the combined effects of the Project on the primary emissions of CACs and VOCs indicator are considered to be of medium magnitude. Although predicted concentrations are expected to exceed ambient air quality objectives for some pollutants in some areas (see Air Quality and GHG Technical Report Volume 5C) these exceedances are not due to the Project, would occur without the Project, and the Project makes only a small contribution to these maximum ambient concentrations (Table 7.11.1-4, point 1[g]). A summary of the rationale for all of the significance criteria of combined effects on primary emissions of CACs and VOCs is provided below.

- Spatial Boundary: Air Quality RSA – changes to ambient ground-level concentrations of CACs and VOCs from construction and operation are expected to occur within the Air Quality RSA.
- Duration: long-term – the events resulting in emissions of CACs and VOCs occur short-term for construction but long-term during Project operation.
- Frequency: continuous – fugitive VOC emissions occur continuously over the Project life.
- Reversibility: long-term – emissions of CACs and VOC will extend long-term over the Project life and reverse within a few days at the end of the Project.
- Magnitude: medium – the increase in ambient ground-level concentrations of CACs and VOC is expected to be small and not exceed regulatory limits, but in some cases are expected to approach regulatory limits.
- Probability: high – storage tank construction will result in emissions of CACs.
- Confidence: moderate – residual effects assessment is based on a good understanding of cause-effect relationships between construction and air emissions but in some cases reliant on information from previous projects.

Combined Effects on Formation of Secondary Particulate Matter and Ozone Indicator

The components of the Project which affect the formation of secondary particulate matter and ozone indicator include the construction and operations of the storage tanks and Westridge Marine Terminal. Residual effects varied between the construction and operations phases and were dependant on the type of activities. The significance of the combined effects on formation of secondary particulate matter and ozone from construction and operations of the Project is summarized in Table 7.11.1-4.

The evaluation of the combined effects of the Project on the formation of secondary particulate matter and ozone indicator considers collectively the assessment of the combined effects on this indicator from construction and operations of all applicable Project components. Overall, the Project has the potential to cause secondary particulate matter and ozone increases during construction and operations which is considered to have a negative impact balance. Through implementation of industry standard recommended mitigation measures during the construction and operations phases of the Project, the combined effects of the Project on the formation of secondary particulate matter and ozone indicator are considered to be of medium magnitude (Table 7.11.1-4, point 2[g]). A summary of the rationale for all of the significance criteria of combined effects on formation of secondary particulate matter and ozone is provided below.

- Spatial Boundary: LFV – changes to ambient ground-level concentrations of secondary PM and ozone and visibility reductions are expected to occur within the LFV photochemical modelling domain.
- Duration: long-term – the combined effects on secondary particulate matter and ozone are expected to occur for the operational life of the Project and, therefore, are considered long-term.
- Frequency: continuous – the combined effects on secondary particulate matter and ozone (*i.e.*, mostly from VOC fugitive precursor emissions and combustion products causing formation of ozone) occur continuously during Westridge Marine Terminal operations.
- Reversibility: long-term – combined effects on secondary particulate matter and ozone reflect fugitive emissions of VOCs during operations at the terminals which will extend for the operational life of the terminal. Combined emissions are reversible as the increase in ambient particulate matter and ozone will cease when the facility is decommissioned.
- Magnitude: medium – the increase in ambient ground-level concentrations of particulate matter and ozone and reduction in visibility are expected to be small relative to existing conditions, but for some areas within the LFV, ambient ground-level concentrations of ozone might approach Canadian Ambient Air Quality Standards.
- Probability: high – an increase in Project-related product storage, handling, and loading as well as equipment use will result in precursor emissions, which contribute to secondary PM and ozone formation and reduced visibility.
- Confidence: moderate – based on a good understanding of cause-effect relationships between the Project, air emissions, and atmospheric reactions; however, there is uncertainty with respect to non-Project emissions, and atmospheric chemical reactions are complex.

Combined Effects on Hydrogen Sulphide and Mercaptans Indicator

The components of the Project which affect the H_2S and mercaptans indicator include the operations of the storage tanks and Westridge Marine Terminal. The significance of the combined effects on H_2S and mercaptans from operations of the Project is summarized in Table 7.11.1-4.

The evaluation of the combined effects of the Project on the H_2S and mercaptans indicator considers collectively the assessment of the combined effects on this indicator from the operations of all applicable Project components. Overall, the Project has the potential to cause increases in H_2S and mercaptans during operations which is considered to have a negative impact balance. Through implementation of industry standard recommended mitigation measures during the operations phase of the Project, the combined effects of the Project on the H_2S and mercaptans indicator are considered to be of low magnitude and are expected to meet applicable ambient air quality objectives (Table 7.11.1-4, point 3[g]). A summary of the rationale for all of the significance criteria of combined effects on formation of secondary particulate matter and ozone is provided below.

- Spatial Boundary: Air Quality RSA – changes to ambient ground-level concentrations of H_2S and mercaptans are expected to occur within the Air Quality RSA.
- Duration: long-term – emissions of H_2S and mercaptans and subsequent changes to ambient ground-level concentrations are expected to occur for the life of the Project and, therefore, are considered long-term.

- Frequency: continuous – emissions of H_2S and mercaptans will occur continuously throughout the operations phase.
- Reversibility: long-term – emissions of H_2S and mercaptans during operations at the terminals will extend over the operational life of the terminal.
- Magnitude: low – the increase in ambient ground-level concentrations of H_2S and mercaptans is expected to cause nuisance odour at some locations and times but is not expected to approach regulatory limits.
- Probability: high – an increase in Project volumes of product being handled and stored will result in an increase in emissions of H_2S and mercaptans.
- Confidence: moderate – based on a good understanding of cause-effect relationships but used assumptions for equipment based on previous projects pending Project design.

Combined Effects on Air Emissions

All components of the Project affect air quality. These include: the construction and operations of the proposed pipeline, temporary facilities, pump stations and storage tanks, as well as construction and operations activities associated with the Westridge Marine Terminal and pipeline reactivation. Residual effects from these activities varied between the construction and operations phases and were dependant on the type of activities. The significance of the combined effects on air emissions from construction and operations of the Project is summarized in Table 7.11.1-4.

For the residual effects assessments of air emissions, regulatory limits (*e.g.* ambient air quality objectives and standards) were taken into consideration. Exceedances of ambient air quality objectives are predicted within the air quality RSA; however, the Project is not responsible for these exceedances and the Project's contribution to these exceedances is not considered significant for the purpose of this assessment. In addition to numerical regulatory limits, other references to air quality that were found in land and resource use management plans, municipal development plans, and government policies are briefly described here.

A number of documents identify the goal to maintain existing good air quality (District of Clearwater 2012, Government of Alberta 2003, Township of Langley 1979) or improve air quality (City of Abbotsford 2005, City of Burnaby 1998, City of Coquitlam 2001a,b, City of Edmonton 2010, City of Spruce Grove 2010, Metro Vancouver 2011, RDFFG 2006). The Thompson-Nicola Regional District Regional Growth Strategy (TNRD 2000) encourages the development and adoption of policies that contribute to the reduction or prevention of air pollution.

More stringently, Robson Valley wants to reduce and work to eliminate pollution of air (BC ILMB 1999), and Nicola Valley (TNRD 2011e) requires that new industrial developments should not emit substances that would have a detrimental effect on air quality. Given the limited duration of Project-related construction emissions and the localized nature of operation emissions, the Project is not expected to negatively affect these plans. In addition, the mitigation measures proposed in this assessment support these general plans and strategies.

The City of Edmonton (2010) describes a general framework for policies and initiatives on emission reductions, but does not provide any specific targets, goals or objectives. Strathcona County (2007) plans to work with those authorities having jurisdiction, to assist in identifying existing and potential air quality concerns and to mitigate or eliminate these issues. It further encourages industrial associations, the federal government, and the provincial government to collaboratively expand and implement a regional airshed monitoring system. A similar cooperative approach with appropriate jurisdictions to protect air quality is proposed by the FVRD (2004). The Government of Alberta (2003) also emphasizes the importance of expanded monitoring efforts to provide a comprehensive picture of regional air quality. Adequate siting of industrial facilities to minimize dust, smoke, or odour issues for nearby residences and other land uses is are required by the Town of Stony Plain (2005), Parkland County (2012), the Village of Wabamun (2010), and the Town of Hinton (1998). PMV (2010) is working on the implementation of an air emissions strategic plan that encompasses new technologies to reduce air emissions. Minimizations and restriction of slash burning and open burning are required in BC ILMB (1999) and City of Chilliwack (1998).

The evaluation of the combined effects of the Project on air emissions considers collectively the assessment of the combined effects on the primary emissions of CACs and VOCs, secondary particulate matter and ozone, and H_2S and mercaptan indicators from the construction and operations of all applicable Project components. Overall, the Project has the potential to cause increased air emissions during construction and operations which is considered to have a negative impact balance. Through implementation of industry standard recommended mitigation measures during the construction and operations phases of the Project, the combined effects of the Project on the air emission indicators are considered to be of medium magnitude (Table 7.11.1-4, point 4[a]). A summary of the rationale for all of the significance criteria of combined effects of the Project on the air emission indicators is provided below.

- Spatial Boundary: LFV and Air Quality RSA – changes to ambient ground-level concentrations of secondary $PM_{2.5}$ and ozone as well as changes to visibility are expected to occur within the LFV, which includes the Air Quality RSA. Outside the LFV, changes are expected to occur in the Air Quality RSA.
- Duration: long-term – emissions of fugitive VOCs, H_2S, and mercaptans and subsequent changes to ambient ground-level concentrations are expected to occur for the life of the Project and, therefore, are considered long-term.
- Frequency: continuous – emissions of fugitive VOCs, H_2S, and mercaptans will occur continuously throughout the operations phase.
- Reversibility: long-term – emissions air contaminants during operations at the terminals will extend over the operational life of the terminal.
- Magnitude: medium – the increase in ambient ground-level concentrations of some CAC is expected to approach but not exceed regulatory limits.
- Probability: high – increased emissions of air contaminants will occur and will result in increased ambient concentrations, secondary formation of ozone and $PM_{2.5}$, and reductions in visibility.
- Confidence: moderate – based on a good understanding of cause-effect relationships, but in some cases, information from previous projects had to be used.

Summary

As identified in Table 7.11.1-4, there are no situations where there is a high probability of occurrence of a permanent or long-term environmental effect on air emissions of high magnitude that cannot be technically or economically mitigated. Consequently, it is concluded that the environmental effects of the Project on air emissions indicators will be not significant.

TABLE 7.11.1-4

SIGNIFICANCE EVALUATION OF THE PROJECT ON AIR EMISSIONS

	Potential Effect	Impact Balance	Spatial Boundary[1]	Temporal Context			Magnitude	Probability	Confidence	Significance[2]
				Duration	Frequency	Reversibility				
1.	Air Emissions Indicator – Primary Emissions of Criteria Air Contaminants and Volatile Organic Compounds									
1(a)	Combined effects from pipeline.	Negative	RSA	Short-term	Periodic	Short-term	Medium	High	Moderate	Not significant
1(b)	Combined effects from temporary facilities.	Negative	RSA	Short-term	Isolated	Short-term	Medium	High	Moderate	Not significant

TABLE 7.11.1-4 Cont'd

	Potential Effect	Impact Balance	Spatial Boundary[1]	Temporal Context: Duration	Temporal Context: Frequency	Temporal Context: Reversibility	Magnitude	Probability	Confidence	Significance[2]
1(c)	Combined effects from pump station activities.	Negative	RSA	Short-term	Isolated	Short-term	Medium	High	Moderate	Not significant
1(d)	Combined effects from tanks.	Negative	RSA	Long-term	Continuous	Long-term	Low	High	Moderate	Not significant
1(e)	Combined effects from Westridge Marine Terminal.	Negative	RSA	Long-term	Continuous	Long-term	Low	High	Moderate	Not significant
1(f)	Combined effects from pipeline reactivation.	Negative	RSA	Short-term	Isolated	Short-term	Low	High	Moderate	Not significant
1(g)	Combined effects of the Project on the primary emissions of CACs and VOCs indicator (1[a] to 1[f]).	Negative	RSA	Long-term	Continuous	Long-term	Medium	High	Moderate	Not significant
2.	Air Emissions Indicator – Formation of Secondary Particulate Matter and Ozone									
2(a)	Combined effects from pipeline.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2(b)	Combined effects from temporary facilities.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2(c)	Combined effects from pump station activities.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2(d)	Combined effects from tanks.	Negative	LFV	Long-term	Continuous	Long-term	Medium	High	Moderate	Not significant
2(e)	Combined effects from Westridge Marine Terminal.	Negative	LFV	Long-term	Continuous	Long-term	Medium	High	Moderate	Not significant
2(f)	Combined effects from pipeline reactivation.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2(g)	Combined effects of the Project on the secondary particulate matter and ozone indicator (2[d] and 2[e]).	Negative	LFV	Long-term	Continuous	Long-term	Medium	High	Moderate	Not significant
3.	Air Emissions Indicator – Hydrogen Sulphide and Mercaptans									
3(a)	Combined effects from pipeline.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3(b)	Combined effects from temporary facilities.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3(c)	Combined effects from pump station activities.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3(d)	Combined effects from tanks.	Negative	RSA	Long-term	Continuous	Long-term	Low	High	Moderate	Not significant
3(e)	Combined effects from Westridge Marine Terminal.	Negative	RSA	Long-term	Continuous	Long-term	Low	High	Moderate	Not significant
3(f)	Combined effects from pipeline reactivation.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3(g)	Combined effects of the Project on the H_2S and mercaptans indicator (3[d] and 3[e]).	Negative	RSA	Long-term	Continuous	Long-term	Low	High	Moderate	Not significant
4.	Combined Effects of the Project on Air Emissions									
4(a)	Combined effects of the Project on air emissions indicators (1[g], 2[g] and 3[g]).	Negative	LFV and RSA	Long-term	Continuous	Long-term	Medium	High	Moderate	Not significant

Notes: 1 RSA = Air Quality RSA; LFV = Lower Fraser Valley.

2 Significant Residual Environmental Effect: A high probability of occurrence of a permanent or long-term residual effect of high magnitude that cannot be technically or economically mitigated.

7.11.1.5 Greenhouse Gas Emissions

The evaluation of the effects of the Project on GHG emissions considers the combined effect of applicable Project components on each of the following GHG emission indicators: emissions of CO_2, CH_4 and N_2O; and effects on overall climate change.

The evaluation of the combined effects of the Project on each of the above GHG emission indicators are noted in Table 7.2.5-8 and the accompanying discussion in Section 7.2.5.6 provides an evaluation of the significance of the individual effects on these indicators. The rationale for the significance evaluation of the combined indicators is provided below.

Combined Effects of the Project on GHG Emissions and Overall Climate Change

The evaluation of the combined effects of the Project on GHG emissions considers collectively the assessment of the combined effects of the Project on the following indicators: emissions of CO_2, CH_4 and N_2O; and effects on overall climate change.

Local and regional management plans containing goals and objectives applicable to GHG emissions and overall climate change (listed in Appendix 7.1) provide only limited guidance in the assessment of Project-related effects on GHG emissions and overall climate change indicators. Most local and regional management plans have high-level goals of GHG emission reductions without setting explicit targets. The only exception is Nicola Valley's Official Community Plan, which spells out the objective to become carbon neutral. The Municipal Development Plan of the City of Edmonton describes a general framework for policies and initiatives on emission reductions, but it does not describe any specific targets, goals or objectives. Parkland County's Integrated Community Sustainability Plan mentions efforts and plans for energy conservation and GHG emissions reduction options but only within the scope of community operations.

Temporary GHG emissions (*e.g.*, from fossil fuel combustion in construction equipment or from forest clearing) are typically not considered in the context of local and regional management plans, nor do provincial GHG reporting requirements in BC and Alberta apply to temporary construction emissions. In addition, indirect emissions caused by electricity use for the pump assemblies are to be accounted for by the generating facility. Therefore, to avoid double counting, the Project's indirect emissions do not fall under local and regional management plans or provincial GHG reporting requirements in BC and Alberta. The Project's other sources of GHG emissions are negligible or so small that they are unlikely to be included in any local or regional inventory. Note that the only substantial source of GHG emissions is currently from vapour flaring of fugitive emissions at the Westridge Marine Terminal and that these emissions will be substantially reduced with the Project. Other management plans listed in Appendix 7.1 were reviewed and determined to have no specific goals or objectives related to the GHG emissions and overall climate change indicators.

The combined effects of the Project on GHG emissions and overall climate change are considered to be of low magnitude (Table 7.11.1-5, point 3[a]). A summary of the rationale for all of the significance criteria of combined effects of the Project on GHG emissions is provided below.

- Spatial Boundary: international – Project emissions of GHG disperse globally and overlap with global GHG emissions to cause cumulative international effects on climate change.
- Duration: long-term – Project emissions of GHG and their effects on climate change occur over a range of durations. GHG emissions related to construction of the pipeline, pump stations, (including power lines), installation of the storage tanks, and expansion of the Westridge Marine Terminal as well as operation of temporary facilities and pipeline reactivation activities are limited to the duration of the construction phase, and are therefore, short-term. Operation-related GHG emissions and the resulting climate change are expected to occur for the life of the operating pipeline and associated facilities and, therefore, are considered long-term.
- Frequency: continuous – the events resulting in GHG emissions and their potential effects on climate change occur over a range of frequencies. Emissions and climate change effects from construction of the pipeline, pump stations (including power lines), installation of the storage tanks, and expansion of the Westridge Marine Terminal as well as operation of temporary facilities and pipeline reactivation activities are limited to a specific period (*i.e.*, construction phase) and, therefore, are isolated. Operation-related GHG emissions and climate change effects from maintenance and inspection activities, building space heating and electricity use, and fugitive vapour combustion from vessel loading at the Westridge Marine Terminal are expected to occur periodically (intermittently but repeatedly) over the life of the operating pipeline and associated facilities. Finally, fugitive emissions, indirect GHG emissions from electricity use by pump assemblies and the associated potential climate change effects are expected to occur continuously over the life of the operating pipeline and associated facilities.

- Reversibility: permanent - emissions of GHG are assumed to cease within one year of decommissioning of the Project; however, effects on climate change will last past the life of the operating Project for hundreds to thousands of years and, therefore, are considered effectively permanent.
- Magnitude: low - Project emissions of GHG can be estimated and will be detectable. In the absence of environmental or regulatory emission limits for GHG emissions, the magnitude is rated as low. The resulting changes in environmental parameters (*e.g.*, increase in global average temperature), resulting from Project-related activities are not detectable from existing (baseline) climate variability.
- Probability: high - Project-related activities will result in emissions of GHG, and this is likely to contribute to an overall global climate change.
- Confidence: moderate - combined effects assessment is based on a good understanding of cause-effect relationships between the Project and GHG emissions; however, equipment-specific data are limited and, in some cases, obtained from outside the Project. With regards to climate change, determination of significance is based on a good understanding of cause-effect relationships between GHG emissions from Project activities and overall climate change. Observational and numerical modelling data also support the significance determination.

Summary

As identified in Table 7.11.1-5, there are no situations where there is a high probability of occurrence of a permanent or long-term environmental effect on GHG emissions of high magnitude that cannot be technically or economically mitigated. Consequently, it is concluded that the environmental effects of the Project on GHG emissions indicators will be not significant.

TABLE 7.11.1-5

SIGNIFICANCE EVALUATION OF THE PROJECT ON GHG EMISSIONS

	Potential Effect	Impact Balance	Spatial Boundary	Temporal Context			Magnitude	Probability	Confidence	Significance[1]
				Duration	Frequency	Reversibility				
1.	GHG Emission Indicator – Emissions of CO_2, CH_4 and N_2O									
1(a)	Combined effects of the Project on the emissions of CO_2, CH_4 and N_2O indicator.	Negative	International	Short- to long-term	Isolated to continuous	Permanent	Low	High	Moderate	Not significant
2.	GHG Emission Indicator – Effects on Overall Climate Change									
2(a)	Combined effects of the Project on the effects on overall climate change indicator.	Negative	International	Short to long-term	Isolated to continuous	Permanent	Negligible	High	High	Not significant
3.	Combined Effects of the Project on GHG Emissions									
3(a)	Combined effects of the Project on the GHG emissions indicators (1[a] and 2[a]).	Negative	International	Long-term	Continuous	Permanent	Low	High	Moderate	Not significant

Note: 1 Significant Residual Environmental Effect: A high probability of occurrence of a permanent or long-term residual effect of high magnitude that cannot be technically or economically mitigated.

7.11.1.6 Acoustic Environment

The evaluation of the effects of the Project on the acoustic environment indicators considers the combined effect of applicable Project components on each of the following physical environment indicators: sound levels; and vibration levels.

Combined Effects on the Sound Levels Indicator

The components of the Project which affect the sound levels indicator include the construction and operations of the proposed pipeline, temporary facilities, pump stations and storage tanks, Westridge Marine Terminal as well as pipeline reactivation. Residual effects varied between the construction and operations phases and were dependant on the type of activities. The significance of the combined effects on sound levels from construction and operations of the Project is summarized in Table 7.11.1-6.

The evaluation of the combined effects of the Project on the sound levels indicator considers collectively the assessment of the combined effects on this indicator from construction and operations of all Project components. Overall, the Project has the potential to cause sound level increases at residences during construction and operations which is considered to have a negative impact balance. Through implementation of industry standard recommended mitigation measures during the construction and operations phases of the Project, the combined effects of the Project on the sound levels indicator are considered to be of low to medium magnitude (Table 7.11.1-6, point 1[g]). A summary of the rationale for all of the significance criteria of combined effects on sound levels is provided below.

- Spatial Boundary: Acoustic Environment LSA – the combined effects of the Project on the sound levels indicator result in increases which comply with the AER *Directive 038* (ERCB 2007), BC OGC *Noise Control Best Practices Guideline* (BC OGC 2009) and Health Canada guidance within the Acoustic Environment LSA.
- Duration: short to long-term – the events causing the combined effects of the Project on the sound levels indicator will be short-term during the construction phase and in relation to pipeline operations. Pump stations, storage tanks and Westridge Marine Terminal all experience long-term changes in sound levels during the operations phase.
- Frequency: continuous – the combined effects of the Project on the sound levels indicator may be isolated to periodic for construction of the Project but will be continuous for pump station, tanks and Westridge Marine Terminal operations.
- Reversibility: long-term – the combined effects of the Project on the sound levels indicator considers operations at pump stations, storage tanks and the Westridge Marine Terminal which will extend over the life of the Project. All sound level changes are reversible as the sound will cease when the pipeline or facility is decommissioned.
- Magnitude: low to medium – with the implementation of appropriate mitigation measures during construction and at the pumps stations, noise levels at receptors are expected to comply with AER, BC OGC and Health Canada limits.
- Probability: high – the combined effects of the Project on the sound levels indicator are expected based on the proximity of residential receptors to Project activities.
- Confidence: moderate – based on the nature of the data inputs.

Combined Effects on the Vibration Indicator

The component of the Project which affects the vibration levels indicator is the pipeline. Vibration levels are affected by blasting of rock, which only occurs during the construction phase. No potential effects were identified for operations of the proposed pipeline nor for the construction or operations of temporary facilities, pump stations and storage tanks, or Westridge Marine Terminal. No potential effects were identified for vibration levels resulting from pipeline reactivation activities along the Hinton to Hargreaves Segment and Darfield to Black Pines Segment. Therefore, the significance of the combined effects on vibration levels reflect the construction of the pipeline only as described in Section 7.2.6.6 and is summarized in Table 7.11.1-6 (point 2[g]).

Combined Effects on the Acoustic Environment

All components of the Project affect the acoustic environment. These include the construction and operations of the proposed pipeline, temporary facilities, pump stations and storage tanks, as well as construction and operations activities associated with the Westridge Marine Terminal and pipeline reactivation. Residual effects from these activities varied between the construction and operations phases and were dependant on the type of activities. The significance of the combined effects on sound levels from construction and operations of the Project is summarized in Table 7.11.1-6.

Sound level limits from oil and gas related projects are regulated in Alberta under AER *Directive 038: Noise Control* (ERCB 2007). In BC, the BC OGC has issued the *Noise Control Best Practices Guideline* (2009) to be used for oil and gas development. No other legislation or bylaw requires a quantified sound level be met, except the City of Burnaby bylaw under specific conditions. Generally, noise bylaws indicate times for noisy activities such as construction and look to prevent annoyance, where they exist.

The evaluation of the combined effects of the Project on the acoustic environment considers collectively the assessment of the combined effects on the sound levels and vibration level indicators from construction and operations of all applicable Project components. Overall, the Project has the potential to cause sound level increases at residences during construction and operations which is considered to have a negative impact balance. Through implementation of industry standard recommended mitigation measures during the construction and operations phases of the Project, the combined effects of the Project on the acoustic environment indicators are considered to be of low to medium magnitude (Table 7.11.1-6, point 3[a]). A summary of the rationale for all of the significance criteria of combined effects of the Project on the acoustic environment indicators is provided below.

- Spatial Boundary: Acoustic Environment LSA – combined effects of the Project on the acoustic environment indicators result in increases which comply with the AER *Directive 038* (ERCB 2007), BC OGC *Noise Control Best Practices Guideline* (BC OGC 2009) and Health Canada guidance within the Acoustic Environment LSA. Vibration levels effects may extend into the Acoustic Environment RSA.
- Duration: short to long-term – the events causing combined effects on the acoustic environment will be short-term during the construction phase and in relation to pipeline operations. Pump stations, storage tanks and Westridge Marine Terminal all experience long-term changes in sound levels during the operations phase.
- Frequency: continuous – the combined effects of the Project on sound levels and vibration levels indicators may be isolated to periodic for construction of the Project but will be continuous for sound levels at pump stations, tanks and Westridge Marine Terminal operations.
- Reversibility: long-term – the combined effects of the Project on the acoustic environment consider operations at pump stations, tanks and Westridge Marine Terminal which will extend over the life of the Project. All sound level changes are reversible as the sound will cease when the pipeline or facility is decommissioned. Construction sound levels and vibration levels are reversible in the short-term.
- Magnitude: low to medium – with the implementation of appropriate mitigation measures during construction and at the pump stations, tanks and Westridge Marine Terminal during operations, noise levels at receptors are expected to comply with AER, BC OGC and Health Canada limits.
- Probability: high – combined effects of the Project on the acoustic environment are expected based on the proximity of residential receptors to Project activities.
- Confidence: moderate – based on the nature of the data inputs.

Summary

As identified in Table 7.11.1-6, there are no situations where there is a high probability of occurrence of a permanent or long-term environmental effect on the acoustic environment of high magnitude that cannot be technically or economically mitigated. Consequently, it is concluded that the environmental effects of the Project on the acoustic environment indicators will be not significant.

TABLE 7.11.1-6

SIGNIFICANCE EVALUATION OF THE PROJECT ON THE ACOUSTIC ENVIRONMENT

	Potential Effect	Impact Balance	Spatial Boundary[1]	Temporal Context			Magnitude	Probability	Confidence	Significance[2]
				Duration	Frequency	Reversibility				
1.	Acoustic Environment Indicator – Sound Level									
1(a)	Combined effects from pipeline.	Negative	LSA	Short-term	Isolated	Short-term	Low to medium	High	Moderate	Not significant
1(b)	Combined effects from temporary facilities.	Negative	LSA	Short-term	Isolated	Short-term	Low to medium	High	Moderate	Not significant
1(c)	Combined effects from pump station activities.	Negative	LSA	Long-term	Continuous	Long-term	Negligible to medium	High	Moderate	Not significant
1(d)	Combined effects from tanks.	Negative	LSA	Long-term	Continuous	Long-term	Negligible to medium	High	Moderate	Not significant
1(e)	Combined effects from Westridge Marine Terminal.	Negative	LSA	Long-term	Continuous	Long-term	Negligible to low	High	Moderate	Not significant
1(f)	Combined effects from pipeline reactivation.	Negative	LSA	Short-term	Isolated	Short-term	Low to medium	High	Moderate	Not significant
1(g)	Combined effects of the Project on the sound levels indicator (1[a]to 1[f]).	Negative	LSA	Short to long-term	Continuous	Long-term	Low to medium	High	Moderate	Not significant
2.	Acoustic Environment Indicator – Vibration Level									
2(a)	Combined effects from pipeline.	Negative	LSA	Short-term	Isolated	Short-term	Low to medium	High	Moderate	Not significant
2(b)	Combined effects from temporary facilities.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2(c)	Combined effects from pump station activities.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2(d)	Combined effects from tanks.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2(e)	Combined effects from Westridge Marine Terminal.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2(f)	Combined effects from pipeline reactivation.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2(g)	Combined effects of the Project on the vibration level indicator (2[a]).	Negative	LSA	Short-term	Isolated	Short-term	Low to medium	High	Moderate	Not significant
3.	Combined Effects of the Project on Acoustic Environment									
3(a)	Combined effects of the Project on acoustic environment indicators (1[g] and 2[g]).	Negative	LSA	Short to long-term	Continuous	Long-term	Low to medium	High	Moderate	Not significant

Notes: 1 LSA = Acoustic Environment LSA.

2 Significant Residual Environmental Effect: A high probability of occurrence of a permanent or long-term residual effect of high magnitude that cannot be technically or economically mitigated.

7.11.1.7 Fish and Fish Habitat

The evaluation of the effects of the Project on fish and fish habitat considers the combined effect of applicable Project components on each of the following fish and fish habitat indicators: riparian habitat; instream habitat; fish mortality and injury; Arctic grayling; Athabasca rainbow trout; bull trout; burbot; northern pike; walleye; bull trout/Dolly Varden; Chinook salmon; coho salmon; cutthroat trout; and rainbow trout/steelhead.

Combined Effects of the Project on Fish and Fish Habitat Indicators

The evaluation of the combined effects of the Project on each of the 14 fish and fish habitat indicators are noted in Table 7.11.1-7. Table 7.2.7-3 and the accompanying discussion in Section 7.2.7.6 provide an evaluation of significance of the combined effects of the Project on these indicators.

Combined Effects of the Project on Fish and Fish Habitat

The evaluation of the combined effects of the Project on the fish and fish habitat indicators considers collectively the assessment of the combined effects of the Project on the following fish and fish habitat indicators: riparian habitat; instream habitat; fish mortality or injury; Arctic grayling; Athabasca rainbow trout; bull trout; burbot; northern pike; walleye; bull trout/Dolly Varden; Chinook salmon; coho salmon; cutthroat trout; and rainbow trout/steelhead. Project components contributing to combined effects include the construction and operations of the pipeline, temporary facilities (specifically temporary access roads), pump stations (including power lines), storage tanks (through hydrostatic testing) and pipeline reactivation activities (through hydrostatic testing). No interactions between fish and fish habitat and the Westridge Marine Terminal were predicted.

Local and regional management plans containing goals and objectives applicable to fish and fish habitat aid in the assessment of Project-related effects on fish and fish habitat and influenced the mitigation developed to reduce or avoid adverse effects. For example, through the implementation of the mitigation measures for each fish and fish habitat indicator, it is believed that the Project meets the goals of the plans and strategies for fish and fish habitat within the Aquatics RSA. These relate to the protection of fish and fish habitat, restoring or maintaining populations and maintaining diversity, for particular species (Alberta Lake Sturgeon Recovery Team 2011, ASRD 2012, Berry 1998, Berry 1999, Berry 1995, Pearson *et al.* 2008, National Recovery Team for Cultus Pygmy Sculpin 2007), some of which apply to indicator species and are discussed in Section 7.2.7-6. In addition, some local and regional management plans had general goals and objectives related to fish and fish habitat as a whole (Appendix 7.1). Mitigation measures to reduce effects on fish and fish habitat are provided in the Pipeline EPP and Facilities EPP and include the selection of appropriate pipeline and vehicle crossing methods, adherence to least risk work windows, implementation of erosion controls and reclamation and access control measures. With the successful implementation of the mitigation measures and since Project activities will be conducted in accordance with all applicable federal and provincial legislation, the Project is not expected to interfere with goals and objectives of the various management plans as they relate to fish and fish habitat.

The combined effects of the Project on fish and fish habitat are considered to be of medium to long-term reversibility and low to medium magnitude (Table 7.11.1-7, point 15[a]). A summary of the rationale for all of the significance criteria of combined effects on the fish and fish habitat indicators is provided below.

- Spatial Boundary: Aquatics RSA – the combined effects of the Project on the fish and fish habitat indicators will extend beyond the Fish and Fish Habitat LSA.
- Duration: immediate to short-term – most events causing combined effects on the fish and fish habitat indicators are attributed to instream watercourse activities (*e.g.,* increase in suspended sediment) or the construction phase of various Project components (*e.g.,* clearing of riparian habitat for the pipeline, hydrostatic testing of tanks and pipeline reactivation).
- Frequency: isolated – most of the Project activities contributing to combined effects on the fish and fish habitat indicators occur during the construction phase although it is acknowledged that maintenance activities during the operations phase also contribute to combined effects.
- Reversibility: medium to long-term – combined effects of the Project on the fish and fish habitat indicators with respect to instream habitat and fish mortality and injury at pipeline and temporary vehicle crossings are typically reversible in the medium-term while effects from riparian habitat associated with the pipeline, temporary access roads and power lines, are reversible in the medium to long-term depending on the pre-existing vegetative community (*e.g.,* shrubs or trees).
- Magnitude: low to medium – combined effects of the Project on the fish and fish habitat indicators are generally considered to be of low magnitude given the implementation of mitigation measures reflective of industry standards and federal and provincial guidelines and that the Project is not expected to interfere with goals and objectives of the various management plans as they relate to fish and fish habitat. However, for instream construction activities at large flowing watercourses where suspended sediment concentrations could contribute to a HADD and fish mortality or injury, regulatory authorization will be obtained, reducing the magnitude to medium.

- Probability: high – various Project components are predicted to affect one or more fish and fish habitat indicators.
- Confidence: moderate – based on the professional experience of the assessment team.

<u>Summary</u>

There are no situations where there is a high probability of occurrence of a permanent or long-term environmental effect on fish and fish habitat of high magnitude that cannot be technically or economically mitigated. Consequently, it is concluded that the environmental effects of the Project on fish and fish habitat indicators will be not significant.

TABLE 7.11.1-7

SIGNIFICANCE EVALUATION OF THE PROJECT ON FISH AND FISH HABITAT

	Potential Effect	Impact Balance	Spatial Boundary[1]	Temporal Context			Magnitude	Probability	Confidence	Significance[2]
				Duration	Frequency	Reversibility				
1.	Fish and Fish Habitat Indicator – Riparian Habitat									
1(a)	Combined effects of the Project on the riparian habitat indicator.	Negative	RSA	Short-term	Isolated to occasional	Medium to long-term	Low	High	High	Not significant
2.	Fish and Fish Habitat Indicator – Instream Habitat									
2(a)	Combined effects of the Project on the instream habitat indicator.	Negative	RSA	Immediate to short-term	Isolated	Short to medium-term	Low	High	High	Not significant
3.	Fish and Fish Habitat Indicator – Fish Mortality and Injury									
3(a)	Combined effects of the Project on the fish mortality and injury indicator.	Negative	RSA	Immediate to short-term	Isolated	Medium-term	Low to medium	High	Moderate	Not significant
4.	Fish and Fish Habitat Indicator – Arctic Grayling (Alberta Indicator Species)									
4(a)	Combined effects of the Project on Arctic grayling.	Negative	RSA	Immediate to short-term	Isolated	Medium to long-term	Low	High	Moderate	Not significant
5.	Fish and Fish Habitat Indicator – Athabasca Rainbow Trout (Alberta Indicator Species)									
5(a)	Combined effects of the Project on Athabasca rainbow trout.	Negative	RSA	Immediate to short-term	Isolated	Medium to long-term	Low	High	Moderate	Not significant
6.	Fish and Fish Habitat Indicator – Bull Trout (Alberta Indicator Species)									
6(a)	Combined effects of the Project on bull trout.	Negative	RSA	Immediate to short-term	Isolated	Medium to long-term	Low	High	Moderate	Not significant
7.	Fish and Fish Habitat Indicator – Burbot (Alberta Indicator Species)									
7(a)	Combined effects of the Project on burbot.	Negative	RSA	Immediate to short-term	Isolated	Medium to long-term	Low	High	Moderate	Not significant
8.	Fish and Fish Habitat Indicator – Northern Pike (Alberta Indicator Species)									
8(a)	Combined effects of the Project on northern pike.	Negative	RSA	Immediate to short-term	Isolated	Medium to long-term	Low	High	Moderate	Not significant
9.	Fish and Fish Habitat Indicator – Walleye (Alberta Indicator Species)									
9(a)	Combined effects of the Project on walleye.	Negative	RSA	Immediate to short-term	Isolated	Medium to long-term	Low	High	Moderate	Not significant
10.	Fish and Fish Habitat Indicator – Bull Trout/Dolly Varden (BC Indicator Species)									
10(a)	Combined effects of the Project on bull trout/Dolly Varden.	Negative	RSA	Immediate to short-term	Isolated	Medium to long-term	Low	High	Moderate	Not significant

TABLE 7.11.1-7 Cont'd

Potential Effect	Impact Balance	Spatial Boundary[1]	Temporal Context: Duration	Temporal Context: Frequency	Temporal Context: Reversibility	Magnitude	Probability	Confidence	Significance[2]
11. Fish and Fish Habitat Indicator – Chinook Salmon (BC Indicator Species)									
11(a) Combined effects of the Project on Chinook salmon.	Negative	RSA	Immediate to short-term	Isolated	Medium to long-term	Low	High	Moderate	Not significant
12. Fish and Fish Habitat Indicator – Coho Salmon (BC Indicator Species)									
12(a) Combined effects of the Project on coho salmon.	Negative	RSA	Immediate to short-term	Isolated	Medium to long-term	Low	High	Moderate	Not significant
13. Fish and Fish Habitat Indicator – Cutthroat Trout (BC Indicator Species)									
13(a) Combined effects of the Project on cutthroat trout.	Negative	RSA	Immediate to short-term	Isolated	Medium to long-term	Low	High	Moderate	Not significant
14. Fish and Fish Habitat Indicator – Rainbow Trout/Steelhead (BC Indicator Species)									
14(a) Combined effects of the Project on rainbow trout/steelhead.	Negative	RSA	Immediate to short-term	Isolated	Medium to long-term	Low	High	Moderate	Not significant
15. Combined Effects of the Project on Fish and Fish Habitat									
15(a) Combined effects of the Project on the fish and fish habitat indicators (1[a] to 14[a]).	Negative	RSA	Immediate to short-term	Isolated	Medium to long-term	Low to medium	High	Moderate	Not significant

Notes: 1 RSA = Aquatics RSA.

2 Significant Residual Environmental Effect: A high probability of occurrence of a permanent or long-term residual effect of high magnitude that cannot be technically or economically mitigated.

7.11.1.8 Wetland Loss or Alteration

The evaluation of the effects of the Project on wetlands considers the combined effect of applicable Project components on the wetland loss or alteration indicator: wetland function.

Combined Effects of the Project on Wetland Loss or Alteration

The components of the Project which may affect the wetland loss or alteration indicator (*i.e.,* wetland function) include the proposed pipeline, temporary facilities and pump stations (and associated power lines). No potential effects on wetland function are anticipated from the pipeline reactivation activities and the construction and operations activities related to the tanks and the Westridge Marine Terminal. The evaluation of the combined effects of the Project on wetland loss or alteration considers collectively the assessment of the combined effects of the applicable Project components on the following wetland loss or alteration indicator: wetland function (*i.e.,* habitat, hydrological and biogeochemical).

Through the implementation of the mitigation measures for the wetland loss or alteration indicator, it is believed that the Project meets the wetland function-related objectives of the Federal Policy on Wetland Conservation (FPWC) and the following management plans:

- Strathcona Municipal Development Plan (Strathcona County 2007);
- City of Edmonton Municipal Development Plan (City of Edmonton 2010);
- Spruce Grove Municipal Development Plan (City of Spruce Grove 2010);
- Regional District of Fraser-Fort George Official Community Plans (Regional District of Fraser-Fort George 2013);

- Hope Official Community Plan Bylaw No. 1147 (District of Hope 2004);
- Fraser Valley Regional District Community Plan Electoral Area B (Fraser Valley Regional District 1998); and
- Fraser Valley Regional District Community Plan Electoral Area D (Fraser Valley Regional District 1997).

With the successful implementation of the mitigation measures and since the Project activities will be conducted in accordance with all applicable federal, provincial and municipal legislation, the Project is not expected to interfere with goals and objectives of the various management plans relevant to wetland function. For example, where feasible, Trans Mountain has met the intent of the FPWC (National Wetland Working Group 1997) by managing potential effects on wetlands (*e.g.,* loss of wetland function) by implementing a routing decision framework that takes into consideration aligning the route along an adjacent existing pipeline corridor, reducing length within environmentally sensitive areas, developing construction and reclamation mitigation measures to ensure wetland function in maintained and monitoring wetland function post-construction. Post-construction environmental monitoring of wetland function conducted for past pipeline construction projects (TERA 2011b,c,e, 2012b,c,d) have successively documented the reduction in severity of disturbance to wetland function. These previous projects have shown that mitigation measures implemented during construction can be successful and that wetlands have proven to be resilient.

However, if it becomes apparent following post-construction environmental monitoring that wetland function has not been effectively maintained and if additional remediation to restore wetland function is determined not to be an appropriate course of action following consultation with federal and provincial regulatory authorities, then compensation may be discussed with Environment Canada. This measure will ensure that the overall goal of “no net loss” of wetland function, as outlined in the FPWC, is achieved for the Project.

By aligning the proposed pipeline corridor to travel through a existing transportation utility corridor where feasible and by developing and implementing mitigation measures to reduce the Project-related effects on wetland function, it is estimated that the Project meets the goals of the Strathcona County, City of Edmonton and City of Spruce Grove Municipal Development Plans (City of Edmonton 2010, City of Spruce Grove 2010, Strathcona County 2007), as well as the meeting the requirements of federal (*e.g.,* Environment Canada) and provincial regulatory authorities (*e.g.,* BC OGC, BC MOE and AESRD). Through the implementation of specific mitigation measures to reduce the disturbance to wetlands through the maintenance of riparian vegetation, narrowing the width of the construction right-of-way and with appropriate approvals in place, the Project aligns with the Regional District of Fraser-Fort George, District of Hope and the Fraser Valley Regional District Official Community Plans (District of Hope 2004, Fraser Valley Regional District 1997, Fraser Valley Regional District 1998, Regional District of Fraser-Fort George 2013).

The combined effects of the Project on the wetland loss or alteration indicator are of low magnitude which is based in part on the limited areal extent where the effects would occur (Table 7.11.1-8, point 1[g]). A summary of the rationale for all of the significance criteria of combined effects of the Project on wetland element is provided below.

- Spatial Boundary: Wetland LSA – combined effects of the Project on wetlands with respect to loss or alteration of wetland function (*i.e.,* habitat, hydrological and biogeochemical) may extend beyond the Footprint of the applicable Project components.
- Duration: short-term – the events causing combined effects of the Project on wetlands are construction of the pipeline, temporary facilities, pump stations (including power lines) and maintenance activities which will be completed within any one year during the operations phase (*i.e.,* short-term).
- Frequency: isolated to periodic – the events contributing to combined effects on wetlands include those causing alteration of wetland function (*i.e.,* construction of the proposed pipeline corridor, temporary facilities and maintenance activities) which occur intermittently but repeatedly over the

assessment period whereas events causing loss of wetland function (*i.e.,* partial infilling of wetlands due to construction of the proposed power line structures) are confined to a specified phase of the assessment period (*i.e.,* construction).

- Reversibility: medium to long-term – loss or alteration of wetland function depends on the growth of wetland species (medium-term) found along the proposed pipeline corridor and within the potential restoration/enhancement site, the time required to restore pre-construction elevation and contours (medium-term) and the time for biogeochemical processes to be restored or created along the proposed pipeline corridor or in the potential restoration/enhancement site (medium to long-term). The reversibility of the combined effect of the Project on the wetland loss or alteration element may take longer than one year with the possibility of being greater than 10 years.
- Magnitude: low – based on the proposed mitigation measures (*i.e.,* substrate being restored to pre-construction profile and allowing natural regeneration in wetlands) and the post-construction literature that demonstrates that wetlands are resilient provided habitat function is not permanently altered. Also, with meeting the goals and objectives of applicable management plans and with the potential implementation of compensation, if required, there will be “no net loss” of wetlands (for all effects).
- Probability: high – the proposed pipeline corridor and temporary facilities as well as the proposed Kingsvale power line encounter a number of wetlands, and disturbances within these wetlands will likely occur during pipeline construction and site-specific maintenance activities as well as during construction activities along the power line.
- Confidence: high – based on available research literature, results of mitigation measures and post-construction environmental monitoring programs of past pipeline projects and the professional experience of the assessment team.

Summary

As identified in Table 7.11.1-8, there are no situations where there is a high probability of occurrence of a permanent or long-term environmental effect on wetland loss or alteration of high magnitude that cannot be technically or economically mitigated. Consequently, it is concluded that the environmental effects of the Project on the wetland loss or alteration indicators will be not significant.

TABLE 7.11.1-8

SIGNIFICANCE EVALUATION OF THE PROJECT ON WETLAND LOSS OR ALTERATION

	Potential Effect	Impact Balance	Spatial Boundary[1]	Temporal Context			Magnitude	Probability	Confidence	Significance[2]
				Duration	Frequency	Reversibility				
1.	Wetland Loss or Alteration – Wetland Function									
1(a)	Combined effects from pipeline.	Negative	LSA	Short-term	Periodic	Medium to long-term	Low	High	High	Not significant
1(b)	Combined effects from temporary facilities.	Negative	LSA	Short-term	Isolated	Medium to long-term	Low	High	High	Not significant
1(c)	Combined effects from pump station activities.	Negative	LSA	Short-term	Isolated	Medium to long-term	Low	High	High	Not significant
1(d)	Combined effects from tanks and terminal activities.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1(e)	Combined effects from Westridge Marine Terminal.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1(f)	Combined effects from pipeline reactivation.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1(g)	Combined effects of the Project on wetlands and wetland function indicator (1[a] to 1[c]).	Negative	LSA	Short-term	Isolated to periodic	Medium to long-term	Low	High	High	Not significant

Notes: 1 LSA = Wetland LSA.

2 <u>Significant Residual Environmental Effect</u>: A high probability of occurrence of a permanent or long-term residual effect of high magnitude that cannot be technically or economically mitigated.

7.11.1.9 Vegetation

The evaluation of the effects of the Project on vegetation considers the combined effect of applicable Project components on the vegetation indicators: vegetation communities of concern; plant and lichen species of concern; and presence of infestations of Provincial weed species and other invasive non-native species identified as a concern.

Combined Effects of the Project on Vegetation Communities of Concern

The components of the Project which affect vegetation communities of concern include the construction and operations of the proposed pipeline, temporary facilities, pump stations and storage tanks, as well as pipeline reactivation activities. No potential effects were identified for vegetation communities of concern resulting from construction and operations activities at the Westridge Marine Terminal. The significance of the combined effects of the Project on the vegetation communities of concern indicator from each of these components is summarized in Table 7.11.1-9.

The evaluation of the combined effects of the Project on vegetation communities of concern considers collectively the effects from construction and operations of all applicable Project components. Overall, the Project has the potential to alter vegetation communities of concern, including grasslands in the BG BGC Zone and rare ecological communities, which is considered to have a negative impact balance. The proposed pipeline corridor was routed along existing rights-of-way and other linear disturbance to the extent practical. Based on TEM mapping, approximately 2,231 ha of native vegetation may be disturbed or altered during construction and operations of the proposed pipeline, pump stations (including power lines) and storage tanks.

Key mitigation measures to reduce combined effects on vegetation communities of concern are highlighted below.

- Site-specific mitigation will include avoidance, narrowing the construction right-of-way, fencing or protecting.
- Conduct a pre-construction weed survey and record problem vegetation (designated weeds) infestations on and immediately adjacent to the construction right-of-way.
- Consider delaying clearing to allow seed set and to limit drying of the soils.
- Mow or walk down rather than wholly remove shrubs, where feasible.
- Conduct straw crimping on disturbed agricultural or native grassland soils where wind erosion may be problematic.
- Disturbed areas through native vegetation segments will be allowed to naturally regenerate or will be seeded with the appropriate native seed mix.
- Manage all problem vegetation along the construction right-of-way during all pipeline construction phases (*i.e.,* pre-construction, construction, post-construction environmental monitoring) and the operational phase.
- Monitor the effectiveness of revegetation efforts during the post-construction environmental monitoring of the construction rights-of-way. Conduct additional remedial work, where warranted.

By preserving native vegetation using the mitigation highlighted above, highlighted in Table 7.2.9-3 and the EPPs of Volume 6B and 6C, the Project will achieve the objectives of the land use plans for the areas traversed by the proposed corridor. Objectives of the management plans include maintaining natural vegetation throughout the development process, preserving natural vegetation including trees to the extent feasible in all undeveloped and riparian areas and discouraging further clearing or development in areas where native vegetation is important for soil conservation, water resources protection or wildlife habitat (City of Kamloops 2004, Strathcona County 2007, TNRD 2000, TNRD 2011a-e, Town of Edson 2006, Yellowhead County 2005, Yellowhead County 2006, Yellowhead County 2007). See Appendix 7.1 for more details of the land use plan objectives related to vegetation.

Through implementation of best practices, objectives and provincial guidelines during the construction and operations phases of the Project, the combined effects of the Project on vegetation communities of concern are considered to be of low to medium magnitude (Table 7.11.1-9, point 1[g]). In addition, effects on vegetation communities of concern will be monitored as part of the post-construction environmental monitoring program (Volume 6A). A summary of the rationale for all of the significance criteria of combined effects of the Project on vegetation communities of concern is provided below.

- Spatial Boundary: Vegetation LSA – alteration of vegetation communities of concern may extend beyond the Footprint associated with each Project component.
- Duration: short-term – the events causing combined effects on the vegetation communities of concern indicator are the construction of the various Project components and maintenance activities which will be completed within any one year during the operations phase.
- Frequency: periodic - the events causing the combined effects on the vegetation communities of concern indicator are generally confined to the construction phase but may occur intermittently but repeatedly (*e.g.,* maintenance activities) during the operations phase.
- Reversibility: medium to long-term – combined effects of the Project on the vegetation communities indicator depends on the communities being disturbed by Project components and the time required to restore pre-construction conditions of vegetation, hydrology and light levels (medium [for pipeline or power line construction] to long-term [in the case of pump stations or terminals]). The reversibility of the residual effect may take longer than one year with the possibility of being greater than 10 years (in the case of facilities or mature treed areas [*i.e.,* treed fens]).
- Magnitude: low to medium – based on the proposed mitigation measures (*i.e.,* allowing natural regeneration in native vegetation areas, revegetating with an appropriate native seed mix, implementing a Reclamation Management Plan or applying appropriate migration to protect rare ecological communities as per the Rare Ecological Community and Rare Plant Population Management Plan) and the post-construction environmental monitoring literature that demonstrates that vegetation communities are resilient. Combined effects on vegetation communities of concern are anticipated to be largely mitigated during construction.
- Probability: high – the Project components will collectively disturb vegetation communities of concern.
- Confidence: moderate – based on available research literature, results of mitigation measures and post-construction environmental monitoring programs of past pipeline projects and the professional experience of the assessment team.

Combined Effects of the Project on Plant and Lichen Species of Concern

The components of the Project which affect plant and lichen species of concern include the construction and operations of the proposed pipeline, pump stations and storage tanks, as well as pipeline reactivation activities. No potential effects were identified for plant and lichen species of concern resulting from construction and operations of temporary facilities or activities at the Westridge Marine Terminal. The significance of the combined effects of the Project on the plant and lichen species of concern indicator from each of these components is summarized in Table 7.11.1-9.

The evaluation of the combined effects of the Project on plant and lichen species of concern considers collectively the effects from construction and operations of all applicable Project components. Overall, the Project has the potential to alter plant and lichen species of concern through direct disturbance or indirectly through changes in hydrology or light levels, which is considered to have a negative impact balance.

Mitigation measures for rare plant and lichen species generally fall into categories of avoidance, (*e.g.,* realignment, change of work side, narrowing), reducing disturbance (*e.g.,* narrowing, adjusting workspaces, protective matting, snow cover in the winter) and alternative construction/reclamation techniques (*e.g.,* salvaging seed or sod, relocation of substrates, plant propagation, plant or lichen transplanting, separate strippings salvage, delay clearing, access management) (see the Vegetation

Technical Report of Volume 5C for more details). Refer to the Rare Ecological Community and Rare Plant Population Management Plan in the EPPs of Volume 6B and 6C for additional measures. These proposed mitigation measures have been used previously on other major pipeline construction projects with good success.

Through implementation of best practices, objectives and provincial guidelines during the construction and operations phases of the Project, the combined effects of the Project on the plant and lichen species of concern indicator are considered to be of medium magnitude (Table 7.11.1-9, point 2[g]). A summary of the rationale for all of the significance criteria of combined effects of the Project on the plant and lichen species of concern indicator is provided below.

- Spatial Boundary: Vegetation LSA – although combined effects of the Project on rare plant and lichen species of concern are generally confined to the disturbed portion of the construction right-of-way, potential changes in hydrology, dust and light levels may extend beyond the Footprint associated with each Project component.
- Duration: short-term – the events causing combined effects on the plant and lichen species of concern indicator are the construction of the various Project components and maintenance activities which will be completed within any one year during the operations phase.
- Frequency: periodic – the events causing the combined effects on the plant and lichen species of concern indicator are generally confined to the construction phase but may occur intermittently but repeatedly (*e.g.,* maintenance activities) during the operations phase.
- Reversibility: medium to long-term – combined effects of the Project on the plant and lichen species of concern indicator depends on the species and their habitats that occur on the Footprint of the Project component (*e.g.,* annual vs. perennial) and the time required to restore pre-construction conditions of vegetation, hydrology and light levels. The reversibility of the residual effect may take more than one year plus adequate precipitation levels in order for natural drainage patterns to be restored, and it will take years for vegetation to grow back to former heights, which is what affects the light levels reaching surrounding vegetation communities.
- Magnitude: medium – combined effects of the Project on plant and lichen species of concern are anticipated to be mitigated during construction. Mitigation for species of concern is selected from a suite of proven and successful mitigation strategies to ensure the local population will not be placed at risk. Post-construction environmental monitoring will be conducted following construction to monitor the success of the applied mitigation measures.
- Probability: high – Project components are likely to encounter plant and lichen species of concern.
- Confidence: moderate – based on available research literature, results of field surveys, post-construction environmental monitoring programs of past pipeline projects and the professional experience of the assessment team.

Combined Effects of the Project on Presence of Infestations of Provincial Weed Species and Other Invasive Non-Native Species Identified as a Concern

The components of the Project which affect weeds and other invasive non-native species include the construction and operations of the proposed pipeline, temporary facilities, pump stations, storage tanks, and Westridge Marine Terminal as well as pipeline reactivation activities. The significance of the combined effects on weeds and other invasive non-native species from each of these components is summarized in Table 7.11.1-9.

The evaluation of the combined effects of the Project on weeds and other invasive non-native species considers collectively the effects from construction and operations of all Project components. Overall, the Project has the potential to increase infestations of weeds and other invasive non-native species, which is considered to have a negative impact balance.

Mitigation measures outlined in Table 7.2.9-3 and in the EPPs of Volume 6B and 6C are effective industry standard measures to reduce the potential for the introduction and spread of weeds. These measures will be implemented during both construction and maintenance of the Project.

Experience during past construction programs has shown that, while weed infestations were encountered, the implementation of appropriate mitigation measures during construction resulted in limited weed issues (Alliance Pipeline 2002, Inter Pipeline 1995, Enbridge Pipelines Inc 2000, 2002, TERA 2012). In addition, the final post-construction environmental monitoring report for the TMX Anchor Loop Project indicated that after 5 years, the post-construction vegetation management program had effectively controlled or suppressed non-native invasive broadleaf species of concern, identified during the pre-construction survey, along the right-of-way (TERA 2013).

Key mitigation measures to reduce the introduction and spread of weeds includes: conducting a pre-construction weed survey; cleaning equipment (*i.e.,* shovel and sweep, pressurized water or compressed air) involved in topsoil/root zone material handling at weed-infested sites prior to leaving the location; using only Certified Canada No. 1 or the best available agronomic seed and for native seed, obtaining the highest seed grade available; implementing the Weed and Vegetation Management Plan; using herbicides for problem vegetation management along the construction right-of-way during construction and operations; and monitoring the effectiveness of revegetation efforts during the post-construction environmental monitoring of the construction rights-of-way.

Through implementation of industry standard and provincially recommended mitigation measures during the construction and operations phases of the Project, the combined effects of the Project on weeds and other invasive non-native species are considered to be of low to medium magnitude (Table 7.11.1-9, point 3[g]). A summary of the rationale for all of the significance criteria of combined effects of the Project on weed species and other invasive non-native species identified as a concern is provided below.

- Spatial Boundary: Vegetation RSA – combined effects of the Project on the weeds and other invasive non-native species indicator may extend past the Footprint and Vegetation LSA into the Vegetation RSA.
- Duration: short-term – the events causing combined effects on the weeds and other invasive non-native species indicator are the construction of various Project components and maintenance activities which will be completed within any one year during the operations phase.
- Frequency: periodic – the events causing the combined effects on the weed and other invasive non-native species indicator are generally confined to the construction phase, and may occur intermittently but repeatedly over operations phase (*e.g.,* herbicide control).
- Reversibility: short to medium-term – the reversibility of the combined effects of the Project depends on the weed species, the size/location of the weed occurrence, the associated land use and mitigation monitoring. Project effects may take longer than one year to reverse, but will be addressed during post-construction environmental monitoring.
- Magnitude: low to medium – combined effects of the Project on the weed and invasive non-native species indicator are anticipated to be largely mitigated during construction and post-construction environmental monitoring.
- Probability: high – pipeline and facility construction is expected to cause some weed introduction and spread.
- Confidence: high – based on available research literature, results of field surveys, post-construction environmental monitoring programs of past pipeline projects and the professional experience of the assessment team.

Combined Effects of the Project on Vegetation

The evaluation of the combined effects of the Project on the vegetation indicators considers collectively the effects of the Project on the following vegetation indicators: vegetation communities of concern; plant and lichen species of concern; and presence of infestations of Provincial weed species and other invasive non-native species identified as a concern.

Local and regional management plans containing goals and objectives applicable to vegetation have aided in the assessment of Project-related effects on the vegetation indicators and influenced the mitigation developed to reduce or avoid adverse effects. In addition, through the implementation of the mitigation measures for each vegetation indicator, it is believed that the Project meets the goals of both the Official Community Plan (City of Surrey 1996) to discourage clearing of trees and vegetation, and the Strathcona County Municipal Development Plan (Strathcona County 2007) to discourage further clearing or development in areas where native vegetation is important for soil conservation, water resources protection or wildlife habitat. For example, mitigation measures to reduce clearing of native vegetation include maintaining a low growing vegetation cover within the riparian zone around watercourses and wetlands. Through implementation of mitigation measures and post-construction environmental monitoring, the Project also aligns with the policies of the City of Coquitlam Citywide Official Community Plan (City of Coquitlam 2001a) to use appropriate native vegetation in areas to be replanted, as well as the policies of the Way We Grow: Municipal Development Plan (City of Edmonton 2010) to restore ecologically degraded and/or damaged ecological systems and linkages to protect, expand and enhance biodiversity. Mitigation measures developed for protection of grassland vegetation communities, including minimizing the trench width on native grasslands where possible and conducting native seed collection for use in revegetation efforts, achieves the objectives of the KAMPLAN – Official Community Plan (City of Kamloops 2004), which includes maintaining natural vegetation and protecting grasslands.

Additional goals and objectives contained in the various local and regional management plans relevant to vegetation are listed in Appendix 7.1. Other management plans listed in Appendix 7.1 were reviewed and determined to have no specific goals or objectives related to the vegetation indicators. With the successful implementation of the mitigation measures, and since Project activities will be conducted in accordance with all applicable provincial and municipal legislation, the Project is not expected to interfere with goals and objectives of the various management plans relevant to vegetation as listed in Appendix 7.1.

The combined effects of the Project on the vegetation indicators are considered to have a negative impact balance. Through implementation of industry standard and provincially recommended mitigation measures during the construction and operations phases of the Project, the combined effects of the Project on the vegetation indicators are considered to be of low to medium magnitude (Table 7.11.1-9, point 4[a]). In addition, combined effects on vegetation will be monitored as part of the post-construction environmental monitoring program (Volume 6A). A summary of the rationale for all of the significance criteria of combined effects of the Project on the vegetation indicators is provided below.

- Spatial Boundary: Vegetation RSA – combined effects of the Project on the vegetation indicators may extend beyond the construction or operations workspace to the Vegetation RSA.
- Duration: short-term – the events causing the combined effects of the Project on the vegetation indicators are the construction of various Project components and maintenance activities which will be completed within any one year during the operations phase.
- Frequency: periodic – the events causing the combined effects of the Project on the vegetation indicators are generally confined to the construction period but some may occur intermittently but repeatedly during the operations phase.
- Reversibility: medium to long-term – combined effects of the Project on the vegetation indicators may be reversible in the medium-term for some vegetation communities of concern, rare plant and lichen species of concern and invasive weed areas associated with the Project, and long-term (*i.e.,* greater than 10 years) for specific sites associated with Project components where native vegetation will not be fully restored until decommissioning and abandonment (*e.g.,* areas where mature treed areas were cleared for construction and mowed during operations).
- Magnitude: low to medium – combined effects of the Project on the vegetation indicators are anticipated to be largely mitigated during construction and post-construction environmental

monitoring. The Project is not expected to interfere with goals and objectives of various management plans relevant to vegetation.

- Probability: high – based on data pertinent to the Project area and the professional experience of the assessment team.
- Confidence: high – based on data pertinent to the Project area and the professional experience of the assessment team.

Summary

As identified in Table 7.11.1-9, there are no situations where there is a high probability of occurrence of a permanent or long-term environmental effect on vegetation of high magnitude that cannot be technically or economically mitigated. Consequently, it is concluded that the environmental effects of the Project on vegetation indicators will be not significant.

TABLE 7.11.1-9

SIGNIFICANCE EVALUATION OF THE PROJECT ON VEGETATION

	Potential Effect	Impact Balance	Spatial Boundary[1]	Temporal Context			Magnitude	Probability	Confidence	Significance[2]
				Duration	Frequency	Reversibility				
1.	Vegetation – Vegetation Communities of Concern									
1(a)	Combined effects from pipeline.	Negative	LSA	Short-term	Periodic	Medium to long-term	Low to medium	High	Moderate	Not significant
1(b)	Combined effects from temporary facilities.	Negative	Footprint	Short-term	Isolated	Medium to long-term	Low to medium	High	Moderate	Not significant
1(c)	Combined effects from pump station activities.	Negative	Footprint	Short-term	Periodic	Medium to long-term	Low to medium	High	High	Not significant
1(d)	Combined effects from tanks and terminal activities.	Negative	Footprint	Short-term	Isolated	Medium to long-term	Low to medium	High	High	Not significant
1(e)	Combined effects from Westridge Marine Terminal.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1(f)	Combined effects from pipeline reactivation.	Negative	Footprint	Short-term	Isolated	Short to medium-term	Low	High	High	Not significant
1(g)	Combined effects of the Project on the vegetation communities of concern indicator (1[a] to 1[d] and 1[f]).	Negative	LSA	Short-term	Periodic	Medium to long-term	Low to medium	High	Moderate	Not significant
2	Vegetation – Plant and Lichen Species of Concern									
2(a)	Combined effects from pipeline.	Negative	LSA	Short-term	Periodic	Medium to long-term	Medium	High	High	Not significant
2(b)	Combined effects from temporary facilities.	NA	NA	NA	NA	NA	NA	NA	NA	NA
2(c)	Combined effects from pump station activities.	Negative	LSA	Short-term	Periodic	Medium to long-term	Medium	High	High	Not significant
2(d)	Combined effects from tanks and terminal activities.	Negative	Footprint	Short-term	Isolated	medium to long-term	Medium	High	High	Not significant
2(e)	Combined effects from Westridge Marine Terminal.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2(f)	Combined effects from pipeline reactivation.	Although residual effects were identified, none were considered to be likely, therefore, an evaluation of combined effects was not deemed necessary.								
2(g)	Combined effects of the Project on the plant and lichen species of concern indicator (2[a], 2[c] and 2[d]).	Negative	LSA	Short-term	Periodic	Medium to long-term	Medium	High	Moderate	Not significant
3	Vegetation – Presence of Infestations of Provincial Weed Species and Other Invasive Non-native Species Identified as a Concern									
3(a)	Combined effects from pipeline.	Negative	RSA	Short-term	Periodic	Short to medium-term	Low to medium	High	High	Not significant

TABLE 7.11.1-9 Cont'd

Potential Effect		Impact Balance	Spatial Boundary[1]	Temporal Context			Magnitude	Probability	Confidence	Significance[2]
				Duration	Frequency	Reversibility				
3(b)	Combined effects from temporary facilities.	Negative	RSA	Short-term	Isolated	Short to medium-term	Low to medium	High	High	Not significant
3(c)	Combined effects from pump station activities.	Negative	RSA	Short-term	Periodic	Short to medium-term	Low to medium	High	High	Not significant
3(d)	Combined effects from tanks and terminal activities.	Negative	RSA	Short-term	Isolated	Short to medium-term	Low to medium	High	High	Not significant
3(e)	Combined effects from Westridge Marine Terminal.	Negative	RSA	Short-term	Isolated	Short to medium-term	Low	High	High	Not significant
3(f)	Combined effects from pipeline reactivation.	Negative	RSA	Short-term	Isolated	Short to medium-term	Low to medium	High	High	Not significant
3(g)	Combined effects of the Project on the weeds and other non-native species indicator (3[a] to 3[f]).	Negative	RSA	Short-term	Periodic	Short to medium-term	Low to medium	High	High	Not significant
4.	Combined effects of the Project on Vegetation									
4(a)	Combined effects of the Project on the vegetation indicators (1[g], 2[g] and 3[g]).	Negative	RSA	Short-term	Periodic	Medium to long-term	Low to medium	High	High	Not significant

Notes: 1 LSA = Vegetation LSA; RSA = Vegetation RSA.

2 Significant Residual Environmental Effect: A high probability of occurrence of a permanent or long-term residual effect of high magnitude that cannot be technically or economically mitigated.

7.11.1.10 Marine Sediment and Water Quality

The evaluation of the effects of the Project on marine sediment and water quality considered the combined effects of applicable Project components (*i.e.,* construction and operations of the Westridge Marine Terminal) on the marine sediment and water quality indicators: marine sediment quality and marine water quality.

The evaluation of the combined effects of the Project on each of the above marine sediment and water quality indicators noted in Table 7.11.1-10 (points 1[g] and 2[g]) reflect the construction and operations of the Westridge Marine Terminal since this is the only Project component affected. Table 7.6.8-3 and the accompanying discussion in Section 7.6.8.6 provide an evaluation of significance of the combined effects on these indicators.

Combined Effects of the Project on Marine Sediment and Water Quality

The combined effects of construction and operations of the Westridge Marine Terminal on marine sediment and water quality are associated with dredging during construction and with release of treated stormwater during operations (Table 7.11.1-10, point 3[a]). Release of TSS and existing contaminants from sediment during dredging (should dredging occur) will be limited. TSS levels will be managed through use of a clamshell dredge and turbidity curtains to limit the amount and spatial extent of TSS generated and to meet water quality guidelines outside of the immediate dredge area. Contaminant concentrations are similar throughout the Marine Sediment and Water Quality LSA (and meet screening criteria for disposal at sea for PAHs and PCBs, but are above the screening levels for some metals) and mitigation measures will be used to reduce the amount of sediment released and dispersed. Release of petroleum hydrocarbons in stormwater during operations will be controlled through the use of an oil/water separator, which is well understood technology, and concentrations will meet provincial permit requirements for an effluent discharge; there will be no change compared to the existing conditions.

There is no specific local or regional management plan with goals and objectives applicable to marine sediment and water quality to aid in the assessment of Project-related effects on the marine sediment and water quality and quantity indicators. There are, however, specific regulatory requirements for TSS management and disposal of dredged sediment during construction and discharge of stormwater during operations. By meeting permit requirements (as is the case currently) and implementing the mitigation measures for each sediment and water quality indicator, it is believed that the Project will support the objectives described in the "Ambient water quality objectives for Burrard Inlet Coquitlam-Pitt River area" (Nijman 1990).

A summary of the rationale for all of the significance criteria of combined effects of the Project on the marine sediment and water quality indicators is provided below (Table 7.11.1-10, point 3[a]), assuming the largest effect criteria predicted for either sediment or water.

- Spatial Boundary: Marine Sediment and Water Quality LSA – rapid dilution of treated stormwater within a short distance of the outfall, given that the outfall is located in the LSA (sediment disturbance would be limited to the Footprint).
- Duration: long-term – stormwater discharges will occur throughout the operations phase (construction effects would be short-term).
- Frequency: periodic – effluent release will occur intermittently but repeatedly over the assessment period during rainfall events (construction effects will be isolated, confined to the dredging period).
- Reversibility: short-term – each stormwater event is reversible soon after the discharge stops; however, the overall effect of stormwater discharge will not stop until the end of operations (the construction effects are reversible in the short-term).
- Magnitude: low – site runoff will be within permit requirements, which are set to protect marine aquatic biota; for both construction and operations, the expansion of Westridge Marine Terminal facilities will not result in quantifiable changes in measurable parameters as there will be no change from existing conditions.
- Probability: high – given the rainfall regime in the Project area and the dredging activity, should it occur.
- Confidence: high – for construction and operations, there is a good understanding of the cause-effect relationships between contaminant conditions and potential for adverse effects on marine life, effectiveness of mitigation measures, and site-specific data upon which to base the assessment.

Summary

As identified in Table 7.11.1-10, there are no situations where there is a high probability of occurrence of a permanent or long-term environmental effect on marine sediment and water quality of high magnitude that cannot be technically or economically mitigated. Consequently, it is concluded that the environmental effects of the Project on marine sediment and water quality indicators will be not significant.

TABLE 7.11.1-10

SIGNIFICANCE EVALUATION OF THE PROJECT ON MARINE SEDIMENT AND WATER QUALITY

Potential Effect	Impact Balance	Spatial Boundary[1]	Temporal Context: Duration	Temporal Context: Frequency	Temporal Context: Reversibility	Magnitude	Probability	Confidence	Significance[2]
1. Marine Sediment and Water Quality Indicator – Marine Sediment Quality									
1(a) Combined effects from pipeline.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1(b) Combined effects from temporary facilities.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1(c) Combined effects from pump station activities.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

TABLE 7.11.1-10 Cont'd

	Potential Effect	Impact Balance	Spatial Boundary[1]	Temporal Context: Duration	Temporal Context: Frequency	Temporal Context: Reversibility	Magnitude	Probability	Confidence	Significance[2]
1(d)	Combined effects from tanks.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1(e)	Combined effects from Westridge Marine Terminal.	Negative	LSA	Short-term	Isolated	Short-term	Low	High	High	Not significant
1(f)	Combined effects from pipeline reactivation.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1(g)	Combined effects of the Project on the marine sediment quality indicator (1[e]).	Negative	LSA	Short-term	Isolated	Short-term	Low	High	High	Not significant
2.	Marine Sediment and Water Quality Indicator – Marine Water Quality									
2(a)	Combined effects from pipeline.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2(b)	Combined effects from temporary facilities.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2(c)	Combined effects from pump station activities.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2(d)	Combined effects from tanks.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2(e)	Combined effects from Westridge Marine Terminal.	Negative	LSA	Long-term	Periodic	Short-term	Low	High	High	Not significant
2(f)	Combined effects from pipeline reactivation.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2(g)	Combined effects of the Project on the marine water quality indicator (2[e]).	Negative	LSA	Long-term	Periodic	Short-term	Low	High	High	Not significant
3.	Combined Effects of the Project on Marine Sediment and Water Quality									
3(a)	Combined effects of the Project on the marine sediment and water quality indicators (1[g] and 2[g]).	Negative	LSA	Long-term	Periodic	Short-term	Low	High	High	Not significant

Notes: 1 LSA = Marine Sediment and Water Quality LSA.

2 Significant Residual Environmental Effect: A high probability of occurrence of a permanent or long-term residual effect of high magnitude that cannot be technically or economically mitigated.

7.11.1.11 Marine Fish and Fish Habitat

The evaluation of the effects of the Project on marine fish and fish habitat considered the combined effects of applicable Project components (*i.e.,* construction and operations of the Westridge Marine Terminal) on the marine fish and fish habitat indicators: marine riparian habitat; intertidal habitat; subtidal habitat; Dungeness crab; inshore rockfish; and Pacific salmon.

The evaluation of the combined effects of the Project on each of the above marine fish and fish habitat indicators noted in Table 7.11.1-11 (points 1[g], 2[g], 3[g], 4[g], 5[g] and 6[g]) reflect the construction and operations of the Westridge Marine Terminal since this is the only Project component affected. Table 7.6.9-3 and the accompanying discussion in Section 7.6.9.6 provide an evaluation of significance of the combined effects on these indicators.

Combined Effects of the Project on Marine Fish and Fish Habitat

Construction of the Westridge Marine Terminal will result in the loss of marine riparian vegetation, intertidal habitat and subtidal habitat within the Footprint. The existing marine riparian habitat is a narrow fringe of small shrubs, brambles and herbaceous plants, and likely provides little value to marine fish. The intertidal habitat is mostly anthropogenic (rip rap), which was created during construction of the original Westridge Marine Terminal in the mid-1950s. Shoreline infilling will extend the shoreline seaward and will effectively replace the existing intertidal habitat like-for-like (*i.e.,* rip rap with rip rap). Subtidal habitats lost due to infilling and pile installation are primarily soft sediment (sand and mud), although a small area of subtidal rip rap near the shoreline will also be covered during the placement of fill material. The loss of marine fish habitat will be partially offset by the creation of rocky intertidal and subtidal habitat along the outer face of the fill slope. Though anthropogenic in nature, this habitat is expected to be colonized by a suite of marine organisms similar to those currently inhabiting the existing rocky habitats within the Marine Fish and Fish Habitat LSA.

The loss of marine riparian, intertidal and subtidal habitats will result in a temporary reduction of the productive capacity of marine fish habitats within the Marine Fish and Fish Habitat LSA. This effect will be offset through the implementation of a marine fish habitat compensation program, which will ensure there is no net loss of productive capacity. The specific compensation measures to be implemented will be developed in consultation with DFO, Aboriginal communities, and other interested parties during the permitting phase of the Project. One potential option is the construction of a subtidal rock reef near the Westridge Marine Terminal, which would provide high-value, structurally complex habitat for a variety of harvested fish and invertebrates, including Pacific salmon, inshore rockfish and Dungeness crabs. The reef would be colonized by a diverse assemblage of algae and sedentary invertebrates, which would provide prey for fish and mobile invertebrates. Colonization of the reef would begin immediately after construction, and full establishment of a functional community would be expected to take 2 to 3 years.

Shoreline infilling and dredging will result in the mortality of sessile and slow-moving invertebrates within the Footprint, while fish and more mobile invertebrates are expected to avoid harm by dispersing away from the work area. To minimize the number of Dungeness crabs injured or killed, a crab salvage program will be conducted immediately prior to any infilling or dredging works. Crabs will be collected with baited traps and relocated to suitable habitats outside of the Marine Fish and Fish Habitat LSA. To minimize the potential injury or mortality of finfish, including Pacific salmon and inshore rockfish, infilling and dredging works will be conducted during the DFO least risk timing window for Burrard Inlet – August 16 to February 28. If this becomes impractical, timing will be determined in consultation with DFO. Loud underwater noise produced during pile driving may also result in the injury or mortality of a small number of Pacific salmon and inshore rockfish. To minimize this potential effect, a vibratory method of pile installation, which produces substantially lower underwater noise levels, will be used wherever possible. If an impact hammer method is required, bubble curtains will be installed around the full wetted length of the pile in order to reduce the noise levels to the extent practicable. With these mitigation measures, injury or mortality to marine fish is considered unlikely. The combined Project effects on marine fish and fish habitat resulting from construction of the Westridge Marine Terminal are considered to have a negative impact balance. While the habitat losses associated with construction will be permanent, implementation of a marine fish habitat compensation program will ensure there is no net loss of productive capacity. The objective of the compensation program will be to increase the productive capacity of fish habitats in Burrard Inlet through the creation of high-value habitats with direct benefits to a variety of ecologically, economically and culturally important species. The injury or mortality of a small number of fish and invertebrates during construction will not affect the viability of any local or regional populations. With the implementation of mitigation measures described in Section 7.6.9, combined Project effects on marine fish and fish habitat are predicted to be low in magnitude (Table 7.11.1-11, point 7[a]). A summary of the rationale for all of the significance criteria of combined effects of the Project on the marine fish and fish habitat indicators is provided below.

- Spatial Boundary: Marine Fish and Fish Habitat LSA – although the physical effects to marine fish habitat will be limited to the Footprint, the productive capacity of surrounding habitats may be affected as a result of decreased productivity (*e.g.,* algal biomass) and decreased prey availability.
- Duration: short-term - the activities and works that have the potential to affect marine fish and fish habitat will occur during the construction of in-water and shore-based infrastructure, which is expected to take approximately 2 years.
- Frequency: isolated – the activities and works that have the potential to affect marine fish and fish habitat will be limited to the construction phase.
- Reversibility: medium-term to permanent – although the loss of marine fish habitat is considered to be permanent, productive capacity will be restored once biotic communities become fully established on the marine compensation habitat (expected to take 2 to 3 years) and the intertidal and subtidal rip rap habitat created as a result of infilling.
- Magnitude: low – with the implementation of a marine fish habitat compensation program and the other mitigation measures described in Section 7.6.9, there will be no net loss of the productive capacity of marine fish habitat.

- Probability: high – the proposed in-water construction activities at the Westridge Marine Terminal are likely to result in the loss of marine fish habitat, causing a temporary decrease in productive capacity, as well as the injury or mortality of a small number of fish and invertebrates.
- Confidence: high – based on a good understanding by the assessment team of the cause-effect relationships between construction of the Westridge Marine Terminal and effects on marine fish and fish habitat, and a good understanding of the effectiveness of the proposed mitigation measures including the marine fish habitat compensation program.

Summary

As identified in Table 7.11.1-11, there are no situations where there is a high probability of occurrence of a permanent or long-term environmental effect on marine fish and fish habitat of high magnitude that cannot be technically or economically mitigated. Consequently, it is concluded that the environmental effects of the Project on marine fish and fish habitat indicators will be not significant.

TABLE 7.11.1-11

SIGNIFICANCE EVALUATION OF THE PROJECT ON MARINE FISH AND FISH HABITAT

				Temporal Context						
Potential Effect		Impact Balance	Spatial Boundary[1]	Duration	Frequency	Reversibility	Magnitude	Probability	Confidence	Significance[2]
1.	Marine Fish and Fish Habitat Indicator – Marine Riparian Habitat									
1(a)	Combined effects from pipeline.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1(b)	Combined effects from temporary facilities.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1(c)	Combined effects from pump station activities.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1(d)	Combined effects from tanks.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1(e)	Combined effects from Westridge Marine Terminal.	Negative	Footprint	Short-term	Isolated	Permanent	Low	High	High	Not significant
1(f)	Combined effects from pipeline reactivation.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1(g)	Combined effects of the Project on the marine riparian habitat indicator (1[e]).	Negative	Footprint	Short-term	Isolated	Permanent	Low	High	High	Not significant
2.	Marine Fish and Fish Habitat Indicator – Intertidal Habitat									
2(a)	Combined effects from pipeline.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2(b)	Combined effects from temporary facilities.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2(c)	Combined effects from pump station activities.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2(d)	Combined effects from tanks.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2(e)	Combined effects from Westridge Marine Terminal.	Negative	Footprint	Short-term	Isolated	Permanent	Low	High	High	Not significant
2(f)	Combined effects from pipeline reactivation.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2(g)	Combined effects of the Project on the intertidal habitat indicator (2[e]).	Negative	Footprint	Short-term	Isolated	Permanent	Low	High	High	Not significant
3.	Marine Fish and Fish Habitat Indicator – Subtidal Habitat									
3(a)	Combined effects from pipeline.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3(b)	Combined effects from temporary facilities.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3(c)	Combined effects from pump station activities.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3(d)	Combined effects from tanks.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3(e)	Combined effects from Westridge Marine Terminal.	Negative	Footprint	Short-term	Isolated	Permanent	Low	High	High	Not significant
3(f)	Combined effects from pipeline reactivation.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3(g)	Combined effects of the Project on the subtidal habitat indicator (3[e]).	Negative	Footprint	Short-term	Isolated	Permanent	Low	High	High	Not significant
4.	Marine Fish and Fish Habitat Indicator – Dungeness Crab									
4(a)	Combined effects from pipeline.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4(b)	Combined effects from temporary facilities.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4(c)	Combined effects from pump station activities.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

TABLE 7.11.1-11 Cont'd

Potential Effect		Impact Balance	Spatial Boundary[1]	Temporal Context			Magnitude	Probability	Confidence	Significance[2]
				Duration	Frequency	Reversibility				
4(d)	Combined effects from tanks.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4(e)	Combined effects from Westridge Marine Terminal.	Negative	LSA	Short-term	Isolated	Medium-term	Low	High	High	Not significant
4(f)	Combined effects from pipeline reactivation.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4(g)	Combined effects of the Project on the Dungeness crab indicator (4[e]).	Negative	LSA	Short-term	Isolated	Medium-term	Low	High	High	Not significant
5.	Marine Fish and Fish Habitat Indicator – Inshore Rockfish									
5(a)	Combined effects from pipeline.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5(b)	Combined effects from temporary facilities.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5(c)	Combined effects from pump station activities.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5(d)	Combined effects from tanks.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5(e)	Combined effects from Westridge Marine Terminal.	Negative	LSA	Short-term	Isolated	Medium-term	Low	Low	High	Not significant
5(f)	Combined effects from pipeline reactivation.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5(g)	Combined effects of the Project on the inshore rockfish indicator (5e]).	Negative	LSA	Short-term	Isolated	Medium-term	Low	Low	High	Not significant
6.	Marine Fish and Fish Habitat Indicator – Pacific Salmon									
6(a)	Combined effects from pipeline.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6(b)	Combined effects from temporary facilities.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6(c)	Combined effects from pump station activities.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6(d)	Combined effects from tanks.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6(e)	Combined effects from Westridge Marine Terminal.	Negative	LSA	Short-term	Isolated	Medium-term	Low	Low	High	Not significant
6(f)	Combined effects from pipeline reactivation.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6(g)	Combined effects of the Project on the Pacific salmon indicator (6[e]).	Negative	LSA	Short-term	Isolated	Medium-term	Low	Low	High	Not significant
7.	Combined Effects of the Project on Marine Fish and Fish Habitat									
7(a)	Combined effects of the Project on the marine fish and fish habitat indicators (1[g], 2[g], 3[g], 4[g], 5[g] and 6[g]).	Negative	LSA	Short-term	Isolated	Medium-term to permanent	Low	High	High	Not significant

Notes: 1 LSA = Marine LSA.

2 Significant Residual Environmental Effect: A high probability of occurrence of a permanent or long-term residual effect of high magnitude that cannot be technically or economically mitigated.

7.11.1.12 Wildlife and Wildlife Habitat

The evaluation of the effects of the Project on wildlife and wildlife habitat considered the combined effects of applicable Project components on the 26 wildlife and wildlife habitat indicators.

The evaluation of the combined effects of the Project on each of the wildlife and wildlife habitat indicators noted in Table 7.11.1-12 (points 1[a]to 26[a]) reflect the construction and operations of the pipeline, temporary facilities, pump stations (including power lines), storage tanks and Westridge Marine Terminal. Tables 7.2.10-6, 7.2.10-9, 7.2.10-12 and 7.2.10-15 and accompanying discussion in Sections 7.2.10.9, 7.2.10.10, 7.2.10.11 and 7.2.10.12 provide an evaluation of significance of the combined effects on the wildlife indicators.

<u>Combined Effects of the Project on Wildlife and Wildlife Habitat</u>

Pipeline construction and operations activities have the potential to affect wildlife and wildlife habitat through changes in habitat, movement and mortality risk. Section 7.2.10 describes the anticipated effects on wildlife and wildlife habitats, which considers all the Project components in an integrated manner. The characterization of magnitude for each indicator incorporated quantitative metrics and accepted biological thresholds or standards, where available. The ecological context, including sensitivity of the indicator, was considered in the determination of magnitude. The magnitude evaluation also considered relevant land use and recovery planning objectives and strategies, and previous environmental assessments for projects of similar scope. These sources provide useful information on social values and risk tolerance, which are an essential component of significance determination. With application of the proposed mitigation, the overall predicted effects for the wildlife and wildlife habitat indicators are concluded to be of medium magnitude.

A summary of the rationale for all of the significance criteria of combined effects of the Project on the wildlife and wildlife habitat indicators is provided below, assuming the largest effect criteria rating predicted for the suite of indicators.

- Spatial Boundary: RSA – habitat changes and alteration of movement will be limited to the Wildlife LSA; however, changes in mortality risk for many indicators are assessed at the regional scale.
- Duration: short-term – the events causing effects are construction and operational activities (*e.g.,* monitoring, vegetation management and site-specific maintenance), the latter of which are limited to any one year during operations.
- Frequency: periodic – the events causing effects will occur during construction and intermittently during operations for monitoring, vegetation control and maintenance.
- Reversibility: long-term – effects are reversible in the long-term following decommissioning and abandonment, once native vegetation regenerates over the Project Footprint.
- Magnitude: medium – the construction and operations of the Project will cause a reduction in effective habitat for most wildlife indicators, change movement patterns (in some cases potentially creating barriers or filters to movement) and increase wildlife mortality risk. The Project is likely to affect a variety of wildlife species, including common, abundant and resilient species, as well as rare or uncommon and sensitive species. The proposed mitigation measures have been developed to align with regulatory guidelines and recommendations, as well as regional resource management objectives and strategies. Application of appropriate mitigation is expected to reduce the magnitude of Project effects on the wildlife and wildlife habitat indicators to low to medium magnitude.
- Probability: high – the Project will alter habitat, movement patterns and mortality risk to affect the wildlife indicators.
- Confidence: moderate – for most indicators, the assessment is based on a good understanding of cause-effect relationships and relevant data, with some limitations and uncertainty associated with available data specific to the Project area, resulting in a moderate confidence level. The assessment of some indicators has low confidence given the limitations of current scientific knowledge (*i.e.,* research and published literature relevant to effects pathways and response) and available data relevant to the Project area. Confidence in the conclusion for some wildlife and wildlife habitat indicators is expected to improve with completion of supplemental studies and analysis for the Project.

Summary

As identified in Table 7.11.1-12, there are no situations where there is a high probability of occurrence of a permanent or long-term environmental effect on a wildlife indicator of high magnitude that cannot be technically or economically mitigated. Consequently, it is concluded that the environmental effects of the pipeline and facilities component of the Project on wildlife and wildlife habitat indicators will be not significant.

TABLE 7.11.1-12

SIGNIFICANCE EVALUATION OF THE PROJECT ON WILDLIFE AND WILDLIFE HABITAT

	Potential Effect	Impact Balance	Spatial Boundary[1]	Temporal Context			Magnitude	Probability	Confidence	Significance[2]
				Duration	Frequency	Reversibility				
1.	Wildlife Indicator – Grizzly Bear									
1(a)	Combined effects of the Project on the grizzly bear indicator.	Negative	Grizzly Bear RSA	Short-term	Periodic	Long-term	Medium	High	Moderate	Not significant
2.	Wildlife Indicator – Woodland Caribou									
2(a)	Combined effects of the Project on the woodland caribou indicator.	Negative	Caribou RSA	Short-term	Periodic	Long-term	Medium	High	High	Not significant
3.	Wildlife Indicator – Moose									
3(a)	Combined effects of the Project on the moose indicator.	Negative	Wildlife RSA	Short-term	Periodic	Long-term	Low	High	Moderate	Not significant
4.	Wildlife Indicator – Forest Furbearers									
4(a)	Combined effects of the Project on the forest furbearers indicator.	Negative	Wildlife RSA	Short-term	Periodic	Long-term	Low	High	Moderate	Not significant
5.	Wildlife Indicator – Coastal Riparian Small Mammals									
5(a)	Combined effects of the Project on the coastal riparian small mammals indicator.	Negative	LSA	Short-term	Periodic	Long-term	Medium	High	Low	Not significant
6.	Wildlife Indicator – Bats									
6(a)	Combined effects of the Project on the bats indicator.	Negative	LSA	Short-term	Periodic	Long-term	Low	High	Low	Not significant
7.	Wildlife Indicator – Grassland/Shrub-steppe Birds									
7(a)	Combined effects of the Project on the grassland/shrub-steppe birds indicator.	Negative	LSA	Short-term	Periodic	Long-term	Low	High	Moderate	Not significant
8.	Wildlife Indicator – Mature/Old Forest Birds									
8(a)	Combined effects of the Project on the mature/old forest birds indicator.	Negative	LSA	Short-term	Periodic	Long-term	Medium	High	Moderate	Not significant
9.	Wildlife Indicator – Early Seral Forest Birds									
9(a)	Combined effects of the Project on the early seral forest birds indicator.	Negative	LSA	Short-term	Periodic	Long-term	Low	High	Moderate	Not significant
10.	Wildlife Indicator – Riparian and Wetland Birds									
10(a)	Combined effects of the Project on the riparian and wetland birds indicator.	Negative	LSA	Short-term	Periodic	Long-term	Low	High	Moderate	Not significant
11.	Wildlife Indicator – Wood Warblers									
11(a)	Combined effects of the Project on the wood warblers indicator	Negative	LSA	Short-term	Periodic	Long-term	Low	High	Moderate	Not significant
12.	Wildlife Indicator – Short-eared Owl									
12(a)	Combined effects of the Project on the short-eared owl indicator.	Negative	LSA	Short-term	Periodic	Long-term	Low	High	Moderate	Not significant
13.	Wildlife Indicator – Rusty Blackbird									
13(a)	Combined effects of the Project on the rusty blackbird indicator.	Negative	LSA	Short-term	Periodic	Long-term	Low	High	Moderate	Not significant
14.	Wildlife Indicator – Flammulated Owl									
14(a)	Combined effects of the Project on the flammulated owl indicator.	Negative	LSA	Short-term	Periodic	Long-term	Low	High	Moderate	Not significant
15.	Wildlife Indicator – Lewis's Woodpecker									
15(a)	Combined effects of the Project on the Lewis's woodpecker indicator.	Negative	LSA	Short-term	Periodic	Long-term	Medium	High	Moderate	Not significant
16.	Wildlife Indicator – Williamson's Sapsucker									
16(a)	Combined effects of the Project on the Williamson's sapsucker indicator.	Negative	LSA	Short-term	Periodic	Long-term	Medium	High	Moderate	Not significant

TABLE 7.11.1-12 Cont'd

Potential Effect	Impact Balance	Spatial Boundary[1]	Temporal Context			Magnitude	Probability	Confidence	Significance[2]
			Duration	Frequency	Reversibility				
17. Wildlife Indicator – Western Screech-owl									
17(a) Combined effects of the Project on the western screech-owl indicator.	Negative	LSA	Short-term	Periodic	Long-term	Low	High	Moderate	Not significant
18. Wildlife Indicator – Great Blue Heron									
18(a) Combined effects of the Project on the great blue heron indicator.	Negative	LSA	Short-term	Periodic	Long-term	Low	High	Moderate	Not significant
19. Wildlife Indicator – Spotted Owl									
19(a) Combined effects of the Project on the spotted owl indicator.	Negative	LSA	Short-term	Periodic	Long-term	Medium	High	Moderate	Not significant
20. Wildlife Indicator – Bald Eagle									
20(a) Combined effects of the Project on the bald eagle indicator.	Negative	LSA	Short-term	Periodic	Long-term	Low	High	Moderate	Not significant
21. Wildlife Indicator – Common Nighthawk									
21(a) Combined effects of the Project on the common nighthawk indicator.	Negative	LSA	Short-term	Periodic	Long-term	Low	High	Moderate	Not significant
22. Wildlife Indicator – Northern Goshawk									
22(a) Combined effects of the Project on the northern goshawk indicator.	Negative	LSA	Short-term	Periodic	Long-term	Low	High	Moderate	Not significant
23. Wildlife Indicator – Olive-sided Flycatcher									
23(a) Combined effects of the Project on the olive-sided flycatcher indicator.	Negative	LSA	Short-term	Periodic	Long-term	Low	High	Moderate	Not significant
24. Wildlife Indicator – Pond-dwelling Amphibians									
24(a) Combined effects of the Project on the pond-dwelling amphibians indicator.	Negative	LSA	Short-term	Periodic	Long-term	Medium	High	Low	Not significant
25. Wildlife Indicator – Stream-dwelling Amphibians									
25(a) Combined effects of the Project on the stream-dwelling amphibians indicator.	Negative	LSA	Short-term	Periodic	Long-term	Medium	High	Moderate	Not significant
26. Wildlife Indicator – Arid Habitat Snakes									
26(a) Combined effects of the Project on the arid habitat snakes indicator.	Negative	LSA	Short-term	Periodic	Long-term	Medium	High	Moderate	Not significant
27. Combined Effects of the Project on Wildlife and Wildlife Habitat									
27(a) Combined effects of the Project on the wildlife and wildlife habitat indicators (1[a] to 26[a]).	Negative	RSA	Short-term	Periodic	Long-term	Medium	High	Moderate	Not Significant

Notes: 1 LSA = Wildlife LSA; RSA = Wildlife RSA.

2 Significant Residual Environmental Effect: a high probability of occurrence of a permanent or long-term residual effect of high magnitude that cannot be technically or economically mitigated.

7.11.1.13 Marine Mammals

The evaluation of the effects of the Project on marine mammals considered the combined effects of applicable Project components (*i.e.,* construction and operations of the Westridge marine Terminal) on the marine mammal indicator: harbour seals.

Combined Effects of the Project on Marine Mammals

Since the harbour seal is the only indicator for marine mammals, combined effects of the Project on marine mammals are the same as combined effects of the Project on harbour seals. The significance evaluation for combined effects on marine mammals (*i.e.,* effects of Westridge Marine Terminal on the harbour seal indicator) is provided in Section 7.6.11.6 and summarized in Table 7.11.1-13, point 2(a).

There is no local or regional management plan with specific goals and objectives applicable to marine mammals to aid in the assessment of Project-related effects on the marine mammals indicator. The Port Metro Vancouver Consolidated Land Use Plan 2010 (PMV 2010) does, however, note the generally-applicable objectives of exercising responsible environmental stewardship of PMV water areas so that growth and development takes place in an environmentally sensitive and sustainable manner, and of exploring innovative environmental mitigation measures and strategies to minimize the environmental impacts of growth. Both of these objectives are encompassed within the assessment and proposed mitigation measures for marine mammals.

Summary

As identified in Table 7.11.1-13, there are no situations where there is a high probability of occurrence of a permanent or long-term environmental effect on marine mammals of high magnitude that cannot be technically or economically mitigated. Consequently, it is concluded that the environmental effects of the pipeline and facilities component of the Project on the marine mammals indicator will be not significant.

TABLE 7.11.1-13

SIGNIFICANCE EVALUATION OF THE PROJECT ON MARINE MAMMALS

Potential Effect		Impact Balance	Spatial Boundary[1]	Temporal Context			Magnitude	Probability	Confidence	Significance[2]
				Duration	Frequency	Reversibility				
1.	Marine Mammal Indicator – Harbour Seal									
1(a)	Combined effects from pipeline.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1(b)	Combined effects from temporary facilities.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1(c)	Combined effects from pump station activities.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1(d)	Combined effects from tanks.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1(e)	Combined effects from Westridge Marine Terminal.	Negative	RSA	Short-term	Isolated	Medium-term	Medium	High	High	Not significant
1(f)	Combined effects from pipeline reactivation.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1(g)	Combined effects of the Project on harbour seals (1[e]).	Negative	RSA	Short-term	Isolated	Medium-term	Medium	High	High	Not significant
2.	Combined Effects of the Project on Marine Mammals									
2(a)	Combined effects of the Project on the marine mammals indicators (1[g]).	Negative	RSA	Short-term	Isolated	Medium-term	Medium	High	High	Not significant

Notes: 1 RSA = Marine RSA.

2 Significant Residual Environmental Effect: A high probability of occurrence of a permanent or long-term residual effect of high magnitude that cannot be technically or economically mitigated.

7.11.1.14 Marine Birds

The evaluation of the effects of the Project on marine birds considered the combined effects of applicable Project components (*i.e.,* construction and operations of the Westridge marine Terminal) on the marine bird indicators: bald eagle; great blue heron; pelagic cormorant; Barrow's goldeneye; glaucous-winged gull; and spotted sandpiper.

The evaluation of the combined effects of the Project on each of the above marine bird indicators noted in Table 7.11.1-14 (points 1[g], 2[g], 3[g], 4[g], 5[g] and 6[g]) reflect the construction and operations of the Westridge Marine Terminal since this is the only Project component affected. Table 7.6.12-3 and the accompanying discussion in Section 7.6.12.6 provide an evaluation of significance of the combined effects on these indicators.

Combined Effects of the Project on Marine Birds

The combined effects of construction and operations of the Westridge Marine Terminal on marine birds includes potential habitat loss from clearing and construction at the shoreline and nearshore foraging areas of the Marine Birds LSA, and disturbance from noise, night-lighting and human activities associated with development and expansions of terminal facilities. The objectives of the Project are to avoid, or limit, any potential adverse effects from activities related to construction and operations through the use of acceptable and effective mitigation measures and environmental management procedures. Primary goals of the Project include supporting the objectives of local land management plans, parks and conservation areas within the Marine RSA, and environmental management of local ecological values, such as the Burrard Inlet Environmental Action Program. Working with and obtaining ecological knowledge from local groups, such as the Tsleil-Waututh Nation, Maplewood Flats Conservation Area and Pacific Wildlife Foundation, will facilitate these objectives.

Local management plans, such as the Burrard Inlet Environmental Action Program (2002) are focused on managing valued habitats in the Burrard Inlet, maintaining and enhancing the quality of existing ecosystems, and preservation of biodiversity, Other objectives include ensuring industry compliance with the BC *Wildlife Act*, *Migratory Birds Convention Act* (MBCA), and other provincial and federal legislative guideline that protect and preserve biodiversity values and species at risk. The Marine RSA is a component of the larger Burrard Inlet and English Bay Important Bird Area that recognizes the importance of these habitats to migrating and resident marine birds and seeks to protect their associated habitats. These objectives can be addressed during the construction and operations of the expansion of the Westridge Marine Terminal by the application of a comprehensive set of management plans that include mitigation measures to avoid adverse effects to marine birds and other wildlife. Environmental inspection prior to and during construction, and collaboration with local stakeholders, the directors of ecological conservation areas, parks and protected areas, and with local Aboriginal communities will ensure there is a forum for information gathering, to facilitate the continued management of wildlife habitat, marine birds, and the support of local community objectives.

Through a background of ecological knowledge of the surrounding local and regional marine areas, and the implementation of best management practices and mitigation measures, it is believed that the Project can meet the objectives for protection of marine bird species, species at risk, traditional use and regional biodiversity values, namely to minimize the potential for loss of habitat, and wildlife disturbance, injury or mortality. Primarily with consideration of the context of existing commercial and industrial development, shipping and other marine traffic and activities; and with the application of appropriate mitigation measures primarily associated with avoiding disturbance to marine birds that may be foraging or nesting within the Marine Birds LSA, the combined effects to marine birds from the expansion of the Westridge Marine Terminal are considered to be not significant (Table 7.11.1-14, point 7[a]).

- Spatial Boundary: Marine RSA – combined effects from construction and operations could potentially occur within all spatial scales of the assessment area.
- Duration: long-term – combined effects may occur during construction and throughout the operations phase for the life of the Project.
- Frequency: periodic – combined effects have the potential to occur on a regular basis and extend for the life of the Project.
- Reversibility: medium-term – potential combined effects of sensory disturbance and habitat alteration or loss are expected to recover in less than 10 years.
- Magnitude: low – combined effects will be detectable at the individual level but if mitigated may not be detectable at the population level with consideration for the context of abundant industry in the Marine RSA.
- Probability: high – the Project is likely to have combined effects.
- Confidence: high – based on a good understanding by the assessment team of cause-effect relationships between the Project activities and marine birds.

Summary

As identified in Table 7.11.1-14, there are no situations where there is a high probability of occurrence of a permanent or long-term environmental effect on a marine birds indicator of high magnitude that cannot be technically or economically mitigated. Consequently, it is concluded that the environmental effects of the Project on marine birds indicators will be not significant.

TABLE 7.11.1-14

SIGNIFICANCE EVALUATION OF THE PROJECT ON MARINE BIRDS

Potential Effect		Impact Balance	Spatial Boundary[1]	Temporal Context			Magnitude	Probability	Confidence	Significance[2]
				Duration	Frequency	Reversibility				
1.	Marine Bird Indicator – Bald Eagle									
1(a)	Combined effects from pipeline.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1(b)	Combined effects from temporary facilities.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1(c)	Combined effects from pump station activities.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1(d)	Combined effects from tanks.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1(e)	Combined effects from Westridge Marine Terminal.	Negative	RSA	Long-term	Periodic	Medium-term	Low	High	High	Not significant
1(f)	Combined effects from pipeline reactivation.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1(g)	Combined effects of the Project on the bald eagle indicator (1[e]).	Negative	RSA	Long-term	Periodic	Medium-term	Low	High	High	Not significant
2.	Marine Bird Indicator – Great Blue Heron									
2(a)	Combined effects from pipeline.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2(b)	Combined effects from temporary facilities.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2(c)	Combined effects from pump station activities.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2(d)	Combined effects from tanks.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2(e)	Combined effects from Westridge Marine Terminal.	Negative	RSA	Long-term	Periodic	Medium-term	Low	High	High	Not significant
2(f)	Combined effects from pipeline reactivation.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2(g)	Combined effects of the Project on the great blue heron indicator (2[e]).	Negative	RSA	Long-term	Periodic	Medium-term	Low	High	High	Not significant
3.	Marine Bird Indicator – Pelagic Cormorant									
3(a)	Combined effects from pipeline.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3(b)	Combined effects from temporary facilities.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3(c)	Combined effects from pump station activities.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3(d)	Combined effects from tanks.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3(e)	Combined effects from Westridge Marine Terminal.	Negative	RSA	Long-term	Periodic	Medium-term	Low	High	High	Not significant
3(f)	Combined effects from pipeline reactivation.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3(g)	Combined effects of the Project on the pelagic cormorant indicator (3[e]).	Negative	RSA	Long-term	Periodic	Medium-term	Low	High	High	Not significant
4.	Marine Bird Indicator – Barrow's Goldeneye									
4(a)	Combined effects from pipeline.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4(b)	Combined effects from temporary facilities.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4(c)	Combined effects from pump station activities.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4(d)	Combined effects from tanks.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4(e)	Combined effects from Westridge Marine Terminal.	Negative	RSA	Long-term	Periodic	Medium-term	Low	High	High	Not significant
4(f)	Combined effects from pipeline reactivation.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4(g)	Combined effects of the Project on the Barrow's goldeneye indicator (4[e]).	Negative	RSA	Long-term	Periodic	Medium-term	Low	High	High	Not significant
5.	Marine Bird Indicator – Glaucous-winged Gull									
5(a)	Combined effects from pipeline.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5(b)	Combined effects from temporary facilities.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5(c)	Combined effects from pump station activities.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

TABLE 7.11.1-14 Cont'd

Potential Effect		Impact Balance	Spatial Boundary[1]	Temporal Context			Magnitude	Probability	Confidence	Significance[2]
				Duration	Frequency	Reversibility				
5(d)	Combined effects from tanks.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5(e)	Combined effects from Westridge Marine Terminal.	Negative	RSA	Long-term	Occasional	Medium-term	Low	High	High	Not significant
5(f)	Combined effects from pipeline reactivation.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5(g)	Combined effects of the Project on the glaucous-winged gull indicator (5e]).	Negative	RSA	Long-term	Occasional	Medium-term	Low	High	High	Not significant
6.	Marine Bird Indicator – Spotted Sandpiper									
6(a)	Combined effects from pipeline.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6(b)	Combined effects from temporary facilities.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6(c)	Combined effects from pump station activities.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6(d)	Combined effects from tanks.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6(e)	Combined effects from Westridge Marine Terminal.	Negative	RSA	Long-term	Periodic	Medium-term	Low	High	High	Not significant
62(f)	Combined effects from pipeline reactivation.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6(g)	Combined effects of the Project on the spotted sandpiper indicator (6[e]).	Negative	RSA	Long-term	Periodic	Medium-term	Low	High	High	Not significant
7.	Combined Effects of the Project on Marine Birds									
7(a)	Combined effects of the Project on the marine birds indicators (1[g], 2[g], 3[g], 4[g], 5[g] and 6[g]).	Negative	RSA	Long-term	Periodic	Medium-term	Low	High	High	Not significant

Notes: 1 RSA = Marine RSA.

2 Significant Residual Environmental Effect: A high probability of occurrence of a permanent or long-term residual effect of high magnitude that cannot be technically or economically mitigated.

7.11.1.15 Species at Risk

Refer to Section 7.11.1.7 Fish and Fish Habitat, Section 7.11.1.9 Vegetation, Section 7.11.1.11 Marine Fish and Fish Habitat, Section 7.11.1.12 Wildlife and Wildlife Habitat, Section 7.11.1.13 Marine Mammals and Section 7.11.1.14 Marine Birds.

7.11.2 Summary of the Changes to the Project Caused by the Environment

Environmental conditions such as flooding, geotechnical hazards, seismic hazards, wildfire and climate change were considered to have the potential to adversely affect the Project either during construction or operations or both. However, through the implementation of the mitigation measures provided in Table 7.10-2, the effects on the Project caused by the environment are reduced and considered to be not significant.

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APPENDIX 7.1

SUMMARY OF LAND AND RESOURCE USE MANAGEMENT PLANS, MUNICIPAL DEVELOPMENT PLANS AND GOVERNMENT POLICIES CONSIDERED IN THE ENVIRONMENTAL EFFECTS ASSESSMENT

		Element[1,2,3]								
Name of Plan	Summary of Plan	Physical and Meteorological Environment	Soil and Soil Productivity	Water Quality and Quantity	Air Emissions/GHG Emissions	Acoustic Environment	Fish and Fish Habitat	Wetland Loss or Alteration	Vegetation	Marine Sediment and Water Quality, Marine Fish and Fish Habitat, Marine Mammals and Marine Birds
<u>Alberta</u>										
Water for Life – Alberta's Strategy for Sustainability (AENV 2003d) Water for Life – A Renewal (Alberta Environment 2008) Water For Life – Action Plan (Alberta Environment 2009)	• The goals of this strategy are to ensure: safe, secure drinking water supply; healthy aquatic ecosystems; and reliable, quality water supplies for a sustainable economy. To that end, Albertans will be assured their drinking water is safe, the province's aquatic ecosystems are maintained and protected, and water is managed effectively to support sustainable economic development.	• N/A	• N/A	• Safe, secure drinking water supply. • Healthy aquatic ecosystems. • Reliable, quality water supplies for a sustainable economy.	• N/A	• N/A	• Healthy aquatic ecosystems. • Protection of aquatic ecosystems in critical areas. • Establishment of priorities for sustaining aquatic ecosystems to be implemented through watershed plans. • Protect Alberta's critical aquatic ecosystems and develop a provincial action plan to improve the health of substantially impacted aquatic ecosystems.	• Heathy aquatic ecosystems.	• N/A	• N/A
Integrated Watershed Management Plan for the North Saskatchewan River in Alberta (North Saskatchewan Watershed Alliance 2012)	• The goals of this plan relate to water quality, instream flow needs, aquatic ecosystem health, quality and quantity of non-saline groundwater, and incorporating watershed management into land use planning in the North Saskatchewan River Watershed.	• N/A	• N/A	• Maintain or improve water quality in the North Saskatchewan River watershed. • Ensure that instream flow needs in the North Saskatchewan River watershed are met.	• N/A	• N/A	• Maintain and restore riparian areas and minimize or reduce the impacts of municipal and industrial development on aquatic ecosystem health.	• Healthy aquatice ecosystems. • Protect, maintain and restore wetlands.	• Maintain and rstore riparian areas.	• N/A
Strathcona County Municipal Development Plan Bylaw 1-2007 (Strathcona County 2007)	• The purpose of this plan is to aid in making decisions pertaining to growth and development in an orderly manner over the next 20 years and beyond, and presents the means by which the long-term goals of the county can be achieved. The approach to sustainability focuses on the social, economic and environmental elements of the community.	• N/A	• Protect, wherever possible, agricultural land which has a Canada Land Inventory soil class ranking of 1 or 2. • Protect areas prone to flooding, erosion, soil instability and other potential hazards. • Ensure no development is permitted adjacent to the North Saskatchewan River Valley, lakes or other watercourses which would lead to soil erosion or shoreline damage. • Discourage further clearing or development in areas where native vegetation is important for soil conservation, unless it is demonstrated to the County's satisfaction, that these resources will not be negatively affected.	• Improve surface and subsurface water quality. • Reduce the consumption of freshwater resources from lakes, rivers and aquifers. • Work with the appropriate jurisdictions to establish an ongoing groundwater monitoring and comprehensive water testing program to protect and maintain groundwater quality and quantity. • Protect lands where sensitive groundwater resources have been identified through environmental protection instruments and policies.	• Work with those agencies having jurisdiction, to assist in identifying existing and potential air quality concerns and to mitigate or eliminate these issues. • Aid in the reduction of GHG emissions. • Encourage industrial associations, the federal government and the provincial government to collaboratively expand and implement a regional airshed monitoring system.	• N/A	• Ensure no development is permitted along the North Saskatchewan River Valley, lakes or other watercourses that would negatively impact fish habitat. • Create development guidelines to protect land and riparian areas along watercourses and waterbodies.	• The plan discusses the development of a wetland policy to ensure wetlands and/or low areas are not filled in, drained or altered to accommodate development except where sanctioned by the approving authority.	• Discourage further clearing or development in areas where native vegetation is important for soil conservation, water resources protection or wildlife habitat. • Develop a County policy for the requirement of tree retention and tree planting programs.	• N/A

Name of Plan	Summary of Plan	Element[1,2,3]							
		Physical and Meteorological Environment	Soil and Soil Productivity	Water Quality and Quantity	Air Emissions/GHG Emissions	Acoustic Environment	Fish and Fish Habitat	Wetland Loss or Alteration	Vegetation	Marine Sediment and Water Quality, Marine Fish and Fish Habitat, Marine Mammals and Marine Birds
The Way We Grow: Municipal Development Plan, Bylaw 15100 (City of Edmonton 2010)	• The objectives of this plan are to: support sustainable urban form; integrate land use and transportation; design complete, healthy and livable communities; encourage urban design; support prosperity; protect, preserve and enhance the natural environment; support working within our region; manage land and resources; and maintain food and urban agriculture.	• N/A	• Recognize the value of agricultural characteristics, including micro climate, soil capabilities and moisture content, to contribute to sustainable food and agriculture systems for Edmonton.	• Protect, maintain and continually enhance the water quality of the North Saskatchewan Watershed. • Ensure water resources are conserved and used efficiently by the public, industry and the City of Edmonton.	• Monitor and improve air quality in Edmonton. • The plan describes general framework for policies and initiatives on emission reductions without laying out any specific targets, goals or objectives.	• N/A	• N/A	• To protect, maintain and incorporate natural wetlands into new and existing development.	• Protect, preserve and enhance a system of conserved natural areas. • Restore ecologically degraded and / or damaged ecological systems and linkages to protect, expand and enhance biodiversity.	• N/A
Growing Forward – the Capital Region Growth Plan (Capital Region Board 2009)	• The purpose of this plan is to: provide an integrate and strategic approach to planning for future growth in the Capital Region; identify the overall development patterns and key future infrastructure investments that would best complement existing infrastructure, services and land uses; and coordinate decisions in the Capital Region to sustain economic growth and ensure strong communities and a healthy environment.	• N/A	• N/A	• Minimize the impact of development on regional watersheds.	• N/A	• N/A	• N/A	• N/A	• N/A	• N/A
Your Bright Future: Municipal Development Plan 2010-2020 (City of Spruce Grove 2010)	• The overarching objective of this plan is to provide a framework to direct growth and change in Spruce Grove to 2020 in a way that conforms to the City's interpretation of community sustainability. The concepts of balance and adaptability underlie this framework.	• N/A	• N/A	• Develop an integrated watershed management approach that will sustainably manage the impact of development on the watershed, conserve water use and improve water quality. • Prohibit the discharge of hazardous wastes or contaminants into surface water or groundwater. • Work with developers, landowners and AENV to protect surface water and groundwater flow which supports environmentally significant areas affected by development within the City of Spruce Grove boundaries.	• Pursue strategies to reduce corporate and community greenhouse gas emissions and improve air quality.	• N/A	• N/A	• To protect and maintain natural areas within the City of Spruce Grove. The city has identified environmentally significant areas within it's boundaries. An assessment of a proposed development is required for developments that may affect one of these environmentally significant areas.	• Preserving green space both within the city and surrounding areas. • To protect and maintain natural areas within the City of Spruce Grove. The city has identified environmentally significant areas within it's boundaries. An assessment of a proposed development is required for developments that may affect one of these environmentally significant areas. • Connect residents to nature and educate them on value of environmentally significant areas.	• N/A
City of Spruce Grove Environmental Sustainability Action Plan (City of Spruce Grove 2011)	• The objectives of this plan are to: protect and enhance natural areas, green space and biodiversity; live within the capacity of our natural resources of air, land, water and energy; and to lead by example through stewardship and a creative approach.	• N/A	• N/A	• Maintain quality of local watersheds. • Reduce water consumption.	• To reduce GHG emissions.	• N/A	• N/A	• N/A	• Protect sustainable natural areas. • Provide residents access to green space.	• N/A

Name of Plan	Summary of Plan	Element[1,2,3]								
		Physical and Meteorological Environment	Soil and Soil Productivity	Water Quality and Quantity	Air Emissions/GHG Emissions	Acoustic Environment	Fish and Fish Habitat	Wetland Loss or Alteration	Vegetation	Marine Sediment and Water Quality, Marine Fish and Fish Habitat, Marine Mammals and Marine Birds
Town of Stony Plain Municipal Development Plan 2005-2020 (Town of Stony Plain 2005)	• This plan provide directions to manage growth and development over the next 15 years to accommodate population growth. Some of the guiding principles of the plan are to: preserve and enhance the quality of life for residents of Stony Plan; pursue mutually beneficial regional partnerships and alliances; maintain a small town atmosphere; and promote environmental stewardship by protecting and preserving natural areas.	• N/A	• N/A	• Protect and integrate natural watercourses and natural areas in new development.	• Care must be taken in siting industrial uses which may pose a risk or have nuisance affects (*e.g.* smell, dust) on nearby residents. • Ensure that adequate separation distances and transition between industrial and non-industrial uses are maintained in siting potentially noxious industry that may create land use conflicts with regard to dust, smoke or odour.	• Care must be taken in siting industrial uses which may pose a risk or have nuisance affects (*e.g.* noise) on nearby residents. • Ensure that adequate separation distances and transition between industrial and non-industrial uses are maintained in siting potentially noxious industry that may create land use conflicts with regard to noise or vibration.	• N/A	• Maintain wetlands with a minimum 10 m setback starting at the 1:100 year highwater mark. However, this is geared more towards lot developments.	• Preserve and enhance the quality of life for residents by maintaining attractive parks and open spaces. • Promote environmental stewardship by protecting and preserving natural areas and encouraging environmentally sound practices.	• N/A
Village of Wabamun Municipal Development Plan (Village of Wabamun 2010)	• This plan seeks to harness the ideas and creativity of the Village of Wabamun's Council and residents, and articulate these ideas as goals and objectives for future development. The plan facilitates multi-faceted growth and development, encourages the maintenance of a physical separation between incompatible land uses, and encourages the preservation and maintenance of the quality of life, among other goals.	• Developments should be suited to existing topography and other natural features of the area to minimize cut-and-fill and grading throughout the site.	• No proposed development shall be approved by the Village where it is shown that the proposal shall cause or result in unnecessary financial burdens to the Village or future residents because of soil contamination. • Prior to considering the approval of any development permit, the Development Authority may require a soil analysis.	• N/A	• Normal use of industrial sites shall be such that it does not unduly interfere with the surrounding land uses by way of dust, harmful or objectionable odours or emissions.	• Normal use of industrial sites shall be such that it does not unduly interfere with the surrounding land uses by way of noise or vibration.	• N/A	• No applicable goals or objectives specific to wetlands. However, the plan includes development ideas for recreational use associated with the wetlands in the area.	• Use vegetation to reduce storm water run-off and reduce energy consumption through shading, wind protection, decreased irrigation and water consumption. • Enhance visual aesthetics by increasing vegetation cover.	• N/A
Entwistle Area Structure Plan Bylaw No. 23-2012 (Parkland County 2012)	• The purpose of this plan is to provide direction for balanced and sustainable development of the Hamlet of Entwistle and its surrounding. The plan will guide future development by supporting and directing growth that will be capable of meeting the residential, service, commercial and community needs of the area's residents.	• N/A	• To support a rural community that works towards protecting the natural systems that support life by minimizing soil pollution.	• To support a rural community that works towards protecting the natural systems that support life by minimizing water pollution. • To manage storm water in a manner that sustains the quality and quantity of water being released into the County's water features.	• Land uses that cause the creation of odor, dust, and smoke will be discouraged within a 200 m buffer area of residential land designations.	• Land uses that cause the creation of noise will be discouraged within a 200 m buffer area of residential land designations.	• N/A	• N/A	• N/A	• N/A

Name of Plan	Summary of Plan	Element[1,2,3]								
		Physical and Meteorological Environment	Soil and Soil Productivity	Water Quality and Quantity	Air Emissions/GHG Emissions	Acoustic Environment	Fish and Fish Habitat	Wetland Loss or Alteration	Vegetation	Marine Sediment and Water Quality, Marine Fish and Fish Habitat, Marine Mammals and Marine Birds
Parkland County Municipal Development Plan, Bylaw No. 37-2007 (Parkland County 2007)	• The guiding principles of the plan are to achieve sustainability while still protecting existing lifestyles and established land use patterns by: supporting environmental sustainability; supporting fiscal sustainability; supporting social sustainability; emphasizing economic development; respecting community character; and maintaining a reasonable degree of land use certainty.	• N/A	• The County supports communities that are designed to minimize soil pollution. • Protect and enhance the County's valuable agricultural land resource, while still accommodating appropriate non-agricultural land uses. • Promote agricultural practices that are sustainable and environmentally responsible. • Conserve agricultural lands for agricultural and related uses.	• Maintain the environmental integrity of the County's rivers, streams and lakes. • To protect the quality and quantity of surface and groundwater,	• N/A	• N/A	• N/A	• N/A	• N/A	• N/A
Parkland County Integrated Community Sustainability Plan (Parkland County 2011)	• The purpose of this plan is to provide direction for the communities within Parkland County to realize sustainability objectives it has for the environmental, social/cultural, governance and economic dimensions of its identity.	• N/A	• N/A	• Minimize water use, waste water volume and water contamination. • Minimize the destruction of waterways, wetlands and riparian areas.	• The plan mentions efforts and plans for energy conservation and GHG emissions reduction options within the scope of community operations.	• N/A	• Minimize the destruction of waterways and riparian areas.	• Protect water resources by minimizing the destruction of wetlands.	• Minimize the destruction to riparian areas. • Showcase the benefits of sustainable gardening and sustainable farming to residents of Parkland County.	• N/A
Hamlet of Evansburg Area Structure Plan Bylaw No. 12.03 (Yellowhead County 2003)	• The objectives of this plan are to: identify and encourage new residential and non-residential development in Evansburg and its periphery; identify opportunities to enhance existing commercial and public spaces; and improve the quality of life for community landowners, residents and visitors.	• A geotechnical engineer with coal mine engineering experience should review the potential undermining hazards on lands which may have been subject to past mining operations.	• N/A	• N/A	• N/A	• N/A	• N/A	• N/A	• N/A	• N/A
Hamlet of Wildwood Area Structure Plan (Yellowhead County 2005)	• The objectives of this plan are to: provide lifestyle options and development opportunities for Wildwood and area residents; protect the integrity of existing developments by building upon what exists; create a Hamlet General District that allows for a mix of potentially compatible uses; and to optimize the use of existing infrastructure and facilities.	• N/A	• N/A	• N/A	• N/A	• N/A	• N/A	• N/A	• Maintain natural vegetation and add strategically located trees to provide color and shade for sitting spaces.	• N/A
Town of Edson Municipal Development Plan (Town of Edson 2006)	• This plan is a statement of how the Council and residents of the Town of Edson wish to see the community evolve over the next fifteen to twenty years. Some of the objectives of the plan are to maximize the quality of life of town residents, provide for growth to occur in an orderly and efficient manner, and to preserve and enhance important local heritage features.	• N/A	• N/A	• N/A	• N/A	• N/A	• N/A	• N/A	• Protect and consider environmental features such as existing vegetation.	• N/A

Name of Plan	Summary of Plan	Element[1,2,3]								
		Physical and Meteorological Environment	Soil and Soil Productivity	Water Quality and Quantity	Air Emissions/GHG Emissions	Acoustic Environment	Fish and Fish Habitat	Wetland Loss or Alteration	Vegetation	Marine Sediment and Water Quality, Marine Fish and Fish Habitat, Marine Mammals and Marine Birds
Edson Urban Fringe Intermunicipal Development Plan (Yellowhead County 2007)	• This plan provides a framework for the long-term growth and development of the lands located within the Edson Fringe Plan Area that includes lands in Yellowhead County and the Town of Edson. The objectives of the plan include joint municipal plan objectives, objectives for lands within the town of Edson, and objectives for lands within Yellowhead County.	• Any applicant for an industrial subdivision or development application may be required to complete an Area Structure Plan that will consider those items listed in section 118(8) of the RI District that include: the environmental suitability of the site with particular consideration to slopes and drainage.	• Any applicant for an industrial subdivision or development application may be required to complete an Area Structure Plan that will consider those items listed in section 118(8) of the RI District that include: the environmental suitability of the site with particular consideration to soils. • The purpose of Rural District areas is to provide for uses which are appropriate in a rural environment and support or can co-exist in areas of agricultural use.	• Cooperate in the protection of the McLeod River and Bench Creek aquifer recharge areas and drainage channels that are important to the integrity of the local water supply and environment.	• N/A	• N/A	• Cooperate in the protection of the McLeod River and Bench Creek drainage channels that are important to the integrity of the environment.	• N/A	• Preserve natural landforms and vegetation through the development process as a means to protect the natural visual quality in Yellowhead County and to provide screening for new development. • Limit clear cutting – pipeline rights-of-way to be better maintained and cleared of weeds.	• N/A
Town of Hinton Municipal Development Plan (Town of Hinton 1998)	• This plan provides guidance for public and private development decisions within the Town. It provides a means of coordinating the thinking and actions of the Town and directing it towards achieving immediate and long term land use goals and aspirations. The Plan is a guide for future development – a framework for decision making.	• Given the Town of Hinton's dramatic topography, every opportunity should be made for protecting land in areas of steep slopes. • Development should be designed to provide a functional relationship to the site's topography.	• N/A	• N/A	• Industrial developments need to be developed in such a manner that minimizes negative impacts (*e.g.*, odour and dust).	• Industrial developments need to be developed in such a manner that minimizes negative impacts (*e.g.*, noise).	• N/A	• N/A	• Provide a focal improvement in park and trail spaces that access the Athabasca River waterfront. Working in partnership with others; design and build a waterfront park and related trail infrastructure.	• N/A
Town of Hinton Community Development and Enhancement Plan (Town of Hinton 2003)	• This plan integrates the Town of Hinton Parks Master Plan, Visitor Attractions Plan and Urban form Plan. The underlying objective of this three-part plan is to provide a practical and effective framework for community development and enhancement within the Town of Hinton.	• Hinton values the natural surrounding environment and is committed to development which is in harmony with the natural features of the area.	• N/A	• N/A	• N/A	• N/A	• N/A	• Hinton values the natural surrounding environment and is committed to development which is in harmony with the natural features of the area.	• Hinton values the natural surrounding environment and is committed to development which is in harmony with the natural features of the area.	• N/A

Name of Plan	Summary of Plan	Element[1,2,3]								
		Physical and Meteorological Environment	Soil and Soil Productivity	Water Quality and Quantity	Air Emissions/GHG Emissions	Acoustic Environment	Fish and Fish Habitat	Wetland Loss or Alteration	Vegetation	Marine Sediment and Water Quality, Marine Fish and Fish Habitat, Marine Mammals and Marine Birds
Yellowhead County Municipal Development Plan Bylaw No. 1.06 (Yellowhead County 2006)	• The purpose of this plan is to provide residents and Council with a framework to guide decision-making that is necessary to achieve the county's 20 year vision for the future. The plan has been developed to guide future policy, land use and infrastructure investment decisions, and strike a balance between economic, social, physical development and environmental considerations, among other goals.	• Prevent development in areas subject to known hazardous conditions, unless the hazard to development has been adequately addressed. • Prohibit development in areas that are prone to flooding, erosion, landslides, or any other natural or human-induced hazards. Development on escarpments, steep or unstable slopes (*e.g.*, slopes greater than 20%) may be considered only if recommended in a geotechnical study prepared by an accredited professional. • Where feasible, natural landforms will be preserved through the development process as a means to protect the natural visual quality in Yellowhead County.	• Consider requiring all structural developments to identify soil type during preliminary planning. All developments proposed on soils with evidence of peat, muskeg, sand dunes or soft lacustrine soils, must have a geotechnical assessment prepared which identifies measures to mitigate the substandard soils to ensure a safe building site. • Direct, where possible, non-agricultural development to areas where such development will not constrain agricultural activities. • Maintain and support agriculture as an important industry and way of life in Yellowhead County. • Ensure that agricultural uses are the primary use in this policy area. • Encourage the viability of agriculture through the conservation of agricultural land.	• Maintain and enhance surface and groundwater quality in water systems with a focus on the "Water for Life" strategy as developed by the Province of Alberta. • Continue to support the protection of aquifers in the region. • Work with the Province of Alberta to support a safe, secure drinking water supply for residents through ongoing record-keeping of water suppy and quality from surface and groundwater sources throughout Yellowhead County.	• N/A	• N/A	• N/A	• Although wetlands are considered to be environmentally sensitive lands and would generally require a 20 m buffer, consultation with the County has revealed that disturbances to wetlands from pipeline construction will be deferred to the province.	• Preserve vegetation through the development process as a means to protect the natural visual quality in Yellowhead County.	• N/A
Coal Branch Sub-Regional Integrated Resource Plan (Government of Alberta 1990)	• The purpose of this plan is to effectively mitigate conflicts between resource use objectives by determining resource priorities and allocating land uses for specific portions of the Coal Branch planning area on public lands.	• Protect representative and unique examples of the natural features, landscapes and ecosystems of the Foothills and Rocky Mountain Natural Regions of Alberta.	• Minimize erosion and soil losses resulting from land use activity. • Ensure that reclamation guidelines and standards minimize soil erosion and protect inherent soil productivity. • Where compatible with other resource uses, to maintain and expand the permanent agricultural land base. • Protect eolian soils east of Brule Lake from wind and water erosion by minimizing impacts on the area's sensitive eolian deposits. • Protect shallow soil resources from damage by land use activities.	• Ensure that land use activities are managed to provide optimal water yield in terms of quality, quantity and timing. • Maintain the long-term integrity of natural watercourses and ensure protection of the watersheds.	• N/A	• N/A	• Protect and enhance fish and fish habitat. • Maintain and/or increase habitat and populations of specific species including bull trout, Arctic grayling, rainbow trout, mountain whitefish, brook trout and walleye.	• N/A	• Preserve and maintain sites with sensitive vegetation.	• N/A

		Element[1,2,3]								
Name of Plan	Summary of Plan	Physical and Meteorological Environment	Soil and Soil Productivity	Water Quality and Quantity	Air Emissions/GHG Emissions	Acoustic Environment	Fish and Fish Habitat	Wetland Loss or Alteration	Vegetation	Marine Sediment and Water Quality, Marine Fish and Fish Habitat, Marine Mammals and Marine Birds
The Northern East Slopes Sustainable Resource and Environmental Management Strategy (Government of Alberta 2003)	• This plan guides the Northern East Slopes of Alberta region toward sustainable development while balancing economic, environmental and community values. Addressing current and emerging issues, the strategy provides clear, long-term direction for managing resources and activities on Crown lands while considering cumulative effects.	• Protect unique landscape elements.	• Ensure that regional soil quality receives a high priority in land-use planning and environmental impact assessment. • Ensure that best practices for the protection of soil are uniformly applied by all industries in the region. • Conserve soil resources to sustain primary productivity and minimize degradation and contamination. • Maintain soil fertility and minimize negative impacts of land use on the regional soil base. • Identify and apply best management practices for soil fertility, contamination and remediation. • Design an appropriate soil-monitoring program that addresses regional soil management issues. • Ensure that industrial, agricultural and recreational activities do not reduce soil fertility, with particular emphasis on sensitive areas and highly productive soils.	• Maintain the quality and quantity of the region's water resources to ensure the protection of the aquatic environment. • Manage water resources using an integrated watershed approach, recognizing the linkages between water quality/quantity and activities and disturbances. • Ensure that regional surface and groundwater quality meets or exceeds existing standards. • Ensure use of regional surface and groundwater resources remains at sustainable levels and that water supply and quality is adequate for downstream use.	• Maintain good air quality levels within the region. • Identify areas that require expanded monitoring efforts in order to provide a comprehensive picture of regional air quality.	• N/A	• N/A	• Protect and enhance wetland ecosystems. • Retain permanent and ephemeral wetlands.	• Maintain species richness and diversity on the landscape. • Protect rare vegetation (species designated as Endangered or Threatened under the Alberta *Wildlife Act*. • Minimize the introduction and spread of exotic vegetation species in the Green Area of Alberta. • Maintain a diversity of ecosystem types and local elements within the natural range of variability. • Maintain landscape connectivity and representative landscape patterns of vegetation. • Manage landscapes and vegetation in the region based on a broad –scale "coarser-filer" approach that considers natural disturbance regimes to achieve primary biodiversity objectives. • Establish objectives for salvage logging and for residual structure within the harvest areas, recognizing both the importance of wood fiber recovery and the importance of naturally disturbed habitat and residual vegetation for biodiversity.	• N/A

Name of Plan	Summary of Plan	Element[1,2,3]								
		Physical and Meteorological Environment	Soil and Soil Productivity	Water Quality and Quantity	Air Emissions/GHG Emissions	Acoustic Environment	Fish and Fish Habitat	Wetland Loss or Alteration	Vegetation	Marine Sediment and Water Quality, Marine Fish and Fish Habitat, Marine Mammals and Marine Birds
Jasper National Park of Canada Management Plan (Parks Canada 2010)	• The key strategies of this plan include: welcoming visitors to mountains of opportunity; bringing the mountains to people where they live; celebrating history, culture and the world heritage site; ensuring healthy ecosystems; fostering open management and innovation; strengthening Aboriginal relationships; and managing growth and development.	• There are no potential Project effects associated with physical environment indicators anticipated to result from pipeline reactivation activities in Jasper National Park, therefore goals and objectives of this plan related to the physical environment were not considered.	• N/A	• Maintain aquatic ecosystems within their range of natural variability for factors such as water quality, water levels and flow regimes. • Ensure that instream flow needs for aquatic and riparian areas take precedence over withdrawals or diversions of surface and ground water.	• N/A	• N/A	• Maintain aquatic ecosystems within their range of natural variability for factors such as native species. • Restore aquatic connectivity in locations where it has been disrupted by transportation or impoundment and where it will benefit aquatic communities. • Maintain/restore viable populations of native fish and other aquatic species, especially provincially or federally listed species and create a plan to manage non-native species. • Ensure that instream flow needs take precedence over withdrawals for aquatic and riparian area. • Work with the Province of Alberta to maintain or restore native populations of Athabasca rainbow trout and bull trout. • Develop/refine goals and markers to assess aquatic ecosystem health and understanding community function.	• Wetlands are not expected to be disturbed along the reactivated pipeline segments in Jasper National Park, therefore goals and objectives of this plan related to wetlands were not considered.	• Maintain or restore ecological integrity (use fire to maintain healthy vegetation, control of invasive plants).	• N/A
<u>BC</u>										
Mount Robson Park Management Plan (BC MOE 2011b)	• This management plan defines the role of Mount Robson Provincial Park in the BC protected areas system and establishes objectives and strategies to guide management and development.	• There are no potential Project effects associated with physical environment indicators anticipated to result from pipeline reactivation activities in Mount Robson Provincial Park, therefore goals and objectives of this plan related to the physical environment were not considered.	• N/A	• Protect and maintain water quality and quantity resources within the provincial park.	• N/A	• N/A	• Maintain and enhance fish populations.	• Wetlands are not expected to be disturbed along the reactivated pipeline segments in Mount Robson Provincial Park, therefore goals and objectives of this plan related to wetlands were not considered.	• The ecosystem management plan outlines objectives and actions for each zone pertaining items such as tbiodiversity conservation and forest health. • Maintain the long-term natural diversity of native plant species. • Ensure that any management actions employed are preceded by an assessment of plant species at risk present.	• N/A

Name of Plan	Summary of Plan	Element[1,2,3]								
		Physical and Meteorological Environment	Soil and Soil Productivity	Water Quality and Quantity	Air Emissions/GHG Emissions	Acoustic Environment	Fish and Fish Habitat	Wetland Loss or Alteration	Vegetation	Marine Sediment and Water Quality, Marine Fish and Fish Habitat, Marine Mammals and Marine Birds
Village of Valemount Official Community Plan (Village of Valemount 2006)	• This plan provides a framework for future growth through statements of objectives and policies as well as providing a degree of certainty about the future form and character of the municipality. It provides Village Council and the public with the basis to evaluate development proposals and to ensure that these proposals are consistent with the vision of the plan. In essence, the Plan is the village's central land use management policy document.	• It is the policy of Council to prevent development on the steep slopes (25% or greater) and areas where rock fall, land slip or erosion hazards are known or suspected. Council will, however, consider permitting development on steep slopes or areas subject to rock fall, land slips or erosion hazards if the developer provides a report from an engineer experienced in geotechnical engineering setting out how the area can be developed safely.	• It is the policy of Council to prevent development in areas where soil subsidence or erosion hazards are known or suspected. Council will, however, consider permitting development on areas subject to soil subsidence or erosion hazards if the developer provides a report from an engineer experienced in geotechnical engineering setting out how the area can be developed safely.	• Maintain the integrity of the Swift Creek Watershed so that the supply of drinking water is not adversely affected.	• N/A	• N/A	• N/A	• Protection of the Robert Starret Marsh south of the Village of Valemount.	• Use of vegetation as visual barriers to separate Central Business District and residential areas.	• N/A
Blue River Official Community Plan (TNRD 2011a)	• The purpose of this plan is to provide direction for future development and land uses within the identified Plan Boundary, which surrounds the community of Blue River. The plan contains objectives, policies and future land use designations adopted by the Board of Directors of the TNRD.	• New industrial development will be designed in such a manner as to maximize efficient use of the land and to fit into the natural form and character of the site.	• Support the preservation of agricultural lands and local food production.	• Ensure the protection of creeks, rivers, lakes, riparian areas and groundwater supplies within the plan area.	• To reduce GHG emissions.	• N/A	• Avoiding development near fish habitat whenever possible and, if development is necessary, follow federal and provincial regulations. • Ensure the protection of creeks, rivers, lakes and riparian areas within the plan area.	• N/A	• Encourage tree planting where appropriate and the retention of existing healthy trees and natural vegetation during new development.	• N/A
Robson Valley Land and Resource Management Plan-Summary (BC ILMB 1999)	• This plan provides broad direction for the sustainable use of Crown land and resources in the Robson Valley area. The plan balances economic, ecological, spiritual, recreational and cultural interests. It will help to provide greater land use certainty, preserve natural areas for future generations, maintain resource-sector jobs for local workers and increase opportunities for tourism and recreation.	• Identify high terrain hazard areas and manage development in these areas to minimize erosion and slope failures. • Exploration, mine development and other land uses that affect visual quality will utilize existing topography and ground conditions to reduce impact on visual values.	• To protect soil and soil fertility by minimizing activities that cause soil erosion and degradation. • Support the purpose and intent of the Agricultural Land Reserve (ALR). • Minimize conflict with other land use activities which may negatively impact the productivity and sustainability of agricultural uses of Crown resources.	• Protect or enhance surface water quality. • Protect or restore water quantity and natural hydrologic regime of each watershed.	• To reduce and work to eliminate pollution of air. • Minimize the use of slash burning to protect air quality.	• N/A	• To maintain or enhance species genetic diversity, abundance and compositions, and protect unique and rare species. • Conserve, restore or enhance the abundance and genetic diversity of naturally occurring fish stocks. • Protect or restore the structural, functional and biological diversity of stream and riparian habitat. • Maintain or enhance the benefits of Aboriginal, sport and commercial fisheries. • Ensure adequate instream flows and high water quality standards for sustainable fish populations. •	• Protect waterfowl habitat. • Locate roads away from wetlands. • Protect wetlands.	• Promote vegetation management strategies that maintain the quality and quantity of browse species (*e.g.,* willow and red osier dogwood, Saskatoon berries, hazel nuts) during stand management activities. • Maintain or enhance opportunities for use of Crown land, vegetation, and resources for agriculture, fisheries and food production. • Allow the control for competing brush to optimize growth, through effective vegetation management techniques. •	• N/A

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Robson Valley Land and Resource Management Plan-Summary (BC ILMB 1999) (cont'd)	See above	See above	See above	See above	See above	• N/A	• Manage riparian areas adjacent to the McLennan River to ensure fish habitat and recreation values are maintained.	See above	• Control noxious weeds where necessary by implementing Noxious Weed Control plans and enforcing proper vegetation. • Manage riparian areas adjacent to the McLennan River. • Establish a 60 m riparian reserve and a 20 m riparian management zone above the high water mark. • Reduce the use of herbicides.	• N/A
Robson Valley-Canoe Upstream Official Community Plan (RDFFG 2006)	• The purpose of this plan is to state the broad land use objectives and policies of the Regional Board to guide decisions on planning and land use management for the Robson Valley-Canoe Upstream area within the RDFFG, as set out in the Local Government Act.	• To protect areas which may be subject to natural hazards including avalanche, rockfall, debris flows and torrents, flooding, unstable slopes, and high rates of erosion.	• To protect for agriculture those areas that have easy access to water for irrigation. • To encourage the establishment and maintenance of farms and the use of land within the Agricultural Land Reserve compatible with agricultural purposes and to guide other forms of development so as to minimize negative impacts on agricultural uses. • Not promote development of agricultural land for non-agricultural uses unless it is shown that there is no practical alternative location and that it will not be detrimental to the long term agricultural potential of the land.	• Protection of watercourses and adjacent habitat through the retention of natural vegetation in riparian areas next to streams and water bodies. • Ensure the protection of the water quality of watercourses.	• To reduce GHG emissions and air pollution.	• N/A	• Recognizes the importance of the Fraser River and tributaries to salmon populations, and take into account the effects on fish stocks during riparian development planning. • Development Permit requirements on riparian areas in certain watercourses in the Plan area.	• N/A	• Protection of watercourses and adjacent habitat through the retention of natural vegetation in riparian areas next to streams and water bodies. • Protect riparian flora and fauna and their associated habitats from potential impacts of a development through the retention of vegetation along the watercourses. • Screen commercial development from Highway 16 by retention of natural vegetation, or replanting of vegetation, where possible.	• N/A
Eight Peaks Sustainable Resource Management Plan (BC Ministry of Sustainable Resource Management 2003)	• The goal of this plan is to establish resource management objectives that create conditions that support forestry, heli-skiing and other winter recreation activities while incorporating the principles of sustainability and stewardship.	• N/A	• The biological richness and services of terrestrial processes (*e.g.*, soil productivity) should be maintained at all scales through time.	• N/A	• N/A	• N/A	• N/A	• N/A	• Integrate winter recreation activities with forest management to optimize economic and social benefits derived from both.	• N/A
District of Clearwater Official Community Plan (District of Clearwater 2012)	• This plan takes into account environmental sustainability, social sustainability, cultural sustainability and economic sustainability. The objectives related to environmental sustainability include: ensuring residents have a safe and sufficient supply of drinking water; sustainable growth; decreasing energy demands and GHG emissions; ensuring a safe and clean airshed; and ensuring the negative impacts of land use and development are minimized.	• To recognize and respect the development constraints imposed by environmental factors and to avoid development in hazardous areas or require adequate precautions, if development is unavoidable, to reduce the risk to citizens and property.	• To preserve agricultural land to ensure present and future food production. • Protect all ALR land for either soil based agriculture or for non soil bound agriculture.	• To protect and enhance the quality of Clearwater area lakes, rivers, streams and groundwater sources thereby supporting the Clearwater River and North Thompson River watershed ecosystem and the Russell, Hascheak, and McDougall Creek watersheds.	• To reduce GHG emissions. • Ensure the continuation of a fresh, clean and safe airshed.	• N/A	• N/A	• Preserve and enhance sensitive ecosystems including wetlands.	• Encourage vegetation growth (including invasive species) for ditch maintenance. • Encourage planting of vegetation that will transpire and filter groundwater. • Protection of riparian areas	• N/A

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Nicola Valley Official Community Plan (TNRD 2011e)	• This plan includes objectives related to existing and future land use; residential, rural, commercial and industrial development; preserving agricultural land; use and development of transportation and public facilities; recreation opportunities; heritage conservation; protecting water resources and wildlife habitat; and reducing GHG emissions.	• To recognize and respect the development constraints imposed by environmental factors and to ensure that developments in hazardous areas are avoided or that adequate precautions are taken if development is unavoidable.	• All development shall incorporate soil conservation practices recognizing slope, soil type and precipitation, in order to prevent any increase in the sediment loading of streams and rivers in the Plan Area. • To preserve agricultural land to ensure present and future food production.	• All development shall incorporate soil conservation practices recognizing slope, soil type and precipitation, in order to prevent any increase in the sediment loading of streams and rivers in the Plan Area. • Particular attention to protection of stream banks and prevention of erosion material or deleterious substances entering the watercourse during development. • Activities involving landfill, diking, channelization or any change to the natural system of watercourses shall be discouraged except where such activities either: form part of a riverbank stabilization project designed to prevent erosion of agricultural land; or have been approved by the appropriate federal and provincial agencies having authority. • Recognize all Improvement District groundwater wells and surface water intake locations and provide necessary protection of these public utilities/facilities from development and potential sources of contamination.	• To be carbon neutral and reduce GHG emissions. • New industrial development should not emit substances which would have a detrimental effect on air quality.	• N/A	• Preservation of fisheries through the controlled disposition of Crown land and development of private land. • Particular attention to protection of stream banks and prevention of erosion material or deleterious substances entering the watercourse during development. • Appropriate federal or provincial approval for development around fish habitat and watercourses. • Encourage continuation of fish stocking, particularly in Guichon Creek.	• N/A	• Protection of riparian shoreline and streambank vegetation. • Preservation of natural vegetation including trees in all undeveloped and riparian areas.	• N/A
Avola Official Community Plan (TNRD 2011d)	• This plan includes objectives related to existing and future land use; residential, rural, commercial and industrial development; preserving agricultural land; use and development of transportation and public facilities; recreation opportunities; heritage conservation; protecting water resources and wildlife habitat; and reducing GHG emissions.	• New industrial development will be designed in such a manner as to maximize efficient use of the land and to fit into the natural form and character of the site.	• To preserve agricultural land to ensure present and future food production.	• Recognize and provide special protection for creeks, rivers and habitat areas within the Plan area.	• To be carbon neutral and reduce GHG emissions.	• N/A	• Recognize and provide protection for creeks and rivers within the Plan area. • Refer development proposals which may impact fisheries to appropriate government agencies.	• N/A	• Encourage tree planting where appropriate and the retention of existing healthy trees and natural vegetation during new development.	• N/A

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Kamloops Land and Resource Management Plan (BC ILMB 1995)	• The goals of this plan are: balanced use of the land and resources; protection and security of the land and resources for future generations; sustainable resource management practices; compatibility with natural watershed processes and respect for the intrinsic value of nature; social and economic stability and vitality of local communities; and communication, education, and awareness of all values, including those of Aboriginal peoples.	• N/A	• Minimize soil productivity losses. • Provide opportunities for growth and expansion of the agriculture industry.	• Primary objectives for Special Resource Management - Community Watershed Zones are to: - maintain the quality and quantity of community water supply; - minimize risk to lives and property from flooding and erosion; and - maintain natural stream flow regimes within acceptable limits. • Recognize interaction of groundwater and surface water sources.	• N/A	• N/A	• Maintain a mosaic of angling opportunities within the recreational spectrum (*i.e.*, walk-in lakes, drive-to lakes, trophy lakes). • Maintain or increase the natural production of spawning streams through habitat protection measures (*i.e.*, streamside management) and enhancement activities. • Protect and maintain the genetic diversity of wild fish stocks. • Maintain, rebuild or enhance salmon stocks to historic levels. • Achieve a net gain in productive capacity by habitat management. • Avoid irreversible human-made changes to fish-producing habitats. • Maintain the physical and biological diversity of fish habitats. • Optimize the value of commercial, sport, and Aboriginal fisheries.	• Maintain the integrity of wetlands.	• Maintain and/or restore the integrity and function of streamside riparian vegetation to provide for bank and channel stability, long-term supply of large organic debris, suitable stream temperatures and input of nutrients.	• N/A
KAMPLAN-Official Community Plan (City of Kamloops 2004)	• The goal of this plan is to provide the best quality of life for all residents by: building strong and diverse neighborhoods; providing a variety of housing types; encouraging healthy and active lifestyles; supporting cultural and athletic pursuits; diversifying economic and educational opportunities; and maintaining sustainable environmental stewardship.	• Preserve and creatively integrate existing trees and topographical features into the development where feasible. • Slopes steeper than 25% shall be considered unsuitable for development and shall be designated open space unless it can be shown by geotechnical or engineering studies that the steep slopes can accommodate the proposed development and that there will be no detrimental impact on adjacent lands or the proposed development.	• To ensure that agricultural lands are preserved for agricultural purposes and to enhance the viability of agricultural operations within the City of Kamloops.	• General goal to protect and enhance the quality of the natural environment.	• To reduce GHG emissions.	• N/A	• To protect and enhance fish habitats in balance with flood protection and recreational access to riverbank and open space areas. • To protect and enhance fish and wildlife habitats in balance with urban development and human use and enjoyment of open space.	• General goal to protect and enhance the quality of the natural environment.	• Maintain natural vegetation • Protect grasslands.	• N/A
Kamloops North Official Community Plan (TNRD 2011b)	• The purpose of this plan is to provide direction for future development and land uses within the area north of the City of Kamloops including: Mclure, Vinsulla, Black Pines, Heffley Lake, and Sullivan (Knouff) Lake. The plan contains objectives, policies, and future land use designations adopted by the board of directors of the TNRD.	• N/A	• To maintain and improve the viability of agricultural operations within the plan area, preserve land with agricultural capability and to support the ALR.	• To ensure the protection for creeks, rivers and lakes within the Plan area.	• To reduce GHG emissions.	• N/A	• Direct development away from spawning habitats within the Plan area. • Encourage the continuation of fish stocking programs by the Province of BC. • Encourage developers to refer potentially harmful proposals to the appropriate government agencies. • To ensure the protection for creeks, rivers and lakes within the Plan area.	• N/A	• Encourage tree planting where appropriate and the retention of existing healthy trees and natural vegetation during new development.	• N/A

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Thompson-Nicola Regional District Regional Growth Strategy (TNRD 2000)	• This plan provides a framework for: taking action on development and settlement issues by the Regional District, its municipalities, and government agencies; coordinating efficient use of land, public facilities, services, finances, and other resources over the next 25 years; encouraging a variety of economic opportunities, land use choices, and quality of life attributes in an affordable and efficient manner; and ensuring the environment and natural amenities are protected and conserved as the region continues to develop.	• N/A	• N/A	• Protect and enhance the quality and quantity of the water of the region's lakes, rivers, streams and groundwater sources.	• Encourage the development and adoption of policies that contribute to the reduction or prevention of air pollution.	• N/A	• Promote conservation and sustainability of watershed ecosystems and riparian areas.	• Promote conservation and sustainability of wetland areas.	• Encourage tree planting where appropriate and the retention of existing healthy trees and natural vegetation during new development. • Promote conservation and sustainability of riparian areas. • Collaborate in the implementation of invasive terrestrial and aquatic plant management plans and integrated pest management plans to maintain natural biodiversity in the region.	• N/A
City of Merritt Official Community Plan (City of Merritt 2011)	• This plan provides Council and the public with direction for development and the basis to evaluate proposals to ensure these proposals are consistent with the vision. The intent of this plan is to provide an appropriate amount of planning direction while also providing flexibility to customize development to suit specific and unique circumstances within the city as well as facilitating creative and unusual development proposals.	• Natural features such as important trees, rock outcroppings and changes in topography should be maintained. • Ensure lands located on steep slopes, in ravines, directly adjacent to creeks and rivers in areas considered undevelopable remain in their natural condition. • Address site grading and drainage control measures in areas where steep slopes and unstable soils exist. • Prevent development within areas designated as hazardous slopes or unstable soils where hazards cannot be mitigated.	• Address site grading and drainage control measures in areas where steep slopes and unstable soils exist. • Prevent development within areas designated as unstable soils where hazards cannot be mitigated. • Support the preservation of agricultural lands and local food production within the municipal boundaries and beyond. • Minimize conflicts between agricultural operations and non-agricultural uses by encouraging buffering and setback provisions as suggested by the Ministry responsible for agricultural land.	• Encourage water conservation that restricts and reduces water usage and consumption. • Ensure future development and improvements respect the ecology of the Coldwater River and other streams in this sector including erosion prone riverbanks, fisheries values and the area identified as an environmental buffer along the southern shore. • Pursue water conservation measures and efforts aimed at managing demand for water.	• To reduce GHG emissions.	• N/A	• Support preservation of sensitive habitat adjacent to the Nicola River, the Coldwater River and other streams that is consistent with the appropriate best management practices for land development in providing protection for streams. • Promote the conservation of fish habitat along streams within the municipal boundary as defined under the *Riparian Areas Regulations* as part of the *Fish Protection Act*. • Ensure future development and improvements respect the ecology of the Coldwater River and other streams in this sector including erosion prone riverbanks, fisheries values and the area identified as an environmental buffer along the southern shore.	• N/A	• Ensure future development and improvements respect the ecology of the Coldwater River and other streams in this sector including erosion prone riverbanks and the area identified as an environmental buffer along the southern shore.	• N/A
District of Hope Official Community Plan (District of Hope 2004)	• This OCP is a municipal bylaw that sets the broad framework for managing development in the District of Hope by providing objectives for different land uses anticipated to meet future needs for a 5 to 10 year period. Additionally, the plan sets objectives for community services and facilities.	• Regulate development in areas with natural hazards in order to mitigate risk in such areas.	• Support the preservation and use of lands within the ALR for agricultural purposes.	• Protect riparian areas from the impact of the residential, commercial and industrial development, through ensuring that all development initiatives within 30 m of a watercourse are properly assessed as required under the *Fisheries Act* and its regulations.	• To reduce GHG emissions.	• N/A	• Protect riparian areas from the impact of the residential, commercial and industrial development, through ensuring that all development initiatives within 30 m of a watercourse are properly assessed as required under the *Fisheries Act* and its regulations.	• Protect riparian areas from the impact of the residential, commercial and industrial development, through ensuring that all development initiatives within 30 m of a watercourse are properly assessed as required under the *Fisheries Act* and its regulations. This also applies to wetlands.	• Protect riparian areas from the impact of the residential, commercial and industrial development, through ensuring that all development initiatives within 30 m of a watercourse are properly assessed as required under the *Fisheries Act* and its regulations.	• N/A

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City of Chilliwack Official Community Plan (City of Chilliwack 1998)	• The purpose of this plan is to provide direction for future development, environmental protection, parks, transportation, recreation and service infrastructure. In addition, the plan will act as a policy guide to Council for short and long-term land use and development decisions, including associated social, economic, environmental and physical development.	• To undertake environmental protection and enhancement of steep slopes, viewscapes and other sensitive environmental features. • To integrate natural and rural landscape features within the City of Chilliwack • To restrict development within hazard areas. Buffer hazard lands from any form of development that will increase potential for erosion and surficial material movement.	• To protect viable, high quality, productive agricultural lands for long term agricultural use.	• Environmental protection, enhancement and remediation of creeks and riparian habitat. • Protect aquifers from surficial and groundwater pollution.	• To reduce GHG emissions. • Restrict open burning.	• N/A	• To undertake environmental protection, enhancement and remediation of creeks and riparian habitat. • Minimize disturbance of natural features along watercourses.	• Protect significant wetlands.	• Protect riparian areas	• N/A
Chilliwack District Sustainable Resource Management Plan (BC MFLNRO 2013e)	• This plan describes the approved landscape unit plans and legal OGMAs in the Chilliwack Forest District.	• N/A	• N/A	• N/A	• N/A	• N/A	• N/A	• N/A	• Manage biodiversity through retention of old growth forests.	• N/A
City of Chilliwack Agricultural Area Plan (Don Cameron Associates 2012)	• The purpose of the Agricultural Area Plan is to define the City of Chilliwack's role with respect to agriculture and identify appropriate policies and actions to support the viability of farming. The plan emphasizes the City of Chilliwack's farm area, proposes solutions to issues, and identifies opportunities to strengthen farming.	• Generally enhance environmental protection and remediate sensitive environmental features.	• Create a centre of excellence for agriculture in Chilliwack. • Provide support to maximize agricultural industry sustainability. • Create a viable and enduring community by encouraging conservation and environmentally responsible practices.	• Generally enhance environmental protection and remediate creeks, riparian habitat and other sensitive environmental features. • To secure a water supply for ALR lands.	• To reduce the extent of open air burning on Chilliwack farms.	• N/A	• Generally enhance environmental protection and remediate creeks, riparian habitat and other sensitive environmental features.	• Generally enhance environmental protection and remediate sensitive environmental features.	• Generally enhance environmental protection and remediate riparian habitat and other sensitive environmental features.	• N/A
City of Abbotsford Official Community Plan (City of Abbotsford 2005)	• This plan is built on five major planning strategies intended to realize the vision of the city, including: creating a complete community; protecting our natural environment; building a healthy, inclusive community; making better connections; and strengthening the city centre.	• Prohibit land clearing, site grading, soil/rock removal or other works in areas designated as being within an Environmental Development Permit Area prior to obtaining an Environmental Development Permit. • Prohibit development on lands subject to subsidence, rock fall, debris flow or other natural hazard.	• Support and enhance the agriculture sector. • Prohibit land clearing, site grading, soil/rock removal or other works in areas designated as being within an Environmental Development Permit Area prior to obtaining an Environmental Development Permit. • Prohibit development on lands subject to subsidence.	• Protect the integrity of watercourses and riparian areas.	• To reduce GHG emissions and improve air quality.	• N/A	• Enhance fish and wildlife habitat connections and protect streams and riparian habitat in continuous systems by implementing the Streamside Protection Bylaw.	• N/A	• Protect riparian areas.	• N/A
Fraser Valley Regional District Official Community Plan for Popkum-Bridal Falls part of Electoral Area "D" (FVRD 1997)	• This is the background report to the OCP for Popkum-Bridal Falls, of the FVRD. The plan serves as a statement of the broad objectives and policies of the Regional board regarding the form and character of existing and future land use and servicing in the plan area. The plan has a number of purposes related to growth and development; land use and the provision of public services, protection of the environment, and implementing zoning and other bylaws.	• N/A	• Direct development away from farmland in the agricultural land reserve. • Protect agricultural land uses and ensure compatibility between adjoining residential and agricultural land uses.	• Effluents, whether domestic, agricultural or industrial, should not be permitted to enter any watercourse in the Plan area if they will impair the quality of the water. • Waste material should not be placed adjacent to a natural watercourse in such a way as to result in leachate or silt introduction to the watercourse via surface drainage or groundwater contamination.	• N/A	• N/A	• To avoid development near fish habitat whenever possible and, if development is necessary, following federal and provincial regulations.	• Protect natural wetlands.	• N/A	• N/A

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Fraser Valley Regional District Official Community Plan for Portions of Electoral Area "B" Yale, Emory Creek, Dogwood Valley and Choate Bylaw No.150, 1998 (FVRD 1198)	• The objectives of this plan relate to health protection, community enhancement, safe transportation, economic stability, natural hazard protection, heritage conservation, environmental conservation, compatible land use, community consultation and flexible implementation.	• Development shall be directed away from lands susceptible to slope instability, erosion, rockfall and other forms of geological and snow avalanche hazard.	• Lands which are susceptible to flooding, inundation or erosion should, wherever possible, be used for agricultural and other unintensive land uses.	• N/A	• N/A	• N/A	• Control access, development, and use of fish habitat in cooperation with the government. • Preserve watercourses with fish populations in as natural of a state as possible, unless they can be improved. • Avoid development near fish habitat including riparian wetlands, if possible, and , if development is necessary, following federal and provincial regulations.	• Avoid development near fish habitat including riparian wetlands, if possible, and , if development is necessary, following federal and provincial regulations.	• Preserve streamside vegetation of Yale Creek. • Preserve and maintain vegetation along railway to enhance aesthetics. • Leave a strip of natural vegetation along the watercourse when development occurs with a site-specific width.	• N/A
Fraser Valley Regional District Official Community Plan for Electoral Area "E" Bylaw No. 1115, 2011. (FVRD 2011)	• The objectives of this plan relate to: preserving scenic values; protecting habitat and water resources; encouraging residents as stewards of the environment; encouraging sustainable development, agriculture and recreation activities; and fostering the resiliency of rural and resort communities.	• N/A	• Promote agricultural viability and strengthen agriculture by providing flexibility in land uses and fostering sustainable practices. • The objective of Development Permit Area 5-E is to protect the natural environment, its ecosystems and biological diversity. More specifically, this DPA will protect streams and riparian habitat primarily through the involvement of qualified environmental professionals and the identification of Streamside Protection and Enhancement Areas (SPEAs) that should remain free of development, including the disturbance of soils.	• Activities or developments that may result in potential inputs to groundwater or substantial groundwater withdraws, or which could otherwise negatively affect the groundwater system, will require hydrological assessment to identify and mitigate impacts.	• To reduce GHG emissions.	• N/A	• Protect riparian habitat from development and enhance to improve habitat values where riparian vegetation has been degraded.	• N/A	• Protect scenic value of area by maintaining natural vegetation along the Columbia Valley Highway and Chilliwack Lake Road. • Protect riparian habitat from development and enhance to improve habitat values where riparian vegetation has been degraded.	• N/A
Regional Growth Strategy for the Fraser Valley Regional District (FVRD 2004)	• The purpose of the strategy is to provide support to the FVRD members as they continue to address growth management challenges. The vision is that the FVRD will be a network of vibrant, distinct and sustainable communities that accept responsibly managed growth while being committed to protecting the land resource and the natural environment to ensure that a high quality of life is accessible to all.	• N/A	• Support and enhance the agricultural sector. • Minimize land use conflicts between agricultural, recreational and urban uses. • Promote the reclamation of lands back to agricultural use, where appropriate.	• Protection of surface water. • To support ongoing monitoring and management of the region's groundwater supply through water conservation measures, nutrient management initiatives, Best Management Practices in industry and groundwater protection legislation. • To protect the region's potable surface and groundwater resources by supporting water conservation and stormwater management measures and by supporting the development of needed water protection legislation.	• Cooperate with appropriate jurisdictions to protect air quality.	• N/A	• No disturbance to riparian buffer from streams, watercourses and wetlands to protect water quality, hydrological functions and riparian habitat.	• No disturbance to riparian buffer from wetlands to protect water quality, hydrological functions and riparian habitat.	• Supporting watershed management plans which would include the management of large forested, vegetated areas and riparian corridors.	• N/A

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		Physical and Meteorological Environment	Soil and Soil Productivity	Water Quality and Quantity	Air Emissions/GHG Emissions	Acoustic Environment	Fish and Fish Habitat	Wetland Loss or Alteration	Vegetation	Marine Sediment and Water Quality, Marine Fish and Fish Habitat, Marine Mammals and Marine Birds
Township of Langley Official Community Plan (Township of Langley 1979)	• The goals of this plan are to: attractively service urban areas providing diverse opportunities, suitable to the varied lifestyles in the municipality; maintain the rural character outside designated urban growth areas; preserve good quality air, water and land environments; rational development of agricultural, industrial and commercial enterprises to provide a balance between residential and other uses; provide adequate physical and social services within the means of the municipality; and to preserve and enhance the unique and character-defining aspects of Langley's historic sites, communities and cultural resources.	• To ensure development is controlled in all flood plain areas where a hazard exists. • To regulate development on steep slopes or in areas where there is landslide hazard, in order to prevent high damage costs in the case of ground movement.	• To enhance agricultural viability. • To protect agricultural lands from industrial encroachment.	• To encourage the enhancement of the aquatic environment of the rivers and creeks. • To enhance the natural amenities existing along the south bank of the Fraser River. • To protect watersheds which act as a natural landscape unit.	• To reduce GHG emissions. • Preservation of good air quality.	• N/A	• To encourage the enhancement of the aquatic environment of the rivers and creeks. • To enhance the natural amenities existing along the south bank of the Fraser River. • To protect watersheds which act as a natural landscape unit.	• N/A	• Identifying, conserving, restoring and enhancing corridors that connect streamside (riparian) habitat, upland habitat patches, and other green spaces where appropriate.	• N/A
Township of Langley Water Management Plan (Compass Resource Management Ltd. 2009)	• This plan provides a series of recommendations to better protect the aquifers in the Township of Langley from overuse and contamination.	• N/A	• Maintain native soils.	• To ensure safe and sustainable groundwater for the community for generations to come. Protect groundwater quality and quantity. • Reduce groundwater use (reduce demand, optimize supply) and enhance recharge areas. • Minimize risks from point and non-point source contaminants (nitrates, pesticides, and others). • Preserve baseflows in fish-bearing streams and minimize groundwater quality risks to fish bearing streams. • Maintain suitable baseflows and water levels in riparian and wetland areas and minimize contamination risks.	• N/A	• N/A	• Preserve baseflows in fish-bearing streams and minimize groundwater quality risks to fish bearing streams. • Maintain suitable baseflows and water levels in riparian and wetland areas and minimize contamination risks.	• Maintain suitable baseflows and water levels in riparian and wetland areas and minimize contamination risks.	• Maintain native soils and vegetation. • Promote healthy riparian and wetland habitats.	• N/A

Name of Plan	Summary of Plan	Element[1,2,3]								
		Physical and Meteorological Environment	Soil and Soil Productivity	Water Quality and Quantity	Air Emissions/GHG Emissions	Acoustic Environment	Fish and Fish Habitat	Wetland Loss or Alteration	Vegetation	Marine Sediment and Water Quality, Marine Fish and Fish Habitat, Marine Mammals and Marine Birds
City of Surrey Official Community Plan (City of Surrey 2012)	• This plan was adopted by the City of Surrey City Council to guide land use and development over the next 5 to 20 years. It is Council's intention to achieve orderly growth for complete sustainable communities with sensitivity to the environment. This growth includes residential growth as well as a growing business base for Surrey.	• Preserve and protect the natural environment.	• Preserve and protect the natural environment and agricultural land. • Protect and enhance agriculture within the agriculturally designated areas and maintain agricultural boundaries. • Encourage the development of effective buffers along the boundary of agriculturally designated land. • Encourage adjacent land uses to be compatible with existing farm use and ensure that the impacts (*e.g.* water runoff from upland areas) on agricultural lands will be minimized.	• Protect and enhance the aquatic environment. • Preserve ravines and watercourses in their natural state, and wherever possible, link them with green spaces to develop a continuous network of the natural environment throughout and between the developed areas of the City of Surrey. • Provide adequate control of sedimentation and erosion in runoff water during construction. • Attempt to maintain water quality, base flows and the natural flow pattern in any receiving watercourse to avoid flood damage and to protect aquatic biota (vegetation and wildlife) and habitats. • Manage the quality and quantity of stormwater runoff to help protect and enhance aquatic habitats.	• To reduce GHG emissions.	• N/A	• Protect and enhance the aquatic environment. • Preserve ravines and watercourses in their natural state, and wherever possible, link them with green spaces to develop a continuous network of the natural environment throughout and between the developed areas of the City of Surrey. • Identify and endeavour to protect Fisheries Sensitive Zones (instream aquatic habitats, out-of-stream habitat features: side channels, wetlands, riparian areas) as defined in conjunction with DFO, BC MOE and the City of Surrey.	• Preserve wetlands. • Identify and endeavour to protect Fisheries Sensitive Zones (wetlands) as defined in conjunction with DFO, BC MOE and the City of Surrey.	• A greener Surrey includes a connected network of protected natural ecosystems comprised of urban forests, riparian areas and wetlands, foreshore areas, grasslands and protected farmlands. • Preserve ravines and watercourses in their natural state, and wherever possible, link them with green spaces to develop a continuous network of the natural environment throughout and between the developed areas of the City of Surrey.	• N/A
City of Coquitlam Citywide Official Community Plan (City of Coquitlam 2001a)	• The purpose of this plan is to guide future land use and servicing provisions in ways that sustain its citizens' values. The plan provides a broader framework for considering and managing future change, including policies to implement the framework and address related needs for amenities, services and infrastructure support.	• To enhance the City's response to geotechnical and natural safety issues which could affect development and infrastructure. • To preserve hazard lands as environmentally significant areas. • To improve emergency response for addressing incidents involving natural hazards.	• Encourage retention of topsoil in new developments.	• To provide for effective and prudent management of the City of Coquitlam's watercourses through sustainable land use and development and other comprehensive watershed and stormwater management approaches.	• To reduce GHG emissions and improve air quality.	• N/A	• Riparian areas along watercourses shall be protected in accordance with standards which Council may approve by bylaw and through any necessary authorization by senior levels of government.	• N/A	• Recognize the benefits of vegetation and landscaping treatments in improving air quality, and regulating temperature. • Recognize the importance of vegetation in maintaining slope stability. • Continue to provide for safe tree retention, where appropriate. Review the existing Tree Cutting Permit Bylaw and Zoning Bylaw to ensure that any leave strips are not susceptible to tree falls.	• N/A

Name of Plan	Summary of Plan	Element[1,2,3] Physical and Meteorological Environment	Soil and Soil Productivity	Water Quality and Quantity	Air Emissions/GHG Emissions	Acoustic Environment	Fish and Fish Habitat	Wetland Loss or Alteration	Vegetation	Marine Sediment and Water Quality, Marine Fish and Fish Habitat, Marine Mammals and Marine Birds
City of Coquitlam Citywide Official Community Plan (City of Coquitlam 2001a) (cont'd)	See above	See above	See above	See above	See above	• N/A	See above	• N/A	• In areas to be replanted, encourage the use of appropriate native vegetation. Native trees and plants provide habitat for birds and wildlife and are best suited to local soils and climate. • Riparian areas along watercourses shall be protected in accordance with standards which Council may approve by bylaw and through any necessary authorization by senior levels of government. • Minimized trail impacts on riparian corridors and other sensitive lands.	• N/A
Coquitlam Lougheed Neighbourhood Plan (City of Coquitlam 2001b)	• The purpose of the plan is to guide future land use and servicing decisions in ways that enhance the Lougheed Neighbourhood and to provide City Council with a plan to manage change in an efficient and effective manner. The plan is a comprehensive land use and servicing plan for lands within the City of Coquitlam that lie within an approximate 1.0 km radius of the Lougheed SkyTrain Station.	• Policies aiming to identify and preserve environmentally sensitive land, preserve and enhance the natural environment and areas of unique character, and aim to avoid and mitigate the impacts of urban development in hazardous lands, on lands of high environmental sensitivity.	• N/A	• Encourage new development to incorporate sustainable design features pertaining to water efficiency. • Encourage green infrastructure systems addressing water use, waste water and stormwater. • Maintain the Austin Creek drainage function in a manner that prevents further environmental degradation. • Ensure that new development conforms to the City of Coquitlam's Stormwater Management Policy and Design Manual.	• In general, to improve air quality.	• N/A	• Policies aiming to identify and preserve environmentally sensitive land and aim to avoid and mitigate the impacts near critical fish habitat.	• N/A	• Policies aiming to identify and preserve environmentally sensitive land, preserve and enhance the natural environment and areas of unique character, and aim to avoid and mitigate the impacts of urban development in hazardous lands, on lands of high environmental sensitivity, and near critical fish and wildlife habitat.	• N/A
Burnaby Official Community Plan (City of Burnaby 1998)	• The purpose of this plan is to provide direction for the growth management role that the city should play over the next 10 years and beyond. The goal of the plan is to create a more complete and livable community that reflects local needs, aspirations and values, and at the same time define Burnaby's contribution to helping shape a livable region for the next decade and beyond.	• N/A	• The long term protection of the lands within the ALR is an important objective in the City of Burnaby's overall planning framework. • To protect and enhance agricultural uses within the designated agricultural areas in the Big Bend.	• To Improve the quality of water runoff. • To achieve a zero net increase in runoff and avoid degradation of water flowing into the City of Burnaby's three major watersheds. • Adoption of the Burnaby Watercourse Bylaw which focuses on reducing contamination of stormwater and local waterways.	• In general, to improve air quality.	• Reduce operational noise at industrial sites.	• N/A	• N/A	• Adoption of an Integrated Pest Management Program which uses an ecological approach to vegetation and pest management on City of Burnaby properties. • Adoption of a Tree Protection and Replacement Bylaw. • Recognition that the developing system of Green Zone and other park lands in the City of Burnaby are to be protected and, as such, will not be available for accommodating any non-park uses in the future. • Preserving ecological continuity.	• N/A

Name of Plan	Summary of Plan	Element[1,2,3]								
		Physical and Meteorological Environment	Soil and Soil Productivity	Water Quality and Quantity	Air Emissions/GHG Emissions	Acoustic Environment	Fish and Fish Habitat	Wetland Loss or Alteration	Vegetation	Marine Sediment and Water Quality, Marine Fish and Fish Habitat, Marine Mammals and Marine Birds
Watershed Management Plan (GVRD 2002)	• This plan is based upon the GVRD Board's overall vision statement, Creating Our Future, which states that the purpose of Greater Vancouver's watersheds is to produce clean, safe water. The Board's overall goal in this plan is to ensure that watersheds provide clean, safe water and are managed and protected as natural assets of the highest importance to the Greater Vancouver region.	• N/A	• To minimize the impact of soil erosion on the quality of the water entering the water distribution system.	• To provide clean, safe water. • Restoration of natural systems. • Support for natural processes consistent with water quality, safety and environmental quality. • Stewardship guided by research, monitoring and public involvement. • To verify that the watersheds will continue to provide an adequate supply of clean safe water for the water system.	• N/A	• N/A	• Preserve ecological functions for habitats and biodiversity. • Implement provincial fish strategies.	• Preserve ecological functions for habitats and biodiversity.	• Preserve ecological functions for habitats and biodiversity.	• N/A
Metro Vancouver 2040 – Shaping our Future (Metro Vancouver 2011)	• This plan focuses on land use policies to guide the future development of the region and support the efficient provision of transportation, regional infrastructure and community services. In combination with other management plans, Metro Vancouver's Regional Growth Strategy can help meet the region's priorities and mandates and support the long-term commitment to sustainability.	• Protect and enhance natural features and their connectivity. • Encourage land use that improves the ability to withstand natural hazard risks.	• Support agricultural uses within the ALR and, where appropriate, outside of the ALR. • Protect the supply of agricultural land. • Protect, enhance and restore ecologically important systems, features and corridors and establish buffers along agricultural lands and other ecologically important features.	• To protect natural features that support clean drinking water.	• Reduce GHG emissions and improve air quality	• N/A	• N/A	• Protect and enhance natural features and their connectivity. • Protect conservation and recreation lands.	• Protect and enhance natural features and their connectivity. • Protect conservation and recreation lands.	• N/A
Port Metro Vancouver Consolidated Land Use Plan 2010 (PMV 2010)	• This plan contains a comprehensive set of policies that will shape the way the PMV meets its objectives and fulfills its mandate under the Canada Marine Act. It facilitates the Port's obligation to manage the land and water within its jurisdiction in a manner that supports port activity while respecting the environment as well as the needs and interests of its neighbours. This plan also provides a tool for the Port to communicate land use policies and coordinate land use initiatives with neighbouring communities and external agencies.	• N/A	• N/A	• N/A	• Work on implementation of an air emissions strategic plan including new technologies to reduce air emissions. • Reduce GHG emissions.	• N/A	• Development of the most productive habitat areas in the Plan area is usually not permitted unless it is demonstrated that no alteration to or alienation of the habitat will occur.	• N/A	• Development of the most productive habitat areas in the Plan area is usually not permitted unless it is demonstrated that no alteration to or alienation of the habitat will occur.	• Exercise responsible environmental stewardship of PMV land and water areas so that growth and development takes place in an environmentally sensitive and sustainable manner. • Explore innovative environmental mitigation measures and strategies to minimize the environmental impacts of growth. • Maintain areas appropriate for environmental conservation and habitat enhancement within PMV.

Notes:
1 N/A means no applicable goals or objectives were found to be relevant to a given element.
2 Management objectives and guidelines for wildlife and wildlife habitat are discussed in Section 7.2.10.4.
3 Species at risk are discussed under the fish and fish habitat and vegetation columns of this table, and in Section 7.2.10.4 for wildlife species at risk.

8.0 CUMULATIVE EFFECTS ASSESSMENT

Cumulative effects are changes to the environment that are caused by an action in combination with other past, present and future human actions (Hegmann *et al.* 1999). A cumulative effects assessment is conducted to identify how impacts from a proposed project could interact with impacts from other developments occurring in the same ecosystem or region. A cumulative effects assessment expands the scope of traditional environmental assessment to evaluate how multiple activities may cause cumulative effects at both the local and regional scales (Finley and Revel 2002). In addition, a cumulative effects assessment differs from conventional project-specific environmental effects assessments by considering larger geographic study areas, longer time frames and unrelated projects or activities (Antoniuk 2002).

The scope of this cumulative effects assessment is a project-specific cumulative effects assessment as required under the *CEA Act*, *2012* which is appropriate for the scale of the Project. Project-specific cumulative effects assessments must determine if that particular project is incrementally responsible for adversely affecting a given element (Hegmann *et al.* 1999). They may also assist municipal, provincial and federal authorities by identifying requirements for additional planning, monitoring or mitigation that are beyond the direct control of the proponent and need to be implemented or led by others. Therefore, the total cumulative effect on a given environmental or socio-economic indicator must be identified; however, the cumulative effects assessment must also make clear to what degree the project under review is contributing to that total effect.

According to the *CEA Act, 2012,* a project-specific cumulative effects assessment need only focus on regional concerns where the principal project's activities may incrementally contribute to these concerns. Only those resources that are likely to be directly affected by the project under review, as well as other likely projects or activities, need to be included in the project-specific cumulative effects assessment.

The cumulative effects assessment evaluates the residual environmental effects directly associated with the Project (as identified in Section 7.0) in combination with reasonably foreseeable residual effects arising from other projects and activities that have been or will be carried out in the element-specific LSA or RSA of the Project. Future projects considered in the assessment do not include proposed or hypothetical projects where formal plans have not been disclosed.

8.1 Methodology

The Project cumulative effects assessment applies the following steps.

1. Identify potential residual effects of the Project (Section 8.1.1).
2. Determine spatial and temporal boundaries for each environmental indicator where residual effects have been identified for the Project (Section 8.1.2).
3. Identify existing activities and reasonably foreseeable developments with residual effects that may act in combination with the residual effects of the Project (Sections 8.1.3 and 8.1.4).
4. Identify potential cumulative effects (Section 8.1.5).
5. Develop technically and economically feasible mitigation measures (Section 8.1.6).
6. Determine the significance of the Project's contribution to cumulative effects (Section 8.1.7).

Each of the above steps is described below in the applicable methodology subsection. This cumulative effects assessment methodology has been developed primarily based on the CEA Agency's Cumulative Effects Assessment Practitioners Guide (Hegmann *et al.* 1999), the CEA Agency's Addressing Cumulative Environmental Effects under the *CEA Act, 2012* (CEA Agency 2013a), the *CEA Act, 2012* and the NEB *Filing Manual* (NEB 2013a). Additional guidance was also obtained from FEARO's The Authority's Guide to the *CEA Act*: Part II: The Practitioner's Guide (FEARO 1994a), FEARO's A Reference Guide for the *CEA Act*: Addressing Cumulative Environmental Effects (FEARO 1994b) and FEARO's A Reference Guide for the *CEA Act*: Determining Whether a Project is Likely to Cause Significant Environmental Effects (FEARO 1994c).

8.1.1 Identify Residual Effects of the Project

Scoping of the potential residual effects to be included in the cumulative effects assessment helps focus the cumulative effects assessment on issues that are non-trivial. While Hegmann *et al.* (1999), Hegmann, Eccles *et al.* (2002), Finley and Revel (2002) and Antoniuk (2000, 2002), among others, support the idea of narrowing the scope of issues to those of regional concern and a subset of Valued Ecosystem Components (VECs), Duinker and Greig (2006) recommend that project scale environmental assessment analyses should proceed on the assumption that all effects are cumulative. The latter statement reflects the expectations of the NEB, which are that each residual environmental effect is evaluated for potential cumulative effects (see Guide A.2.7 of the NEB *Filing Manual*). Nevertheless, Table A-2 of the NEB *Filing Manual* indicates that likely residual effects for the physical environment and GHG elements need not be subject to a cumulative effects assessment. Consequently, all other likely residual environmental effects for element-specific indicators identified in Section 7.0 are evaluated for potential cumulative effects, while those residual effects that are considered of regional concern are selected for more detailed analysis.

As per Guides A.2.6 and A.2.7 of the NEB *Filing Manual*, if a physical, biological or socio-economic element or indicator evaluated in the environmental effects assessment (Section 7.0) had no residual effects predicted or effects were not considered likely, then these elements or indicators were excluded from the cumulative effects assessment. Therefore, the cumulative effects assessment is limited to Project elements or indicators with residual effects that could act cumulatively with residual effects from other projects or activities.

8.1.2 Spatial and Temporal Boundaries

8.1.2.1 Spatial Boundaries

Defining appropriate spatial boundaries for potential cumulative effects is a critical step in the cumulative effects assessment. The selection of an excessively wide or large spatial boundary can cause any project-related cumulative effects to appear negligible compared to other actions (Hegmann *et al.* 1999) and increases the likelihood that an impact will be erroneously judged to be of no concern because it is relatively small in comparison (Antoniuk 2000, 2002, URS Corporation 2002).

Conversely, important regional and long-term effects may be overlooked if the spatial boundary is too small (Hegmann *et al.* 1999). An excessively small boundary may cause project-related cumulative effects to appear very significant compared to other activities within the study boundary, and potentially important issues outside the established boundary may be overlooked (Finley and Revel 2002). Antoniuk (2000, 2002) and URS Corporation (2002) note that the selection of a small study area prevents consideration of incremental and cumulative effects that are best evaluated over large areas. If boundaries are small, a more detailed or quantitative examination may be feasible; however, an understanding of the broad context may be sacrificed.

Spatial boundaries or zones of influence for pipeline-related effects are variable and may be based on a consideration of the local and regional environmental setting and any common connections or links that the pipeline project possesses with other activities or projects. As a result, different boundaries may be appropriate for different cumulative environmental effects (FEARO 1994b, Finley and Revel 2002). The spatial boundaries used in the Project cumulative effects assessment were areas where potential cumulative effects are non-trivial and have been identified. The spatial boundaries for each element as well as the rationale for the boundaries are presented in the respective subsection for each element in Section 7.0.

8.1.2.2 Temporal Boundaries

Current accepted practice for NEB applications is to use current conditions as the baseline for pipeline cumulative effects assessment (Antoniuk 2000, URS Corporation 2002). A general discussion of the historical developments and activities that have created the baseline is included as background information (Section 8.1.3).

The temporal boundaries used in the cumulative effects assessment include past development (up to the construction of the Project), the construction phase of the proposed development commencing in early 2016, and the operation phase that will commence following completion of construction and extending to the expected life of the Project (*i.e.*, 50+ years). Temporal boundaries identified for each element are presented in Sections 8.2 to 8.15.

8.1.3 Existing Activities and Events

Existing activities in the Project area will vary depending on the spatial boundaries identified for each specific environmental element.

Historical Context of Alberta

Aboriginal communities settled in Alberta about 8,000 years ago. European explorers came to Alberta in the mid-eighteenth century; however, European settlement at that time was discouraged by the Hudson’s Bay Company, which controlled the region for their fur trading activities. In 1870, the Hudson’s Bay Company turned over control of the entire northwest region, including present-day Alberta, to Canada. The area was subsequently opened to European settlement in 1872. Following construction of the Canadian Pacific Railway in 1881, settlement of Alberta rapidly increased. Alberta's population rose from 73,022 in 1901 to 584,454 in 1921. Most of the early settlers were ranchers in the arid southern region of the province, although the fertile soils of the central parkland region were suitable for agriculture and many settlers established grain farms (Stamp 2012). Settlement in the central Alberta foothills was influenced by extraction and processing of natural resources. The Town of Hinton developed as a result of coal mining in the early twentieth century, as well as the opening of a pulp mill in 1957 (Holmgren 2012).

By 1910, most of the available agricultural land in Alberta had been settled; however, many of these settlements were abandoned during the Great Depression and not resettled until the 1940s and 1950s. Although a trend toward urbanization was underway, rapid acceleration in this trend began following World War II, brought on by a shift in the economic base from agriculture to petroleum. This shift was initiated by the discovery of oil at Leduc in February 1947. The resulting development of oil and natural gas resources transformed the cities of Edmonton and Calgary into prosperous metropolitan centres: in 1946, 27% of Alberta's population lived in Edmonton and Calgary; by 2001 this had increased to 80.9% (Stamp 2012).

Historical Context of British Columbia

Occupation of BC by Aboriginal communities has been confirmed at about 6,000 to 8,000 years ago by carbon dating. The coastal people concentrated along the lower reaches of the major salmon rivers. They were a semi-sedentary people and developed an elaborate culture distinguished by totem poles and potlatches. Interior inhabitants developed a generally nomadic hunting and fishing culture adapted to the forested mountains, dry central interior and the riverine resources of the area.

The first permanent European settlement came with the development of the fur trade in the early nineteenth century. At mid-nineteenth century, the only non-native settlements in what was to become BC were fur trade posts on the coast, such as Victoria, Nanaimo and Fort Langley, and in the interior, such as Kamloops, Fort George (later Prince George) and Fort St. James.

This relatively quiet period of history ended in 1858 following the discovery of gold along the lower and middle reaches of the Fraser River, which led to an inland supply and transportation system along the Fraser River to the Cariboo Mountains. Thousands of prospectors journeyed to the region from California and other parts of the world. Mining became important in 1858 with the Fraser Gold Rush and later discoveries in the Cariboo region. Permanent mining towns began to establish along valleys of southeast BC by the 1880s, supported by local forestry, small farms and complex rail, road and water transport. In the early 1980s, mining in the area was highlighted by large, open-pit copper mines southwest of Kamloops. In contrast, settlement was more urban and commercial on the southwest coast.

Vancouver was selected as the site for the western terminal of the Canadian Pacific Railway in 1886, and it became the main port through which both coastal and interior products moved to world markets. Construction of the Grand Trunk Pacific Railway west from Edmonton through the upper Fraser, Bulkley and Skeena valleys from 1907 to 1914 was intended to give Canada a second gateway through the mountains to the Pacific coast.

Lumber mills were established in the southwest after the middle of the nineteenth century to supply the building needs of the growing settlements and to export to nearby Pacific settlements. The pulp and paper industry remained coastal until the mid-1960s, when mills were opened in several places across the interior. This interior expansion was part of the general spread of the forest industry into the interior of the province. Forestry was and continues to be an important economic pillar for the province, however, the industry has experienced considerable decline over recent years.

Farming began to supply the trading posts in BC in the mid-nineteenth century. The growing cities of Vancouver and Victoria stimulated agricultural expansion in the Fraser Valley and on Vancouver Island. In the 1890s, fruit and vegetable growing were established in the Okanagan and beef ranching in the Cariboo region. Agriculture brought settlers to the south-central interior. At the time of the Cariboo Gold Rush, ranching was established in the grassland valleys and rolling basins across the southern interior plateau. From 1966 to 1971, urban expansion was consuming over 6,000 ha per year of prime agricultural land. About 20% of the prime agricultural land of the Lower Fraser Valley and 30% of the Okanagan had already been converted when, in 1973, the *Land Commission Act* froze the disposition of agricultural land for non-agricultural use, despite competing demands for housing, industry, hobby farms and country estates.

Steep, rugged geography and high precipitation make many areas of BC suitable for hydroelectric power generation. Hydroelectric power was first produced at the close of the nineteenth century from small rivers in the southwest for urban consumers in Victoria and Vancouver. The largest single power site in the southwest prior to 1940 was developed on Bridge River, just east of the Coast Mountains.

Early in the nineteenth century, salmon canneries were dispersed all along the BC coast. However, the gradual introduction of improved boats with longer ranges and refrigeration resulted in the closing of most canneries on the central coast, and fish processing was concentrated into a few large plants near Prince Rupert and Vancouver.

Coastal BC was, and still is, served by an extensive ferry service which moves freight, cars and passengers across the Strait of Georgia. Small coastal boats, tugs and barges move natural resources, supplies and people along the sheltered "Inside Passage" between Vancouver Island and the mainland of BC, and northward to Prince Rupert, Haida Gwaii and the Alaska Panhandle.

By the mid to late twentieth century, thousands of Canadians migrated to BC, attracted by the mild climate and perceived economic opportunities, joining thousands of other immigrants from Asia. In the twenty-first century, BC is now one of Canada's most prosperous and fastest growing provinces in part due to its diverse natural resource industry and, in particular, the more recent growth and development of the natural gas sector in the northeast of the province. However, the population has always been primarily urban - in 2001, 84.7% was classified as urban, with most people residing in the southwest region (Robinson 2012).

8.1.3.1 Alberta (Edmonton to Hinton)

The economic base of the City of Edmonton and area (*i.e.*, Strathcona, Parkland, Lac Ste. Anne, Sturgeon, Brazeau and Leduc counties) is diverse and has expanded from a provincial government and regional commercial centre to include agriculture, biofuels, chemicals and petrochemicals, commercial/retail, residential, forestry and related industries, infrastructure, institutional, mining, oil and gas, oil sands, other industrial, pipelines, power, and tourism and recreation. In 2011, the most active industries in the City of Edmonton (by industrial classification) were: retail trade (employing approximately 12% of the labour force); health care and social assistance (11%); and construction (8%) (Statistics Canada 2013).

West of the City of Edmonton and surrounding municipalities in Yellowhead County, the economy is more resource-based. Key sectors include forestry, coal, oil and gas, agriculture and tourism. Forestry and coal mining are in flux, but the oil and gas industry is a steady contributor to the economy within Yellowhead County (Lyons pers. comm.). Within Yellowhead County, the most active industries (by industrial classification) in 2011 were: mining, quarrying, and oil and gas extraction (employing approximately 17% of the labour force); retail trade (11%); construction (8%); and accommodation and food services (8%) (Statistics Canada 2013).

The Socio-Economic Technical Report (Volume 5D) provides additional information on employment and economy of counties and communities in the various RSAs along the proposed pipeline corridor.

Natural Disturbance

Natural disturbance in various RSAs in Alberta commonly results from: forest fires; forest pests, particularly the mountain pine beetle west of the Town of Edson; and flooding, particularly along the North Saskatchewan, Pembina and McLeod rivers.

Settlement Patterns

In 2011, the total population of the City of Edmonton and surrounding counties (*i.e.*, Strathcona, Parkland, Lac Ste. Anne, Sturgeon, Brazeau and Leduc counties) was 1,188,962; a 12% increase from 2006. The median age of people in this urbanized region was 37 and 5.5% of the population identified as Aboriginal (Statistics Canada 2012a).

In 2011, the total population of Yellowhead County was 29,336; a 3.5% increase from 2006. The median age of people in the county was 43.5 and 11.5% of the population identified as Aboriginal (Statistics Canada 2012a).

The Socio-Economic Technical Report (Volume 5D) provides additional census information on population and demographics of counties and communities in the various RSAs along the proposed pipeline corridor.

Agriculture and Livestock Grazing

Agricultural production is the primary land use in the RSAs throughout Strathcona and Parkland counties, and eastern regions of Yellowhead County (Parkland County 2007, Strathcona County 2007, Yellowhead County 2006), and continues to be supported by regional municipalities. For example: a policy of the Parkland County Municipal Development Plan (MDP) is to preserve the integrity of productive agricultural areas and the conservation of agricultural land (Parkland County 2007); a goal of the Yellowhead County MDP is to concentrate future development in areas that do not fragment existing agricultural land (Yellowhead County 2006); and an objective of the Strathcona County MDP is to maintain and enhance the viability of the existing agricultural community and agricultural industry (Strathcona County 2007).

The dominant type of agricultural activity in Strathcona County by number of reporting farms is other animal production, followed by other crop farming, hay farming, and horse and other equine production (182 farms, 159 farms, 154 farms, and 141 farms, respectively) (Statistics Canada 2012b). Agricultural land use in Strathcona County is predominantly crops, followed by natural land for pasture and tame or seeded pasture (60,759 ha, 13,355 ha, and 7,914 ha, respectively) (Statistics Canada 2012b).

The dominant type of agricultural activity in Parkland County by number of reporting farms is beef cattle ranching and farming, followed by hay farming, horse and other equine production, and other grain farming (219 farms, 148 farms, 140 farms, and 61 farms respectively) (Statistics Canada 2012c). Agricultural land use in Parkland County is predominantly crops, followed by tame or seeded pasture, and natural land for pasture (73,051 ha, 35,367 ha, and 34,983 ha respectively) (Statistics Canada 2012c).

The dominant type of agricultural activity in Yellowhead County by number of reporting farms is beef cattle ranching and farming, followed by hay farming, horse and other equine production and animal combination farming (205, 183, 135, and 43 farms respectively) (Statistics Canada 2012d). Agricultural land use in Yellowhead County is predominantly natural land for pasture, followed by crops, and tame or seeded pasture (65,379 ha, 62,913 ha and 34,372 ha, respectively) (Statistics Canada 2012d).

Crown-owned grazing leases also are present within the RSAs. These grazing leases are broadly managed by Alberta Environment and Sustainable Resource Development (AESRD), although individual land users are responsible for the day-to-day management of the land.

Forestry

The volume of timber harvested in Forest Management Agreements (FMAs) along the proposed pipeline corridor provide an indication of current forestry activity in the various RSAs.

Effective in 2007, the approved Annual Allowable Cut (AAC) for the Weyerhaeuser Company Ltd. (Edson) (Weyerhaeuser) FMA is 514,856 m^3 of coniferous wood and 328,663 m^3 of deciduous wood, up from an approved AAC in 2006 of 384,363 m^3 for coniferous and 317,440 m^3 for deciduous. As of 2007, no mountain pine beetle was detected in the Weyerhaueser FMA; however, the increase in AAC is part of Weyerhaeuser's 20-year plan to create a forest that is more resistant to such outbreaks by dramatically reducing the overall susceptibility of pine forests in the FMA (Weyerhaeuser 2008a).

The approved AAC for the West Fraser Mills Ltd. (Hinton) (West Fraser) FMA is 1,766,576 m^3 of coniferous wood and 249,832 m^3 of deciduous wood, up from an approved AAC of 1,535,000 m^3 for coniferous and 169,449 m^3 for deciduous from 2008 to 2010. The West Fraser FMA is in the leading edge zone for mountain pine beetle, where the increase in AAC for coniferous wood is part of the strategy to eradicate all mountain pine beetle infestations as they become known (West Fraser 2010).

Recreation

Outdoor recreational activities such as snowmobiling, cross-country skiing, all-terrain vehicle (ATV) use, mountain biking, hiking, camping, rafting, kayaking, canoeing and sight-seeing are expected to occur within various RSAs along the proposed pipeline segment. Recreational boating and fishing occurs on the larger watercourses (*e.g.*, North Saskatchewan, Pembina and McLeod rivers) and lakes (*e.g.*, Wabamun Lake).

The Socio-Economic Technical Report (Volume 5D) provides additional information on recreation activities in the various RSAs along the proposed pipeline corridor.

Rural and Urban Residential and Commercial

The proposed pipeline corridor crosses urban and rural commercial and residential centres including the City of Edmonton, City of Spruce Grove, Town of Stony Plain, Town of Edson, Town of Hinton, as well as three Hamlet Growth Areas within Yellowhead County: Niton Junction (approximately RK 187); Wildwood (approximately RK 151); and Evansburg (approximately RK 137). The Yellowhead County MDP notes that these Hamlet Growth Areas have a 3 km radius around existing hamlets and provide space to accommodate new development (Yellowhead County 2006).

The City of Edmonton surrounding communities (*e.g.*, City of Spruce Grove, Town of Stony Plain) have experienced rapid population growth over the past 5 years (refer to the Socio-Economic Technical Report of Volume 5D). As a result, residential development within the City of Edmonton surrounding communities has also increased, with the largest residential housing market located in the City of Edmonton.

In the more rural area of Yellowhead County, communities experienced rapid growth in 2007/2008, during the last oil and gas boom. Since that time, growth has declined and, as a result, residential development overall within Yellowhead County has also declined.

The Socio-Economic Technical Report (Volume 5D) provides additional details on rural and urban residential development in counties and communities in the various RSAs along the proposed pipeline corridor.

Transportation and Infrastructure

Current and ongoing transportation activities in the RSA for various elements may include regular and commercial vehicle traffic, as well as maintenance activities on roads, bridges, highways, railways and airports.

According to approximately five permanent traffic measurement sites located on Highway 16 within the City of Edmonton and Parkland County, overall Monthly Average Daily Traffic (MADT) volumes have increased from 2009 to 2011, with larger volumes occurring close to the City of Edmonton. This is likely due to commuters driving to Edmonton from the City of Spruce Grove and the Town of Stony Plain (Alberta Transportation 2012).

There are four permanent traffic measurement sites located on Highway 16 within Yellowhead County. Overall MADT volumes have increased from 2009 to 2011, with larger volumes occurring close to the

Town of Edson and the Town of Hinton, likely due to commuters. Throughout Yellowhead County, MADT volumes are highest during the summer months (Alberta Transportation 2012).

The Socio-Economic Technical Report (Volume 5D) provides additional information on transportation and infrastructure, including traffic volume measurements, at various locations in vicinity to the proposed pipeline corridor.

Utility Activities

Current and ongoing utility activities in the RSA for various elements include maintenance on transmission line and gas distribution rights-of-way (*e.g.*, ATCO Gas and Pipelines Ltd. [ATCO Gas], EPCOR Distribution and Transmission Inc. [EPCOR]) as well as operational activities at thermal electric power generating plants, such as the TransAlta Corp. (TransAlta) Sundance and Keephills thermal electric power generating plants approximately 6 km southwest and 12 km south of Wabamun, respectively (TransAlta 2013a).

In addition, three major transmission line developments are currently under construction in the various RSAs; the AltaLink Management Ltd. (AltaLink) Western Alberta Transmission Line Project, EPCOR and AltaLink Heartland Transmission Project and ATCO Electric Ltd. (ATCO Electric) Eastern Alberta Transmission Line Project (see Section 8.1.4.1 for additional details).

Oil and Gas

As home to Canada's largest oil refining complex and North America's third largest petrochemical complex, Strathcona County's economic base is oil and gas. The county supports oil and gas exploration and development with the least possible impact on the environment, health, safety and quality of life for residents and the community (Strathcona County 2007). Likewise, one of the main industries in Parkland and Yellowhead counties is oil and gas exploration and development.

Oil and gas activity in the RSAs for various elements has been ongoing since the 1950s. Oil and gas exploration and development activities conducted over the years include seismic operations and the construction and operation/maintenance of pipelines, access roads and lease sites (*e.g.*, wells, gas plants, compressor stations).

Mineral Resources

Ongoing mining operations in the various RSAs include aggregate quarries and coal mines. The TransAlta Highvale Mine located approximately 10 km southwest of Wabamun delivers coal to TransAlta's Sundance and Keephills thermal generating plants (see Utility Activities above) (TransAlta 2013b). The Whitewood Mine, located approximately 8 km north of Wabamun Lake, was closed in 2010 and TransAlta is now focused on reclaiming the former coal mine (TransAlta 2013c). The Teck Resources Ltd. (Teck) Cardinal River Mine approximately 40 km south of Hinton produces mostly metallurgical coal (Teck 2013a), while the Sherritt International Corporation (Sherritt) Coal Valley Mine approximately 60 km south of Edson produces mostly thermal generating coal for international export (Sherritt 2013). Two other coal mines operated by Sherritt — Gregg River Mine and Obed Mountain Mine located south and northeast of Hinton, respectively — are currently inactive (Sherritt 2013).

8.1.3.2 British Columbia (Hargreaves to Westridge)

The economic base of the Regional District of Fraser-Fort George (RDFFG) and Thompson-Nicola Regional District (TNRD) includes forestry and wood products, agriculture, tourism and government services. For both regional districts overall, the most active industries (by industrial classification) in 2011 were: retail trade (employing approximately 12% of the labour force); health care and social assistance (12%); accommodation and food services (8%); and construction (8%) (Statistics Canada 2013).

The economy of the Fraser Valley Regional District (FVRD) is based primarily on agriculture, manufacturing and construction. Historically, the predominant sectors have been agriculture and resource development, including forestry, however, the economy is diversifying based on growth in the manufacturing, services, aerospace and technology sectors (FVRD 2010). For the FVRD overall, the most active industries (by industrial classification) in 2011 were: retail trade (employing approximately

13% of the labour force); health care and social assistance (12%); construction (11%); and manufacturing (10%) (Statistics Canada 2013).

The economic base of Metro Vancouver is diverse and includes trade and commerce, manufacturing, goods distribution, professional services, tourism, education and agriculture. For Metro Vancouver overall, the most active industries (by industrial classification) in 2011 were: retail trade (employing approximately 10% of the labour force); health care and social assistance (10%); accommodation and food services (8%); and professional, scientific and technical services (9%) (Statistics Canada 2013).

The Socio-Economic Technical Report (Volume 5D) provides additional information on employment and economy of regional districts and communities in the various RSAs along the proposed pipeline corridor.

Natural Disturbance

Natural disturbance in various RSAs within BC commonly result from forest fires (mainly interior BC); forest pests (mainly interior BC), particularly the mountain pine beetle, but also the balsam bark beetle, Douglas-fir bark beetle, western spruce budworm and aspen leaf miner; debris slides and flows, particularly between the Village of Valemount and District of Clearwater, as well as the City of Merritt and District of Hope; avalanches along the Coquihalla River valley; and flooding, particularly along the North Thompson, Thompson, Coldwater, Coquihalla and lower Fraser rivers.

Settlement Patterns

Key incorporated population centres in the RDFFG and TNRD along the proposed pipeline corridor include the Village of Valemount, the District of Clearwater, the City of Kamloops, the City of Merritt and the District of Barriere, as well as many small, unincorporated communities such as Blue River, Vavenby, Avola and Little Fort. In 2011, the total combined population of electoral areas, communities and Indian Reserves (IRs) along and in vicinity to the proposed pipeline corridor in the RDFFG and TNRD was 128,978; a 4.6% increase from 2006. In 2011, the median age was 45 and 10.6% of the population identified as Aboriginal (Statistics Canada 2012a).

The FVRD is largely agricultural, and key incorporated municipalities include the District of Hope, the City of Chilliwack and the City of Abbotsford. In 2011, the total combined population of electoral areas, communities and IRs along and in vicinity to the proposed pipeline corridor in the FVRD was 274,404; an 8% increase from 2006. In 2011, the median age was 42.6 and 6.4% of the population identified as Aboriginal (Statistics Canada 2012a).

In 2011, the total population of Metro Vancouver, which includes the cities of Surrey, Coquitlam, Burnaby and Vancouver, was 2,313,328; a 9.3% increase from 2006. In 2011, the median age of the population in Metro Vancouver was 41 and 2.4% of the population identified as Aboriginal (Statistics Canada 2012a).

The Socio-Economic Technical Report (Volume 5D) provides additional census information on population and demographics of electoral areas and communities in the various RSAs along the proposed pipeline corridor.

Agriculture and Livestock Grazing

Limited agricultural activities in the various RSAs north of Kamloops consist predominantly of grazing areas and permanent pastures near Valemount, Blue River, Avola and Clearwater. Beyond Clearwater to the southwest, the river valley widens and the land use in the valley bottom is mainly pasture and forest grazing. Natural grazing lands are common along the Coquihalla Highway from the area south of Kamloops to south of Merritt, where forest begins to dominate from south of the Coquihalla Lakes to Hope.

The Agricultural Land Reserve (ALR) in the TNRD accounts for less than 13% of the overall area of the regional district. The dominant types of agricultural activity in TNRD are classified as unmanaged pasture and managed pasture at 79% and 10%, respectively. Crops, mainly alfalfa and other fodder crops, account for 7% (BC Ministry of Agriculture and Lands 2008).

Two-thirds of the land base in the City of Chilliwack is reserved for agriculture, which is dominated by dairy, poultry, nurseries and greenhouses (City of Chilliwack 2012). Approximately 75% of the Township of Langley is classified as ALR, which is utilized for a variety of purposes, including greenhouses, nurseries, berry operations, equestrian farms, wineries, poultry farms and vegetable farms (Township of Langley 2013). The City of Abbotsford is one of the most intensively and diversely farmed areas in Canada, supporting a wide range of crop and livestock enterprises (City of Abbotsford 2011). Agriculture is also a predominant land use activity in the City of Surrey, where approximately 8,692 ha of the city's total area is classified as ALR, of which approximately 5,864 ha is used for agriculture production (City of Surrey 2013a).

Further northwest into the cities of Coquitlam and Burnaby, agricultural land uses are almost entirely absent due to the presence of higher density urban development, mountainous terrain and protected areas.

Forestry

The volume of timber harvested in Timber Supply Areas (TSAs) along the proposed pipeline corridor provide an indication of current forestry activity in the various RSAs. Of an AAC of 536,000 m^3, only 146,179 m^3 was harvested in the Robson Valley TSA, up from a low of 50,086 m^3 in 2009. Due to recent closures of lumber mills in McBride and Valemount, the Robson Valley TSA is generally a source of timber for Carrier Lumber in Prince George and Canfor in Vavenby (BC Ministry of Forests, Lands and Natural Resource Operations [MFLNRO] 2012a). Of an AAC of 4 million m^3, only 2.87 million m^3 was harvested in the Kamloops TSA, up from a low of 1.7 million m^3 in 2009 (BC MFLNRO 2012b). Every year from 2007 to 2011, the Merritt TSA recorded harvest rates greater than AAC rates, at approximately 118% over the 5-year period, due to pine beetle management activities. The greatest disparity was in 2011, when 3.38 million m^3 was harvested, compared to the AAC of 2.4 million m^3.

More recent AAC and harvest information for the Fraser TSA were not available; however, the current AAC of 1.27 million m^3 provides an indication that the Fraser TSA is experiencing some degree of active timber harvesting. The AAC is projected to stay at 1.27 million m^3 until the next AAC determination prior to August 1, 2014 (BC MFLNRO 2013a).

Active timber harvesting also occurs in several community forests within the various RSAs, including the Valemount Community and McBride Community forests.

Recreation

Outdoor recreational activities within various RSAs along the proposed pipeline corridor include snowmobiling, heli-skiing, cross-country skiing, ATV use, mountain biking, hiking, horseback riding, camping, golfing, rafting, kayaking, canoeing and sight-seeing. Recreational boating and fishing occurs on the larger watercourses (*e.g.*, Fraser, North Thompson, Thompson, Nicola, Coldwater and Coquihalla rivers) and lakes (*e.g.*, Kamloops, Jacko, Nicola and Coquihalla lakes).

The Socio-Economic Technical Report (Volume 5D) provides additional information on recreation activities in the various RSAs along the proposed pipeline corridor.

Rural and Urban Residential and Commercial

The proposed pipeline corridor crosses various types of residential land use, from rural parcels with residences to urban centres such as the City of Kamloops, City of Chilliwack, City of Abbotsford, Township of Langley, City of Coquitlam and the City of Burnaby.

Most communities along the proposed pipeline corridor in the RDFFG and TNRD have experienced average population growth from 2006 to 2011. As a result, residential development within the regional districts has also remained consistent. The demand for housing for communities along the proposed pipeline corridor in the FVRD has expanded with population and economic growth. Close proximity to Metro Vancouver is a factor in the region's increased demand for housing, although the FVRD generally has more affordable housing than Metro Vancouver (FVRD 2011). The private housing market in the Greater Vancouver area has seen low sales activity in 2012; below historical averages (Real Estate Board of Greater Vancouver [REBGV] 2013). In Metro Vancouver, home prices have declined 2.8% since January 2012 (REBGV 2013).

Refer to the Socio-Economic Technical Report (Volume 5D) for additional details on rural and urban residential development in regional districts and communities in the various RSAs along the proposed pipeline corridor.

Transportation and Infrastructure

Current and ongoing transportation activities in the RSA for various elements may include regular and commercial vehicle traffic, as well as maintenance activities on roads, bridges, highways, railways and airports.

There are three permanent traffic measurement sites located along Highway 5: north of the Village of Valemount; west of the City of Kamloops; and north of the District of Hope. Traffic count data are available for 2010, 2011 and 2012 for these sites. Overall between the three sites, MADT volumes have remained relatively consistent from 2010 to 2012. At all three sites, MADT volumes are highest during the summer months likely due to travel associated with tourism and recreation: north of the Village of Valemount, 2012 MADT volumes ranged from a low of 1,413 in January to a high of 3,977 in July; west of the City of Kamloops, 2012 MADT volumes ranged from a low of 5,412 in January to a high of 13,537 in August; and north of the District of Hope, 2012 MADT volumes ranged from a low of 5,456 in January to a high of 18,476 in August (BC Ministry of Transportation and Infrastructure 2012).

Three permanent traffic measurement sites are located on Highway 1 between the District of Hope and City of Abbotsford: west of Hope; and within the cities of Chilliwack and Abbotsford. Traffic count data are available from 2010 to 2012 for the Hope and Abbotsford sites and 2012 for the Chilliwack site. Overall MADT volumes have remained consistent from 2010 to 2012, with larger volumes occurring in the cities of Chilliwack and Abbotsford (likely due to commuters moving between communities). The permanent traffic measurement sites on Highway 1 west of Hope is considered seasonal, as evidenced by the difference in monthly average daily traffic between winter and summer months. Increased traffic during summer months is likely due to travel associated with tourism and recreation. The permanent traffic measurement sites on Highway 1 in Chilliwack and Abbotsford are relatively consistent, with more modest variations in MADT between winter and summer months.

There are four permanent traffic measurement sites located on Highway 1 in vicinity to the proposed pipeline corridor within Metro Vancouver. Traffic count data are available for 2010 for these sites and, in some cases, 2011 and 2012 as well. Overall MADT volumes have remained consistent from 2010 to 2012, with larger volumes occurring at the Port Mann Bridge crossing (likely due to commuters driving between communities in Metro Vancouver). The permanent traffic measurement sites on Highway 1 are considered consistent, with little difference in MADT between winter and summer months.

The Socio-Economic Technical Report (Volume 5D) provides additional information on transportation and infrastructure, including traffic volume measurements, at various locations in vicinity to the proposed pipeline corridor.

Utility Activities

Current and ongoing utility activities in the RSA for various elements include maintenance on transmission line, fibre optic line and gas distribution rights-of-way (*e.g.*, BC Hydro, Telus Communications Corp. [Telus], FortisBC Energy Inc. [FortisBC]) as well as operational activities at run-of-river hydroelectric plants, including Brookfield Renewable Power Inc. (Brookfield) East Twin Creek, located approximately 22 km northwest of McBride; Hauer Creek Power Ltd. Hauer Creek, located approximately 15 km northwest of Valemount; Brookfield Hystad Creek, located approximately 6 km west of Valemount; TransAlta Bone Creek, located approximately 20 km northeast of Blue River; and Boston Bar Hydro Scuzzy and Six Mile creeks, located approximately 55 km north of Hope (BC Hydro 2013a).

Other ongoing and current utility activities include operation and maintenance activities associated with public utilities and services (*e.g.*, water and sewer lines, landfills), electric substations and waste-to-energy facilities, such as Metro Vancouver's Waste-to-Energy Facility located in the City of Burnaby, which is responsible for the environmentally safe disposal of over 25% the region's waste (Metro Vancouver 2013), and MAXIM's 7.4 MW electrical and 9.1 MW thermal landfill gas cogeneration project in Delta, BC (MAXIM 2013).

In addition, major utility developments currently under construction in the various RSAs include the BC Transmission Corporation Interior – Lower Mainland Transmission Project and the BC Hydro Merritt Area Transmission Project (see Section 8.1.4.2 for additional details).

Oil and Gas

There are currently no oil and gas exploration and development activities within any RSAs in BC. There are, however, existing oil and gas transportation and storage developments such as the existing TMPL system and associated facilities, the Suncor Energy Corp. (Suncor) Products Partnership Terminal at the Kamloops Airport and the FortisBC Kingsvale Compressor Station. The Kingsvale Compressor Station serves a Spectra Energy Corp. pipeline that originates in northern BC within the various RSAs and extends from the Kingsvale area to the Lower Mainland via a route through Prince George, Cache Creek and the Coquihalla River valley.

Mineral Resources

Ongoing mining operations in the various RSAs include aggregate quarries and metal mines. The New Gold Inc. (New Gold) New Afton Mine is an underground and open-pit copper-gold mine located approximately 10 km west of the City of Kamloops that began production in June 2012 (New Gold 2013). Located approximately 50 km southwest of Kamloops, the Teck Highland Valley Copper Mine produces copper and molybdenum concentrates, and is one of the largest open-pit mining operations in BC (Teck 2013b).

Exploration activities (*e.g.*, sample drilling) are currently underway in various RSAs along the proposed pipeline corridor. Mining activities identified in the various RSAs in the exploration phase include the proposed Imperial Metals Corp. Ruddock Creek Zinc-Lead Mine Development Project near Avola, the proposed Discover Corp. Enterprises Inc. Galaxy Mine near Kamloops, the proposed Strongbow Exploration Inc. Shovelnose Mine near the City of Merritt, the proposed Gold Mountain Mining Corp. Elk Gold Mine near Merritt and the proposed New Carolin Gold Corp. Ladner Gold Project near Hope.

Marine Commercial, Recreational and Tourism Use

Although regulation and authorization of marine transportation is not specifically within the jurisdiction of the NEB, the environmental and socio-economic effects of the increased marine traffic is considered by Trans Mountain in accordance with the NEB's direction from their List of Issues for the Project, released on July 29, 2013.

The City of Vancouver, which bounds most of the southern shore of Burrard Inlet, is Canada's third largest city and its busiest port (Port Metro Vancouver [PMV] 2013a). Fishing vessels use Burrard Inlet to berth, fuel, and to access fishing grounds. Commercial fishers in Burrard Inlet mainly target Dungeness crab, prawn and shrimp. A small commercial fishery for surf smelt takes place in Burrard Inlet, mostly off spawning beaches in English Bay (Fisheries and Oceans Canada [DFO] 2013).

Under the *Canada Marine Act*, the PMV is mandated as the port authority responsible for the safe and efficient movement of marine vessel traffic in Burrard Inlet. The PMV provides oversight for operations of 28 major cargo and container terminals, 23 of which are in Burrard Inlet (PMV 2013a). The Outer Harbour and eastern area of the harbour contain multiple commercial anchorages for large deep draft marine vessels. The Inner Harbour is heavily industrialized, containing several major marine cargo, container and cruise ship terminals (PMV 2010).

The SeaBus commuter ferry travels between Vancouver and North Vancouver in the Inner Harbour, from Coal Harbour to Lonsdale Quay. In 2011, an average of 23,020 passengers used the SeaBus weekly (TransLink 2013a). In addition, a seaplane base is located in Coal Harbour. The area has one of the highest levels of seaplane activity in the world and is rated as one of the busiest aerodromes in Canada, with a total of 8 destinations serviced by a fleet of 30 planes (Global Aviation Resource 2010).

The Central Harbour continues east of the Second Narrows and contains marine terminals including the Westridge Marine Terminal, as well as the Chevron Refinery (PMV 2013a). Marine terminals are also present in Port Moody Inlet, east of the Westridge Marine Terminal.

Log handling occurs in Burrard Inlet and along the Fraser River. Mill & Timber Products in Port Moody handles and stores logs in Port Moody Inlet (Natland pers. comm.). Logs are also stored in numerous locations along the Fraser River. A log pond area is active in nearshore areas south of Point Grey in Vancouver. Many of these logs stored on the river are processed at the remaining mill sites along the river (Natland pers. comm.).

Commercial anchorages are located in the central harbour around the Westridge Marine Terminal, in the Inner Harbour and the Outer Harbour. Some anchorages are designated for different purposes, such as short-term use, emergency use, or for outbound vessels only (PMV 2012).

Marine recreation in Burrard Inlet is both intense and diverse, including fishing, boating, kayaking, paddle boarding, windsurfing and kite boarding, swimming, and scuba diving. Recreational users also access major destinations through Burrard Inlet; notably Indian Arm, where provincial and regional parks cover much of the shoreline.

Vancouver is the home port for the Vancouver–Alaska cruise ship industry, with two cruise ship terminals in the Inner Harbour that provide berthing facilities for 14 cruise ship companies (PMV 2013a). Over 800,000 passengers are expected to pass through one of the two cruise terminals in Vancouver Inner Harbour in 2013 (Cruise Lines International Association 2013). Local charter companies based in the Vancouver area offer boat tours and corporate and private cruises on large yachts in Vancouver Harbour, including the Inner Harbour and Indian Arm (Destination BC 2013, Harbour Cruises 2013).

8.1.4 Reasonably Foreseeable Developments

Reasonably foreseeable developments that are likely to occur in the Project area will vary depending on the spatial boundaries identified for the specific socio-economic element.

The criteria used to determine projects that may act cumulatively with the Project are:

- certain – the physical activity will proceed or there is a high probability it will proceed (*i.e.*, the project is either under construction, has been approved or is in the process of obtaining approval); or
- reasonably foreseeable – the physical activity is expected to proceed (*i.e.*, the project proponent has publicly disclosed its intention to seek the necessary approvals to proceed).

Sources reviewed to identify any projects/activities that could have cumulative interactions with the Project include: Alberta Inventory of Major Projects (Alberta Enterprise and Advanced Education [AEAE] 2013); BC Major Projects Inventory (BC Ministry of Jobs, Tourism and Skills Training and Responsible for Labour [MJTST] 2012); Alberta Transportation (2013a,b); Alberta Energy Regulator (AER, formerly Alberta Energy Resources Conservation Board [ERCB]) (ERCB 2013a); Alberta Utilities Commission (AUC) (2013a); BC Utilities Commission (2013); BC Oil and Gas Commission (BC OGC) (2013); BC Land Tenure Branch (BC MFLNRO 2013b); BC Environmental Assessment Office (EAO) (Province of BC 2013); PMV (2013b); CEA Registry (CEA Agency 2013b); NEB (2013b); Canada's Economic Action Plan (Government of Canada 2013a); Major Projects Management Office (Government of Canada 2013b); and county, regional district and municipality websites.

Other activities and reasonably foreseeable developments included in the assessment were identified as of May 31, 2013 and are summarized in the subsections below and in Appendix 8.1. Only those certain and reasonably foreseeable future developments with identified footprints outside of urban disturbed areas are mapped and included in Tables 8A.1-1 to 8A.1-4 of Appendix 8.1 and Figures 8.1-1a, 8.1-1b and 8.1-1c. Reasonably foreseeable developments summarized in Table 8A.1-5 (for Alberta) and Table 8A.1-6 (for BC) of Appendix 8.1 with the potential to act in combination with the Project were excluded from mapping since development details (*e.g.*, approval status, location) were either not available or the developments were located within urban municipal boundaries, such as the City of Edmonton and Lower Mainland Developed Area (LMDA) (Figure 8.1-1c). The LMDA encompasses the City of Chilliwack and municipalities extending west (*e.g.*, Abbotsford, Surrey, Coquitlam, Burnaby and Vancouver). The LMDA was delineated in an effort to address the agglomeration of municipalities in the Lower Mainland, an area recognized as having a development and human use priority and that has already been transformed from natural conditions by extensive urban, commercial, industrial, and agricultural activity, but which contains areas of highly valued green space.

A concern expressed from a public perspective during ESA Workshops and Community Workshops was the continued protection of valued green space within the LMDA, therefore, future developments identified as encroaching into defined natural spaces that may also be affected by the Project were identified. Only one such development was identified – a portion of the Golden Ears Connector development through a City of Surrey greenbelt, as shown in Figure 8.1-1c and described in Appendix 8.1.

8.1.4.1 Alberta (Edmonton to Alberta/British Columbia Border)

Agriculture and Livestock Grazing

Strathcona, Parkland and Yellowhead counties are working to support and maintain the agricultural sector in light of global demands on certain commodities and cost to invest in agriculture. For example, an objective of Parkland County and Strathcona County MDPs is to encourage the growth and expansion of value-added agricultural or industrial agricultural uses such as food processing facilities (Parkland County 2007, Strathcona County 2007). Similarly, an objective of the Yellowhead County MDP is to maintain and support agriculture as an important industry and way of life in Yellowhead County and promote the growth and diversification of extensive and intensive agricultural operations (Yellowhead County 2006).

Agriculture activities within the RSAs of various elements are expected to continue into the future and will act cumulatively with the Project. However, no specific future developments such as feedlot proposals have been identified.

Forestry Activities

Future forestry activities within the RSAs are generally limited to timber harvesting within RSAs along the western portion of the Edmonton to Hinton Segment in the Weyerhaeuser and West Fraser FMAs.

Effective until 2024, the approved AAC for the Weyerhaeuser FMA is 514,856 m^3 of coniferous wood and 328,663 m^3 of deciduous wood. According to estimates provided in Weyerhaeuser's Detailed Forest Management Plan Mountain Pine Beetle Addendum, actual harvest volumes for coniferous and deciduous wood are predicted to gradually increase in the FMA over this time period (Weyerhaeuser 2008b). Although the AAC for coniferous wood in the West Fraser FMA is 1,766,576 m^3, estimated volumes provided in West Fraser's 2011 Annual Operating Plan increase gradually per year from 1,507,780 m^3 in 2011 to 1,676,000 m^3 in 2015. With the exception of a 2011 estimate of 130,000 m^3, estimated deciduous volumes remain at 125,000 m^3 over the same period (West Fraser 2011). Increases in AACs result from implementation of harvest strategy measures supported by provincial initiatives to combat the increasing threat to Alberta forests from mountain pine beetle infestations.

Due to limited quantitative data and general nature of the information available regarding timber harvesting plans in the vicinity of the proposed pipeline corridor, forest harvest was not included in the quantitative analysis of reasonably foreseeable future developments.

Public, Tourism, Arts and Recreation Development and Activities

The Alberta Inventory of Major Projects (AEAE 2013) provides an information source from which future public, tourism, arts and recreation-based developments were identified. Details are variable for any given development and, as such, it is difficult to determine how likely "proposed" developments are to proceed without confirmation through other publicly available information. Most public, tourism, arts and recreational-based future developments are located in the City of Edmonton and the immediate surrounding area.

Public, tourism, arts and recreational-based future developments currently under construction or proposed are provided in Table 8A.1-5 of Appendix 8.1 and include: new libraries; expansion of the Edmonton Valley Zoo; heath care facilities, including Edson Health Care Centre and Strathcona Hospital Phase 1; recreation and arts facilities, including the Entertainment District Development Project and Downtown Performing Arts Centre; park and historical site upgrades and restorations; and an Edmonton Police Service Northwest Campus.

Various elementary, secondary and post-secondary institution capital projects, including expansions, upgrades and new developments, are proposed in the City of Edmonton and surrounding communities (Government of Alberta 2013a, Alberta Infrastructure n.d.). Notable developments for post-secondary institutions are provided in Table 8A.1-5 of Appendix 8.1 and include: University of Alberta Dentistry/Pharmacy Building Repurposing; University of Alberta Student Physical Activity and Wellness Centre; NorQuest College North Learning Centre (Downtown Campus) Development; and NAIT Centre for Applied Technologies.

Many of these developments will be in-service prior to 2016 and, therefore, will not occur concurrently with construction of the Project. A notable exception is the Downtown Performing Arts Centre in the City of Edmonton, which involves construction of an open-air arts galleria, a 1,600-seat theatre and 3 smaller spaces, an underground parking garage and an office tower. The current construction schedule of this development is from 2014 to 2017 (AEAE 2013). In addition, two large-scale developments — the Edmonton Area and Entertainment District Development Project, which includes a new arena to house the Edmonton Oilers, and the Royal Alberta Museum — are scheduled to be in-service by 2016 (Alberta Infrastructure 2013, City of Edmonton 2013a).

Rural and Urban Residential and Commercial Development

Population of the City of Edmonton and many surrounding communities will continue growing into the immediate future, with particularly strong growth projected for the City of Edmonton. In general, slower growth is projected for many rural communities further west along the Edmonton to Hinton Segment (the Socio-Economic Technical Report [Volume 5D] provides additional information).

Residential and commercial developments over $50 million in the RSAs that are either proposed or under construction in Alberta under the Alberta Inventory of Major Projects (AEAE 2013) include:

- Station Pointe Greens Residential Co-operative – Edmonton ($65 million) (proposed);
- The Corners I Condo Tower – Edmonton ($80 million) (proposed);
- Kelly Ramsey Building Redevelopment – Edmonton ($250 million) (proposed);
- Ultima Tower Luxury Condo Development – Edmonton ($65 million) (construction started [2012 to 2015]); and
- Century Crossing Commercial Development – Spruce Grove ($75 million) (construction started [2010 to 2013]).

Other proposed developments under $50 million in the RSAs include condominiums, apartments, housing complexes, retirement residences, retail outlets and other commercial and residential developments in the City of Edmonton and surrounding areas (AEAE 2013). The identified residential and commercial developments are anticipated to be in-service prior to 2016 and, therefore, will not occur concurrently with construction of the Project. Other proposed residential and commercial developments where schedule details are unavailable are assumed to be constructed concurrently with the Project.

Transportation and Infrastructure Development

Current and future transportation activities within the RSAs of various elements include regular and commercial vehicle traffic and rail traffic, as well as maintenance, reconstruction and upgrade activity on roads, bridges and highways, particularly within and near the City of Edmonton, where many transportation and infrastructure developments are currently under construction and in various planning and design phases (Alberta Enterprise and Advanced Education 2013, Alberta Transportation 2013a,b). Proposed future transportation developments currently under construction or proposed in the Edmonton area are provided in Appendix 8.1 and include: a new park and ride; light rail transit (LRT) upgrades; the Queen Elizabeth II Highway and 41st Avenue S.W. Interchange; a Northeast Transit Garage; and the Northeast Anthony Henday Project.

According to the growth forecast in the Capital Region Growth Plan, low-density residential use will continue to expand to Greenfield areas as the most common form of residential land use development in the Capital Region (*i.e.*, an “out” not “up” approach), which encompasses, among other areas, the City of Edmonton and Strathcona and Parkland counties (Capital Region Board 2009). In an effort to discourage urban sprawl and support infill development, the Capital Region, particularly the City of Edmonton, places a high priority on development of alternate transportation modes, which includes considerable expansion of LRT services (Capital Region Board 2009, City of Edmonton 2011).

Five LRT extension projects are in various stages of development along the existing LRT system in Edmonton. Currently under construction, the North LRT to NAIT (Metro Line) is a 3.3 km extension from Churchill LRT Station in downtown Edmonton northwest to NAIT (Table 8A.1-5 of Appendix 8.1). The expected in-service date for the Metro Line is spring 2014 (City of Edmonton 2013b). The proposed Southeast to West LRT (Valley Line) is a priority project for the City of Edmonton, which has approved partial funding for the project (LRT Projects Information Centre pers. comm.). The proposed 27 km Valley Line will run from Mill Woods to Lewis Farms, crossing through downtown Edmonton (City of Edmonton 2013b) (Table 8A.1-5 of Appendix 8.1). Construction of the Valley Line is expected to begin in 2015, with an anticipated completion date of 2019 (LRT Projects Information Centre pers. comm.).

Concept plans have been developed for the Northeast LRT, Northwest LRT and South LRT extension projects; however, construction of these lines has not been prioritized by the City of Edmonton and funding is not currently in place for these developments. Construction timelines will depend on a number of factors including funding availability, projected ridership potentials, and current and future community growth. The City of Edmonton is committed to expanding the LRT network to five lines running to all sectors of the city by 2040 (LRT Projects Information Centre pers. comm.). These developments are, however, considered hypothetical and excluded from this cumulative effects assessment.

West of Edmonton, Highway 16 preservation and overlay activities are planned between 2013 and 2016 at selected sites between the towns of Hinton and Edson, resulting in approximately 80 km of upgrades (Alberta Transportation 2013a). Several other smaller preservation and overlay projects are planned along Highway 16 at locations between Edmonton and Hinton within the same period (Alberta Transportation 2013a), as well as Highway 22 bridge construction and highway realignment near Drayton Valley (refer to Table 8A.1-5 of Appendix 8.1 for additional details). In addition, the Parkland Airport is a proposed $35 million (Phase 1 only) development near Spruce Grove, with construction of Phase 1 conditionally planned for 2013 to 2014 and Phase 2 in 2015 or later (Table 8A.1-1 of Appendix 8.1 and Figure 8.1-1a).

Utility Activities

The AltaLink Western Alberta Transmission Line Project will operate as a 500 kV high-voltage direct current overhead line extending from the Genesee area west of Edmonton to the Langdon area east of Calgary (Table 8A.1-1 of Appendix 8.1 and Figure 8.1-1a). The transmission line is currently under construction, with an expected in-service date of spring 2015 (AltaLink 2013).

The EPCOR and AltaLink Heartland Transmission Project will operate as an overhead double circuit 500 kV transmission line, which will connect the Heartland Substation (northwest of Fort Saskatchewan) to the Ellerslie Substation in Sherwood Park (Table 8A.1-1 of Appendix 8.1 and Figure 8.1-1a). The transmission line is currently under construction, with an expected in-service date of spring 2015 (AltaLink and EPCOR 2013).

The ATCO Electric Eastern Alberta Transmission Line Project will operate as a 500 kV high-voltage direct current overhead line extending 500 km from the Gibbons-Redwater area northeast of Edmonton to the Brooks area southeast of Calgary (Table 8A.1-1 of Appendix 8.1 and Figure 8.1-1a). The transmission line is currently under construction, with an expected in-service date of late 2014 (ATCO Electric 2013).

The proposed ATCO Gas Urban Pipelines Replacement Project entails the construction of a new high-pressure natural gas pipeline network in the Transportation/Utility Corridor of Edmonton over a period of five years (ATCO Gas 2013). The application is currently under review by the AUC (2013b) and, pending project approval, construction of the Urban Pipelines Replacement Project is expected to be concurrent with Project construction (refer to Table 8A.1-5 of Appendix 8.1 for additional details).

Other ongoing utility activities within the RSAs include maintenance on transmission line rights-of-way and electrical facilities.

Oil and Gas Exploration and Development Activities

Companies that have recently applied to federal and provincial authorities to construct and operate oil and gas developments within the RSAs for various elements are listed in Tables 8A.1-1 to 8A.1-4 of Appendix 8.1 and are shown on Figure 8.1-1a.

Major Developments

Enbridge Pipelines Inc. (Enbridge) is proposing to construct and operate the Edmonton to Hardisty Pipeline Project; a proposed 181 km new 914.4 mm (NPS 36) crude oil pipeline from the existing Enbridge Edmonton Terminal to the existing Enbridge Hardisty Terminal (Table 8A.1-1 of Appendix 8.1 and Figure 8.1-1a). The proposed pipeline right-of-way will be alongside and contiguous to an existing Enbridge pipeline right-of-way and other linear disturbances for approximately 96.6% of its length. The application to the NEB is currently under review (submitted December 14, 2012) (NEB 2013c). Pending regulatory approval, the proposed pipeline is expected to be in-service by early 2015 (NEB 2013c).

The proposed 38.2 km Enbridge Line 2 Replacement Project parallels the alignment of the Edmonton to Hardisty Pipeline Project (above) from the Enbridge Edmonton Terminal at NE 32-52-23 W4M to a valve located near Joseph Lake at SW 1-50-22 W4M (Table 8A.1-1 of Appendix 8.1 and Figure 8.1-1a). NEB approval was granted for the pipeline project on May 17, 2013 (Order XO-E101-013-2013) and construction commenced in August 2013 with an in-service date of late 2013 (NEB 2013d).

Enbridge is applying to the NEB to construct the Edmonton Terminal (South) Expansion Project (Table 8A.1-5 of Appendix 8.1). The project involves the construction and operation of several new tanks and associated facilities at the existing Enbridge Edmonton Terminal at NW 32-52-23 W4M, with transfer pipe via NE 32-52-23 W4M that integrates the new tanks to the existing terminal at SE 5-53-23 W4M. NEB approval was granted for the facility project on July 25, 2013 (Order XO-E101-017-2013) and pre-clearing activities commenced in fall 2013 with operations to begin in the first half of 2015 (NEB 2013e).

As Northern Gateway Pipelines Ltd. Partnership, Enbridge is also applying to the NEB to construct the Northern Gateway Project from Bruderheim, Alberta to Kitimat, BC (Table 8A.1-1 of Appendix 8.1 and Figure 8.1-1a). Key components of the project include: separate oil and condensate pipelines, each of about 1,172 km in length; 10 pump stations; all-weather road access and electrical power infrastructure for the pump stations and the Kitimat Terminal; fourteen 78,860 m^3 (496,000 bbl) capacity tanks; a utility berth; and two marine loading and unloading berths. Pending regulatory approval, construction is anticipated to occur from 2014 to 2017 (NEB 2013f). Therefore, construction of the Northern Gateway Project is assumed to be concurrent with Project construction.

ACCESS Pipeline Inc. (ACCESS) is proposing to construct and operate the ACCESS Northeast Pipeline Expansion from the Conklin area to the Redwater area (Table 8A.1-1 of Appendix 8.1 and Figure 8.1-1a). The proposed 1,067 mm low vapour pressure bitumen blend pipeline is approximately 295 km long and will extend from a pump station near Conklin at 1-16-77-5 W4M to the existing ACCESS Sturgeon Terminal at 4-18-56-21 W4M. The application to the AER is currently under review (submitted June 15, 2012) (ERCB 2013b). Pending regulatory approval, the proposed pipeline is expected to be in-service by early 2015 (ACCESS 2013).

Grand Rapids Pipeline GP Ltd. (Grand Rapids), a subsidiary of TransCanada PipeLines Ltd. (TransCanada), is proposing to construct and operate the Grand Rapids Pipeline Project, a proposed pipeline that includes both a crude oil and a diluent line to transport volumes approximately 500 km between the producing area northwest of Fort McMurray and the Edmonton/Heartland region (Table 8A.1-1 of Appendix 8.1 and Figure 8.1-1a). The application to the AER is currently under review (submitted May 23, 2013) (ERCB 2013c). Pending regulatory approval, construction is expected to commence in summer 2014, with an expected in-service date of early 2017 (TransCanada 2013a). Therefore, construction of the Grand Rapids Pipeline Project is assumed to be concurrent with Project construction.

Heartland Pipeline GP Ltd. and TC Terminals GP Ltd., subsidiaries of TransCanada, are proposing to construct and operate the Heartland Pipeline and TC Terminals Projects (Table 8A.1-1 of Appendix 8.1 and Figure 8.1-1a). The development is split into two separate projects. The first project is a proposed 914 mm (36 inch) crude oil pipeline extending approximately 200 km from 13 km northeast of Fort

Saskatchewan to 7 km south of Hardisty, also entailing the construction of two pump stations. The second is a proposed tank storage facility near Fort Saskatchewan at SW/SE 28-55-21 W4M. The project is currently in the pre-application stage (AER filing planned for Q3 2013), with construction expected to commence from summer 2014 to early 2015 (TransCanada 2013b).

Enhance Energy Inc. has received regulatory approval to build the Alberta Carbon Trunk Line (AEAE 2013). The proposed route for the carbon capture and storage project begins near Fort Saskatchewan, Alberta and ends southeast of Lacombe, Alberta (Table 8A.1-1 of Appendix 8.1 and Figure 8.1-1a). Construction of the facilities associated with the Alberta Carbon Trunk Line began in 2012 and the pipeline is set to begin construction in 2013 with completion of the project expected by the end of 2013.

Enbridge Pipelines (Woodlands) Inc. is proposing to construct and operate the Woodland Pipeline Extension Project, which entails construction and operation of two pump stations and a pipeline that would transport diluted bitumen from Enbridge Pipelines (Athabasca) Inc.'s existing Cheecham terminal, located at 7-8-84-6 W4M in Fort McMurray, Alberta, to Enbridge's existing Edmonton terminal, located at 5-4-53-23 W4M in Sherwood Park, Alberta (Table 8A.1-1 of Appendix 8.1 and Figure 8.1-1a). The proposed pipeline route generally parallels several existing pipelines and is approximately 385 km in length (Enbridge 2012). The Woodland Pipeline Extension Project was approved by the ERCB on August 30, 2012 (ERCB 2012). The construction schedule was revised and the anticipated start date is not known, however, operation is scheduled for 2015 (Enbridge 2012).

Shell Canada Ltd. (Shell) is proposing to construct and operate the Quest Carbon Capture and Storage Project, which entails construction of facilities for the capture of 1.2 megatonnes of CO_2 per year at the existing Shell Scotford Upgrader at 12-32-55-21 W4M; construction of an 80 km pipeline to transport dense-phase CO_2 from the Scotford Upgrader to the sequestration site located north of the County of Thorhild at 15-29-60-21 W4M; and construction of three to eight CO_2 injection wells connected to the main pipeline by laterals, each of which would be less than 15 km long (Table 8A.1-1 of Appendix 8.1 and Figure 8.1-1a). The Quest Carbon Capture and Storage Project was approved by the ERCB on July 10, 2012 and is anticipated to enter operation during 2015 (Shell 2013).

Inter Pipeline Ltd. (Inter Pipeline) is proposing to construct and operate the Polaris Expansion Project – Edmonton Extension from Lamont to Sherwood Park (Table 8A.1-1 of Appendix 8.1 and Figure 8.1-1a). The project consists of the installation of approximately 50 km of 24 inch diluent pipeline and facilities from Edmonton area diluent receipt points to the Polaris Lamont Pump Station. The new pipeline will provide 111,290 m^3/d (700,000 bbl/d) of diluent supply capacity to the Lamont Station. The project is currently in the proposal stage, with construction expected to commence from 2013 to 2016 (Inter Pipeline 2012).

Plains is proposing to construct and operate the Western Reach Pipeline System from Gordondale to Fort Saskatchewan (Table 8A.1-1 of Appendix 8.1 and Figure 8.1-1a). The project entails construction of a dual 570 km pipeline system originating in the Gordondale area to meet the transportation and processing demands of producers drilling in the Deep Basin. The project is currently in pre-application stages and, pending regulatory approval, is expected to be in-service by late 2015 (Plains 2013).

Trans Mountain is currently in the process of constructing the Edmonton Terminal Expansion Project, which involves constructing 10 new tanks and associated facilities at the Edmonton Terminal. This project was approved by the NEB in March 2008 and is now being constructed under Amending Order AO-005-XO-T246-04-2008. In February 2013, Trans Mountain applied to the NEB to vary Amending Order AO-005-XO-T246-04-2008 to permit construction of four additional tanks at the Edmonton Terminal for a total of 14 tanks. The NEB issued an Amending Order AO-006-XO-T246-04-2008 on June 20, 2013 and the four additional tanks are expected to come into service by late 2014.

Sasol Canada Holdings Ltd. (Sasol) is proposing to construct and operate the Natural Gas to Liquid Fuel Plant in Edmonton, which is a gas to liquid conversion facility. The approximately $8 billion development would create more than 500 new, permanent skilled jobs once in operation and employ over 5,000 other individuals during peak construction periods. The project is currently in the pre-application stages. Pending approval, the anticipated in-service date is late 2015 (Sasol 2012).

Minor Developments

The aforementioned oil and gas developments are considered to be major capital projects. In addition to these, however, there are numerous smaller oil and gas developments, including pipelines, facilities and wells, within the RSAs for various elements (ERCB 2013a, IHS Inc. 2013a,b,c) (Tables 8A.1-2 to 8A.1-4 of Appendix 8.1 and Figure 8.1-1a). Although the development schedules for these developments are unknown, given the limited scope and short anticipated construction times, for the purposes of the cumulative effects assessment, it was assumed that these developments would be constructed prior to construction of the Project.

Additional activities in the various RSAs not listed in Appendix 8.1 may include ongoing oil and gas exploration as well as regular pipeline and facility upgrades and maintenance activities.

Mineral Resources

Within the various RSAs, two proposed coal mine developments have been identified with project applications currently under regulatory review by the AER.

The Coal Valley Resources Inc. Robb Trend Project is a proposed extension to the existing mining and coal processing activities at Coal Valley Mine, approximately 40 km southeast of Hinton. The development is located adjacent to existing mining operations, and will yield approximately 88.75 million clean metric tonnes of coal available for sale. This additional tonnage would provide Coal Valley Resources Inc. with the necessary resources to operate until 2038. The proposed development application was submitted to ERCB in April 2012 and is currently under review. Pending regulatory approval, construction and operation will occur in stages, with construction of Stages 1A and 1B occurring from late 2013 to 2017 and initial operations anticipated to commence in late 2014 (AESRD 2013). Consequently, construction of the Robb Trend Project is assumed to be concurrent with Project construction.

The proposed Coalspur Mines Ltd. (Coalspur) Vista Coal Mine Project (Vista Project) will develop 5 million clean tonnes per year of moderately low-rank bituminous coal, suited for thermal electric generation. The proposed mine is approximately 10 km east of the Hinton town boundary and extends southeast for approximately 12 km to the McLeod River valley. The proposed development will involve construction of a surface coal mine including pits, external waste rock dumps and a full range of surface coal mining and support equipment and infrastructure. A load-out facility will load coal into rail cars on a siding that will be constructed, owned and operated by CN Rail. Projected labour requirements include approximately 700 person-years of construction and approximately 510 full-time positions during operation. The proposed development application was submitted to ERCB in May 2012 and is currently under review (AESRD 2013). Pending regulatory approval, construction will occur in stages, and is expected to start in 2014. Initial operations are anticipated to commence in 2015. Although operations will commence prior to Project construction, construction activities are expected to be ongoing and, therefore, construction of the Vista Project is assumed to be concurrent with Project construction.

Both the Robb Trend and Vista coal mine projects are listed in Table 8A.1-1 of Appendix 8.1 and shown on Figure 8.1-1a.

8.1.4.2 British Columbia (Alberta/British Columbia Border to Westridge Marine Terminal)

Agriculture and Livestock Grazing

Within interior BC, there is increasing awareness of the importance and vulnerability of agricultural lands, as reflected in the recent amendment to the Thompson-Nicola Regional Growth Strategy, which is to provide support for the preservation of agricultural lands and local food production (TNRD 2013).

ALR-designated lands in southwest BC, particularly those west of the City of Abbotsford, are under encroachment from urban expansion and other non-agricultural uses (Condon and Mullinix 2009). The need to protect the over 50,000 ha of agricultural lands in Metro Vancouver is considered an important challenge moving into the future (Metro Vancouver 2011). In an effort to address this important issue, the Township of Langley and cities of Surrey, Abbotsford and Chilliwack have endeavoured to develop agricultural plans to guide agricultural practices into the future. Some of the key objectives, strategies and/or goals of Surrey's Agriculture Protection and Enhancement Strategy, the Township of Langley's

Draft Agricultural Viability Strategy, Abbotsford's Agriculture Strategy and Chilliwack's Agricultural Area Plan are to enhance opportunities for agricultural enterprise; encourage agricultural use, conservation and environmentally responsible practices; and invest in agricultural services and infrastructure (City of Abbotsford 2011, City of Chilliwack 2012, City of Surrey 2013b, Township of Langley 2013).

As an increasingly valued resource, agriculture and related activities within the RSAs of various elements are expected to continue strongly into the future and will act cumulatively with the Project. However, no specific future developments such as meat packing plants or greenhouses have been identified.

Forestry Activities

Future forestry activities within the RSAs are generally limited to timber harvesting within the RSAs along the Hargreaves to Darfield and Black Pines to Hope Segments.

Over the last decade, AAC for beetle-affected TSAs was increased as part of a provincial action plan to manage the mountain pine beetle infestation (BC Ministry of Forests 2004). For example, in 2011 approximately 63%, 52% and 75% of timber harvested in the Robson Valley, Kamloops and Merritt TSAs was pine, when pine stands only account for 13%, 30% and 58% of the timber harvesting land base, respectively (BC MFLNRO 2012a,b,c). However, harvest patterns are expected to change over the coming years, as the mountain pine beetle infestation is considered to have mostly run its course; as a result, the Province is working to update its forest inventory and reforestation plans (BC MFLNRO 2012d).

The latest provincial-level mountain pine beetle model for the Robson Valley TSA suggests that mortality is projected to end in 2017 with a cumulative total (TSA and community forests) dead pine volume of 3.2 million m^3. Future harvest rates and locations are difficult to predict. The Robson Valley TSA is currently undergoing a formal timber supply review process that is expected to be complete with a new AAC determination in late 2013 (BC MFLNRO 2012a).

The timber supply review analysis indicates the timber supply in the Kamloops TSA is expected to decline from an AAC of 4 million m^3 to 1.82 million m^3 for an estimated 80 years, preceded by a step down in 2012 to 2.5 million m^3 over the first 5 years (BC MFLNRO 2012b). Since actual harvest levels have not approached the AAC, the impact of maintaining a high AAC on timber supply is uncertain. Furthermore, current forecasts of the mountain pine beetle infestation are less severe. Original predictions were for a 78% cumulative kill of pine by 2017, whereas current projections are 51% by 2022 (BC MFLNRO 2012b). A decrease from the current harvest level of 2.5 million m^3 to 1.82 million m^3 will result in a reduction of approximately 948 person-years of total employment within the TSA (BC MFLNRO 2012b). Considerable reductions in the AAC uplift that was adjusted to address the mountain pine beetle infestation could reduce current regional milling output (BC MFLNRO 2012b).

A recent timber supply forecast demonstrated that timber supply in the Merritt TSA is projected to decline by 39%, from 2.4 million m^3 a year to 1.47 million m^3, which will be implemented over several decades of gradual reductions. Similar to the Kamloops TSA, if the volume cannot be replaced from other sources, reductions in the AAC uplift that was adjusted to address the mountain pine beetle infestation could reduce current regional milling output (BC MFLNRO 2012c).

Now that the mountain pine beetle infestation has mostly run its course, many beetle-affected TSAs are entering a recovery period and it is difficult to predict what future harvest activities will be. Based on reduced AAC rates, it could be inferred that forest harvesting activities in many RSAs will decrease to some degree compared to recent levels. However, other types of forestry activities may be on the rise as BC MFLNRO begins to concentrate greater efforts on reforestation, fuel management and intensive and innovative silviculture (BC MFLNRO 2012d).

Public, Tourism, Arts and Recreation Development and Activities

The BC Major Projects Inventory (BC MJTST 2012) provides an information source from which future public, tourism, arts and recreation-based developments are identified in the various RSAs. Details are variable for any given development, as such, it is difficult to determine how likely "proposed" developments are to proceed without confirmation from other publicly available information. Most public, tourism, arts and recreational-based future developments are located in the LMDA, which is shown on Figure 8.1-1c.

Public, tourism, arts and recreational-based future developments currently under construction or proposed are provided in Table 8A.1-6 of Appendix 8.1 and, in the Lower Mainland, include heath care facilities, such as the BC Children's and Women's Hospital Expansion and Surrey Memorial Hospital Emergency Department and Critical Care Tower; recreation and entertainment facilities, including the Pacific National Exhibition Expansion, Vancouver Aquarium Revitalization and Expansion Project and the Casino, Hotel and Convention Centre; arts facilities, including relocation of the Vancouver Art Gallery; and the Surrey City Hall and Civic Facility.

Various elementary, secondary and post-secondary institution capital projects, including expansions, upgrades and new developments, are proposed in the Lower Mainland (BC MJTST 2012). Notable developments for post-secondary institutions are provided in Table 8A.1-6 of Appendix 8.1 and include Great Northern Way Campus Expansion; Simon Fraser University Student Union Building and Stadium; and UBC Student Union Building.

Public, tourism, art and recreational-based future developments identified outside of the Lower Mainland include a new clinical services building, parking and site infrastructure upgrading at the Royal Inland Hospital in Kamloops, and a Faculty of Law Building at Thompson Rivers University in Kamloops.

Many of these developments will be in-service prior to 2016 and, therefore, will not occur concurrently with construction of the Project. Notable exceptions include:

- the Simon Fraser University Student Union Building and Stadium: construction of a 9,290 m^2 student union building and 2,500 seat outdoor stadium from 2013 to 2017 (Table 8A.1-6 of Appendix 8.1);
- BC Children's and Women's Hospital Expansion: redevelopment of the BC Children's and Women's Hospital to create a state of the art facility for pediatric care and research, which is currently under construction with an expected in-service date of 2018 (Table 8A.1-6 of Appendix 8.1); and
- the Great Northern Way Campus Expansion: construction of a state-of-the-art Emily Carr visual, media and design art facility that would accommodate up to 1,800 students, which is currently under construction with an expected in-service date of July 2016 (Table 8A.1-6 of Appendix 8.1).

Several developments were identified in the various RSAs in early development stages, or appeared to be inactive or on hold, including Westscapes Development Inc. Coquihalla Pass Resort Development Project, Fraser Health Royal Columbian Hospital Expansion, and Valemount Glacier Destinations Ltd. Valemount Glacier Destination Resort. These developments are considered to be hypothetical and are, therefore, excluded from the cumulative effects assessment.

Rural and Urban Residential and Commercial Development

The populations of many communities in the various RSAs will continue growing into the immediate future, with particularly strong growth projected for communities in the FVRD and Metro Vancouver (the Socio-Economic Technical Report [Volume 5D] provides additional information).

Residential and commercial developments over $200 million that are either proposed or under construction in the Lower Mainland under the BC Major Projects Inventory include:

- 208 Street Residential Neighbourhood – Langley ($250 million) (proposed);
- Mission Waterfront Project – Mission ($1.5 billion) (proposed);
- Delsom Estates Residential Development – Delta ($250 million) (proposed);
- Silverdale Hill Housing Development – Mission ($400 million) (proposed);
- Waterfront Development Complex – New Westminster ($300 million) (proposed);
- Concord Gardens Residential Development – Richmond ($350 million) (proposed);

- River Green Residential Development – Richmond ($500 million) (construction started – summer 2010 to 2022);
- Holland Pointe Residential Development – Surrey ($200 million) (proposed);
- King George Commercial/Residential Development – Surrey ($1.6 billion) (proposed);
- Urban Village Condominium Development – Surrey ($1 billion) (construction started – complete by 2013);
- Quattro Residential Development – Surrey ($625 million) (construction started – completion date unknown);
- Central City Neighbourhood – Surrey ($1 billion) (construction started – completion date unknown);
- Guildford Town Centre Expansion – Surrey ($280 million) (construction started – May 2010 to fall 2015);
- Tsawwassen Springs Development – Tsawwassen ($400 million) (construction started – spring 2010 to 2016);
- the Exchange Office Tower – Vancouver ($200 million) (proposed);
- Burrard Gateway Mixed Use Development: Hornby and Drake Street – Vancouver ($500 million) (proposed);
- Oakridge Centre Redevelopment – Vancouver ($700 million) (proposed);
- Cambieplace Condominiums – Vancouver ($200 million) (proposed);
- Supportive Housing – Vancouver ($225 million) (proposed);
- South Burrard Development – Vancouver ($1 billion) (proposed);
- Little Mountain Housing Redevelopment – Vancouver ($300 million) (proposed);
- Telus Garden Communications Centre – Vancouver ($750 million) (under construction – complete by May 2015);
- Hotel and Residential Development: West Georgia – Vancouver ($500 million) (proposed);
- Residential Development and Arena Complex – Vancouver ($350 million) (proposed);
- BC Social Housing Initiative – Vancouver ($205 million) (under construction – complete by 2013);
- UBC Wesbrook Place Residential Development – Vancouver ($200 million) (under construction – complete by 2015);
- UBC University Town – Vancouver ($350 million) (under construction – complete by summer 2015);
- River District Development – Vancouver ($4 billion) (under construction – complete by 2032);
- Norquay Village Neighbourhood Centre – Vancouver ($ unknown) (under construction – complete by 2030); and
- Vicarro Ranch Residential Development – Abbotsford ($560 million) (proposed).

Other proposed developments under $200 million in the RSAs include condominiums, apartments, townhouses, housing, retail outlets, malls and other commercial and residential developments in Chilliwack, Abbotsford, Surrey, Coquitlam, Burnaby, Vancouver and other municipalities of the Lower

Mainland. The identified residential and commercial developments anticipated to be in-service prior to 2016 will not occur concurrently with construction of the Project. Other proposed residential and commercial developments where schedule details are unavailable are assumed to be constructed concurrently with the Project.

Transportation and Infrastructure Development

Current and future transportation activities within the RSAs of various elements include regular and commercial vehicle traffic and rail traffic, as well as maintenance, reconstruction and upgrade activity on roads, bridges and highways, particularly within the Lower Mainland where many transportation and infrastructure developments are currently under construction and in various planning and design phases (BC MJTST 2012).

Future transportation developments currently under construction or proposed in the Lower Mainland are provided in Appendix 8.1 and include Abbotsford International Airport (YXX) and Vancouver International Airport (YVR) upgrades and expansions; the Skytrain – Evergreen Line Rapid Transit Project and Expo Line Rapid Transit Project; Gateway Project – North and South Fraser Perimeter Road projects; bridge improvements; overpasses and underpasses; road realignments and upgrades; grade separations and improvements; Shortsea shipping projects; and demolition of the old Port Mann Bridge.

Expansion activities at YVR are currently underway and involve several phases, many of which are completed. Future planned activities include an additional terminal (by 2015) and runway (by 2023) and 14 additional gates. Upgrades are also proposed at YVR, including 700 m of corridors, moving walkways and a high-speed baggage system for the international terminal ($408 million), and upgrades to the domestic terminal ($488.7 million). Airfield improvements ($286.4 million) will include runway safety enhancements and upgrades to roads, bridges and dykes ($559.8 million). Upgrades to YVR have not commenced; however, they are anticipated to be complete by 2022. In Abbotsford, expansion of YXX will include a 1,300 m^2 passenger terminal and runway upgrades as well as a hotel and tourist-related services. The $30 million runway expansion portion of the project was completed in September 2011. Approximately 81 ha will be designated for future aerospace-related developments. Expansion activities are anticipated to be completed by 2020 (BC MJTST 2012).

According to the growth forecast in the Regional Growth Strategy, Metro Vancouver is expected to continue to grow by over 35,000 residents per year. Growth without sprawl implies greater density of development, which Metro Vancouver aims to achieve, in part, through support of a compact, transit-oriented urban form supporting a range of sustainable and strategically implemented transportation choices, including expansion of the SkyTrain network (Metro Vancouver 2011).

Two large-scale SkyTrain projects are currently underway in the Lower Mainland: the Evergreen Line; and the Expo Line Upgrade Strategy. The Evergreen Line is a new rapid transit line that will connect Coquitlam to Vancouver via Port Moody and Burnaby. Construction commenced in 2012 and the new line is expected to be in-service by 2016 (BC MTI 2013a, Province of BC 2013). The Expo Line Upgrade Strategy entails doubling the capacity of the existing Expo Line and adding a proposed 6 km SkyTrain extension in the Surrey to Fleetwood area. Construction commenced in 2008 and the project is expected to be complete by 2020 (Province of BC 2013, TransLink 2013b). Construction of both lines is expected to be concurrent with Project construction. TransLink is also considering several other large-scale projects, including the UBC Line, Surrey Line, Burnaby Mountain Gondola and Pattullo Bridge Replacement. However, both SkyTrain lines and the bridge replacement are currently in early planning and routing stages and the gondola is considered low priority; therefore, these developments are hypothetical in nature and were not included in part of this cumulative effects assessment (TransLink 2013b,c).

The Gateway Program was established by the Province of BC in 2003 to improve the movement of people, goods and transit throughout Metro Vancouver by providing efficient transportation choices and better connections. Ongoing projects as part of the Gateway Program include the Port Mann Bridge/Highway 1 Improvements and the South Fraser Perimeter Road. Both developments are anticipated to be fully complete by late 2013. The Port Mann Bridge/Highway 1 Improvements project includes a new 10-lane bridge across the Fraser River between Coquitlam and Surrey, 37 km of highway widening from Vancouver to Langley, including 30 km of new high occupancy vehicle lanes, and the replacement of nine highway interchanges (BC MTI 2013b). As part of the improvements project, a portion of the Golden Ears Connector development has the potential to act in combination with the Project to impact a City of Surrey greenbelt in the LMDA (Figure 8.1-1c and Table 8A.1-1 of Appendix 8.1). The South Fraser Perimeter Road Project includes a 40 km long four-lane route along the south side of the Fraser River from Deltaport Way in southwest Delta to 176th Street (Highway 15) in Surrey, with connections to Highways 1, 15, 17, 91, 99 and TransLink (Fraser Transportation Group Partnership 2011). The North Fraser Perimeter Road Project is currently in the proposal stage, and entails improved trucking and vehicle routes along an extended United Boulevard through Coquitlam along Highway 7 to the north end of the Golden Ears Bridge and along the north end of the Queensborough Bridge along Front, Columbia and Brunette in New Westminster (BC MJTST 2012).

Several Trans-Canada Highway improvement projects are either planned or underway east of the City of Kamloops, including widening Highway 1 between Monte Creek and Pritchard (construction from October 2011 to fall 2014) to four lanes; improvements to re-align and widen 3.1 km of highway to four lanes through Hoffman's Bluff (construction from 2013 to fall 2015); and improvements to widen 3 km of the Trans-Canada Highway to four lanes from Pritchard to Hoffman's Bluff (construction from spring 2013 to fall 2015) (BC MJTST 2012) (Table 8A.1-6 of Appendix 8.1). These developments are part of the Highway 1 Kamloops to Golden Project, the long-term plan of which is to upgrade the primarily two-lane highway to a modern four-lane highway (BC MTI 2013c).

Additional minor capital works in the various RSAs outside the Lower Mainland not listed in Appendix 8.1 include 42 km of Highway 5 resurfacing north of Kamloops between the Avola Overhead and the Whitewater River; a 1.78 km passing lane along Highway 5 north of Blue River; overlay paving of existing lanes and shoulders on 23 km of Highway 5 from Albreda to CN Rail Overhead; resurfacing 19 km of Highway 5 between Valemount and the Junction of Highway 16 at Tête Jaune; asphalt resurfacing of 44 km of lanes along Highway 5 south of Kamloops; asphalt surfacing with overlay along Highway 5 south of Kamloops; and resurfacing of Highway 3 from the Hope overpass to Nicolum Creek Bridge along Highway 5 (6.6 km) and mill and fill of the slow lane along Highway 3 from the Othello Interchange onward, with localized pavement repair taking place as required (BC MTI 2013d). Given the limited scope and short anticipated construction times, for the purposes of the cumulative effects assessment, it was assumed that these developments would be constructed prior to construction of the Project.

Utility, Public Works and Alternative Energy Development

Utility, public works and alternative energy future developments currently under construction or proposed are provided in Tables 8A.1-1 and 8A.1-6 of Appendix 8.1 and include: water power projects; transmission lines; electrical substations; and other developments pertaining to energy generation and waste treatment and disposal.

To be considered in this cumulative effects assessment, at a minimum, water power projects must be granted an investigative license by BC MFLNRO to commence site studies as part of the investigative phase of a proposed water power project. Approximately 20 proposed hydroelectric developments under review as of May 31, 2013 for an investigative license in the various RSAs were considered hypothetical and, therefore, were not included in this cumulative effects assessment.

In total, approximately 49 proposed future water power projects (*e.g.*, run-of-river, pumped storage) were identified within the various RSAs. Future water power projects for which location and footprint details were available (either publicly available online or through direct contact with FrontCounter BC) are provided in Table 8A.1-1 of Appendix 8.1 and shown in Figures 8.1-1b and 8.1-1c. However, location and footprint details were considered insufficient for 7 of the 49 identified future water power projects and, therefore, could not be included in any quantitative analysis. These water power projects are provided in Table 8A.1-6 of Appendix 8.1 and include: the Princeton Energy Inc. Eureka Creek and Berkey Creek hydroelectric projects; the TransAlta Clemina Creek and Serpentine Creek hydroelectric projects; and the Innergex Renewable Energy Inc. Esme Creek Hydroelectric Project. The Clemina and Serpentine creek projects are anticipated to be in-service by summer 2014. As indicated in Table 8A.1-1 of Appendix 8.1, the construction schedule for other waterworks developments is unavailable, therefore, these projects are assumed to be concurrent with Project construction.

Of the 42 water power projects in Table 8A.1-1 of Appendix 8.1, 36 are run-of-river and 6 are pumped storage. Both development types generate power by diverting a specific volume of surface water via a penstock to a generating station, where turbines produce electricity. The electricity is then transported via a substation and transmission line to connect to the existing electrical grid. Penstocks for pumped storage projects are often trenchless (*i.e.*, drilled). Typically, run-of-river projects range in generating capacity from 1 to 20 megawatts (MW), however, three developments — the Robson Valley Hydroelectric Project, Kwoiek Creek Hydroelectric Project and Upper Pitt River Waterpower Project — will generate approximately 76.5 MW, 50 MW and 180 MW, respectively (Figures 8.1-1b and 8.1-1c).

The Holmes Hydro Inc. Robson Valley Hydroelectric Project consists of a series of 10 run-of-river plants with a total of 76.5 MW located on tributaries in the Holmes River watershed, approximately 10 km west of McBride. A License of Occupation was granted by BC MFLNRO and construction is anticipated to commence within the next year (Stanyer pers. comm.).

The Kwoiek Creek Resources and Innergex II Inc. Kwoiek Creek Water Power Project is located on the lower reaches of Kwoiek Creek, a tributary to the Fraser River approximately 22 km south of Lytton. The project will include approximately 80 km of 138 kV transmission line to the BC Hydro substation at Highland Valley. A BC EAO Amendment Certificate was issued in July 2011 and the development is anticipated to be in-service by late 2013 (Province of BC 2013).

Located approximately 45 km north of Coquitlam, the proposed Run-of-river Power Inc. Upper Pitt River Waterpower Project collectively consists of eight hydroelectric projects generating a combined 180 MW on Buklin, Steve, Pinecone, Homer, East Corbold, Corbold, Boise and Shale creeks. The draft Application Terms of Reference for the project (submitted to BC EAO on February 14, 2008) was never finalized and the project is currently considered inactive by the BC EAO (Murphy pers. comm.). However, investigative use permits were recently issued by BC MFLNRO (November 19, 2012 and March 5, 2013) and, although the project is considered low priority, Run-of-river Power Inc. is continuing site studies and other preliminary planning activities for the project (Hopp pers. comm.).

The largest pumped storage hydroelectric project identified for the cumulative effects assessment is the Isabel and Pitt Lake Pumped Storage Hydroelectric Project, a pumped storage hydro power system with a capacity of approximately 225 MW on Isabel and Pitt lakes, approximately 30 km north of Maple Ridge (Figure 8.1-1c). A License for Investigative Use was issued by BC MFLNRO on October 22, 2012 (BC MFLNRO 2013b). As indicated in Table 8A.1-1 of Appendix 8.1, the construction schedule for the Isabel and Pitt Lake Pumped Storage Hydroelectric Project and many other proposed waterworks developments is unavailable, therefore, these projects are assumed to be concurrent with Project construction.

Transmission line developments in the various RSAs that are considered in the quantitative analysis are the Interior to Lower Mainland Transmission Project and Merritt Area Transmission Project (Table 8A.1-1 of Appendix 8.1 and Figure 8.1-1c). Currently under construction, the BC Transmission Corporation Interior to Lower Mainland Transmission Project involves installation of a new 500 kV transmission line, mostly along the existing right-of-way, from the Nicola Substation near Merritt to the Meridian Substation in Coquitlam. The anticipated in-service date is January 2015 (Province of BC 2013). Also currently under construction, the BC Hydro Merritt Area Transmission Project involves the installation of a 35 km 138 kV transmission line between the Merritt and Highland substations, mostly along an existing unused BC Hydro right-of-way. The anticipated in-service date is summer 2014 (BC Hydro 2013b).

In addition, BC Hydro is proposing the Robson Valley Transmission Project, which would entail construction of a 138 kV transmission line from the existing Valemount Substation to a proposed new substation in the McBride area (BC Hydro 2012). However, since this development is currently in the early planning stages it is considered hypothetical and is not included in the cumulative effects assessment.

Utility, public works and alternative energy developments currently under construction or proposed within various RSAs in the Lower Mainland that are not considered in any quantitative analyses are provided in Table 8A.1-6 of Appendix 8.1, and include: the BC Hydro Big Bend Substation; UBC Biomass Heating Project; BC Hydro Burnaby to New Westminster Area Reinforcement; BC Hydro Capilano Substation Upgrade; Greater Vancouver Regional District Capilano (Cleveland) Dam Powerplant; BC Hydro Coquitlam Area Reinforcement; Greater Vancouver Regional District Iona Island Wastewater Treatment

Plant Upgrades; BC Hydro Kidd 2 Substation Upgrade Project; City of North Vancouver Lions Gate Sewage Treatment Plant; BC Hydro Lynn Valley Substation Upgrade, Phase 1; Metro Vancouver Waste-to-Energy Incineration Facility; City of Surrey Organic Biofuel Facility; BC Hydro Ruskin Dam Safety and Powerhouse Upgrade; Metro Vancouver Seymour-Capilano Filtration Project; BC Hydro Silverdale Substation Project; BC Hydro Surrey Area Substation Project; and City of Surrey Waste-to-Energy Incineration Facility. Construction schedules for these developments are provided in Table 8A.1-6 of Appendix 8.1; however, developments where a schedule is unavailable are assumed to be concurrent with Project construction.

In addition, utility, public works and alternative energy developments currently under construction or proposed within various RSAs outside the Lower Mainland that are not considered in any quantitative analyses are provided in Table 8A.1-6 of Appendix 8.1 and include: the Telus Data Centre in Kamloops; the BC Hydro Seymour Arm Series (Capacitor Station 5L71/5L72 Project) in Chase; the BC Hydro Nicola 500 kV Station Reconfiguration in Merritt; the Western Bioenergy Inc. Merritt Green Energy Project; the EcoTECH Energy Group McBride Biomass Project; the City of Kamloops Sewage Treatment Centre Upgrade; and Belkorp Environmental Services' Cache Creek Landfill Extension. Construction schedules for these developments are provided in Table 8A.1-6 of Appendix 8.1; however, developments where a schedule is unavailable are assumed to be concurrent with Project construction.

Environmental conditions in the Merritt area are ideal for wind energy production. However, no reasonably foreseeable wind energy developments have been identified in the RSAs. Proposed projects are either in early planning phases, on hold or inactive, as is the case for the proposed Premier Renewable Energy Nicomen Wind Energy Project (Province of BC 2013).

Additional activities in the various RSAs not listed in Appendix 8.1 may include new transmission lines, utility lines, substations and other facilities; and upgrades and maintenance activities to existing infrastructure.

Marine and Industrial Development

As noted above, although regulation and authorization of marine transportation is not specifically within the jurisdiction of the NEB, the environmental and socio-economic effects of the increased marine traffic is considered by Trans Mountain in accordance with the NEB's direction from their List of Issues for the Project, released on July 29, 2013. As a result, Trans Mountain is participating in Transport Canada's voluntary Technical Review Process of Marine Terminal Systems and Transshipment Sites (TERMPOL) process to address the potential increase in marine traffic to offload product from the Project. As part of the TERMPOL process, information on the movements of marine vessels, including fishing vessels and forecasts of likely future marine vessel traffic (*i.e.*, reasonably foreseeable) in the Marine Transport RSA, which includes Burrard Inlet, were identified (see Volume 8C-2). Marine vessel activities applicable to this cumulative effects assessment are further discussed below.

As a result of the Project, marine vessel traffic volume calling at the Westridge Marine Terminal will increase from approximately 5 to 34 loading tankers per month. The types of tankers calling at the Westridge Marine Terminal (*i.e.*, Panamax and Aframax sized tankers) will not change as a result of the Project. In addition, the vessels calling at the Westridge Marine Terminal (after the Project is in operation) will continue to use the existing marine shipping lanes.

Projected growth rates from 2012 to 2030 of non-Project-related vessel movements by vessel type (*e.g.*, tanker, cargo, tug, passenger) were calculated as part of the cumulative effects assessment for Marine Transportation (Volume 8A). Projected increases were calculated for the entire Marine Transportation RSA, from which predicted growth rates from 2012 to 2030 were roughly extrapolated for Burrard Inlet. Based on this approach, a reasonably foreseeable approximation of 288 vessels/year is anticipated by 2016 above existing 2012 levels of 6,858 and by 2030 there is estimated to be approximately 1,400 vessels/year over 2012 levels (not including Project-related marine vessel traffic) (refer to Section 4.4 of Volume 8A for additional details).

Proposed future industrial developments were identified in the various RSAs within the Lower Mainland, including shoreline developments regulated by PMV, and are listed in Table 8A.1-6 of Appendix 8.1.

The Neptune Bulk Terminals Ltd. Coal Handling Infrastructure Upgrade and Expansion entails expansion of metallurgical coal handling systems at an existing terminal at North Vancouver to increase throughput and improve coal handling operations. The project involves the construction of a second railcar dumper at the existing terminal, a conveyor to transport coal from the new dumper to the storage area, replacement of a shiploader boom, and reinforcement of a berth foundation. The new rail dumper will have a floor area of 420 m^2 and a height of 12 m and will be built within the existing terminal footprint. The Neptune Terminal is located at 1001 Low Level Road, North Vancouver, in the Inner Harbour of Burrard Inlet. This development will not involve any in-water works. The increased vessel traffic from the project is expected to be approximately one additional vessel per week. Construction is currently underway and the expected in-service date is November 2014 (PMV 2013c).

The Richardson International Ltd. Grain Storage Capacity project includes installation of approximately 494 open-ended steel wall piles and 315 timber piles, and construction of two 40,000 metric tonne concrete storage annexes at the existing facility. The new infrastructure will have a floor area of 4,550 m^2 and a height of 55 m, and will be built adjacent to the existing grain storage facility located at 375 Low Level Road, North Vancouver, in the Inner Harbour of Burrard Inlet. This development will not involve any in-water works. Construction is currently underway and the expected in-service date is early 2015 (PMV 2013d).

As part of an initiative of the Canadian Government to build new ships for the Royal Canadian Navy and Canadian Coast Guard, construction of the Seaspan ULC (Seaspan) Vancouver Shipyard Improvements project in Seaspan’s Vancouver shipyard located at 10 Pemberton Avenue in North Vancouver (Burrard Inlet) is underway. This project includes construction of several buildings, offices, cranes and other infrastructure, as well as the installation of state-of-the-art equipment (Seaspan 2013). Additional proposed works under the PMV permit review process for the shipyard modernization include construction of a 32 m wide x 50 m long concrete load-out pier with a marine footprint of approximately 1,720 m^2. The pier will be constructed within Seaspan’s water lot lease located on the north shore of the Inner Harbour of Burrard Inlet. Physical works required to construct the pier include: removal of existing concrete ways; installation of temporary containment sheetpile walls; excavation (dredging) within the sheetpile walls; densification of the seabed within the load-out pier footprint (includes installation of timber piles); installation of concrete caissons and infilling; and removal of the temporary sheetpile walls. Dredge material may be disposed of on-land or at sea depending on the results of contaminant analysis. Construction is currently underway and the project is expected to be in-service by early 2015 (PMV 2013e).

The proposed Fraser Surrey Docks Direct Transfer Coal Facility in Surrey entails the development of a direct transfer coal facility at the southwest end of the existing terminal to handle up to 4 million metric tonnes of coal per year. The coal will be transferred by rail to the terminal and will be loaded onto barges at an existing berth. When loaded, tugs will take single barges down to the mouth of the Fraser River. Once barges pass Sand Heads, they will be towed in tandem to Texada Island. From there the coal will be stored before transferring it to a deep-sea vessel for overseas export. The project application is currently under review. Pending regulatory approval, the facility is expected to be operational some time in 2014 (PMV 2013f).

The proposed Lehigh Hanson Materials Ltd. South Richmond Terminal Project entails the development of an aggregate (sand and gravel) processing and distribution facility on leased property owned by PMV in southeast Richmond. Components include a wash plant, aggregate material stockpiles, reclaimer, rail and truck loading facilities, and two marine berths for loading and unloading barges. Several years of site preparation will be required to achieve the necessary ground settlement across the site prior to construction of the facility, which is expected to begin in 2018. Pending regulatory approval, construction is expected to commence from 2014 to 2022 (PMV 2013g).

PMV is proposing to construct and operate the Roberts Bank Terminal 2 Expansion Project. In 2011, PMV moved 2.5 million twenty-foot equivalent unit (TEUs) containers, and forecasts suggest that container traffic is expected to double over the next 10 to 15 years and triple by 2030. The proposed new multi-berth container terminal at Roberts Bank in Delta would provide 2.4 million TEUs of container capacity. The project is part of PMV’s Container Capacity Improvement Program, a long-term strategy to deliver projects to meet anticipated growth in demand for container capacity to 2030. The project is currently in the pre-application phase (field studies are currently underway), with construction anticipated from 2017/2018 to 2024 (PMV 2013h).

Several industrial parks are either proposed or under construction in the Lower Mainland. In fall 2012, construction began on the Maple Ridge Industrial Park, which entails development of 81 ha of land on 203rd Street in Maple Ridge for an industrial park, community garden, park space, trails and community amenities (BC MJTST 2012).

Oil and Gas Exploration and Development Activities

FortisBC is proposing to construct and operate the Kingsvale – Oliver Natural Gas Pipeline Reinforcement Project, which entails looping the existing FortisBC pipeline system between Kingsvale, BC and Oliver, BC over a length of approximately 161 km, as well as a 1 km pipeline extension near Yahk and the addition of compression facilities at Kingsvale, Trail and Yahk (Table 8A.1-1 of Appendix 8.1 and Figure 8.1-1c). The project is currently in the pre-application phase, having received BC EAO approval of final Application Information Requirements on December 5, 2012. Pending approval, clearing and construction is anticipated to occur from Q4 2015 to Q4 2016 (Province of BC 2013). Therefore, construction of the Kingsvale – Oliver Natural Gas Pipeline Reinforcement Project is expected to be concurrent with Project construction.

Vancouver Airport Fuel Facilities Corp. is proposing to construct and operate the Vancouver Airport Fuel Delivery Project marine terminal expansion in Richmond along the south arm of the Fraser River, a fuel receiving and storage facility near the marine terminal and a new jet fuel delivery pipeline to YVR (Table 8A.1-6 of Appendix 8.1). The project application is currently under review by the BC EAO. Should approval be granted, construction is estimated to occur over a 24 month period. Since the construction schedule could not be determined, construction of the Vancouver Airport Fuel Delivery Project is assumed to be concurrent with Project construction (Province of BC 2013).

Additional activities in the various RSAs not listed in Appendix 8.1 may include regular pipeline and facility upgrades and maintenance activities.

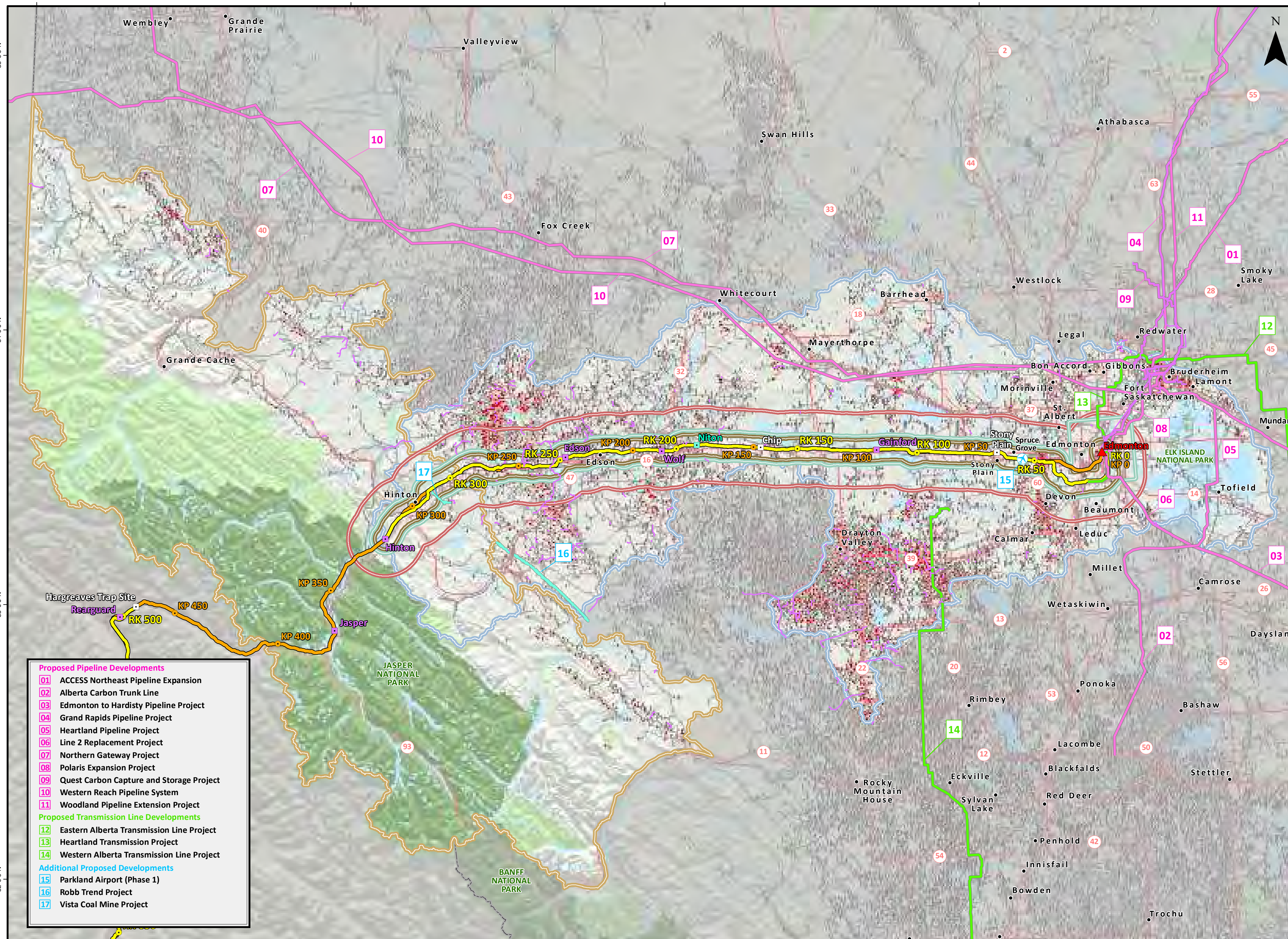
Mineral Resources

KGHM Ajax Mining Inc. (Ajax) proposes to develop the Ajax Copper/Gold Project (Ajax Project), a new open-pit copper and gold mine near Kamloops with a production capacity of 21.9 million tonnes of ore per year (Table 8A.1-1 of Appendix 8.1 and Figure 8.1-1c). The mine's life expectancy is 23 years. The development area is partially within southwest city limits. Project application review will be conducted collaboratively between BC EAO and the CEA Agency. The project is currently in the pre-application stage (Ajax submitted draft Application Information Requirements to BC EAO on January 11, 2012). Pending approval, construction is expected to commence in 2014, with production beginning by 2016 (Province of BC 2013). Therefore, construction of the Ajax Project is assumed to be concurrent with Project construction.

Yellowhead Mining Inc. proposes to develop the Harper Creek Copper-Gold-Silver Project approximately 10 km south of Vavenby (Table 8A.1-1 of Appendix 8.1 and Figure 8.1-1b). This is a proposed open-pit mine with a 28-year mine life based on throughput of 70,000 tonnes/day. Additional infrastructure includes transmission lines, access roads, facilities and storage areas. The mining development is currently moving forward with pre-application activities (final Application Information Requirements submitted to BC EAO on October 21, 2011), including public and stakeholder consultation as well as biophysical and socio-economic studies. Pending regulatory approval, the mine will be constructed over a period of 18 to 24 months, with production expected to begin in late 2016. Therefore, construction of the Harper Creek Copper-Gold-Silver Project is assumed to be concurrent with Project construction.

Construction is currently underway on Teck's $465 million Highland Valley Copper Modernization Project, with the objective of extending the life of the mill and increasing mill capacity (BC MJTST 2012) (Table 8A.1-6 of Appendix 8.1). By mid-2013, an estimated 700 full-time equivalent positions will be required for construction of the new mill (Kamloops Daily News 2013). The modernization project is expected to be complete by late 2013 (BC MJTST 2012).

Several mining developments were identified in the various RSAs in either early development stages (*e.g.*, exploration phase), inactive or on hold, including: the proposed Imperial Metals Corp. Ruddock Creek Zinc-Lead Mine Development Project near Avola; the proposed Discover Corp. Enterprises Inc. Galaxy Mine near Kamloops; the proposed Strongbow Exploration Inc. Shovelnose Mine near Merritt; the Gold Mountain Mining Corp. Elk Gold Mine near Merritt; the proposed New Carolin Gold Corp. Ladner Gold Project near Hope; the proposed North Pacific Alloys Ltd. Cogburn Magnesium Project near Hope; and the proposed Qualark Resources Inc. Hillsbar Aggregate Quarrying Project near Yale. These mining developments are considered to be hypothetical and, therefore, are excluded from the cumulative effects assessment.



TRANS MOUNTAIN

FIGURE 8.1-1a

REASONABLY FORESEEABLE DEVELOPMENTS

TRANS MOUNTAIN EXPANSION PROJECT

- City / Town
- Kilometre Post (KP)
- Reference Kilometre Post (RK)
- Trans Mountain Pipeline (TMPL)
- Trans Mountain Expansion Project Proposed Pipeline Corridor
- Terminal
- Pump Station (Pump Additions, Station Modifications and/or Scraper Facilities)
- Pump Station (Reactivated)
- Existing Pump Station
- Other Existing Facility
- Road
- Railway
- Other Existing Pipeline
- National Park
- Provincial Park
- Natural Area / Provincial Recreation Area / Wilderness Provincial Park
- Provincial Boundary

Minor Proposed Oil and Gas Developments
- Proposed Facility
- Proposed Well Site
- Proposed Pipeline

Major Proposed Developments
- Proposed Airport
- Proposed Pipeline
- Proposed Transmission Line
- Proposed Mine Site

Regional Study Areas
- RSA - Acoustic Environment
- RSA - Air Quality
- RSA - Aquatics/Wetland
- RSA - Grizzly Bear
- RSA - Wildlife

Projection: UTM Zone 11N. Routing: Baseline TMPL & Facilities: provided by KMC, 2012; Proposed Pipeline Corridor V6: provided by UPI, Aug. 23, 2013; Transportation: IHS Inc., ESRI, 2005; Geopolitical Boundaries: Natural Resources Canada, 2003, AltaLIS, 2012, IHS Inc., 2011; First Nation Lands: Government of Canada, 2013, AltaLIS, 2010 & IHS Inc., 2011; Hydrology: Natural Resources Canada, 2007 & BC Crown Registry and Geographic Base Branch, 2008; Parks and Protected Areas: Natural Resources Canada, 2012, AltaLIS, 2012 & BC FLNRO, 2008; ATS Grid: AltaLIS, 2009; Canadian Hillshade: TERA Environmental Consultants, 2008; US Hillshade: ESRI, 2009.

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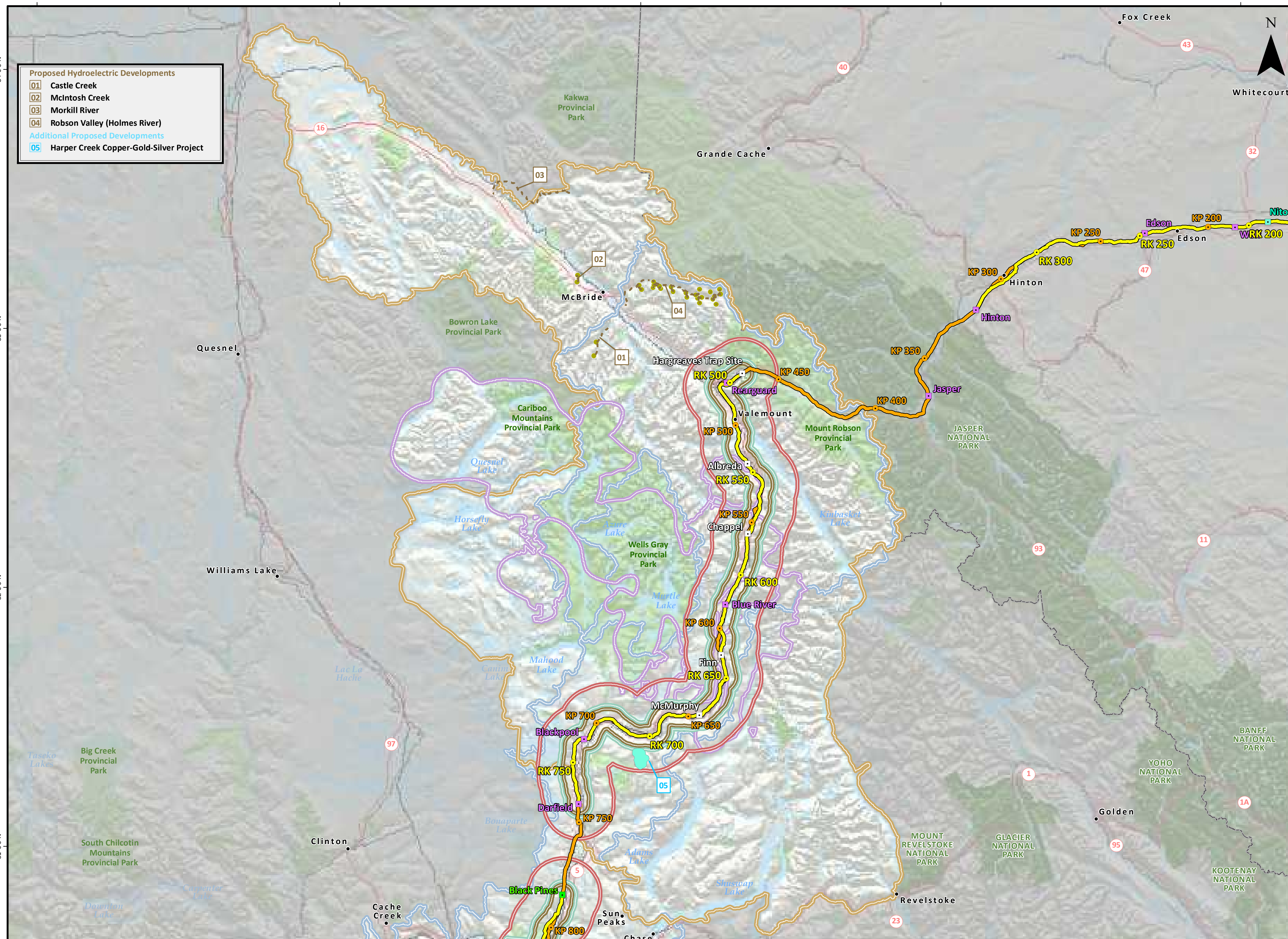

TRANS MOUNTAIN

FIGURE 8.1-1b

REASONABLY FORESEEABLE DEVELOPMENTS

TRANS MOUNTAIN EXPANSION PROJECT

City / Town
Kilometre Post (KP)
Reference Kilometre Post (RK)
Trans Mountain Pipeline (TMPL)
Trans Mountain Expansion Project Proposed Pipeline Corridor
Terminal
Pump Station (Pump Additions, Station Modifications and/or Scraper Facilities)
New Pump Station (Proposed)
Pump Station (Reactivated)
Existing Pump Station
Other Existing Facility
Road
Railway
Other Existing Pipeline
National Park
Provincial Park
Natural Area / Provincial Recreation Area / Wilderness Provincial Park
Provincial Boundary

Hydroelectric Developments

Hydroelectric Point Features (i.e. intakes, dams, staging/laydown areas and/or powerhouses)
Hydroelectric Linear Features (i.e. access roads, penstocks and/or transmission lines)

Major Proposed Developments

Proposed Pipeline
Proposed Transmission Line
Proposed Mine Site

Regional Study Areas

RSA - Acoustic Environment
RSA - Air Quality
RSA - Aquatics/Wetland
RSA - Caribou
RSA - Grizzly Bear
RSA - Wildlife

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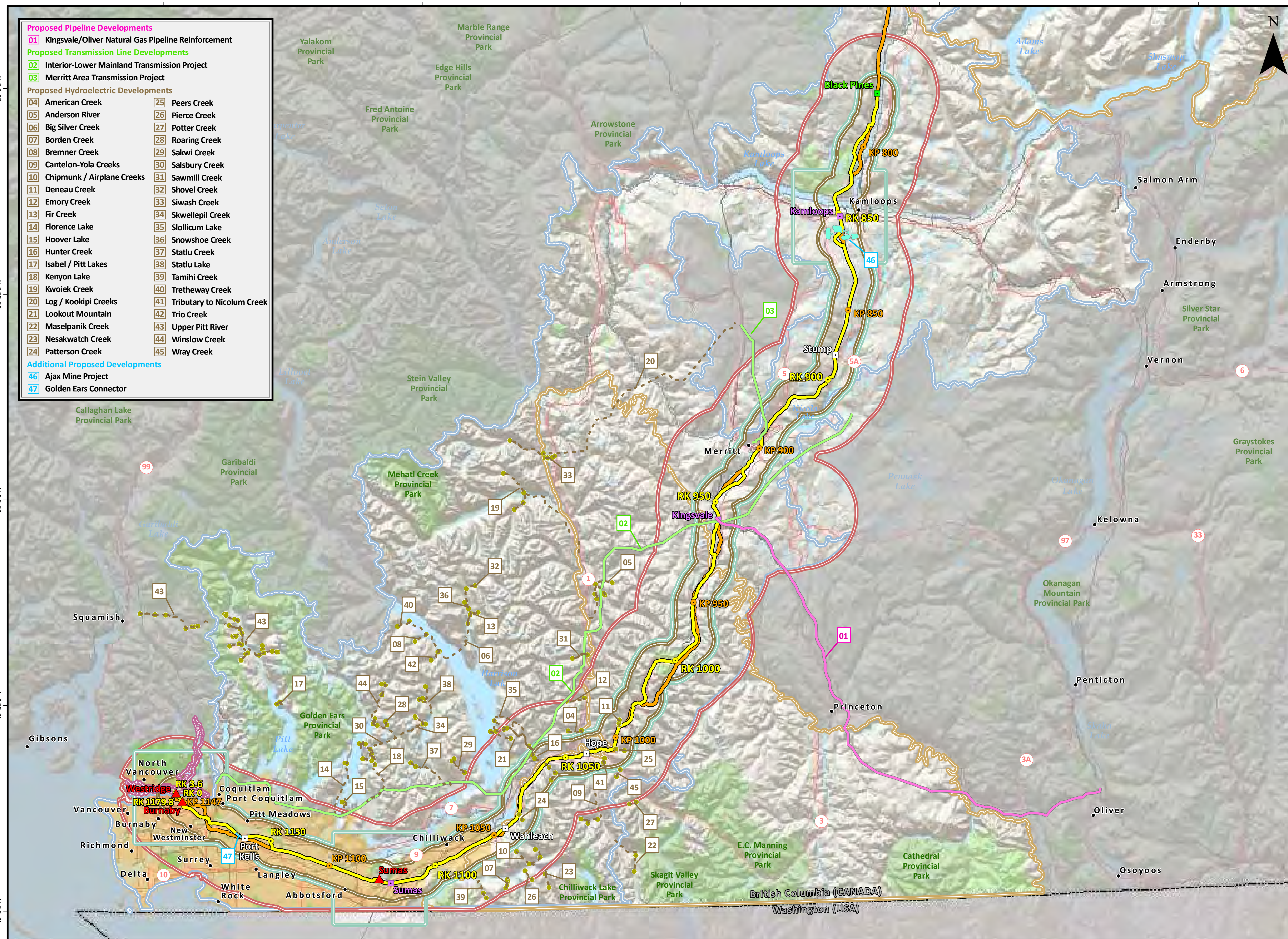

TRANS MOUNTAIN

FIGURE 8.1-1c

REASONABLY FORESEEABLE DEVELOPMENTS

TRANS MOUNTAIN EXPANSION PROJECT

- City / Town
- Kilometre Post (KP)
- Reference Kilometre Post (RK)
- Trans Mountain Pipeline (TMPL)
- Trans Mountain Expansion Project Proposed Pipeline Corridor
- Terminal
- Pump Station (Pump Additions, Station Modifications and/or Scraper Facilities)
- New Pump Station (Proposed)
- Existing Pump Station
- Other Existing Facility
- Road
- Railway
- Other Existing Pipeline
- LMDA
- National Park
- Provincial Park
- Natural Area / Provincial Recreation Area / Wilderness Provincial Park
- International Boundary

Hydroelectric Developments

- Hydroelectric Point Features (i.e. intakes, dams, staging/laydown areas and/or powerhouses)
- Hydroelectric Linear Features (i.e. access roads, penstocks and/or transmission lines)

Major Proposed Developments

- Proposed Pipeline
- Proposed Transmission Line
- Proposed Road
- Proposed Mine Site

Regional Study Areas

- RSA - Acoustic Environment
- RSA - Air Quality
- RSA - Aquatics/Wetland
- RSA - Grizzly Bear
- RSA - Marine
- RSA - Wildlife

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MAP NUMBER		PAGE
201307_MAP_TERA_CEA_00347_REV0_03		SHEET 3 OF 3
DATE: December 2013	TERA REF.: 7894	REVISION: 0
SCALE: 1:1,000,000	PAGE SIZE: 11x17	DISCIPLINE: CEA
DRAWN: AJS	CHECKED: TGG	DESIGN: TGG

0 10 20 30 40 km

ALL LOCATIONS APPROXIMATE

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8.1.5 Identify Potential Cumulative Effects

The Project's contribution to potential cumulative effects depends on many factors, including:

- the source of the disturbance;
- spatial and temporal boundaries;
- resilience of the receiving environment; and
- the way in which disturbances interact in time and space.

The level of detail provided in the analysis reflects the extent to which a cumulative effect on an environmental element is probable, the likely scale or magnitude of effect, as well as the extent to which these effects can be accurately and reasonably quantified and described relative to the receiving environment.

Many potential residual effects were assessed qualitatively due to a lack of detailed information on reasonably foreseeable developments and the routing of the proposed pipeline adjacent to the existing TMPL right-of-way and other rights-of-way for most of its length. A quantitative approach using GIS (*e.g.*, areal disturbance analysis) was used to inform the assessment of fish and fish habitat, wetlands, vegetation, and wildlife and wildlife habitat.

Quantitative analysis generally focuses on the level of new disturbance resulting from the Project in combination with reasonably foreseeable developments. Recognizing most future developments occur within previously disturbed areas of large urban centres, reasonably foreseeable developments identified within municipal boundaries (*e.g.*, City of Edmonton) were not considered in the quantitative analysis. As mentioned in Section 8.1.4, in an effort to address the agglomeration of municipalities in the Lower Mainland, an LMDA was delineated (Figure 8.1-1c). A concern expressed from a public perspective during ESA Workshop and Community Workshops was the continued protection of valued green space within the LMDA, therefore, future developments identified as encroaching into defined natural spaces that may also be affected by the Project were identified and considered in the quantitative analysis, where appropriate. Only one such development was identified – a portion of the Golden Ears Connector development through a City of Surrey greenbelt, as shown in Figure 8.1-1c and described in Appendix 8.1.

8.1.5.1 Quantitative Analysis Methodology

For those residual effects or elements where a quantitative approach is used to assess potential cumulative effects of the Project, the following parameters are calculated:

- the footprint of existing activities using best available GIS data, supplemented where appropriate by aerial photography or satellite imagery, and the assumptions outlined in Table 8.1-1 below to determine the existing condition in the element-specific LSA or RSA;
- the Footprint of the Project using assumptions provided in Section 2.0 for the various components; and
- the footprint of reasonably foreseeable developments in the element-specific RSA as listed in Table 8A.1-1 to 8A.1-4 of Appendix 8.1 using available project information or, in absence of detailed project information, the assumptions outlined in Table 8.1-1 below.

For those residual effects or elements where a quantitative approach is used to assess potential cumulative effects of the Project, the following information is provided:

- the area attributed to existing activities in the applicable RSA;
- the area attributed to the Project;
- the area attributed to existing activities plus the area attributed to the Project;

- the area attributed to reasonably foreseeable developments in the applicable RSA;
- the total cumulative effect (the area attributed to existing activities plus the area attributed to the Project plus the reasonably foreseeable developments in the applicable RSA); and
- the contribution of the Project to the total cumulative effect (percent).

TABLE 8.1-1

LAND USE FEATURES AND ASSUMPTIONS USED FOR THE QUANTITATIVE ANALYSIS

Land Use Feature	Footprint Assumption: Width (m) or Area (ha)	Disturbance Hierarchy	Data Sources
Lower Mainland Developed Area	Administrative boundary	1	BC MFLNRO
Cities/Towns/Communities	Actual or administrative boundary	2	GeoBase, AltaLIS, NRCan, BC MFLNRO digitized from ESRI Satellite Imagery
Airports/Airfields	Actual size	3	IHS Inc., NAVCAN, AltaLIS,
Primary Roads	50 m	4	BC Digital Road Atlas, IHS Inc., TRIM, AltaLIS,
Quarries/Mines/Aggregates	Actual size or average polygon size applied to point data	5	IHS Inc., AltaLIS, ABMI, TRIM
Commercial/Industrial Features	Actual size, 4 ha (oil and gas facilities), 1-2 ha (hydroelectric powerhouses, intakes and portals) or average polygon size applied to point data	6	IHS Inc., TRIM, KMC, ABMI, AltaLIS
Secondary Roads	20 m	7	BC Digital Road Atlas, IHS Inc., TRIM, AltaLIS
Railways	30 m	8	IHS Inc., AltaLIS
Oil and Gas Well Sites	1.2 ha	9	IHS Inc.
Tertiary/Access Roads	8 m	10	BC Digital Road Atlas, TRIM, BC Government, IHS Inc., AltaLIS
Buildings	Actual size or 0.05 ha	11	TRIM, ABMI, Canvec
Recreation	Actual size or average polygon size applied to point data	12	TRIM, BC Gov Landcover, IHS Inc.
Crop/Pasture Land	Actual size	13	GeoBase
Cutlines, Seismic Lines	5 m	14	TRIM, OGC, AltaLIS
Transmission/Power Lines	50 m (15 m for power lines associated with hydroelectric projects)	15	BC Hydro, TRIM, IHS Inc., AltaLIS
Buried Utility Lines	5 m	16	IHS Inc.
Oil and Gas Pipelines	20 m	17	IHS Inc.
Hydroelectric Infrastructure	10 m for penstock/diversion pipe and 2 ha for staging/laydown areas	18	Digitized from Inclusion list
Trails (Recreation)	2 m	19	BC Digital Road Atlas
Cutblocks	Actual size	20	VRI, ABMI

8.1.6 Mitigation Measures

Best management practices implemented to mitigate project-specific effects often limit the potential cumulative environmental effects (Finley and Revel 2002). The goal of mitigation is to attempt to avoid or reduce adverse effects to acceptable or non-significant levels. Mitigation measures are implemented to reduce the impact of any residual effects which may occur including reducing the magnitude of the effect, limiting the extent of the effect and shortening the reversibility of the effect (*i.e.*, time to alleviate the residual effect).

In order to ensure that potential cumulative environmental effects are reduced during Project construction and/or operation of the Project, additional mitigation measures beyond those listed in Section 7.0 are provided, where warranted.

8.1.7 Determination of Significance

The overall cumulative effects on an element and the Project's contribution to these cumulative effects (*i.e.*, cumulative effects of the Project) are described for each applicable element or indicator. The significance of the Project's contribution to cumulative effects is determined in a manner similar to that used to determine the significance of Project-related residual effects as previously outlined in Section 7.1.7 and summarized in Table 7.1-2 with the exception of spatial and temporal boundaries, which are discussed in Sections 7.2 to 7.7.

All significance assessment criteria (*e.g.*, temporal context, magnitude, etc.) listed in Table 7.1-2 applies to cumulative effects and are considered by the assessment team for each cumulative environmental effect.

8.1.8 Cumulative Effects Assessment

Those environmental effects in which adverse residual effects are predicted and are analyzed in the cumulative effects assessment are:

- physical elements such as soils and soil productivity, water quality and quantity, air emissions and acoustic environment;
- biological elements such as fish and fish habitat, wetland loss and alteration, vegetation, wildlife and wildlife habitat, and species at risk; and
- marine physical and biological elements such as marine sediment and water quality, marine fish and fish habitat, marine mammals, marine birds and marine species at risk.

The potential and likely residual effects associated with the construction and operation of the Project on each element are identified in the following subsections along with the identification of existing activities or reasonably foreseeable developments that could act in combination with the Project, as well as the cumulative effect and, if warranted, additional mitigation measures.

Community knowledge and Traditional Ecological Knowledge (TEK) can provide valuable insight in understanding potential impacts of the Project and existing and future developments on current and future use of lands and resources in a given area. Any information gathered through consultation and TEK studies pertaining to the cumulative environmental effects assessment has been incorporated into the assessment of applicable elements for which the information applies.

An evaluation of the significance of the Project's contribution to cumulative effects was conducted. Details of the significance evaluation are also discussed in each of the following subsections.

8.2 Soil and Soil Productivity

This subsection discusses how the Project could act in combination with existing activities and reasonably foreseeable developments to contribute to cumulative effects on soil and soil productivity indicators that were anticipated to have an adverse combined Project-specific residual effect (*i.e.*, soil productivity and soil degradation).

8.2.1 Reasonably Foreseeable Developments

Tables 8A.1-1 to 8A.1-4 of Appendix 8.1 provide a list of the reasonably foreseeable developments located within the Soil LSA considered in the evaluation of cumulative effects on the soil and soil productivity indicators. Descriptions of these developments are provided in Section 8.1.4 and shown on Figures 8.1-1a to 8.1-1c. In the Soil LSA, there are approximately 14 mapped reasonably foreseeable developments either fully within the Soil LSA or, for some transmission lines and pipelines, partially within the Soil LSA (Table 8A.1-1 of Appendix 8.1). In addition, there are approximately 24 mapped reasonably foreseeable minor oil and gas developments in Alberta: 7 pipelines; 14 facilities; and 3 wells (Tables 8A.1-2 to 8A.1-4 of Appendix 8.1).

As indicated in Section 8.1.4, other reasonably foreseeable developments with the potential to act in combination with the Project were excluded from quantitative evaluations since development details (*e.g.*, approval status, location) were either lacking or the development was located within previously disturbed areas of municipal boundaries, such as the city limits of the City of Edmonton and LMDA. Descriptions of these developments are provided in Section 8.1.4 and Table 8A.1-5 for Alberta and Table 8A.1-6 for BC of Appendix 8.1.

The current level of disturbance due to existing activities within the Soil LSA as well as the anticipated disturbance attributed to the Project and reasonably foreseeable developments is provided in Tables 8.2-1 and 8.2-2. A hierarchy table was applied during the cumulative effects assessment quantitative analysis to determine priority of overlapping land use features (*i.e.*, features with greater indirect footprint and assumed effects potential are assigned higher priority).

TABLE 8.2-1

EXISTING AND NEW AREAL DISTURBANCE IN THE SOIL LSA – ALBERTA

Land Use Feature	Existing Areal Disturbance (ha)	New Areal Disturbance (ha)			Total Areal Disturbance (ha)
		Proposed Project	Reasonably Foreseeable Developments	Total	
Cities/Towns/Communities	6,318.9	0	0	0	6,318.9
Airports/Airfields	9.7	0	34.5	34.5	44.2
Primary Roads	1,020.4	0	0	0	1,020.4
Quarries/Mines/Aggregates	314.1	0	0	0	314.1
Commercial/Industrial Features	317.1	1	25.9	26.9	344
Secondary Roads	304.1	0	0	0	304.1
Railways	91	0	0	0	91
Oil and Gas Well Sites	137.2	0	1.6	1.6	138.8
Tertiary/Access Roads	91.4	0	0	0	91.4
Buildings	1,160.1	0	0	0	1,160.1
Recreation	23.9	0	0	0	23.9
Crop/Pasture Land	9,860.9	0	0	0	9,860.9
Cutlines, Seismic Lines	191.8	0	0	0	191.8
Transmission/Power Lines	523	0	91.7	91.7	614.7
Buried Utility Lines	58	0	0	0	58
Oil and Gas Pipelines	452.2	455	20.8	475.8	928
Hydroelectric Infrastructure	0	0	0	0	0
Trails (Recreation)	N/A	N/A	N/A	N/A	N/A
Cutblocks	595	0	N/A	0	595
Total	21,468.8	456	174.5	630.5	22,099.3
Total Area of Soil LSA: 34,036.7 ha					

TABLE 8.2-2

EXISTING AND NEW AREAL DISTURBANCE IN THE SOIL LSA – BC

Land Use Feature	Existing Areal Disturbance (ha)[1]	New Areal Disturbance (ha)			Total Areal Disturbance (ha)
		Proposed Project	Reasonably Foreseeable Developments	Total	
Cities/Towns/Communities	2,989	0	0	0	2,989
Airports/Airfields	7.9	0	0	0	7.9
Primary Roads	1,717.6	0	0.9	0.9	1,718.5
Quarries/Mines/Aggregates	638.2	0	125.9	125.9	764.1
Commercial/Industrial Features	49.8	3.6	2	5.6	55.4
Secondary Roads	552.7	0	0	0	552.7
Railways	577.3	0	0	0	577.3
Oil and Gas Well Sites	0	0	0	0	0

TABLE 8.2-2 Cont'd

Land Use Feature	Existing Areal Disturbance (ha)[1]	New Areal Disturbance (ha)			Total Areal Disturbance (ha)
		Proposed Project	Reasonably Foreseeable Developments	Total	
Tertiary/Access Roads	555.5	0	0	0	555.5
Buildings	61	0	0	0	61
Cities/Towns/Communities	2,989	0	0	0	2,989
Recreation	32.4	0	0	0	32.4
Crop/Pasture Land	2,772.3	0	0	0	2,772.3
Cutlines, Seismic Lines	17.1	0	0	0	17.1
Transmission/Power Lines	793.1	161.5	32	193.5	986.6
Buried Utility Lines	136.3	0	0	0	136.3
Oil and Gas Pipelines	764.3	1,437.2	3.1	1,440.3	2,204.6
Hydroelectric Infrastructure	0	0	1	1	1
Trails (Recreation)	0	0	0	0	0
Cutblocks	6,658	0	N/A	0	6,658
Total	18,322.5	1,602.3	164.9	1,767.2	20,089.7
Total Area of Soil LSA: 68,138.0 ha					

Note: 1 The disturbance in the above table does not include the LMDA in BC, but does include the Surrey Greenbelt proposed disturbance.

8.2.2 Potential Cumulative Effects

The potential and likely combined environmental residual effects associated with the construction and operation of the Project on soil and soil productivity indicators were identified in Section 7.11.1.2 and are listed in Table 8.2-3 along with existing activities and reasonably foreseeable developments that could act in combination with the Project. No residual effects were identified for the indicator of soil contamination in Section 7.11.1.2 and, therefore, this indicator was not assessed for cumulative effects.

TABLE 8.2-3

POTENTIAL RESIDUAL EFFECTS OF THE PROJECT ON SOIL AND SOIL PRODUCTIVITY CONSIDERED FOR THE CUMULATIVE EFFECTS ASSESSMENT

Potential Residual Project Effect on Indicator	Spatial Boundary[1]	Project Component(s)	Temporal Boundary	Potential Cumulative Effect	Existing Activities/Reasonably Foreseeable Developments with Residual Effects Acting in Combination with the Project
1. Combined Project effects on soil productivity.	LSA	Pipeline Temporary Facilities Pump Stations Tanks Westridge Marine Terminal Pipeline Reactivation	Construction to Operation	Project contribution to cumulative change in soil productivity.	• Existing activities including: agriculture and livestock grazing, forestry activities, rural and urban residential and commercial development, transportation and infrastructure development, utility activities, oil and gas exploration and development, and mineral resource exploration and development. • Reasonably foreseeable developments within the Soil LSA listed in Tables 8A.1-1 to 8A.1-6 of Appendix 8.1 and discussed in Section 8.1.4. • Project-related activities that could interact with the above activities including topsoil/root zone material salvaging, grading, trenching, backfilling and reclamation.

TABLE 8.2-3 Cont'd

Potential Residual Project Effect on Indicator	Spatial Boundary[1]	Project Component(s)	Temporal Boundary	Potential Cumulative Effect	Existing Activities/Reasonably Foreseeable Developments with Residual Effects Acting in Combination with the Project
2. Combined Project effects on soil degradation.	LSA	Pipeline Temporary Facilities Pump Stations Tanks Westridge Marine Terminal Pipeline Reactivation	Construction to Operation	Project contribution to cumulative change in soil degradation.	• Existing activities including: agriculture and livestock grazing, forestry activities, rural and urban residential and commercial development, transportation and infrastructure development, utility activities, oil and gas exploration and development, and mineral resource exploration and development. • Reasonably foreseeable developments within the Soil LSA listed in Tables 8A.1-1 to 8A.1-6 of Appendix 8.1 and discussed in Section 8.1.4. • Project-related activities that could interact with the above activities including topsoil/root zone material salvaging, grading, trenching, backfilling and reclamation.
3. Combined Project effects on bedrock and stone disposal.	LSA	Pipeline	Construction to Operation	N/A	• No projects/activities with residual effects acting in combination with the Project have been identified.

Note: 1 LSA = Soil LSA.

8.2.3 Significance Evaluation of Potential Cumulative Effects

A quantitative approach was selected to determine the cumulative effect of the Project on soil productivity since the change to this parameter over existing conditions can be quantified. However, where there are no standards, guidelines, objectives or other established and accepted ecological thresholds to define quantitative rating criteria or where quantitative thresholds are not appropriate, the qualitative method that is based on available research literature and professional judgment is considered to be the appropriate method for determining the significance of the anticipated Project's contribution to cumulative environmental effects. Consequently, the qualitative assessment of soil and soil productivity is considered to be the most appropriate method with the evaluation of significance of Project's contribution to cumulative effects relying on the professional judgment of the assessment team.

Table 8.2-4 provides a summary of the significance evaluation of the Project's contribution to potential cumulative effects on soil and soil productivity indicators. The rationale used to evaluate the significance of each of the cumulative effects is provided below.

TABLE 8.2-4

SIGNIFICANCE EVALUATION OF THE PROJECT'S CONTRIBUTION TO CUMULATIVE EFFECTS ON SOIL AND SOIL PRODUCTIVITY

Potential Cumulative Effects	Impact Balance	Spatial Boundary[1]	Temporal Context: Duration	Temporal Context: Frequency	Temporal Context: Reversibility	Magnitude	Probability	Confidence	Significance[2]
1. Soil Indicator – Soil Productivity									
1(a) Project contribution to cumulative change in soil productivity.	Negative	LSA	Short-term	Periodic	Short to medium-term	Low	High	High	Not significant
2. Soil Indicator – Soil Degradation									
2(a) Project contribution to cumulative change in soil degradation.	Negative	LSA	Short-term	Periodic	Short to medium-term	Low	High	High	Not significant

TABLE 8.2-4 Cont'd

Potential Cumulative Effects	Impact Balance	Spatial Boundary[1]	Temporal Context: Duration	Temporal Context: Frequency	Temporal Context: Reversibility	Magnitude	Probability	Confidence	Significance[2]
3. Project Contribution to Combined Cumulative Effects on Soil and Soil Productivity									
3(a) Project contribution to cumulative effects on the soil and soil productivity indicators (1[a] and 2[a]).	Negative	LSA	Short-term	Periodic	Short to medium-term	Low	High	High	Not significant

Notes: 1 LSA = Soil LSA.

2 Significant Contribution to a Cumulative Environmental Effect: A high probability of occurrence of a permanent or long-term cumulative effect of high magnitude that cannot be technically or economically mitigated.

8.2.3.1 Soil Indicator – Soil Productivity

Chernozems and Solonetzs are the dominant soil orders encountered along the proposed pipeline corridor in Alberta and Brunisols, Luvisols, Podzols, Gleysols and Chernozems are the dominant soil orders in BC (Natural Regions Committee 2006, Valentine *et al.* 1978). Lands traversed by the proposed pipeline corridor are agricultural, disturbed by plowing for cultivation, hay and tame pasture, areas of aspen woodlands and mixed aspen forest, treed pasture, native vegetation, urban, industrial and parks.

Since surface disturbances can affect soil productivity, existing activities, the Project and reasonably foreseeable developments (as identified in Tables 8A.1-1 to 8A.1-6 of Appendix 8.1) will act cumulatively to affect soils in the Soil LSA. Soil productivity within the Soil LSA has been altered in the past due to existing activities such as agriculture and livestock grazing, forestry activities, rural and urban residential and commercial developments, transportation and infrastructure, utility activities, oil and gas activities (including ongoing pipeline maintenance programs), and mineral resource exploration and development.

The likely potential residual effects that may contribute to cumulative change in soil productivity in the Soil LSA include: admixing; changes in evaporation and transpiration rates; use of sand as bedding and padding material; and excessive trench subsidence or remnant crown. Admixing may occur during construction of the proposed pipeline, temporary facilities, at pump stations where new land is required, at the Sumas Terminal, Westridge Marine Terminal and during reactivation activities along existing pipeline segments. The remainder of the likely residual effects are expected to occur during construction of the proposed pipeline only.

Approximately 39,791.3 ha (38.9%) of the soils in the Soil LSA have been affected through surface disturbance associated with existing activities (Tables 8.2-1 and 8.2-2). When combined with the Project and reasonably foreseeable developments, the total cumulative disturbance of soil in the Soil LSA is predicted to be 42,189 ha which increases the percentage of disturbed soils in the Soil LSA to 41.3%. Most of the additional disturbance to soils in the Soil LSA is attributed to transmission lines in Alberta and quarries, mines and aggregates in BC. The Project contributes 2% (2,058.3 ha) to the total cumulative disturbance of soil.

Future developments such as oil and gas wells, facilities and pipelines are likely to act cumulatively with the Project to decrease soil productivity. Soils disturbed by pipeline developments will be replaced following clean-up, whereas wells and facilities are salvaged of topsoil/root zone material for the operational life of the development. Other future developments that have the potential to act cumulatively on soil productivity are agriculture and livestock grazing, forestry activities, rural and urban residential and commercial development, transportation and infrastructure development, utility activities and mineral resource exploration and development. Public, tourism, arts and recreation developments and activities, and marine developments are not expected to cumulatively affect soil productivity. Participants of several of the Community Workshops (*e.g.*, Kamloops, Clearwater, Edmonton and Langley) noted the importance of proper management of topsoil, including handling and separation procedures, and emphasized that the rooting depth of soil is important for soil productivity on agricultural lands.

The Project's contribution to cumulative change in soil productivity will be reduced by following mitigation provided in Table 7.2.2-2 and the Pipeline, Facilities and Westridge Marine Terminal EPPs (Volumes 6B, 6C and 6D). It is expected that other developments will implement mitigation measures similar to those implemented for the Project that have been developed in accordance with industry and provincial regulatory guidelines for soil conservation. Further to this, it is anticipated that best management practices for soil conservation within the agricultural industry will generally be implemented by farmers and ranchers within the Soil LSA. No mitigation measures beyond the Project-specific mitigation already proposed for soil and soil productivity indicators in Section 7.0 and the Pipeline, Facilities and Westridge Marine Terminal EPPs (Volumes 6B, 6C and 6D) are deemed warranted.

The cumulative effect on soil productivity in the Soil LSA is considered to have a negative impact balance. The Project's contribution to this cumulative effect is expected to be reversible in the short to medium-term since soils are expected to approximate pre-disturbance productivity within a few years, as demonstrated by post-construction environmental monitoring programs for past pipeline projects (TERA 2009a,b, 2011a,b,c, 2012, 2013a,b). Although total soil disturbance will increase, the magnitude is considered to be low since most of the proposed pipeline corridor parallels the existing TMPL right-of-way or other linear disturbances, and mitigation measures are to be implemented for soil conservation (Table 8.2-4, point 1[a]). A summary of the rationale for all of the significance criteria of the Project's contribution to cumulative effects on soil productivity is provided below.

- Spatial Boundary: Soil LSA – Project disturbance will be confined to the Soil LSA and this contribution to cumulative effects will not extend beyond the LSA.
- Duration: short-term – the Project events resulting in surface disturbance that contribute to cumulative effects are limited to construction and ongoing pipeline maintenance, the period of which is less than 1 year.
- Frequency: periodic – Project activities that result in surface disturbance that could contribute to cumulative effects could occur intermittently, but repeatedly over the assessment period for maintenance activities.
- Reversibility: short to medium-term – effects on soils are expected to approximate pre-disturbance productivity in less than 10 years.
- Magnitude: low – although the Project will contribute to a change in soil productivity in the Soil LSA, the estimated change in soil productivity is of limited areal extent and the Project's contribution will be reduced through the implementation of mitigation measures.
- Probability: high – a change in soil productivity is likely to occur as a result of the Project acting in combination with existing activities and reasonably foreseeable developments.
- Confidence: high – based on a good understanding by the assessment team of cause-effect relationships between construction activities and soil productivity.

8.2.3.2 Soil Indicator – Soil Degradation

Surface disturbances can affect soil degradation and, therefore, existing activities, the Project and reasonably foreseeable developments (as identified in Tables 8A.1-1 to 8A.1-6 of Appendix 8.1) will act cumulatively to affect soils in the Soil LSA. Soil degradation within the Soil LSA has occurred in the past due to existing activities such as agriculture and livestock grazing, forestry activities, rural and urban residential and commercial developments, transportation and infrastructure, utility activities, oil and gas activities (including ongoing pipeline maintenance programs), and mineral resource exploration and development.

The likely potential residual effects from the construction of the pipeline and temporary facilities that may contribute to cumulative change in soil degradation in the Soil LSA include compaction and rutting, surface erosion and pulverization of soil. Compaction and rutting, surface erosion and pulverization may also occur during construction of temporary facilities, pump stations, tank terminals, Westridge Marine Terminal and during pipeline reactivation activities.

The results of the quantitative analysis of areal disturbance in the Soil LSA from existing disturbance, Project disturbance and disturbance from other activities is provided in Tables 8.2-1 and 8.2-2 and discussed in Section 8.2.3.1.

Future developments such as oil and gas wells, facilities and pipelines are likely to act cumulatively with the Project to increase soil degradation. Soils disturbed by pipeline developments will be replaced following clean-up, whereas topsoil/root zone material is salvaged from wells and facilities for the operational life of the development. Other future developments that have the potential to act cumulatively on soil degradation are agriculture and livestock grazing, forestry activities, rural and urban residential and commercial development, transportation and infrastructure development, utility activities and mineral resource exploration and development. Public, tourism, arts and recreation developments and activities, and marine developments are not expected to cumulatively impact soil degradation. Soil erosion was noted as a concern by stakeholders, including participants of the Wabamun, Hinton, Valemount and Kamloops Community Workshops.

The Project's contribution to cumulative change in soil productivity will be reduced by following mitigation provided in Table 7.2.2-2 and the Pipeline, Facilities and Westridge Marine Terminal EPPs (Volumes 6B, 6C and 6D). It is expected that the other developments will implement mitigation measures similar to those implemented for the Project that have been developed in accordance with industry and provincial regulatory guidelines for soil conservation. Further to this, it is anticipated that best management practices for soil conservation within the agricultural industry will generally be implemented by farmers and ranchers within the Soil LSA. No mitigation measures beyond the Project-specific mitigation already proposed for soil and soil productivity indicators in Section 7.0 and the Pipeline, Facilities and Westridge Marine Terminal EPPs (Volumes 6B, 6C and 6D) are deemed warranted.

The cumulative effect on soil degradation in the Soil LSA is considered to have a negative impact balance. The cumulative effect is expected to be reversible in the short to medium-term since issues related to soil degradation can generally be resolved within one to three years following final clean-up, as demonstrated by post-construction environmental monitoring programs for past pipeline projects (TERA 2009a,b, 2011a,b,c, 2012, 2013a,b). Given the proven effectiveness of the mitigation measures to reduce the severity of soil degradation issues (*i.e.*, compaction and rutting, erosion and pulverization), the magnitude is considered to be low (Table 8.2-4, point 2[a]). A summary of the rationale for all of the significance criteria of combined cumulative effects on soil degradation is provided below.

- Spatial Boundary: Soil LSA – Project disturbance will be confined to the Soil LSA and this contribution to cumulative effects will not extend beyond the LSA.
- Duration: short-term – the Project events resulting in surface disturbance that contribute to cumulative events are limited to construction and ongoing pipeline maintenance, the period of which is less than 1 year.
- Frequency: periodic – Project activities that result in surface disturbance that could contribute to cumulative effects could occur intermittently, but repeatedly over the assessment period for maintenance activities.
- Reversibility: short to medium-term – issues related to soil degradation are anticipated to be resolved in less than 10 years.
- Magnitude: low – the Project will contribute to a change in soil degradation in the Soil LSA and this contribution will be reduced through the implementation of mitigation measures.
- Probability: high – a change in soil degradation is likely to occur as a result of the Project acting in combination with existing activities and reasonably foreseeable developments.
- Confidence: high – based on a good understanding by the assessment team of cause-effect relationships between construction activities and soil degradation.

8.2.3.3 Combined Effects on Soil and Soil Productivity

The potential cumulative effects (*i.e.*, change in soil productivity and soil degradation) may act in combination to affect soil and soil productivity in the Soil LSA. The impact balance is considered negative. The implementation of mitigation measures described in Section 7.0 will reduce the severity of cumulative effects arising from the Project in combination with other reasonably foreseeable developments. The combined cumulative effect of the Project on soil and soil productivity is of low magnitude, reversible in the short to medium-term and of high probability (Table 8.2-4, point 3[a]). A summary of the rationale for all of the significance criteria of combined cumulative effects of the Project on the soil and soil productivity indicators is provided below.

- Spatial Boundary: Soil LSA – Project disturbance will be confined to the LSA and this contribution to cumulative effects will not extend beyond the LSA.
- Duration: short-term – the Project events resulting in surface disturbance that contribute to cumulative effects are limited to construction and ongoing pipeline maintenance, the period of which is less than 1year.
- Frequency: periodic – Project activities that result in surface disturbance that could contribute to cumulative effects could occur intermittently, but repeatedly over the assessment period due to maintenance activities.
- Reversibility: short to medium-term – effects on soil and soil productivity are expected to approximate pre-disturbance in less than 10 years.
- Magnitude: low – the Project will contribute to a change in soil and soil productivity in the Soil LSA, but this contribution will be reduced through the implementation of mitigation measures.
- Probability: high – a change in soil and soil productivity is likely to occur as a result of the Project acting in combination with existing activities and reasonably foreseeable developments.
- Confidence: high – based on a good understanding by the assessment team of cause-effect relationships between construction activities and soil and soil productivity.

8.2.4 Summary

As identified in Table 8.2-4, there are no situations where there is a high probability of occurrence of a permanent or long-term cumulative effect of high magnitude that cannot be technically or economically mitigated. Consequently, the Project's contribution to cumulative effects on soil and soil productivity within the Soil LSA will be not significant.

8.3 Water Quality and Quantity

This subsection discusses how the Project could act in combination with existing activities and reasonably foreseeable developments to contribute to cumulative effects on water quality and quantity indicators that were anticipated to have an adverse combined Project-specific residual effect (*i.e.*, surface water quality and surface water quantity).

Relevant regulatory guidelines, ATK, TEK, ecological context and residual Project effects were considered in the characterization of potential cumulative effects for surface water quality and quantity indicators. Concerns from Aboriginal communities identified during engagement for other development projects were raised with regard to cumulative effects of pipeline construction at watercourse crossings such as turbidity and water quality and quantity (Lifeways of Canada Ltd. 2012, Northern Gateway Pipelines Ltd. Partnership 2010). Additional information on TEK collected during field studies for the Project is provided in the Fisheries (Alberta) Technical Report and Fisheries (BC) Technical Report of Volume 5C.

8.3.1 Reasonably Foreseeable Developments

Tables 8A.1-1 to 8A.1-6 of Appendix 8.1 provide a list of the certain and reasonably foreseeable developments located within the Aquatics RSA in the evaluation of cumulative effects on the water quality and quantity indicators. Description of these developments is provided in Section 8.1.4, and developments in Tables 8A.1-1 to 8A.1-4 are shown on Figures 8.1-1a, 8.1-1b and 8.1-1c. Reasonably foreseeable developments provided in Table 8A.1-5 (for Alberta) and Table 8A.1-6 (for BC) of Appendix 8.1 with the potential to act in combination with the Project were excluded from mapping since development details (*e.g.*, approval status, location) were either not available or the developments were located within urban municipal boundaries, such as the City of Edmonton and LMDA.

In the Aquatics RSA, there are approximately 68 mapped reasonably foreseeable developments either fully within the Aquatics RSA or, for some transmission lines and pipelines, partially within the Aquatics RSA (Table 8A.1-1 of Appendix 8.1). In addition, there are approximately 2,387 mapped reasonably foreseeable minor oil and gas developments in Alberta: 502 pipelines; 1,617 facilities; and 268 wells (Tables 8A.1-2, 8A.1-3 and 8A.1-4 of Appendix 8.1).

8.3.2 Potential Cumulative Effects

The potential and likely combined residual effects associated with the construction and operation of the Project on water quality and quantity indicators were identified in Section 7.11.1.3. These effects are listed in Table 8.3-1 along with existing activities and reasonably foreseeable developments that could act in combination with the Project. A cumulative effects assessment is not deemed warranted as per Section 8.1.1 for combined potential residual effects determined to be of low probability, therefore, a cumulative effects assessment for groundwater quality and quantity is not required.

TABLE 8.3-1

POTENTIAL RESIDUAL EFFECTS OF THE PROJECT ON WATER QUALITY AND QUANTITY CONSIDERED FOR THE CUMULATIVE EFFECTS ASSESSMENT

Potential Residual Project Effect on Indicator	Spatial Boundary[1]	Project Component(s)	Temporal Boundary	Potential Cumulative Effect	Existing Activities/Reasonably Foreseeable Developments with Residual Effects Acting in Combination with the Project
1. Combined Project effects on surface water quality.	RSA	Pipeline Temporary Facilities Pump Stations (power lines) Tanks Pipeline Reactivation	Construction to Operation	Project contribution to cumulative change in surface water quality.	• Existing activities including: agriculture and livestock grazing, forestry, rural and urban residential and commercial development, transportation and infrastructure development, utilities activities, oil and gas exploration and development and mineral resource exploration and development. • Reasonably foreseeable developments within the RSA listed in Tables 8A.1-1 to 8A.1-6 of Appendix 8.1 and discussed in Section 8.1.4. • Project-related activities that could interact with the above activities including clearing, topsoil/root zone material salvaging, grading, trenching, backfilling and reclamation of approaches to water crossings, vehicle crossing installation and removal, bank reclamation, and pump station and facility operations.
2. Combined Project effects on surface water quantity.	RSA	Pipeline Temporary Facilities Pump Stations Tanks Westridge Marine Terminal Pipeline Reactivation	Construction to Operation	Project contribution to cumulative change in surface water quantity.	• Existing activities including: agriculture and livestock grazing, forestry, rural and urban residential and commercial development, transportation and infrastructure development, utilities activities, oil and gas exploration and development and mineral resource exploration and development. • Reasonably foreseeable developments within the RSA listed in Tables 8A.1-1 to 8A.1-6 of Appendix 8.1 and discussed in Section 8.1.4. • Project-related activities that could interact with the above activities including clearing, topsoil/root zone material salvaging, grading, trenching, backfilling and reclamation of approaches to water crossings, vehicle crossing installation and removal, bank reclamation, and pump station and facility operations.

Note: 1 RSA = Aquatics RSA.

8.3.3 Significance Evaluation of Potential Cumulative Effects

Where there are no standards, guidelines, objectives or other established and accepted ecological thresholds to define quantitative rating criteria or where quantitative thresholds are not appropriate, the qualitative method is considered to be the appropriate method for determining the significance of the anticipated Project's contribution to cumulative environmental effects. Consequently, a qualitative assessment of water quality and quantity was determined to be the most appropriate method with the evaluation of significance of the Project's contribution to cumulative effects relying on the professional judgment of the assessment team.

Table 8.3-2 provides a summary of the significance evaluation of the Project's contribution to potential cumulative effects on water quality and quantity indicators. The rationale used to evaluate the significance of each of the cumulative effects is provided below.

TABLE 8.3-2

SIGNIFICANCE EVALUATION OF THE PROJECT'S CONTRIBUTION TO CUMULATIVE EFFECTS ON WATER QUALITY AND QUANTITY

	Potential Cumulative Effects	Impact Balance	Spatial Boundary[1]	Temporal Context			Magnitude	Probability	Confidence	Significance[2]
				Duration	Frequency	Reversibility				
1.	Water Quality and Quantity Indicator – Surface Water Quality									
1(a)	Project contribution to cumulative change in surface water quality.	Negative	RSA	Short-term	Isolated to occasional	Immediate to medium-term	Low to medium	High	High	Not significant
2.	Water Quality and Quantity Indicator – Surface Water Quantity									
2(a)	Project contribution to cumulative change in surface water quantity.	Negative	RSA	Short-term	Isolated to occasional	Short-term to permanent	Low to medium	High	High	Not significant
3.	Project Contribution to Combined Cumulative Effects on Water Quality and Quantity									
3(a)	Project contribution to combined cumulative effects on the water quality and quantity indicators (1[a] and 2[a]).	Negative	RSA	Short-term	Isolated to occasional	Short-term to permanent	Low to medium	High	High	Not significant

Notes: 1 RSA = Aquatics RSA.

2 Significant Contribution to a Cumulative Environmental Effect: A high probability of occurrence of a permanent or long-term cumulative effect of high magnitude that cannot be technically or economically mitigated.

8.3.3.1 Water Quality and Quantity Indicator – Surface Water Quality

Surface water quality is highly variable within the Aquatics RSA. As indicated in Section 7.2.3, construction and operation of the Project is not likely to result in an increase of water quality parameters such as heavy metals, bacteria, nutrients and pesticides. Therefore, since the cumulative effects assessment only considers potential residual effects that are likely to occur, the only Project contribution to cumulative change in surface water quality is attributed to increased suspended sediment loads and turbidity, which is considered to have a negative impact balance. Potential residual effects that may contribute to cumulative increases in suspended sediment loads and turbidity in the Aquatics RSA include: instream construction at trenched crossings; erosion from banks and approach slopes; construction and operation of temporary access roads and borrow sites; construction and operation of the Black Pines and Kingsvale power lines; and construction and operation of new storage tanks at the Burnaby Terminal.

In the Aquatics RSA, past developments and existing activities and land uses responsible for increased sediment inputs are predominantly associated with agricultural runoff and livestock grazing (*e.g.*, trampling along banks), oil and gas development (predominantly in Alberta) and forestry (predominantly in BC). Other developments and activities near waterbodies and watercourses such as rural and urban residential and commercial development, transportation infrastructure and development, utility activities, and mineral resource exploration and development, also have the potential to contribute to increase TSS and turbidity levels within the Aquatics RSA.

Most reasonably foreseeable developments listed in Appendix 8.1 will typically be sited well away from waterbodies and, therefore, are not likely to act cumulatively with the Project to reduce surface water quality. Other reasonably foreseeable developments that may be sited near waterbodies listed in Appendix 8.1 are not likely to act cumulatively with the Project to reduce surface water quality because they will be constructed before the Project and any sedimentation is likely to be flushed away as a result of spring freshet prior to Project construction. Nevertheless, certain reasonably foreseeable developments such as pipelines (Tables 8A.1-1 and 8A.1-2 of Appendix 8.1), hydroelectric projects (Table 8A.1-1 of Appendix 8.1) and infrastructure developments (Tables 8A.1-1, 8A.1-5 and 8A.1-6 of Appendix 8.1) have the potential to reduce surface water quality once operational or in-service due to, for example, increased site and road runoff and subsequent erosion.

Construction activities within the Aquatics RSA taking place concurrently with construction of the Project have the greatest potential to cause a cumulative impact to water quality within the Aquatics RSA. Reasonably foreseeable developments in the Aquatics RSA of Alberta with concurrent construction schedules having potential to increase TSS and turbidity include the Grand Rapids Pipeline Project, Northern Gateway Project, Polaris Expansion Project – Edmonton Extension and Robb Trend Project (Figure 8.1-1a and Table 8A.1-1 of Appendix 8.1), as well as the Northeast Anthony Henday Project and Southeast to West LRT (Valley Line) Project (Table 8A.1-5 of Appendix 8.1). Reasonably foreseeable developments in the Aquatics RSA of BC with concurrent construction schedules having potential to increase TSS and turbidity include the Ajax Project, Kingsvale – Oliver Natural Gas Pipeline Reinforcement Project, Harper Creek Copper-Gold-Silver Project, Castle Creek Hydropower Project, Morkill River Hydroelectric Project, Thretheway, Shovel and Big Silver Creeks Hydroelectric Project (Figures 8.1-1b and 8.1-1c, and Table 8A.1-1 of Appendix 8.1), as well as the Vancouver Airport Fuel Delivery Project, Skytrain – Evergreen Line Rapid Transit Project, Skytrain – Expo Line Upgrade Strategy, Roberts Bank Rail Corridor – Grade Separation and Improvements, Capilano (Cleveland) Dam Powerplant and Ruskin Dam Safety and Powerhouse Upgrade (Table 8A.1-6 of Appendix 8.1).

The Project's contribution to cumulative increases in total suspended sediment (TSS) and turbidity will be reduced by following mitigation provided in Section 7.0 for the surface water quality indicator and the Pipeline and Facilities EPPs (Volumes 6B and 6C). It is expected that most other reasonably foreseeable developments will implement mitigation measures similar to those recommended for the Project that have been developed in accordance with industry and provincial regulatory guidelines for surface water quality. It is also expected that best management practices will be implemented by many farmers, ranchers and other land users to prevent sedimentation of waterbodies associated with agricultural activities within the Aquatics RSA. No mitigation measures beyond the Project-specific mitigation already proposed for surface water quality indicators in Section 7.0 and the Pipeline and Facilities EPPs (Volumes 6B and 6C) are deemed warranted.

As demonstrated by post-construction environmental monitoring programs for past pipeline projects (TERA 2009a,b, 2011a,b,c, 2012, 2013a,b), the Project's contribution to the cumulative effect on surface water quality within the Aquatics RSA is expected to be reversible immediately to short-term, from increased suspended sediment due to upstream construction at select watercourses, and short to medium-term once the watercourse crossings are completed and vegetation is established on the approach slopes and banks, runoff conveyance structures are in place, and effective sediment control measures are taken to reduce erosion and subsequent sedimentation of watercourses. The potential cumulative effect is considered to be of low to medium magnitude depending on the amount of sediment released acting cumulatively with sediment from existing activities near watercourses, and with sediment from reasonably foreseeable developments (Table 8.3-2, point 1[a]). A summary of the rationale for all of the significance criteria of combined cumulative effects on surface water quality is provided below.

- Spatial Boundary: Aquatics RSA – the Project's contribution to combined sediment load and turbidity may interact with reasonably foreseeable developments within the Aquatics RSA to cause a cumulative alteration to water quality in the RSA.

- Duration: short-term – the Project's contribution to cumulative changes in sediment load and turbidity would occur during the construction phase or associated with maintenance activities within any 1 year during the operations phase (*i.e.*, short-term).
- Frequency: isolated to occasional – Project activities that could contribute to cumulative reduction in surface water quality may occur intermittently, but repeatedly over the assessment period due to maintenance activities.
- Reversibility: immediate to medium-term – the Project's contribution to the cumulative effect is expected to be reversible immediately (*e.g.*, increased suspended sediment due to upstream construction at select watercourses) or may take more than a year after the watercourse crossing is completed and effective sediment control measures are established, such as installation of runoff conveyance structures and revegetation of approach slopes and banks. This could require more than 1 year.
- Magnitude: low to medium – established industry best practices will generally reduce the Project's contribution to combined sediment load to low magnitude, but contingency crossing methods, if required, could result in medium magnitude contributions.
- Probability: high – since it is likely that existing activities, the Project and reasonably foreseeable developments will act cumulatively to reduce surface water quality during construction.
- Confidence: high – based on the professional experience of the assessment team.

8.3.3.2 Water Quality and Quantity Indicator – Surface Water Quantity

The Project's contribution to cumulative change in surface water quantity resulting from alteration of natural surface drainage patterns and alteration of natural streamflow from instream activities is considered to have a negative impact balance.

In the Aquatics RSA, past developments and existing activities and land uses responsible for changes in surface water quantity are predominantly associated with water use and altered drainage patterns from agriculture, oil and gas development (predominantly in Alberta), rural and urban residential and commercial development, mineral resource development, hydroelectric development and forestry (predominantly in BC). Other developments and activities such as forestry (predominantly in BC) and transportation infrastructure and development can contribute to changes in surface water quantity predominantly through altered surface drainage patterns and water balance. Streamflow patterns have also been altered in the Aquatics RSA by existing developments such as canals, ditches and other conveyance structures associated with agricultural and rural and urban residential and commercial development. Pipeline and utility crossings (predominantly in Alberta) and hydroelectric developments (predominantly in BC) have also impacted streamflow of many watercourses within the Aquatics RSA.

Most reasonably foreseeable developments listed in Appendix 8.1 will typically be sited well away from waterbodies and, therefore, are not likely to act cumulatively with the Project to alter streamflow. However, many of the pipeline projects in Tables 8A.1-1 and 8A.1-2 of Appendix 8.1 are likely to implement trenched crossing techniques that may result in brief alteration of streamflow from instream construction activities. Many hydroelectric developments in Tables 8A.1-1 and 8A.1-6 of Appendix 8.1 are likely to alter streamflow as well through diversion and instream construction activities, resulting in medium to long-term effects that would still act in combination with the Project to alter streamflow patterns until watercourses crossed by the Project are fully stabilized and natural streamflow is re-established.

Alteration of natural drainage patterns is likely to result from most reasonably foreseeable developments in Tables 8A.1-1 to 8A.1-6 where new land is required or where surface alteration results in increased stormwater discharge. The reversibility of this residual effect varies from short-term to permanent for reasonably foreseeable developments depending on the type of development. For example, pipeline and transmission line developments may be reversed in the short to medium-term while residual effects from above ground facilities may be long-term or permanent until pre-construction contours are restored following decommissioning and abandonment. Reasonably foreseeable developments, such as the Robb Trend Project, Vista Project and Ajax Project (Figures 8.1-1a and 8.1-1b, and Table 8A.1-1 of

Appendix 8.1) will result in permanent alteration of natural drainage patterns since pre-construction contours will not be fully restored following decommissioning and abandonment. Consequently, many developments constructed prior to or after the Project may still act in combination with the Project to alter future drainage patterns. In some instances, such as at the Burnaby Terminal, the contribution of the Project or other reasonably foreseeable development may contribute to a permanent cumulative alteration of drainage patterns. However, given the limited extent of permanent alteration at the Burnaby Terminal, the magnitude of the Project's contribution to any cumulative permanent alternation of natural drainage patterns in the Aquatics RSA is considered low.

Project contribution to changes in surface water quantity will be reduced by following mitigation provided in Section 7.0 for the surface water quantity indicator and the Pipeline, Facilities and Westridge Marine Terminal EPPs (Volumes 6B, 6C and 6D). It is expected that many other reasonably foreseeable developments will implement mitigation measures similar to those recommended for the Project that have been developed in accordance with industry and provincial regulatory guidelines for surface water quantity. It is also expected that best management practices will be implemented by many municipalities, landowners and industry to reduce water needs within the Aquatics RSA. No mitigation measures beyond the Project-specific mitigation already proposed for surface water quantity indicators in Section 7.0 and the Pipeline, Facilities and Westridge Marine Terminal EPPs (Volumes 6B, 6C and 6D) are deemed warranted.

The Project contribution to the cumulative effect on surface water quantity within the Aquatics RSA is expected to be reversible in the short to long-term or permanent depending on the Project component (*e.g.*, short to medium-term for the pipeline once watercourse bed and banks are fully stabilized and trench crown settles and long-term to permanent for above ground facilities depending whether natural drainage patterns can be restored following decommissioning and abandonment). The potential cumulative effect is considered to be of low to medium magnitude since Project contribution to changes in surface water quantity is considered to be minor in relation to changes to surface water quantity resulting from existing activities and reasonably foreseeable developments in the Aquatics RSA (Table 8.3-2, point 2[a]). A summary of the rationale for all of the significance criteria of combined cumulative effects on surface water quantity is provided below.

- Spatial Boundary: Aquatics RSA – the Project's contribution to combined disturbance may interact with reasonably foreseeable developments within the Aquatics RSA to cause a cumulative alteration to water quantity in the RSA.
- Duration: short-term – the Project's contribution to cumulative changes in water quantity would occur during the construction phase or associated with maintenance activities within any one year during the operations phase (*i.e.*, short-term).
- Frequency: isolated to occasional – Project activities that could contribute to cumulative changes in surface water quantity may occur intermittently, but repeatedly over the assessment period due to maintenance activities.
- Reversibility: short-term to permanent – the Project's contribution to the cumulative effect is expected to be reversed in the short to medium-term following construction of the pipeline and power lines and long-term to permanent for above ground facilities depending whether natural drainage patterns can be restored following decommissioning and abandonment.
- Magnitude: low to medium – the Project's contribution to cumulative effects on the surface water quantity indicator are anticipated to be largely mitigated during construction and relatively minor.
- Probability: high – since it is likely that existing activities, the Project and reasonably foreseeable developments will act cumulatively to cause changes to water quantity.
- Confidence: high – based on the professional experience of the assessment team.

8.3.3.3 Combined Cumulative Effects on Water Quality and Quantity

Combined Effects of the Project on Water Quality and Quantity

Past and reasonably foreseeable developments plus the Project (*i.e.*, the Project's contribution to cumulative change in surface water quality and quantity) may act in combination to affect water quality and quantity in the Aquatics RSA. The impact balance is considered negative. The implementation of mitigation measures described in Section 7.0 will reduce the severity of cumulative effects arising from the Project in combination with other reasonably foreseeable developments. The combined cumulative effect of the Project on water quality and quantity is of low to medium magnitude, reversible in the short-term to permanent and of high probability (Table 8.3-2, point 3[a]). A summary of the rationale for all of the significance criteria for the combined cumulative effects of the Project on the water quality and quantity indicators is provided below.

- Spatial Boundary: Aquatics RSA – the Project may interact with existing activities and reasonably foreseeable developments within the Aquatics RSA to cause a combined cumulative alteration to water quality and quantity in the RSA.
- Duration: short-term – the Project activities that contribute to cumulative effects on the water quality and quantity indicators will occur during construction and operations (*e.g.*, maintenance activities) of various Project components.
- Frequency: isolated to occasional – Project activities that could contribute to cumulative effects on the water quality and quantity indicators are generally confined to the construction period but may occur intermittently and sporadically during the operations phase.
- Reversibility: short-term to permanent – the events causing combined cumulative effects on the water quality and quantity indicators will vary, where Project contribution from certain residual effects may be reversed shortly after construction, others may not fully be reversed until reclamation and post-construction environmental monitoring or, for above ground facilities, decommissioning and abandonment (depending whether natural drainage patterns can be restored following decommissioning and abandonment).
- Magnitude: low to medium – the Project's contribution to combined cumulative effects on the water quality and quantity indicators is anticipated to be largely mitigated during construction and operations.
- Probability: high – alteration of water quality and quantity is likely to occur as a result of the Project acting in combination with existing activities and reasonably foreseeable developments.
- Confidence: high – based on a good understanding by the assessment team of cause-effect relationships between construction activities of the Project and reasonably foreseeable developments on water quality and quantity.

8.3.4 Summary

As identified in Table 8.3-2, there are no situations where there is a high probability of occurrence of a permanent or long-term cumulative effect of high magnitude that cannot be technically or economically mitigated. Consequently, the Project's contribution to cumulative effects on water quality and quantity within the Water Quality and Quantity LSA and Aquatics RSA will be not significant.

8.4 Air Emissions

This subsection discusses how the Project could act in combination with existing activities and reasonably foreseeable developments to cumulatively affect air emissions indicators that were anticipated to have an adverse combined Project-specific residual effect (*i.e.*, criteria air contaminants [CACs] and volatile organic compounds [VOCs]).

During normal pipeline operations and after construction of the Project, fugitive air emissions from the pipeline, which consists of welded steel sections, are expected to be nil. As noted in Section 7.4, fugitive emissions from pump stations were shown to be negligible and the extent and magnitude of the predicted impacts was shown to be negligible. Other Project components such as storage tank facilities at the Edmonton, Kamloops, Sumas and Burnaby terminals, and the Westridge Marine Terminal will continue to release fugitive emissions from product handling and storage. Other emissions from reasonably foreseeable developments in the Air Quality RSA have the potential to combine with existing emissions and Project-related fugitive emissions from tank terminals and tanker loading and stationary point sources such as the vapour combustion unit, to create a cumulative effect.

8.4.1 Reasonably Foreseeable Developments

Tables 8A.1-1 to 8A.1-6 of Appendix 8.1 provide a list of the certain and reasonably foreseeable developments located within the Air Quality RSA considered in the evaluation of cumulative effects on the air quality indicators. Description of these developments is provided in Section 8.1.4, and developments in Tables 8A.1-1 to 8A.1-4 are shown on Figures 8.1-1a, 8.1-1b and 8.1-1c. Reasonably foreseeable developments provided in Table 8A.1-5 (for Alberta) and Table 8A.1-6 (for BC) of Appendix 8.1 with the potential to act in combination with the Project were excluded from mapping since development details (*e.g.*, approval status, location) were either not available or the developments were located within urban municipal boundaries, such as the City of Edmonton and LMDA.

In the Air Quality RSA, there are approximately 18 mapped reasonably foreseeable developments either fully within the Air Quality RSA or, for some transmission lines and pipelines, partially within the Air Quality RSA (Table 8A.1-1 of Appendix 8.1). In addition, there are approximately 164 mapped reasonably foreseeable minor oil and gas developments in Alberta: 49 pipelines; 95 facilities; and 20 wells (Tables 8A.1-2, 8.A1-3 and 8A.1-4 of Appendix 8.1).

8.4.2 Potential Cumulative Effects

The potential and likely combined environmental residual effects associated with the construction and operation of the Project on air emissions indicators were identified in Section 7.11.1.4 and are listed in Table 8.4-1 along with existing activities and reasonably foreseeable developments that could act in combination with the Project.

No new odour emissions or residual effects for the indicators of odour such as chemicals like H_2S and mercaptans were identified. Therefore, the combined cumulative effects for this air indicator remains unchanged from the significance evaluation summarised in Table 7.11.1-4 and was not carried forward into the cumulative effects assessment.

TABLE 8.4-1

POTENTIAL RESIDUAL EFFECTS OF THE PROJECT ON AIR EMISSIONS CONSIDERED FOR THE CUMULATIVE EFFECTS ASSESSMENT

Potential Residual Project Effect on Indicator	Spatial Boundary[1]	Project Component(s)	Temporal Boundary	Potential Cumulative Effect	Existing Activities/Reasonably Foreseeable Developments with Residual Effects Acting in Combination with the Project
1. Combined Project effects on CACs and VOCs.	RSA	Pipeline Temporary Facilities Pump Stations Tanks Westridge Marine Terminal Pipeline Reactivation	Construction to Operation	Project contribution to cumulative increase in CAC and VOC emissions during construction and operations activities.	• Existing activities including: agriculture and livestock grazing, forestry activities, rural and urban residential and commercial development, transportation and infrastructure development, utility activities, oil and gas exploration and development, and mineral resource exploration and development. • Reasonably foreseeable developments within the Air Quality RSA listed in Tables 8A.1-1 to 8A.1-6 of Appendix 8.1 and discussed in Section 8.1.4. • Project-related activities involving equipment could interact with the above activities.

TABLE 8.4-1 Cont'd

Potential Residual Project Effect on Indicator	Spatial Boundary[1]	Project Component(s)	Temporal Boundary	Potential Cumulative Effect	Existing Activities/Reasonably Foreseeable Developments with Residual Effects Acting in Combination with the Project
1. Combined Project effects on CACs and VOCs. (cont'd)	See above	Tanks Westridge Marine Terminal	Operation	Project contribution to cumulative increase in VOC emissions from storage tanks and tanker loading.	• Existing activities including oil and gas facilities and related activities. • Reasonably foreseeable developments within the Air Quality RSA listed in Tables 8A.1-5 and 8A.1-6 of Appendix 8.1 and discussed in Section 8.1.4 that are anticipated to result in continuous emissions during operation. • Ongoing emissions associated with operations of proposed storage tanks and tanker loading.
2. Combined Project effects on secondary particulate matter and ozone.	LFV	Tanks Westridge Marine Terminal	Operation	Project contribution to cumulative increases in secondary particulate matter and ozone.	• Existing activities including: oil and gas facilities and related industrial activities and marine and urban emissions in the LFV. • Reasonably foreseeable developments within the LFV listed in Table 8A.1-6 of Appendix 8.1 and discussed in Section 8.1.4 that are anticipated to result in continuous and fugitive emissions during operation. • Ongoing emissions associated with operations of proposed storage tanks and tanker loading.

Note: 1 RSA = Air Quality RSA; LFV = Lower Fraser Valley.

8.4.3 Significance Evaluation of Potential Cumulative Effects

A qualitative approach was selected to evaluate significance of the Project's contribution to cumulative effects on air quality since emissions data for reasonably foreseeable developments were largely unavailable. Due to a lack of regulatory thresholds, standards or guidelines relating to air emissions, the evaluation of significance relied on the professional judgment of the assessment team.

Table 8.4-2 provides a summary of the significance evaluation of the Project's contribution to potential cumulative effects on air emission indicators. The rationale used to evaluate the significance of each of the cumulative effects is provided below.

TABLE 8.4-2

SIGNIFICANCE EVALUATION OF THE PROJECT'S CONTRIBUTION TO CUMULATIVE EFFECTS ON AIR EMISSIONS

Potential Cumulative Effects	Impact Balance	Spatial Boundary[1]	Temporal Context: Duration	Temporal Context: Frequency	Temporal Context: Reversibility	Magnitude	Probability	Confidence	Significance[2]
1. Air Emissions Indicator – Primary Emissions of CACs and VOCs									
1(a) Project contribution to cumulative increase in CAC and VOC emissions during construction and operations activities.	Negative	RSA	Short-term	Isolated to periodic	Long-term	Low to medium	High	Moderate	Not significant
1(b) Project contribution to cumulative increase in fugitive VOC emissions from storage tanks and tanker loading.	Negative	RSA	Long-term	Continuous	Long-term	Low	High	Moderate	Not significant
2. Air Emissions Indicator – Formation of Secondary Particulate Matter and Ozone									
2(a) Project contribution to cumulative increases in secondary particulate matter and ozone.	Negative	LFV	Long-term	Continuous	Long-term	Low to medium	High	Moderate	Not significant

TABLE 8.4-2 Cont'd

	Potential Cumulative Effects	Impact Balance	Spatial Boundary[1]	Temporal Context: Duration	Temporal Context: Frequency	Temporal Context: Reversibility	Magnitude	Probability	Confidence	Significance[2]
3.	Project Contribution to Combined Cumulative Effects on Air Emissions									
3(a)	Project contribution to combined cumulative effects on the air emissions indicators (1[a], [b] and 2[a]).	Negative	RSA or LFV	Long-term	Continuous	Long-term	Low to medium	High	Moderate	Not significant

Notes: 1 RSA = Air Quality RSA; LFV = Lower Fraser Valley.

2 Significant Contribution to a Cumulative Environmental Effect: A high probability of occurrence of a permanent or long-term cumulative effect of high magnitude that cannot be technically or economically mitigated.

8.4.3.1 Air Emissions Indicator – Criteria Air Contaminants and Volatile Organic Compounds

Increased Air Emissions during Construction and Site-Specific Maintenance Activities

Existing sources of increased air emissions in the Air Quality RSA include vehicle emissions arising from agriculture and forestry activities involving equipment use (*e.g.*, cultivation, logging trucks), oil and gas exploration and development, utility activities (*e.g.*, maintenance on transmission lines), transportation activities (*e.g.*, road construction and maintenance), and mineral exploration and development. The aforementioned activities also have the potential to cause increased dust emissions from ground disturbance and road use, and some activities involving clearing (*e.g.*, forestry, agriculture, oil and gas development) may cause increased smoke from burning of slash. The construction of the pipeline, temporary facilities, tanks and pumps stations and, to a lesser extent, pipeline reactivation and operations activities (*e.g.*, vegetation management, routine inspections, site-specific maintenance) will increase air emissions. All of these activities are expected to be short-term events. The construction and/or operations of reasonably foreseeable developments (as identified in Tables 8A.1-1 to 8A.1-6 of Appendix 8.1) will also increase air emissions.

The Project will act in combination with existing activities and reasonably foreseeable developments in the Air Quality RSA to increase air emissions during construction of the Project and operations activities such as vegetation management, routine inspections and site-specific maintenance. Without knowing how long the construction period is for each reasonably foreseeable development, it is difficult to predict the Project's incremental contribution to increased air emissions. The mitigation measures in Sections 7.2.4 and 7.4.4 and the Pipeline, Facilities and Westridge Marine Terminal EPPs (Volumes 6B, 6C and 6D) will reduce the Project-related cumulative air emissions. It is anticipated that many operators of reasonably foreseeable developments will also implement mitigation measures developed in accordance with industry standards for air emissions. For example, Enbridge is recommending the same mitigation measures to reduce air emissions for the Line 2 Replacement Project (Table 8A.1-1 of Appendix 8.1), the Edmonton Terminal (South) Expansion Project (Table 8A.1-5 of Appendix 8.1) and the Edmonton to Hardisty Pipeline Project (Table 8A.1-1 of Appendix 8.1).

Future developments constructed prior to the Project that will not result in increased emissions during operations (*e.g.*, pipelines, transmission lines, municipal infrastructure, commercial and residential developments) are not likely to contribute to a cumulative increase in air emissions in the Air Quality RSA. The Project may act in combination with reasonably foreseeable developments constructed concurrently to increase dust and smoke, as well as air emissions from vehicle and machinery use in the Air Quality RSA. However, for reasons described more fully below, the Project is unlikely to act in combination with most reasonably foreseeable developments to cause increased air emissions in a particular area and it is unlikely that any exceedances of applicable air quality objectives would occur as a result.

For example, major proposed and identified projects include the Vista Project located approximately 10 km east of Hinton (Figure 8.1-1a) and the Ajax Project located partially within Kamloops city limits along the existing TMEP right of way and approximately 4 km south-southeast of the Kamloops Pump Station (Figure 8.1-1c). The Vista Project is currently undergoing regulatory review of the environmental impact assessment documents filed with AESRD (AESRD 2013, Coalspur 2013). These documents indicate that all of the construction activities related to blasting, brush burning and removal of overburden combined with operations-related emissions will meet all applicable Alberta ambient air quality objectives at all off-site receptors. As such, a combined effect from the Vista Project may create an additive effect when combined with TMEP construction activities if they occurred at the same time, however, exceedances of the ambient objectives are not expected to occur due to the benefit of atmospheric dispersion and separation distance. The second project, the Ajax open pit copper and gold mine, is currently in the pre-application phase and information on air emissions from construction or operations activities has not been made public (Ajax 2013, Province of BC 2013). However, detailed dispersion modelling is currently underway as part of the environmental impact assessment for the project (Ajax 2013). Based on the results of detailed dispersion modelling, it is expected that the proponent will be required to meet all BC ambient air quality objectives and standards by incorporating best management practices and mitigation measures to limit particulate emissions. As indicated in the effects assessment in Section 7.0, particulate emissions related to TMEP will be discharged from combustion of natural gas in heaters and their contribution to the maximum concentrations was very small. Most of the combined predicted TMEP and background particulate matter concentrations come from the ambient background (>99%). Under some circumstances, the Ajax mine may contribute to the measured ambient background particulate matter levels in Kamloops, however, emissions from the TMEP Kamloops Terminal heaters and storage tanks, and fugitive emissions from the Kamloops Pump Station are not expected to materially affect these levels nor exceed ambient air quality objectives in the Kamloops area.

Participants at many of the community workshops (*e.g.*, Hinton, Valemount, Blue River, Kamloops, Merritt, Hope, Chilliwack, Abbotsford and Burnaby) raised concerns over construction-related air emissions from the Project affecting air quality. In most communities, construction activities have the potential to act in combination with existing activities as well as reasonably foreseeable developments such as commercial and residential projects and road upgrades and improvements, which are assumed to have the potential to occur in any community at any time. Trans Mountain will reduce construction-related emissions and minimize air emissions at residential locations through implementation of mitigation measures provided in Section 7.2.4 and the Pipeline EPP (Volume 6B).

Participants at the Kamloops ESA Workshop raised concerns over construction-related air emissions, particularly smoke from burning and dust from blasting from the Project affecting air quality. The BC *Open Burning Smoke Control Regulation* requires a number of conditions to limit effects to residents, including setting minimum distances to residences, avoidance of adverse dispersion conditions and limiting the duration of brush burning (Government of BC 1993).

Another proposed development of note is the Surrey Fraser Docks Direct Transfer Coal Facility, which is located approximately 10 km south of the Burnaby Terminal (Table 8A.1-6 of Appendix 8.1). A detailed air quality assessment of CACs was completed for this project by the proponent and included emissions from ship engines as well as fugitive particulate emissions from coal loading. The predicted results indicated exceedances of the ambient air quality objectives for NO_2 near the freighters over water due to engine exhaust. As well, increases in ambient particulate matter levels were predicted to occur. A site-specific particulate matter management plan was developed to reduce the amount of fugitives from coal handling and loading. This facility is required to meet applicable Metro Vancouver ambient air quality objectives on land. With this plan in place and through the benefit of atmospheric dispersion over the 10 km to the Air Quality RSA, it is expected that emissions from the Surrey Fraser coal facility will not act in combination with the Project, particularly the Westridge Marine and Burnaby terminals, to cause a cumulative increase in existing ambient air quality levels in the Air Quality RSA (*i.e.*, no spatial overlap in emissions from the developments is anticipated that would result in a decrease in air quality). Therefore, a quantitative assessment for the Surrey Fraser facility is not required.

The Project's contribution to cumulative increase in air emissions will be reduced by following mitigation provided in Sections 7.2.4 and 7.4.4 and the Pipeline, Facilities and Westridge Marine Terminal EPPs (Volumes 6B, 6C and 6D). It is expected that many other developments will implement mitigation measures similar to those implemented for the Project that have been developed in accordance with industry and provincial regulatory guidelines to reduce effects to air quality. No mitigation measures beyond the Project-specific mitigation already proposed for air emissions indicators in Section 7.0 and the Pipeline, Facilities and Westridge Marine Terminal EPPs (Volumes 6B, 6C and 6D) are deemed warranted.

The Project's contribution to a cumulative increase in CAC and VOC emissions during construction and operations activities (*e.g.*, vegetation management, routine inspections, site-specific maintenance) within the Air Quality RSA is considered to have a negative impact balance, is reversible in the long-term and of low to medium magnitude depending on distance to receptors, land use (*e.g.*, rural vs. urban), construction techniques (*e.g.*, blasting vs. ripping, mulching vs. burning) and soil conditions (Table 8.4-2, point 1[a]). A summary of the rationale for all of the significance criteria of combined cumulative effects on increased CAC and VOC emissions is provided below.

- Spatial Boundary: Air Quality RSA – the Project's contribution to cumulative increases in CAC and VOC emissions from construction and operations activities would dissipate within the Air Quality RSA.
- Duration: short-term – the events causing the Project's contribution to increases in air emissions are construction and operations activities such as routine inspections and site-specific maintenance activities in the LSA.
- Frequency: isolated to periodic – the event causing the Project's contribution to cumulative increases in air emissions (*i.e.*, construction of the pipeline) is confined to a specific period, while operations activities (*e.g.*, vegetation management, routine inspections, site-specific maintenance) will occur intermittently but repeatedly over the assessment period.
- Reversibility: long-term – the Project's contribution to cumulative effects will reverse within several days once construction or inspection and maintenance activities are complete.
- Magnitude: low to medium – the Project's contribution to a cumulative increase in air emissions will vary depending on distance to receptors, land use (*e.g.*, rural vs. urban), construction techniques (*e.g.*, blasting vs. ripping, mulching vs. burning) and soil conditions, while periodic increases in air emissions during routine operations will be within normal variability of existing conditions with the implementation of proposed mitigation measures.
- Probability: high – the equipment and vehicles used will emit air emissions, burning will emit smoke, and ground disturbance will suspend fugitive dust emissions.
- Confidence: moderate – based on the professional experience of the assessment team.

Increased Volatile Organic Compound Concentrations during Storage Tank Operations and Tanker Loading

VOC emissions from storage tanks are fugitive in nature and the magnitude is related to standing losses due to changes in ambient temperature and pressure or working losses due to pumping of the product into or out of the tanks. Losses of VOCs from tanker loading are also fugitive emissions. The potential for a cumulative effect from the Project and interaction with a reasonably foreseeable development was considered. Major proposed projects and available project details were reviewed and evaluated for possible interaction within each Air Quality RSA of the terminals.

At their Edmonton Terminal (South), Enbridge recently received approval (July 26, 2013) from the NEB to construct and operate five new storage tanks as part of the Edmonton Terminal (South) Expansion Project (Table 8A.1-5 of Appendix 8.1). This Enbridge terminal is located approximately 2 km southeast of Trans Mountain's Edmonton Terminal. These storage tanks are expected to receive and store crude oil and have the potential to create fugitive emissions of VOCs in a manner as noted above for the Trans Mountain Edmonton Terminal. An air quality assessment of the proposed upgrade was completed and filed with the NEB (NEB 2013g). The results indicated that the maximum predicted concentrations for all air contaminants were below their applicable Alberta Ambient Air Quality Objectives. Based on a review of the predicted maximum concentration contours for benzene in the vicinity of the Trans Mountain

Edmonton Terminal, the effect of the five new storage tanks is not expected to be distinguishable from current ambient background levels.

In the detailed air quality assessment conducted for the TMEP in Section 7.0, emissions from the existing Enbridge Edmonton Terminal (South) were included in the dispersion model but not these five new tanks. Upon review of the modelling results, VOC emissions from the existing Suncor refinery were found to dominate the maximum predicted VOC concentrations in the Air Quality RSA. Suncor reported 11.5 tonnes for 2011 to the National Pollutant Release Inventory, whereas Enbridge did not report benzene emissions for that year. Based on the reporting threshold of 1 tonnes for benzene, total emissions from the Enbridge Terminal are <10% of those from Suncor. Accordingly, the incremental effects of fugitive emissions from the new tanks are not expected to materially influence the predicted concentration maximum. Therefore, a qualitative assessment was used to determine that no residual effect would be expected and the applicable AESRD ambient air quality objectives would continue to be met. No interaction of VOC emissions at the Sumas, Kamloops, Burnaby and Westridge Marine terminals with reasonably foreseeable projects are expected to occur.

The Project's contribution to a cumulative increase in VOC emissions from storage tanks and tanker loading within the Air Quality RSA during normal operations activities is considered to have a negative impact balance, is reversible over the long-term and of low magnitude (Table 8.4-2, point 1[b]). A summary of the rationale for all of the significance criteria of combined cumulative effects on increased VOC emissions is provided below.

- Spatial Boundary: Air Quality RSA – the Project's contribution to cumulative increases in VOC emissions from storage tanks and during tanker loading would dissipate within the Air Quality RSA.
- Duration: long-term – fugitive emissions of VOCs and subsequent changes to ambient ground-level concentrations are expected to occur for the life of the Project and are, therefore, rated as long-term.
- Frequency: continuous – the Project's contribution to cumulative increases in VOC emissions would be continuous.
- Reversibility: long-term – the Project's contribution to cumulative effects will extend for the life of the operating terminal and will cease when the facility is decommissioned.
- Magnitude: low – the Project's contribution to an increase in VOC emissions is expected to be low.
- Probability: high – Project fugitive emissions will occur on an ongoing basis.
- Confidence: moderate – based on a good understanding of cause-effect relationships between the Project, air emissions, and atmospheric reactions; however, there is uncertainty with respect to existing and future non-Project emissions, and atmospheric chemical reactions are complex.

8.4.3.2 Air Emissions Indicator – Formation of Secondary Particulate Matter and Ozone

There is no detailed inventory information available with respect to major foreseeable developments or urban emissions in the LFV that would permit a future scenario to be modelled for the indicators of secondary particulate matter and ozone. Consequently, a quantitative assessment could not be completed; however, a qualitative assessment of the secondary formation of $PM_{2.5}$ and ozone and visibility was carried forward into the cumulative effects assessment. This assessment was based on professional judgment and relied upon forecast marine emissions, proposed major reasonably foreseeable developments and expected urban growth, all of which is expected to contribute potentially to secondary pollutant formation.

The increase in ambient ground-level concentrations of secondary particulate matter and ozone is considered to have a negative impact balance. The increase in ambient ground-level concentrations of secondary particulate matter and ozone is confined to the photochemical model domain or LFV. Some of the marine emissions will contribute chemical pre-cursors for secondary pollutants periodically when tanker traffic travels through the Marine Air Quality RSA. The change will be continuous in duration and reversible in the long-term, however, the magnitude is expected to be low (Table 8.4-2, point 2[a]). A summary of the rationale for all of the significance criteria is provided below.

- Spatial Boundary: LFV – changes to ambient ground-level concentrations of secondary particulate matter and ozone are expected to occur within the LFV.
- Duration: long-term – emissions of pre-cursors and subsequent changes to ambient ground-level concentrations of secondary particulate matter and ozone are expected to occur for the life of the Project and are, therefore, rated as long-term.
- Frequency: continuous – the Project's contribution to the formation of secondary particulate matter and ozone will occur continuously throughout the operations phase.
- Reversibility: long-term – emissions of pre-cursors will cease and any increases in ambient ground-level concentrations of secondary particulate matter and ozone will reverse shortly after tankers exit the Marine Air Quality RSA; however, Project life is more than 10 years.
- Magnitude: low to medium – the increase in ambient ground-level concentrations of secondary particulate matter and ozone is expected to approach but not exceed regulatory limits.
- Probability: high – an increase in Project-related marine vessel traffic will result in pre-cursor emissions, which will react to form secondary particulate matter and ozone.
- Confidence: moderate – cumulative effects assessment is based on a good understanding of cause-effect relationships between Project pre-cursor emissions and resultant ambient particulate matter and ozone concentrations via atmospheric reactions; however, vessel-specific data are limited.

8.4.3.3 Combined Cumulative Effects on Air Emissions

In the Surrey ESA Workshop, participants noted that Trans Mountain should consider cumulative air quality issues resulting from marine and land activities (cumulative emissions from Project and non Project-related marine transport, loading of tankers at Westridge Marine Terminal, and fugitives from the Burnaby Terminal storage tanks). The results of these combined effects from the marine and terrestrial-based emission sources were modelled and evaluated in terms of local impact from primary emissions and secondary formation of photochemical pollutants (Section 7.5.4.6). Construction related VOC emissions were also considered but are minor compared to the other continuous emission sources noted above and as a result, were not modelled.

The Project will contribute to a combined cumulative increase in air emissions in the Air Quality RSA at terminals where tank emissions have the potential to overlap with CAC and VOC emissions from nearby site-specific maintenance or other routine operations activities. The Project's contribution to a cumulative increase in CAC and VOC emissions during site-specific maintenance activities or other routine operations activities (*e.g.*, vegetation management, routine inspections) and tank operations within the Air Quality RSA and LFV is considered to have a negative impact balance, is reversible in the long-term and of low to medium magnitude (Table 8.4-2, point 3[a]). A summary of the rationale for all of the significance criteria of combined cumulative effects on increases in CAC and VOC emissions is provided below.

- Spatial Boundary: Air Quality RSA and LFV – the Project's contribution to combined cumulative increases in CAC and VOC emissions from maintenance activities, routine operations activities (*e.g.*, vegetation management, routine inspections) and tank emissions would dissipate within the Air Quality RSA. In the Lower Mainland, the spatial boundary is the LFV which includes the Air Quality RSA.
- Duration: long term – the events causing the Project's contribution to combined cumulative increases in air emissions are maintenance and operations activities (*e.g.*, vegetation management, routine inspections, site-specific maintenance) in vicinity to the storage tanks.
- Frequency: continuous – the events causing the Project's contribution to cumulative increases in air emissions due to maintenance and operations related activities in the LSA will occur continuously over the assessment period.

- Reversibility: long-term – the Project's contribution to combined cumulative effects is expected to extend over the life of the operating terminals until they are decommissioned.
- Magnitude: low to medium – the Project's contribution to cumulative increases in air emissions from site-specific maintenance and operations activities with ongoing tank emissions will approach but not exceed regulatory limits.
- Probability: high – overlapping emissions of CACs and VOCs is considered likely to occur during maintenance and operations activities (*e.g.*, vegetation management, integrity digs, repairs) in vicinity to the storage tanks.
- Confidence: moderate – based on a good understanding of cause-effect relationships between the Project and air emissions.

8.4.4 Summary

As identified in Table 8.4-2, there are no situations where there is a high probability of occurrence of a permanent or long-term cumulative effect of high magnitude that cannot be technically or economically mitigated. Consequently, the Project's contribution to cumulative effects on air emissions within the Air Quality RSA will be not significant.

8.5 Acoustic Environment

This subsection discusses how the Project could act in combination with existing activities and reasonably foreseeable developments to cumulatively affect acoustic environment indicators that were anticipated to have an adverse combined Project-specific residual effect (*i.e.*, sound levels and vibration levels).

Potential contribution to cumulative effects on the sound levels indicator is considered to be possible during construction of all Project components and operation of facilities, including the Westridge Marine Terminal. The Project's contribution to cumulative effects on the vibration indicator within the Acoustic Environment RSA is considered to be possible during pipeline construction. Sound emissions and vibrations that occur during Project activities may combine with sound or vibrations emitted from other existing and reasonably foreseeable developments to affect the acoustic environment.

8.5.1 Reasonably Foreseeable Developments

Tables 8A.1-1 to 8A.1-6 of Appendix 8.1 provide a list of the certain and reasonably foreseeable developments located within the Acoustic Environment RSA considered in the evaluation of cumulative effects on the acoustic environment indicators. Description of these developments is provided in Section 8.1.4, and developments in Tables 8A.1-1 to 8A.1-4 are shown on Figures 8.1-1a, 8.1-1b and 8.1-1c. Reasonably foreseeable developments provided in Table 8A.1-5 (for Alberta) and Table 8A.1-6 (for BC) of Appendix 8.1 with the potential to act in combination with the Project were excluded from mapping since development details (*e.g.*, approval status, location) were either not available or the developments were located within urban municipal boundaries, such as the City of Edmonton and LMDA.

In the Acoustic Environment RSA, there are approximately 18 mapped reasonably foreseeable developments either fully within the Acoustic Environment RSA or, for some transmission lines and pipelines, partially within the Air Quality RSA (Table 8A.1-1 of Appendix 8.1). In addition, there are approximately 162 mapped reasonably foreseeable minor oil and gas developments in Alberta: 46 pipelines; 96 facilities; and 20 wells (Tables 8A.1-2, 8A.1-3 and 8A.1-4 of Appendix 8.1).

8.5.2 Potential Cumulative Effects

The potential and likely combined residual effects associated with the construction and operations of the Project on acoustic environment indicators were identified in Section 7.11.1.6 and are listed in Table 8.5-1 along with existing activities and reasonably foreseeable developments that could act in combination with the Project. Sound emitted by pipeline operations (*e.g.*, from site-specific maintenance, vegetation management, inspection) is considered to be of short-term duration and periodic in frequency. As a result, the potential for these activities to overlap with other developments and cumulatively affect day or night sound levels is considered unlikely so pipeline operational noise is not considered further in this cumulative effects assessment.

TABLE 8.5-1

POTENTIAL RESIDUAL EFFECTS OF THE PROJECT ON THE ACOUSTIC ENVIRONMENT CONSIDERED FOR THE CUMULATIVE EFFECTS ASSESSMENT

Potential Residual Project Effect on Indicator	Spatial Boundary[1]	Project Component(s)	Temporal Boundary	Potential Cumulative Effect	Existing Activities/Reasonably Foreseeable Developments with Residual Effects Acting in Combination with the Project
1. Combined Project effects on sound levels.	RSA	Pipeline Temporary Facilities Pump Stations Tanks Westridge Marine Terminal	Construction to Operation	Project contribution to cumulative increase in sound levels during construction and operation.	• Existing activities including: agriculture and livestock grazing, forestry activities, rural and urban residential and commercial development, transportation and infrastructure development, utility activities, oil and gas exploration and development, and mineral resource exploration and development. • Reasonably foreseeable developments within the Acoustic Environment RSA listed in Tables 8A.1-1 to 8A.1-6 of Appendix 8.1 and discussed in Section 8.1.4. • Project-related activities involving mechanical equipment and tank loading could interact with the above activities.
2. Combined Project effects on vibration levels.	RSA	Pipeline	Construction	Project contribution to cumulative increase in vibration emissions.	• There are no existing activities identified with blast vibration emissions. • Reasonably foreseeable developments within the Acoustic Environment RSA listed in Tables 8A.1-1, 8A.1-5 and 8A.1-6 of Appendix 8.1 and discussed in Section 8.1.4 that are anticipated to produce vibration emissions during construction (concurrently with pipeline construction) or during operation. • Blasting associated with pipeline construction.

Note: 1 RSA = Acoustic Environment RSA.

8.5.3 Significance Evaluation of Potential Cumulative Effects

A qualitative approach was selected to determine the Project's contribution to combined effects on the acoustic environment since sound and vibration level data for reasonably foreseeable developments were largely unavailable. The AER and BC OGC guidelines used for the assessment of changes in the acoustic environment apply a cumulative approach to evaluation and compliance determination for sound levels. The guidelines indicate that any reasonably foreseeable development must consider any existing development when evaluating compliance, so any new project must design their development while taking into account all existing sound sources. If existing developments have reached the allowed thresholds, any new development must reduce sound levels to ensure the criteria are met. However, this approach does not consider the potential for additive effects from future projects. Due to a lack of standards or guidelines relating to consideration of reasonably foreseeable developments for the acoustic environment, the evaluation of significance relied on the professional judgment of the assessment team.

Table 8.5-2 provides a summary of the significance evaluation of the Project's contribution to potential cumulative effects on acoustic environment indicators. The rationale used to evaluate the significance of each of the cumulative effects is provided below.

TABLE 8.5-2

SIGNIFICANCE EVALUATION OF THE PROJECT'S CONTRIBUTION TO CUMULATIVE EFFECTS ON THE ACOUSTIC ENVIRONMENT

Potential Cumulative Effects		Impact Balance	Spatial Boundary[1]	Temporal Context			Magnitude	Probability	Confidence	Significance[2]
				Duration	Frequency	Reversibility				
1.	Acoustic Environment Indicator – Sound Levels									
1(a)	Project contribution to cumulative increase in sound levels during construction and operation.	Negative	RSA	Short to long-term	Isolated to continuous	Short to long-term	Low to medium	High	Moderate	Not significant
2.	Acoustic Environment Indicator – Vibration Levels									
2(a)	Project contribution to cumulative increase in vibration emissions.	Negative	RSA	Short-term	Isolated	Short-term	Low to medium	Low	High	Not significant
3.	Project Contribution to Combined Cumulative Effects on the Acoustic Environment									
3(a)	Project contribution to combined cumulative effects on the acoustic environment indicators (1[a] and 2[a]).	Negative	RSA	Long-term	Continuous	Short to long-term	Low to medium	High	Moderate	Not significant

Notes: 1 RSA = Acoustic Environment RSA.

2 Significant Contribution to a Cumulative Environmental Effect: A high probability of occurrence of a permanent or long-term cumulative effect of high magnitude that cannot be technically or economically mitigated.

8.5.3.1 Acoustic Environment Indicator – Sound Levels

Existing sources of sound emissions in the Acoustic Environment RSA include natural sound, human activity in rural to urban settings (*e.g.*, residences, retail areas, roads and rail), equipment used in agriculture and forestry activities, oil and gas exploration and development, utility activities, transportation activities (*e.g.*, road construction and maintenance), and mineral exploration and development. The construction of the pipeline, temporary facilities, tanks, pumps stations and, to a lesser extent, pipeline reactivation and maintenance of the pipeline will increase sound levels. The operation of the tanks, pump stations and Westridge Marine Terminal will also increase sound levels. The construction and/or operation of reasonably foreseeable developments (as identified in Tables 8A.1-1 to 8A.1-6 of Appendix 8.1) will also generate sound.

The Project was assessed cumulatively with existing facilities through the use of ambient sound level conditions within the assessment, with the result discussed in Section 7.11.1.6. To determine if the Project will act cumulatively with reasonably foreseeable developments in the Acoustic Environment RSA, the spatial location and level of the sound and vibration emitted from those developments during construction and operation would be required. During construction of the Project, construction schedule overlap from other reasonably foreseeable developments within the spatial range of the Acoustic Environment RSA would be required in order for a potential cumulative effect to exist. Without knowing how long the construction period is for each reasonably foreseeable development or the expected sound levels emitted, it is not possible to quantify the Project's contribution to increased sound levels. The mitigation measures in Sections 7.2.6, 7.4.6, 7.5.6 and 7.6.6, as well as the Pipeline, Facilities and Westridge Marine Terminal EPPs (Volumes 6B, 6C and 6D), will reduce the magnitude of Project-related cumulative sound levels. It is anticipated that operators of reasonably foreseeable oil and gas development will follow the AER and BC OGC guidance that limits increases in sound levels. It is also assumed that other, non-regulated developments will also implement mitigation measures for control of sound levels, developed in accordance with industry standards.

Reasonably foreseeable developments constructed prior to the Project that do not result in increased sound levels during operation (*e.g.*, pipelines, transmission lines and municipal infrastructure) are not likely to contribute to a cumulative increase in sound levels in the Acoustic Environment RSA. The Project may act in combination with reasonably foreseeable developments constructed concurrently to increase sound levels. Sound from most large industrial operations involving multiple buildings or mobile equipment will usually diminish to below levels where cumulative effects may occur within 5 km (Drew and South 2009). Shorter distances would apply for smaller activities such as a single building or well head. Notwithstanding uncertainties around construction timing, location and duration relative to the Project, the Project is unlikely to act in combination with the construction of most reasonably foreseeable developments in a particular area.

For example, one major proposed project is the Ajax mine located partially within Kamloops city limits in vicinity to the proposed pipeline corridor and approximately 4 km south-southeast of the Kamloops Pump Station. The Ajax open pit copper and gold mine is in the pre-application phase at present and no predicted sound levels from construction or operational activities have been made public (Ajax 2013). It is expected that the proponent will be required to control noise levels at receptors by incorporating best management practices and mitigation measures to limit sound emitted from Ajax mine. The potential for a combined increase in sound levels is unlikely during pipeline construction, based on the current Project schedule. Cumulative effects during Project operations are possible at receptors that may be in between the Ajax mine and Kamloops Pump Station; however, sound levels from the Kamloops Pump Station are predicted to comply with BC OGC *Noise Control Best Practices Guideline* at 500 m from the facility fence line. The potential for sound levels at farther distances to exceed the guideline due to the addition of the Project and future Ajax mine activities is considered unlikely.

Participants of some of the Community Workshops (*e.g.*, Edmonton, Burnaby) raised concerns over sound levels changing due to Project activity. In most communities, Project construction and pump station/tank operations activities have the potential to act in combination with existing activities as well as reasonably foreseeable developments such as commercial and residential projects and road upgrades and improvements, which are assumed to have the potential to occur in any community at any time. The likelihood that background sound will increase with the increased population density in suburban or urban development is taken into account in the determination of guideline limits provided in the AER and BC OGC guidelines (ERCB 2007, BC OGC 2009). The guideline limits on sound levels allow for the density of development, but expect the oil and gas industry to control sound levels to limit increases.

However, reasonably foreseeable development is expected near the Edmonton Terminal as the terminal is located in the approximate centre of an industrial park that hosts a number of other major and minor oil and gas facilities as well as other industry that is not regulated for noise levels. The types of reasonably foreseeable developments identified for the industrial and urban area surrounding the Edmonton Terminal, as identified in Tables 8A.1-1 to 8A.1-5 of Appendix 8.1, are not considered major industrial development that could result in cumulative effects. No receptors were located in the Acoustic Environment LSA; however, high density residential development is located within the Acoustic Environment RSA. Given that the Anthony Henday expressway and other major arterial roads are also located within the RSA, the acoustic environment can be considered saturated. In this type of acoustic environment, incremental changes such as a few pumps or generators associated with pump stations would not result in measurable changes due to the existing ambient sound levels.

Similarly, with respect to residences near the Burnaby Terminal, the acoustic environment can be considered saturated due to the level of urban development. In this type of acoustic environment, incremental changes such as commercial or other non-regulated industry would not result in measurable changes due to the existing ambient sound levels. Only a major redevelopment could result in cumulative effects with existing sound levels as well as other reasonably foreseeable developments

Although regulation and authorization of marine transportation is not specifically within the jurisdiction of the NEB, the environmental and socio-economic effects of the increased marine traffic is considered by Trans Mountain in accordance with the NEB's direction from their List of Issues for the Project, released on July 29, 2013. At Westridge Marine Terminal, non-Project-related vessel traffic growth in Burrard Inlet could result in additional sound at shoreline residential receptors. However, the cumulative effect is expected to be minimal compared to the assessment results discussed in Section 7.6.6. The assessment of the acoustic environment at Westridge Marine Terminal looked at a worst-case with tugs manoeuvring a tanker to the dock. The addition of one or two vessels passing by during this operation is not expected to change the result due to the dominance of the berthing activity. Additional ships in the inlet were determined to not have a cumulative effect on day or night average sound levels as discussed in Section 4.4 of Volume 8A.

The Project's contribution to a combined increase in sound levels will be reduced by following mitigation provided in Section 7.0 and the Pipeline, Facilities and Westridge Marine Terminal EPPs (Volumes 6B, 6C and 6D). It is expected that many other developments will implement mitigation measures similar to those implemented for the Project that have been developed in accordance with industry and provincial guidelines to control sound levels experienced at sensitive receptors. No mitigation measures beyond the Project-specific mitigation already proposed for sound levels in Section 7.0 and the Pipeline, Facilities and Westridge Marine Terminal EPPs (Volumes 6B, 6C and 6D) are deemed warranted.

The Project's contribution to a cumulative increase in sound levels during construction and operation activities within the Acoustic Environment RSA is similar to the potential for increase compared to the existing acoustic environment, except for the probability and confidence. It is considered to have a negative impact balance, is reversible in the short to long-term and of low to medium magnitude depending on distance to receptors, and extent of sound emitting equipment (Table 8.5-2, point 1[a]). A summary of the rationale for all of the significance criteria of combined cumulative effects on increased sound levels is provided below.

- Spatial Boundary: Acoustic Environment RSA – the Project's contribution to cumulative increases in sound levels can result when reasonably foreseeable developments are within 5 km of the Project.
- Duration: short to long-term – the Project's contribution to cumulative increases in sound levels will be short-term during the construction phase, while pump stations, storage tanks and the Westridge Marine Terminal have the potential to contribute to cumulative increases in sound levels during the operations phase.
- Frequency: isolated to continuous – the Project's contribution to a cumulative increase in sound levels is isolated for construction of the Project but will be continuous at pump stations, tanks and the Westridge Marine Terminal during operations.
- Reversibility: short to long-term – the Project's contribution to combined noise levels will cease when at any specific location along the proposed pipeline corridor when construction activities have finished and when equipment or facilities are shut down or decommissioned.
- Magnitude: low to medium – with the implementation of appropriate mitigation measures during construction and at the pump stations, tanks and Westridge Marine Terminal during operations, noise levels at receptors are expected to comply with AER, BC OGC and Health Canada limits at receptors near the facilities.
- Probability: high – cumulative effects on the acoustic environment due to sound levels from both the Project and reasonably foreseeable developments may occur near Edmonton and Kamloops, based on the proximity of residential receptors to Project activities and the types of developments. The potential for cumulative effects to result in a change in magnitude in sound levels due to the combination of activity sound emissions is considered unlikely, but possible.
- Confidence: moderate – based on the professional experience of the assessment team.

8.5.3.2 Acoustic Environment Indicator – Vibration Levels

No existing sources of vibration were identified within the Acoustic Environment RSA. The construction of the pipeline may require blasting, which in turn will increase vibration levels. The construction and/or operations of some reasonably foreseeable developments (as identified in Tables 8A.1-1 to 8A.1-6 of Appendix 8.1) may require blasting and, therefore, cause vibration.

To determine if the Project will act cumulatively with reasonably foreseeable developments in the Acoustic Environment RSA, the spatial location and timing of blasting for reasonably foreseeable developments is required, and this information is not available. Therefore, it is not possible to quantify the Project's contribution to future increased vibration levels. The mitigation measures in Sections 7.2.6 and the Pipeline EPP (Volume 6B) will reduce the Project-related cumulative vibration levels. It is anticipated that operators of reasonably foreseeable developments that employ blasting as a construction method would implement mitigation measures for control of vibration levels developed in accordance with industry standards.

One major proposed project was identified in the Acoustic Environment RSA that is expected to employ blasting on a regular basis. The proposed Ajax mine is located partially within Kamloops city limits in vicinity to the proposed pipeline corridor and approximately 4 km south-southeast of the Kamloops Pump Station. The Ajax open pit copper and gold mine is in the pre-application phase at present and predicted vibration levels from blasting have not been made public (Ajax 2013). It is expected that the proponent will be required to control vibration levels at receptors by incorporating best management practices and mitigation measures. The potential for cumulative vibration levels to occur is unlikely during pipeline construction, based on the current Project construction schedule. As Ajax has not yet submitted an application, mine operations are not expected before completion of pipeline construction in this location.

The Project's contribution to cumulative vibration levels will be reduced by following mitigation provided in Section 7.2.6 and the Pipeline EPP (Volume 6B). It is expected that many other developments will implement mitigation measures similar to those implemented for the Project that have been developed in accordance with industry and provincial guidelines to control sound levels experienced at sensitive receptors. No mitigation measures beyond the Project-specific mitigation already proposed for vibration levels in Section 7.2.6 and the Pipeline EPP (Volume 6B) are deemed warranted.

The Project's contribution to a cumulative increase in vibration levels during pipeline construction within the Acoustic Environment RSA is similar to the potential for increase compared to the existing acoustic environment, except for the probability and confidence. It is considered to have a negative impact balance, is reversible in the short-term and of low to medium magnitude depending on distance to receptors (Table 8.5-2, point 2[a]). A summary of the rationale for all of the significance criteria of combined cumulative effects on increased vibration levels is provided below.

- Spatial Boundary: Acoustic Environment RSA – the Project's contribution to cumulative increases in vibration levels have the potential to result when reasonably foreseeable developments are within 5 km of the Project.
- Duration: short-term – the Project's contribution to cumulative increases in vibration levels will be restricted to the pipeline construction phase.
- Frequency: isolated – the Project's contribution to combined vibration levels would occur only during the moment of a blast and would be restricted to the construction phase.
- Reversibility: short-term – the Project's contribution to combined vibration levels are associated with construction blasting which may occur over a period longer than 2 days. All vibration level changes are reversible as the vibration will cease when construction is finished.
- Magnitude: low to medium – with the implementation of appropriate mitigation measures during construction, contribution to cumulative increases to vibration levels are expected to be in compliance with guidelines at all receptors.
- Probability: low – for the single future development where cumulative effects potential exists, the expected schedule for development compared to the Project schedule indicates that the potential for pipeline construction blasting and Ajax mine blasting to occur concurrently is unlikely.
- Confidence: high – based on the professional experience of the assessment team.

8.5.3.3 Combined Cumulative Effects on Acoustic Environment

The evaluation of the combined cumulative effects of the Project on the acoustic environment considers collectively the assessment of the combined effects on the sound levels and vibration level indicators. Overall, the Project has the potential to contribute to increased sound and vibration emissions from existing and reasonably foreseeable developments. Impact balance is therefore considered negative. Through implementation of industry standard recommended mitigation measures during the construction and operations phases of the Project, the potential for combined cumulative effects on the acoustic environment indicators are considered to be of low to medium magnitude (Table 8.5-2, point 3[a]). A summary of the rationale for all of the significance criteria of combined cumulative effects of the Project on the acoustic environment indicators is provided below.

- Spatial Boundary: Acoustic Environment RSA – the combined effects of the Project and future development on the sound and vibration levels can result in increases when future activities are within 5 km of the Project.
- Duration: long-term – the events causing combined effects on acoustic environment indicators will occur during the construction and operations phases.
- Frequency: continuous – the combined effects of the Project on noise and vibration levels is isolated for construction of the Project but will be continuous for noise at pump stations, tanks and Westridge Marine Terminal operations, therefore any cumulative effect during operations would also be continuous.
- Reversibility: short to long-term – the Project's contribution to combined noise and vibration levels will cease when blasting stops or equipment or facilities are shut down or decommissioned.
- Magnitude: low to medium – with the implementation of appropriate mitigation measures during construction and at the pump stations, tanks and Westridge Marine Terminal during operations, noise and vibration levels at receptors are expected to comply with guidelines at receptors near the activities.
- Probability: high – cumulative effects on the acoustic environment due to sound levels from both the Project and reasonably foreseeable developments may occur based on the proximity of residential receptors to Project activities and the types of developments. The potential for cumulative effects to result in a change in magnitude in sound levels due to the combination of activity sound emissions is considered unlikely but possible. The expected schedule for development compared to the Project schedule indicates that the potential for pipeline construction blasting and Ajax mine blasting to affect vibration levels concurrently is unlikely.
- Confidence: moderate – based on the nature of data inputs.

8.5.4 Summary

As identified in Table 8.5-2, there are no situations where there is a high probability of occurrence of a permanent or long-term cumulative effect of high magnitude that cannot be technically or economically mitigated. Consequently, the Project's contribution to cumulative effects on sound and vibration levels within the Acoustic Environment RSA will be not significant.

8.6 Fish and Fish Habitat

This subsection discusses how the Project could act in combination with existing activities and reasonably foreseeable developments to contribute to cumulative effects on fish and fish habitat indicators that were anticipated to have an adverse combined Project-specific residual effect (*i.e.*, riparian disturbance, instream disturbance, fish mortality and injury and Alberta and BC indicator species).

8.6.1 Reasonably Foreseeable Developments

Tables 8A.1-1, 8A.1-2, 8A.1-3 and 8A.1-4 of Appendix 8.1 provide a list of the certain and reasonably foreseeable developments located within the Aquatics RSA considered in the evaluation of quantitative cumulative effects on the fish and fish habitat indicators. Description of these developments is provided in Section 8.1.4 and is shown on Figures 8.1-1a, 8.1-1b and 8.1-1c. In the Aquatics RSA, there are approximately 68 mapped reasonably foreseeable developments either fully within the Aquatics RSA or, for some transmission lines and pipelines, partially within the Aquatics RSA (Table 8A.1-1 of Appendix 8.1). In addition, there are approximately 2,387 mapped reasonably foreseeable minor oil and gas developments in Alberta: 502 pipelines; 1,617 facilities; and 268 wells (Tables 8A.1-2, 8A.1-3 and 8A.1-4 of Appendix 8.1).

As indicated in Section 8.1, other reasonably foreseeable developments with the potential to act in combination with the Project were excluded from quantitative evaluations since development details (*e.g.*, approval status and location) were either lacking or the development was located within previously disturbed areas of municipal boundaries, such as the city limits of the City of Edmonton and LMDA. Descriptions of these developments are provided in Section 8.1.4 and Table 8A.1-5 for Alberta and Table 8A.1-6 for BC of Appendix 8.1.

The current level of riparian and instream disturbance due to existing activities within the Aquatics RSA as well as the anticipated disturbance attributed to the Project and reasonably foreseeable developments is provided in Tables 8.6-1 and 8.6-2. A hierarchy table was applied during the cumulative effects assessment quantitative analysis to determine priority of overlapping land use features (*i.e.*, features with greater indirect footprint and assumed effects potential are assigned higher priority). In addition, stream crossing density due to existing activities within the Aquatics RSA as well as the anticipated crossing density attributed to the Project and reasonably foreseeable developments is provided in Table 8.6-3 and shown as crossing points on Figures 8.6-1a, 8.6-1b and 8.6-1c.

TABLE 8.6-1

EXISTING AND NEW RIPARIAN DISTURBANCE IN THE AQUATICS RSA

Land Use Feature	Existing Riparian Disturbance (ha)	New Riparian Disturbance (ha)			Total Riparian Disturbance (ha)
		Proposed Project	Reasonably Foreseeable Developments	Total	
Cities/Towns/Communities	5,916.2	0	0	0	5,916.2
Airports/Airfields	3.9	0	2.9	2.9	6.8
Primary Roads	2,972.4	0	0	0	2,972.4
Quarries/Mines/Aggregates	3,571.9	0	973.1	973.1	4,545
Commercial/Industrial Features	1,045.6	0	203.3	203.3	1,248.9
Secondary Roads	3,542	0	0	0	3,542
Railways	1,089	0	0	0	1,089
Oil and Gas Well Sites	396.4	0	2.3	2.3	398.7
Tertiary/Access Roads	2,639.5	0	3.4	3.4	2,642.9
Buildings	2,411.3	0	0	0	2,411.3
Recreation	346.3	0	0	0	346.3
Crop/Pasture Land	56,031.9	0	0	0	56,031.9
Cutlines, Seismic Lines	1,230.5	0	0	0	1,230.5
Transmission/Power Lines	1,057.4	18.6	229	247.6	1,305
Buried Utility Lines	106.7	0	0	0	106.7
Oil and Gas Pipelines	1,014.2	316	187.6	503.6	1,517.8
Hydroelectric Infrastructure	0	0	33.5	33.5	33.5
Trails (Recreation)	1,258.4	0	0	0	1,258.4
Cutblocks	59,106.4	0	0	0	59,106.4
Total	143,740.0	334.6	1,635.1	1,969.7	145,709.7
Total Riparian Area in Aquatics RSA: 717,929.1 ha					

TABLE 8.6-2

EXISTING AND NEW INSTREAM DISTURBANCE IN THE AQUATICS RSA

Land Use Feature	Existing Instream Disturbance (ha)[1]	New Instream Disturbance (ha)			Total Instream Disturbance (ha)
		Proposed Project	Reasonably Foreseeable Developments	Total	
Primary Roads	75.71	0	0	0	75.71
Secondary Roads	44.05	0	0	0	44.05
Railways	28.95	0	0	0	28.95
Tertiary/Access Roads	41.26	0	0.10	0.10	41.36
Cutlines, Seismic Lines	N/A	N/A	N/A	N/A	N/A
Transmission/Power Lines	N/A	N/A	N/A	N/A	N/A

TABLE 8.6-2 Cont'd

Land Use Feature	Existing Instream Disturbance (ha)[1]	New Instream Disturbance (ha)			Total Instream Disturbance (ha)
		Proposed Project	Reasonably Foreseeable Developments	Total	
Buried Utility Lines	5.25	0	0	0	5.25
Oil and Gas Pipelines	33.46	8.52	7.01	15.53	48.99
Hydroelectric Infrastructure	0.00	0	1.12	1.12	1.12
Trails (Recreation)	0.00	0	0	0	0.00
Total	228.67	8.52	8.23	16.75	245.42
Total Instream Area in Aquatics RSA: 60,271.14 ha					

Note: 1 Instream disturbance estimate assumes no trenchless crossings are constructed.

TABLE 8.6-3

EXISTING AND NEW STREAM CROSSING DENSITY IN THE AQUATICS RSA

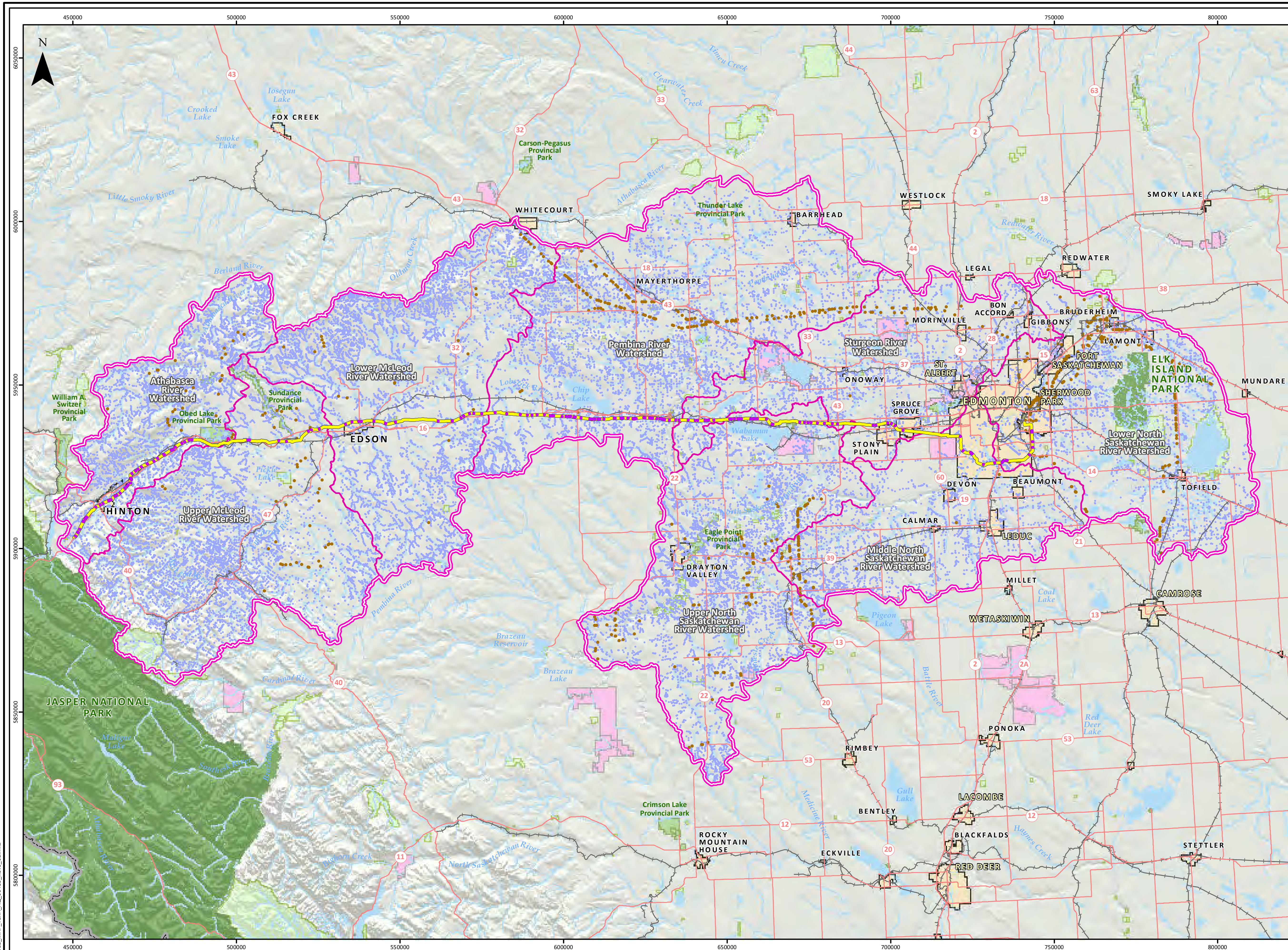
Land Use Feature	Existing Stream Crossing Density (No. Crossings/km² WS)	New Stream Crossing Density (No. Crossings/km² WS)			Total Stream Crossing Density (No. Crossings/km² WS)
		Proposed Project	Reasonably Foreseeable Developments	Total	
Primary Roads	0.08	0	0	0	0.08
Secondary Roads	0.24	0	0	0	0.24
Railways	0.04	0	0	0	0.04
Tertiary Roads	0.56	0	< 0.01	< 0.01	0.56
Cutlines, Seismic Lines	0.33	0	0	0	0.33
Transmission/Power Lines	0.04	< 0.01	0.01	0.01	0.05
Buried Utility Lines	0.11	0	0	0	0.11
Oil and Gas Pipelines	0.14	0.01	< 0.01	0.02	0.15
Hydroelectric Infrastructure	0	0	< 0.01	< 0.01	0
Trails (Recreation)	0	0	0	0	0
Total	1.54	0.01	0.02	0.03	1.57

Note: WS = watershed.

FIGURE 8.6-1a

EXISTING AND NEW STREAM CROSSINGS IN THE AQUATICS RSA ALBERTA

TRANS MOUNTAIN EXPANSION PROJECT



Legend	
●	Existing Linear Disturbance Stream Crossing
●	Project Linear Disturbance Stream Crossing
●	Reasonably Foreseeable Linear Disturbance Stream Crossings
▬	Trans Mountain Expansion Project Proposed Pipeline Corridor
▭	Aquatics Regional Study Area Boundary
▭	Watershed Boundary
•	Village / Hamlet
—1—	Highway
┼┼	Railway
■	City / Town / District Municipality
■	Indian Reserve / Métis Settlement
■	National Park
■	Provincial Park
■	Park / Protected Area
▭	Provincial Boundary

Projection: NAD83 UTM Zone 11N. Baseline TMPL & Facilities: provided by KMC 2012; Proposed Pipeline Corridor V6: provided by UPI Aug. 23, 2013; Transportation: IHS Inc., 2013, BC Forests, Lands and Natural Resource Operations, 2012 & Natural Resources Canada, 2012; Geopolitical Boundaries: Natural Resources Canada, 2003, AltaLIS, 2013, IHS Inc., 2011, BC FLNRO, 2007 & ESRI, 2005; First Nation Lands: Government of Canada, 2013, AltaLIS, 2010 & IHS Inc., 2011; Hydrology: Natural Resources Canada, 2007 & BC Crown Registry and Geographic Base Branch, 2008; Parks and Protected Areas: Natural Resources Canada, 2012, AltaLIS, 2012 & BC FLNRO, 2008; Watershed Boundaries: BC FLNRO 2008, Prairie Farm Rehabilitation Administration - Agriculture and Agri-Food Canada 2008; ATS Grid: AltaLIS, 2009; Canadian Hillshade: TERA Environmental Consultants, 2008.

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Although there is no reason to believe that there are any errors associated with the data used to generate this product or in the product itself, users of these data are advised that errors in the data may be present.

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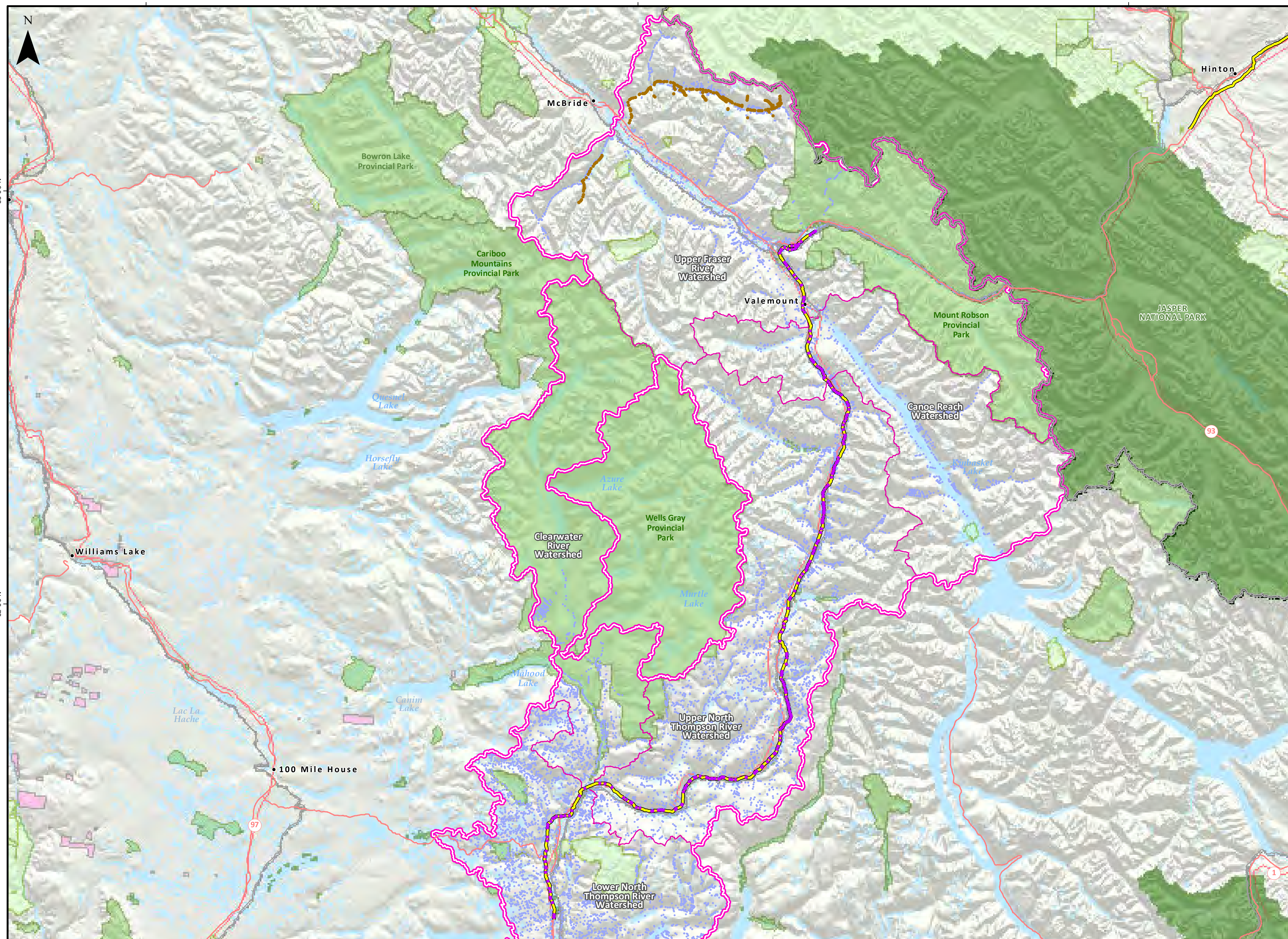

TRANS MOUNTAIN

FIGURE 8.6-1b

EXISTING AND NEW STREAM CROSSINGS IN THE AQUATICS RSA BRITISH COLUMBIA

TRANS MOUNTAIN EXPANSION PROJECT

- Existing Linear Disturbance Stream Crossing
- Project Linear Disturbance Stream Crossing
- Reasonably Foreseeable Linear Disturbance Stream Crossings
- Trans Mountain Expansion Project Proposed Pipeline Corridor
- Aquatics Regional Study Area Boundary
- Watershed Boundary
- Village / Hamlet
- Highway
- Railway
- City / Town / District Municipality
- Indian Reserve / Métis Settlement
- National Park
- Provincial Park
- Park / Protected Area
- Provincial Boundary

Projection: NAD83 UTM Zone 11N. Baseline TMPL & Facilities: provided by KMC 2012; Proposed Pipeline Corridor V6: provided by UPI Aug. 23, 2013; Transportation: IHS Inc., 2013, BC Forests, Lands and Natural Resource Operations, 2012 & Natural Resources Canada, 2012; Geopolitical Boundaries: Natural Resources Canada, 2003, AltaLIS, 2013, IHS Inc., 2011, BC FLNRO, 2007 & ESRI, 2005; First Nation Lands: Government of Canada, 2013, AltaLIS, 2010 & IHS Inc., 2011; Hydrology: Natural Resources Canada, 2007 & BC Crown Registry and Geographic Base Branch, 2008; Parks and Protected Areas: Natural Resources Canada, 2012, AltaLIS, 2012 & BC FLNRO, 2008; Watershed Boundaries: BC FLNRO 2008, Prairie Farm Rehabilitation Administration - Agriculture and Agri-Food Canada 2008; ATS Grid: AltaLIS, 2009; Canadian Hillshade: TERA Environmental Consultants, 2008.

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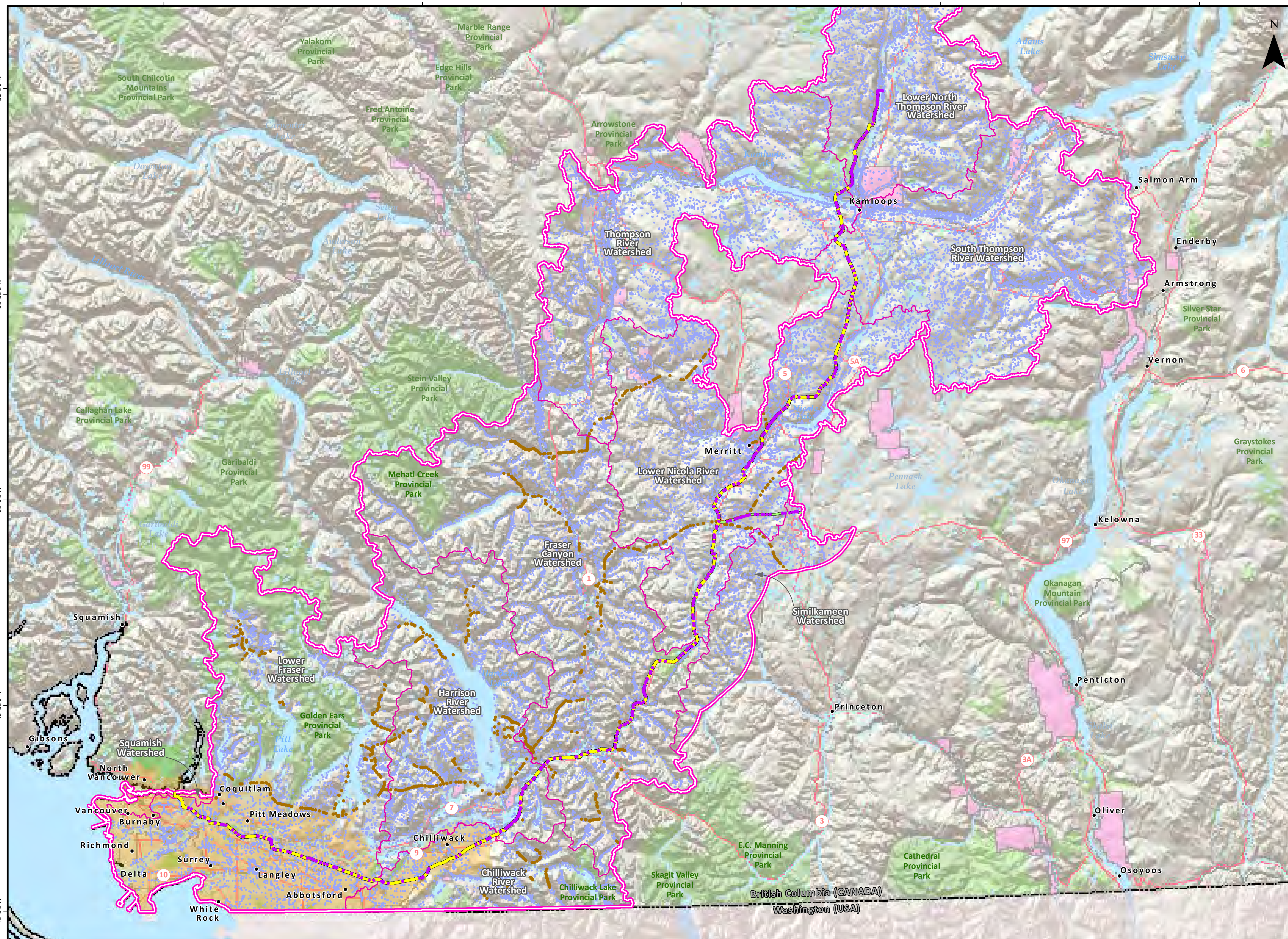

FIGURE 8.6-1c

EXISTING AND NEW STREAM CROSSINGS IN THE AQUATICS RSA BRITISH COLUMBIA

TRANS MOUNTAIN EXPANSION PROJECT

- Existing Linear Disturbance Stream Crossing
- Project Linear Disturbance Stream Crossing
- Reasonably Foreseeable Linear Disturbance Stream Crossings
- Trans Mountain Expansion Project Proposed Pipeline Corridor
- Proposed Power Line
- Aquatics Regional Study Area Boundary
- Watershed Boundary
- Village / Hamlet
- Highway
- Railway
- City / Town / District Municipality
- Indian Reserve / Métis Settlement
- National Park
- Provincial Park
- Park / Protected Area
- Provincial Boundary

Projection: NAD83 UTM Zone 11N. Baseline TMPL & Facilities: provided by KMC 2012; Proposed Pipeline Corridor V6: provided by UPI Aug. 23, 2013; Transportation: IHS Inc., 2013, BC Forests, Lands and Natural Resource Operations, 2012 & Natural Resources Canada, 2012; Geopolitical Boundaries: Natural Resources Canada, 2003, AltaLIS, 2013, IHS Inc., 2011, BC FLNRO, 2007 & ESRI, 2005; First Nation Lands: Government of Canada, 2013, AltaLIS, 2010 & IHS Inc., 2011; Hydrology: Natural Resources Canada, 2007 & BC Crown Registry and Geographic Base Branch, 2008; Parks and Protected Areas: Natural Resources Canada, 2012, AltaLIS, 2012 & BC FLNRO, 2008; Watershed Boundaries: BC FLNRO 2008, Prairie Farm Rehabilitation Administration - Agriculture and Agri-Food Canada 2008; ATS Grid: AltaLIS, 2009; Canadian Hillshade: TERA Environmental Consultants, 2008. Copyright:© 2013 Esri

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ALL LOCATIONS APPROXIMATE

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8.6.2 Potential Cumulative Effects

The potential and likely combined environmental residual effects associated with the construction and operation of the Project on fish and fish habitat indicators were identified in Section 7.2.7 and are listed in Table 8.6-4 along with the identification of existing activities and reasonably foreseeable developments that could act in combination with the Project.

TABLE 8.6-4

POTENTIAL RESIDUAL EFFECTS OF THE PROJECT ON FISH AND FISH HABITAT CONSIDERED FOR THE CUMULATIVE EFFECTS ASSESSMENT

Potential Residual Project Effect on Indicator	Spatial Boundary[1]	Project Component(s)	Temporal Boundary	Potential Cumulative Effect	Existing Activities/Reasonably Foreseeable Developments with Residual Effects Acting in Combination with the Project
1. Combined effects of the Project on riparian habitat.	RSA	Pipeline Temporary Facilities (access roads) Pump Stations (power lines) Tanks (hydrostatic testing) Pipeline Reactivation (hydrostatic testing)	Construction to Operation	Project contribution to cumulative increase in riparian habitat disturbance.	• Existing activities including: agriculture and livestock grazing, forestry, recreation, rural and urban residential and commercial development, transportation and infrastructure development, utilities activities, oil and gas exploration and development, and mineral resource exploration and development. • Reasonably foreseeable developments within the RSA listed in Tables 8A.1-1 to 8A.1-6 of Appendix 8.1 and discussed in Section 8.1.4. • Project-related activities that could interact with the above activities including clearing, topsoil/root zone material salvaging, grading, trenching, backfilling and reclamation of approaches to water crossings and vehicle crossing installation and removal, and bank reclamation.
2. Combined effects of the Project on instream habitat.	RSA	Pipeline Temporary Facilities (access roads) Pump Stations (power lines) Tanks (hydrostatic testing) Pipeline Reactivation (hydrostatic testing)	Construction to Operation	Project contribution to cumulative increase in instream habitat disturbance.	• Existing activities including: agriculture and livestock grazing, forestry, recreation, rural and urban residential and commercial development, transportation and infrastructure development, utilities activities, oil and gas exploration and development, and mineral resource exploration and development. • Reasonably foreseeable developments within the RSA listed in Tables 8A.1-1 to 8A.1-6 of Appendix 8.1 and discussed in Section 8.1.4. • Project-related activities that could interact with the above activities including clearing, topsoil/root zone material salvaging, grading, trenching, backfilling and reclamation of approaches to water crossings and vehicle crossing installation and removal, and bank reclamation.
3. Combined effects of the Project on fish mortality and injury.	RSA	Pipeline Temporary Facilities (access roads) Pump Stations (power lines) Tanks (hydrostatic testing) Pipeline Reactivation (hydrostatic testing)	Construction to Operation	Project contribution to cumulative effects on fish mortality and injury. Project contribution to cumulative effects associated with blockage of fish movements.	• Existing activities including: agriculture and livestock grazing, forestry, recreation, rural and urban residential and commercial development, transportation and infrastructure development, utilities activities, oil and gas exploration and development, and mineral resource exploration and development. • Reasonably foreseeable developments within the RSA listed in Tables 8A.1-1 to 8A.1-6 of Appendix 8.1 and discussed in Section 8.1.4. • Project-related activities that could interact with the above activities including clearing, topsoil/root zone material salvaging, grading, trenching, backfilling and reclamation of approaches to water crossings and vehicle crossing installation and removal, and bank reclamation.

TABLE 8.6-4 Cont'd

Potential Residual Project Effect on Indicator	Spatial Boundary[1]	Project Component(s)	Temporal Boundary	Potential Cumulative Effect	Existing Activities/Reasonably Foreseeable Developments with Residual Effects Acting in Combination with the Project
4. Combined effects of the Project on indicator species (Alberta: Arctic grayling, Athabasca rainbow trout, bull trout, burbot, northern pike and walleye; and BC: bull trout/Dolly Varden, Chinook salmon, coho salmon, cutthroat trout and rainbow trout/steelhead).	RSA	Pipeline Temporary Facilities (access roads) Pump Stations (power lines) Tanks (hydrostatic testing) Pipeline Reactivation (hydrostatic testing)	Construction to Operation	Project contribution to cumulative effects on Arctic grayling. Project contribution to cumulative effects on Athabasca rainbow trout and bull trout. Project contribution to cumulative effects on burbot. Project contribution to cumulative effects on northern pike and walleye. Project contribution to cumulative effects on bull trout/Dolly Varden. Project contribution to cumulative effects on Chinook salmon, coho salmon and cutthroat trout. Project contribution to cumulative effects on rainbow trout/steelhead.	• Existing activities including: agriculture and livestock grazing, forestry, recreation, rural and urban residential and commercial development, transportation and infrastructure development, utilities activities, oil and gas exploration and development, and mineral resource exploration and development. • Reasonably foreseeable developments within the RSA listed in Tables 8A.1-1 to 8A.1-6 of Appendix 8.1 and discussed in Section 8.1.4. • Project-related activities that could interact with the above activities including clearing, topsoil/root zone material salvaging, grading, trenching, backfilling and reclamation of approaches to water crossings and vehicle crossing installation and removal, and bank reclamation.

Note: 1 RSA = Aquatics RSA.

8.6.3 Significance Evaluation of Potential Cumulative Effects

A quantitative analysis was undertaken to evaluate the significance of the Project's contribution to cumulative effects for the disturbance of riparian habitat and instream habitat indicators as these changes were quantifiable. However, as there are no standards, guidelines, objectives or other established and accepted ecological thresholds to define quantitative rating criteria for fish and fish habitat indicators, significance was assessed qualitatively based on the professional judgment of the assessment team.

Table 8.6-5 provides a summary of the significance evaluation of the Project's contribution to potential cumulative effects on fish and fish habitat indicators. The rationale used to evaluate the significance of each of the cumulative effects is provided below.

TABLE 8.6-5

SIGNIFICANCE EVALUATION OF THE PROJECT'S CONTRIBUTION TO CUMULATIVE EFFECTS ON FISH AND FISH HABITAT

Potential Cumulative Effects		Impact Balance	Spatial Boundary[1]	Temporal Context			Magnitude	Probability	Confidence	Significance[2]
				Duration	Frequency	Reversibility				
1.	Fish and Fish Habitat Indicator – Riparian Habitat									
1(a)	Project contribution to cumulative increase in riparian habitat disturbance.	Negative	RSA	Immediate to short-term	Isolated to occasional	Medium to long-term	Low	High	High	Not significant
2.	Fish and Fish Habitat Indicator – Instream Habitat									
2(a)	Project contribution to cumulative increase in instream habitat disturbance.	Negative	RSA	Immediate to short-term	Isolated to occasional	Medium to long-term	Low	High	High	Not significant
3.	Fish and Fish Habitat Indicator – Fish Mortality and Injury									
3(a)	Project contribution to cumulative effects on fish mortality and injury.	Negative	RSA	Immediate to long-term	Occasional to periodic	Long-term	Low	High	High	Not significant
3(b)	Project contribution to cumulative effects associated with blockage of fish movements.	Negative	RSA	Immediate to short-term	Isolated	Immediate to short-term	Low	Low	High	Not significant
4.	Fish and Fish Habitat – Indicator Species									
4(a)	Project contribution to cumulative effects on Arctic grayling.	Negative	RSA	Immediate to short-term	Isolated to occasional	Medium to long-term	Low	High	High	Not significant
4(b)	Project contribution to cumulative effects on Athabasca rainbow trout and bull trout.	Negative	RSA	Immediate to short-term	Isolated to occasional	Medium to long-term	Low	High	High	Not significant
4(c)	Project contribution to cumulative effects on burbot.	Negative	RSA	Immediate to long-term	Isolated to periodic	Long-term	Low	High	High	Not significant
4(d)	Project contribution to cumulative effects on northern pike and walleye.	Negative	RSA	Immediate to short-term	Isolated to occasional	Medium to long-term	Low	High	High	Not significant
4(e)	Project contribution to cumulative effects on bull trout/Dolly Varden.	Negative	RSA	Immediate to short-term	Isolated to occasional	Medium to long-term	Low	High	High	Not significant
4(f)	Project contribution to cumulative effects on Chinook salmon, coho salmon and cutthroat trout.	Negative	RSA	Immediate to short-term	Isolated to occasional	Medium to long-term	Low	High	High	Not significant
4(g)	Project contribution to cumulative effects on rainbow trout/steelhead.	Negative	RSA	Immediate to long-term	Isolated to periodic	Long-term	Low	High	High	Not significant
5.	Project Contribution to Combined Cumulative Effects on Fish and Fish Habitat									
5(a)	Project contribution to combined cumulative effects on the fish and fish habitat indictors (1[a]-4[g]).	Negative	RSA	Immediate to long-term	Isolated to periodic	Immediate to long-term	Low	High	High	Not significant

Notes: 1 RSA = Aquatics RSA.

2 Significant Contribution to a Cumulative Environmental Effect: A high probability of occurrence of a permanent or long-term cumulative effect of high magnitude that cannot be technically or economically mitigated.

8.6.3.1 Fish and Fish Habitat Indicator – Riparian Habitat

Riparian habitat plays an important role in the maintenance of healthy aquatic environments. Riparian vegetation stabilizes streambanks, buffers streams from sedimentation contained in surface runoff, contributes food and nutrients such as insects and organic matter, provides woody debris which contribute to stream diversity, provides shade to help regulate stream temperature, and provides cover that affords safe habitat for smaller fish.

Clearing or disturbance of riparian habitat can affect fish and instream habitat through an increase in sedimentation in the watercourse, decreased bank and approach stability, reductions in stream shading potential and the loss of instream and overhead cover. The degree to which fish can be affected depends upon, among other influences, the total area of disturbed riparian habitat.

The area of riparian habitat disturbance can be used as a quantitative measure of possible bank disturbance, sediment yield and overall watershed health, thereby allowing the Project's contribution to cumulative effects to be estimated (Anderson 1996, Beaudry 1998, CAPP *et al.* 2005, Haas 2001, Hughes *et al.* 2004, Salmo *et al.* 2003, Sawyer and Mayhood 1998, Scrimgeour *et al.* 2003, Sloat *et al.* 2001). Project facilities and activities are located in 8 watersheds within the Athabasca and North Saskatchewan river drainages in Alberta and 13 watersheds within the Fraser, Thompson and Columbia river drainages, and 1 coastal watershed in BC. Watersheds crossed by the Project reflect a broad range of riparian habitat conditions due to past land use activities (Fisheries [Alberta] Technical Report and Fisheries [BC] Technical Report of Volume 5C).

Quantitative analyses were completed for each watershed crossed by the proposed pipeline corridor using readily available data sources as described in Section 8.1.5.1. The potential area of riparian habitat lost or altered was calculated for existing activities, the Project and reasonably foreseeable development activities. Criteria, which are based on channel width, exist for protecting riparian areas from development activities (*e.g.*, riparian management areas in the *Environmental Protection and Management Regulation* of the *Oil and Gas Activities Act* that range from 100 m for large, fish-bearing watercourses to 20 m for small, nonfish-bearing watercourses). For this desktop analysis, it was necessary to assume a standardized riparian width of 30 m for all waterbodies in riparian disturbance calculations because it was not practical to determine the channel width and fish-bearing status of all waterbodies in the Aquatics RSA (AESRD 2012). Disturbance of riparian areas from the Project, existing and reasonably foreseeable development activities, were estimated. Note that riparian disturbance attributed to reasonably foreseeable development is underestimated because spatial data on future harvesting and associated roads was not available.

Existing activities that have disturbed riparian habitat include agriculture (including grazing), rural and urban residential and commercial development, transportation and infrastructure development (*e.g.*, road and rail networks), utility activities, forestry, mineral resource exploration and development, ongoing recreational activities, and oil and gas exploration and development (*e.g.*, seismic cutlines and pipelines). It is anticipated that the Project and reasonably foreseeable developments (as identified in Tables 8A.1-1, 8A.1-2, 8A.1-3 and 8A.1-4 of Appendix 8.1) have the potential to act cumulatively to increase riparian disturbance within the Aquatics RSA in both Alberta and BC. Characterization of the Project's contribution to cumulative effects on riparian disturbance relied on available hazard ratings and the professional judgment of the assessment team. Hazard levels assigned based on the BC Interior Watershed Assessment Procedure (BCFS and BCE 1995) were:

- low hazard: 0-9% disturbed;
- medium hazard: > 9-18% disturbed; and
- high hazard: > 18% disturbed.

Results of riparian disturbance estimates are provided in Tables 8.6-6 and 8.6-7 for each watershed crossed by the proposed pipeline corridor, since potential cumulative effects on fish and fish habitat are most appropriately considered at the watershed scale. From an aquatics perspective, land use features are concentrated in the eastern half of the Alberta Aquatics RSA, (*i.e.*, Sturgeon, Pembina, Upper/Mid/Lower Saskatchewan river watersheds) and in the central portion of the BC Aquatics RSA (*i.e.*, Lower North and South Thompson rivers, the Thompson River and the Lower Nicola River watersheds). Currently, forest harvesting and agriculture are the largest contributors to riparian disturbance in the Aquatics RSA (Table 8.6-1). Alberta TEK participants specifically noted the decrease in water quality and fish populations over the past 30 years in the Edmonton to Hinton region, which they consider to be due to the cumulative effects of pollution and industrial development. As mentioned in Section 8.1.5, larger municipalities, such as the City of Edmonton and the LMDA, were excluded from the quantitative analysis with the exception of the portion of the Golden Ears Connector development through a City of Surrey greenbelt. However, no riparian habitat in the greenbelt is affected by this reasonably foreseeable development or the Project. Effects of the Project on riparian habitat were addressed in Section 7.2.7.

Cumulative effects hazard resulting from riparian disturbance is currently:

- low in the Upper Fraser River, Canoe Reach and Clearwater River watersheds (*i.e.*, 1.50-3.65%);

- moderate in the Upper North Thompson River, Fraser Canyon, Harrison River, Chilliwack River, and Upper McLeod River watersheds (*i.e.*, 11.79-14.89%); and
- high in all remaining watersheds, ranging from 19.03-75.63%.

Existing disturbance of riparian areas is highest in the Lower North Saskatchewan River watershed and is due primarily to agriculture. Cumulative effects hazard is projected to increase incrementally in all watersheds as a result of reasonably foreseeable developments and the Project (*i.e.*, 0.49% increase for Alberta and 0.19% for BC), and is projected to remain the highest in the Lower North Saskatchewan River watershed. The largest incremental increase is projected to occur in the Upper McLeod River watershed and is due primarily to reasonably foreseeable developments (*i.e.*, proposed coal mine developments). The incremental increase in riparian disturbance does not affect the hazard rating in any of the assessed watersheds.

The Project may contribute < 0.01- 0.15%, or an average of 0.05%, to total riparian habitat disturbance in the Aquatics RSA. The mitigation measures outlined in Section 7.2.7.4 (*e.g.*, seeding disturbed riparian areas with the appropriate native seed mix, along with a quick establishing cover crop and additional revegetation efforts, such as planting trees or shrubs at select locations), will limit the Project's contribution to cumulative effects. In addition, it is expected that many other land users will implement riparian habitat protection measures to reduce incremental effects of their activities, as recommended in federal and provincial guidelines and best management practices discussed in Section 7.1.1.2 of the Fisheries (BC) Technical Report, Section 7.1.2 of the Fisheries (Alberta) Technical Report and in activity-specific guidance documents for grazing, back-country tourism and off-roading (BC MFLNRO 2011, BC MFR 2008, BC MOE 2006, Fraser 2009). No mitigation measures beyond the Project-specific mitigation already proposed in Section 7.0 and the Pipeline and Facilities EPPs (Volumes 6B and 6C) are deemed to be warranted.

TABLE 8.6-6

ESTIMATED DISTURBANCES OF RIPARIAN AREAS WITHIN THE ALBERTA AQUATICS RSA

Riparian Disturbance Assessment Scenario	Area (ha) and Percentage of Riparian Disturbance for Each Watershed[1] in Alberta Aquatics RSA							
	Sturgeon River	Lower N. Saskatchewan River	Upper N. Saskatchewan River	Pembina River	Upper McLeod River	Lower McLeod River	Athabasca River	Alberta RSA Total
Total Riparian Area in each Watershed	17,771.6	21,765.7	30,340.3	40,239.2	38,947.5	27,409.8	16,708.0	193,182.1
Existing Riparian Disturbance								
Existing Disturbance of Riparian Area[2,3]	(12,531.2) 70.51	(16,462.5) 75.63	(13,668.0) 45.05	(18,131.5) 45.06	(4,593.1) 11.79	(5,362.7) 19.57	(3,178.8) 19.03	(73,927.8) 38.27
Future Riparian Disturbance								
Amount of Disturbance of Riparian Area Attributed to the Project (Project)[2]	(8.1) 0.05	(1.4) 0.01	(7.8) 0.03	(19.3) 0.05	(3.1) 0.01	(6.1) 0.02	(17.3) 0.10	(63.1) 0.03
Amount of Disturbance of Riparian Area Attributed to Reasonably Foreseeable Developments (Likely Future)[2,3]	(23.5) 0.13	(106.4) 0.49	(115.3) 0.38	(71.8) 0.18	(508.8) 1.31	(12.0) 0.04	(56.3) 0.34	(894.1) 0.46
Cumulative Effects								
Total Cumulative Riparian Disturbance (Existing+Project+Likely Future)	(12,562.8) 70.69	(16,570.3) 76.13	(13,791.1) 45.46	(18,222.6) 45.29	(5,105.0) 13.11	(5,380.8) 19.63	(3,252.4) 19.47	(74,885.0) 38.76
Total Cumulative Riparian Disturbance without Project (Existing+Likely Future)	(12,554.7) 70.64	(16,568.9) 76.12	(13,783.3) 45.43	(18,203.3) 45.24	(5,101.9) 13.10	(5,374.7) 19.61	(3,235.1) 19.36	(74,821.9) 38.73
Total Cumulative Riparian Disturbance Without Reasonably Foreseeable Development (Existing+Project)	(12,539.3) 70.56	(16,463.9) 75.64	(13,675.8) 45.08	(18,150.8) 45.11	(4,596.2) 11.80	(5,368.8) 19.59	(3,196.1) 19.13	(73,990.9) 38.30

Notes: 1 The Middle North Saskatchewan River watershed is not included because Project riparian disturbance in this watershed is located within the City of Edmonton, and the City of Edmonton has been excluded from the quantitative analysis (Section 8.1.5).

2 Calculations based on an average of 30 m riparian area on each bank at all waterbodies.

3 Calculations based on footprint disturbances provided in Table 8.1-1 and are approximate.

TABLE 8.6-7

ESTIMATED DISTURBANCES OF RIPARIAN AREA WITHIN THE BC AQUATICS RSA

Riparian Disturbance Assessment Scenario	Area (ha) and Percentage of Riparian Disturbance for Each Watershed[1] in the BC Aquatics RSA												
	Upper Fraser River	Canoe Reach	Upper North Thompson River	Clearwater River	Lower North Thompson River	Thompson River	South Thompson River	Lower Nicola River	Similkameen	Fraser Canyon	Harrison River	Chilliwack River	BC RSA Total
Total Riparian Area in each Watershed	85,022.8	31,699.2	58,720.3	45,771.3	56,233.3	46,169.6	39,756.2	43,981.4	8,329.4	62,402.8	34,261.9	12,398.8	52,4747.0
Existing Riparian Disturbance													
Existing Disturbance of Riparian Area[2,3]	(2,706.9) 3.18	(1,157.6) 3.65	(6,201.4) 10.56	(688.0) 1.50	(13,658.0) 24.29	(9,089.7) 19.69	(10,074.1) 25.34	(8,746.6) 19.89	(1,908.6) 22.91	(8926.9) 14.30	(5101.1) 14.89	(1553.3) 12.53	(69812.2) 13.31
Future Riparian Disturbance													
Amount of Disturbance of Riparian Area Attributed to the Project (Project)[2]	(12.3) 0.01	(5.7) 0.02	(78.0) 0.13	(0.3) <0.01	(41.2) 0.07	(4.2) 0.01	(10.7) 0.03	(69.9) 0.15	(2.5) 0.03	(28.6) 0.05	(15.6) 0.05	(2.5) 0.02	(271.5) 0.05
Amount of Disturbance of Riparian Area Attributed to Reasonably Foreseeable Developments (Likely Future)[2,3]	(47.5) 0.06	(0.0) 0.00	(27.8) 0.05	(0.0) 0.00	(231.0) 0.41	(76.7) 0.17	(110.4) 0.28	(47.0) 0.11	(4.4) 0.05	(104.0) 0.17	(76.9) 0.22	(15.3) 0.12	(741.0) 0.14
Cumulative Effects													
Total Cumulative Riparian Disturbance (Existing+Project+Likely Future)	(2,766.7) 3.25	(1,163.3) 3.67	(6,307.2) 10.74	(688.3) 1.50	(13,930.2) 24.77	(9,170.6) 19.87	(10,195.2) 25.65	(8,863.5) 20.15	(1,915.5) 22.99	(9,059.5) 14.52	(5,193.6) 15.16	(1,571.1) 12.67	(70,824.7) 13.50
Total Cumulative Riparian Disturbance without Project (Existing+Likely Future)	(2,754.4) 3.24	(1,157.6) 3.65	(6,229.2) 10.61	(688.0) 1.50	(13,889.0) 24.70	(9,166.4) 19.86	(10,184.5) 25.62	(8,793.6) 19.99	(1,913.0) 22.96	(9,030.9) 14.47	(5,178.0) 15.11	(1,568.6) 12.65	(70,553.2) 13.45
Total Cumulative Riparian Disturbance Without Reasonably Foreseeable Development (Existing+Project)	(2,719.2) 3.20	(1,163.3) 3.67	(6,279.4) 10.69	(688.3) 1.50	(13,699.2) 24.36	(9,093.9) 19.70	(10,084.8) 25.37	(8,816.5) 20.04	(1,911.1) 22.94	(8,955.5) 14.35	(5,116.7) 14.94	(1,555.8) 12.55	(70,083.7) 13.36

Notes:

1. The Lower Fraser River and Squamish watersheds are not included because Project riparian disturbance in these watersheds is located within the LMDA, and the LMDA has been excluded from the quantitative analysis (Section 8.1.5).
2. Calculations based on an average of 30 m riparian area on each bank at all waterbodies.
3. Calculations based on footprint disturbances provided in Table 8.1-1 and are approximate.

Given that the Project is adjacent to existing linear disturbances and clearings, where practical, and the Project's contribution is 0.05% of combined riparian disturbance, the Project's contribution to total watershed riparian disturbance is of low magnitude. The cumulative effect of clearing riparian vegetation is considered to be reversible in the medium to long-term, depending on the pre-existing vegetation community (*e.g.*, grasses and shrubs regenerate within several years, but tree canopy regrowth is expected to extend into the long-term) (Table 8.6-5, point 1[a]). A summary of the rationale for all of the significance criteria of combined cumulative effects on riparian habitat is provided below.

- Spatial Boundary: Aquatics RSA – Project pipeline disturbance will be confined to the Fish and Fish Habitat LSA, but watershed-scale effects from overlapping disturbance could extend to the RSA.
- Duration: immediate to short-term – Project activities causing disturbance of riparian vegetation occurs during the construction phase or maintenance during the operations phase (lasting 2 days to less than 1 year).
- Frequency: isolated to occasional – the Project's contribution to cumulative changes in riparian habitat occurs during construction and then intermittently, but sporadically, over the assessment period during maintenance activities.
- Reversibility: medium to long-term – depending upon the pre-construction vegetation community (*e.g.*, grasses and shrubs regenerate within several years, however, tree canopy regrowth is expected to extend into the long-term) and the extent of clearing or alteration of riparian vegetation required for maintenance activities.
- Magnitude: low – the Project's incremental contribution represents 0.05% of the combined riparian disturbance; for comparison purposes a change in the hazard index of 0.1 is equivalent to a 3% increase in riparian disturbance as per the BC Interior Watershed Assessment Procedure. The Project will implement federal and provincial guidance recommendations and the proposed pipeline corridor will follow existing linear disturbances for approximately 89% of its length to reduce watershed-scale riparian disturbance.
- Probability: high – clearing or disturbance of riparian vegetation is expected to occur at all trenched watercourse crossings and any existing activities and/or reasonably foreseeable developments within the Aquatics RSA occurring in proximity to watercourses, having the potential to cause changes in riparian habitat.
- Confidence: high – based on available research literature and the professional experience of the assessment team.

8.6.3.2 Fish and Fish Habitat Indicator – Instream Habitat

Fish need spawning, incubation, rearing, adult feeding and overwintering habitats over their lifetime. The importance of these habitats varies between species and populations and the availability of one or more components may be limiting. Migrant populations must pass through several distinct habitats while moving between feeding, breeding and overwintering areas; these migration corridors are also important habitat features (Meehan 1991).

Direct habitat loss occurs where the bed or banks of waterbodies are disturbed and recovery to preconstruction conditions does not occur. This reduces the quantity of habitat for specific species and life history stages. In extreme cases like stream diversions and channel dewatering, habitat for all aquatic species may be lost. Urban or agricultural development on lakeshores such as dykes, docks, marinas and vegetation removal can alter the physical structure of inshore habitats, rendering them unsuitable for spawning or rearing (Ford *et al.* 1995).

Habitat alteration occurs where waterbodies are disturbed and habitat attributes such as substrate and depth are deliberately or inadvertently changed. In cases where recovery of existing habitat units is allowed or encouraged, the effect of habitat alteration will occur only until the pre-construction conditions are re-established at watercourse crossings. Long-term or permanent habitat alteration can occur where recovery or restoration of different habitat units is accepted (*e.g.*, converting shallow riffle areas to deeper pools). Habitat may also be altered by the introduction of non-native or exotic vegetation that modifies substrate, banks or trophic relationships. Grazing where cattle have direct access to stream channels can disturb instream substrates, negatively impact streambank structure, and result in deposition of manure and urine in the stream.

Changes in water quality and temperature may occur downstream of industrial and municipal stormwater and cooling pond discharges. Indirect introduction of chemical contaminants may also occur where compounds are adsorbed to sediment, deposited from the atmosphere, or released during accidents and malfunctions. Finally, water level control structures, water withdrawals and direct or indirect changes in seasonal flow patterns and peak and minimum flows (*e.g.*, from forest clearing, road networks and hydrostatic testing) can alter instream habitat.

Construction and maintenance of road, transportation, and utility watercourse crossings and other clearing or disturbance of riparian habitat can alter the physical characteristics of a watercourse's bed and banks, result in short-term or chronic erosion that affects water quality and substrate composition, and cause inadvertent inflow of road salt and contaminants from accidental spills. The continued use of these rights-of-way for stream access can exacerbate this concern. The influence of these combined changes on instream habitat depends upon several factors, including: natural variability in channel structure and water quality; season, the volume and extent of contamination or sedimentation; and the type of habitat lost or altered and its use by each species and life cycle stage.

The combined area of instream habitat disturbance was used as a measure of the potential direct disturbance within a stream channel, thereby allowing the Project's contribution to cumulative effects to be estimated. Quantitative analyses were completed for each watershed crossed by the proposed pipeline corridor using readily available data sources as described in Section 8.1.5.1. The area of instream habitat potentially lost or altered by existing activities, the Project, and linear reasonably foreseeable developments were calculated (linear features as identified in Tables 8A.1-1 and 8A.1-2 of Appendix 8.1). GIS hydrology data available for Alberta and BC only provides an indication of channel width for major rivers (*i.e.*, Freshwater Atlas [FWA] of BC river dataset and Base Features hydrology dataset for Alberta). Consequently, Project-specific watercourse crossing data were used to calculate an average channel width on a provincial basis for all streams not included in the major river datasets. Assumptions in the calculation of instream disturbance include:

- it was assumed that instream disturbance would occur at only 50% of mapped crossings, recognizing that only a limited number of existing crossings may continue to contribute to instream disturbance (Harper and Quigley 2000); and
- crossings by transmission lines and cutlines were assumed to not contribute to instream disturbance.

Existing activities that have potentially resulted in disturbed instream habitat include agriculture, rural and urban residential and commercial development, transportation and infrastructure development (*e.g.*, road and rail networks), utility activities, forestry, mineral resource exploration and development, ongoing recreational use of linear features, and oil and gas pipelines. It is expected that the Project and reasonably foreseeable developments (as identified in Tables 8A.1-1 and 8A.1-2 of Appendix 8.1) will have the potential to act cumulatively to increase instream disturbance within the Aquatics RSA. Note that instream disturbance attributed to reasonably foreseeable development is underestimated because spatial data on future harvesting and associated roads was not available.

As mentioned in Section 8.1.5, larger municipalities, such as the City of Edmonton and the LMDA, were excluded from the quantitative analysis with the exception of the portion of the Golden Ears Connector development through a City of Surrey greenbelt. However, no instream habitat in the greenbelt is affected by this reasonably foreseeable development or the Project. Effects of the Project on instream habitat were addressed in Section 7.2.7.

Instream disturbance estimates for existing activities, the Project, and reasonably foreseeable developments are provided in Tables 8.6-8 and 8.6-9, for each watershed crossed by the Project. If practical, approximately 22 watercourses along the proposed pipeline corridor will be crossed using a trenchless crossing technique. Therefore, Tables 8.6-8 and 8.6-9 provide the following two estimates of instream disturbance arising from construction of the Project: assuming all proposed trenchless crossings are implemented, and assuming none of the proposed trenchless crossings are implemented.

TABLE 8.6-8

ESTIMATED DISTURBANCES OF INSTREAM AREA WITHIN THE ALBERTA AQUATICS RSA

Instream Disturbance Assessment Scenario	Area (ha) and Percentage of Instream Disturbance for each Watershed[1] in Alberta Aquatics RSA							
	Sturgeon River	Lower N. Saskatchewan River	Upper N. Saskatchewan River	Pembina River	Upper McLeod River	Lower McLeod River	Athabasca River	Alberta RSA Total
Total Instream Area in each Watershed	472.25	1,081.22	4,790.75	2,723.17	3,016.75	2,777.99	2,483.98	17,346.11
Existing Instream Disturbance								
Existing Disturbance of Instream Area[2]	(4.30) 0.91	(11.50) 1.06	(13.66) 0.29	(10.04) 0.37	(7.23) 0.24	(7.25) 0.26	(6.67) 0.27	(60.65) 0.35
Future Disturbance								
Area of Instream Disturbance Attributed to the Project, Assuming No Trenchless Crossings (Project)[2]	(0.06) 0.01	(0.01) < 0.01	(0.07) < 0.01	(0.26) 0.01	(0.02) < 0.01	(0.33) 0.01	(0.18) 0.01	(0.93) < 0.01
Area of Instream Disturbance Attributed to the Project, Assuming Trenchless Crossings are Constructed (Project)[2]	(0.06) 0.01	(0.01) < 0.01	(0.07) < 0.01	(0.18) 0.01	(0.02) < 0.01	(0.04) < 0.01	(0.18) 0.01	(0.56) < 0.01
Area of Instream Disturbance Attributed to Reasonably Foreseeable Developments (Likely Future)[2]	(0.24) 0.05	(3.55) 0.33	(0.48) 0.01	(1.85) .07	(0.27) < 0.01	(0.45) 0.02	(0.10) < 0.01	(6.94) 0.04
Cumulative Effects (Assuming no Trenchless Crossings by Proposed Project)								
Total Cumulative Instream Disturbance (Existing+Project+Likely Future)	(4.60) 0.97	(15.06) 1.39	(14.21) 0.30	(12.15) 0.45	(7.52) 0.25	(8.03) 0.29	(6.95) 0.28	(68.52) 0.40
Total Cumulative Instream Disturbance without Project (Existing+Likely Future)	(4.54) 0.96	(15.05) 1.39	(14.14) 0.30	(11.89) 0.44	(7.50) 0.25	(7.70) 0.28	(6.77) 0.27	(67.59) 0.39
Total Cumulative Instream Disturbance Without Reasonably Foreseeable Development (Existing+Project)	(4.36) 0.92	(11.51) 1.06	(13.73) 0.29	(10.30) 0.38	(7.25) 0.24	(7.58) 0.27	(6.85) 0.28	(61.58) 0.36
Cumulative Effects (Assuming all Proposed Project Trenchless Crossings are Constructed)								
Total Cumulative Instream Disturbance (Existing+Project+Likely Future)	(4.60) 0.97	(15.06) 1.39	(14.21) 0.30	(12.07) 0.45	(7.52) 0.25	(7.74) 0.28	(6.95) 0.28	(68.15) 0.39
Total Cumulative Instream Disturbance without Project (Existing+Likely Future)	(4.54) 0.96	(15.05) 1.39	(14.14) 0.30	(11.89) 0.44	(7.50) 0.25	(7.70) 0.28	(6.77) 0.27	(67.59) 0.39
Total Cumulative Instream Disturbance Without Reasonably Foreseeable Development (Existing+Project)	(4.36) 0.92	(11.51) 1.06	(13.73) 0.29	(10.22) 0.38	(7.25) 0.24	(7.29) 0.26	(6.85) 0.28	(61.21) 0.35

Notes:
1 The Middle North Saskatchewan River watershed is not included because Project instream disturbance in this watershed is located within the City of Edmonton, and the City of Edmonton has been excluded from the quantitative analysis (Section 8.1.5).

2 Calculations based on footprint disturbances provided in Table 8.1-1 and are approximate.

TABLE 8.6-9

ESTIMATED DISTURBANCES OF INSTREAM AREA WITHIN THE BC AQUATICS RSA

Instream Disturbance Assessment Scenario	Area (ha) and Percentage of Instream Disturbance for each Watershed[1] in BC Aquatics RSA											
	Upper Fraser River	Canoe Reach	Upper North Thompson River	Clearwater River	Lower North Thompson River	Thompson River	South Thompson River	Lower Nicola River	Fraser Canyon	Harrison River	Chilliwack River	BC RSA Total
Total Instream Area in each Watershed	6,116.78	1,385.25	4,652.93	2,522.38	5,565.26	4,160.23	2,781.32	2,131.11	5,350.18	7,506.40	753.19	42,925.03
Existing Instream Disturbance												
Existing Disturbance of Instream Area[2]	(7.31) 0.12	(1.25) 0.09	(15.37) 0.33	(2.62) 0.10	(24.63) 0.44	(23.58) 0.57	(19.63) 0.71	(21.46) 1.01	(24.00) 0.45	(24.57) 0.33	(3.60) 0.48	(168.02) 0.39
Future Disturbance												
Area of Instream Disturbance Attributed to the Project, Assuming No Trenchless Crossings (Project)[2]	(0.48) 0.01	(0.17) 0.01	(2.21) 0.05	(0.25) 0.01	(0.59) 0.01	(1.18) 0.03	(0.16) 0.01	(1.06) 0.05	(0.95) 0.02	(0.49) 0.01	(0.05) 0.01	(7.59) 0.02
Area of Instream Disturbance Attributed to the Project, Assuming Trenchless Crossings are Constructed (Project)[2]	(0.48) 0.01	(0.17) 0.01	(0.52) 0.01	(0.0) 0.00	(0.52) 0.01	(0.06) < 0.01	(0.16) 0.01	(0.81) 0.04	(0.75) 0.01	(0.49) 0.01	(0.05) 0.01	(4.01) 0.01
Area of Instream Disturbance Attributed to Reasonably Foreseeable Developments (Likely Future)[2]	(0.17) < 0.01	(0.0) 0.00	(0.0) 0.00	(0.0) 0.00	(0.0) 0.00	(0.0) 0.00	(0.0) 0.00	(0.07) < 0.01	(0.78) 0.01	(0.14) < 0.01	(0.13) 0.02	(1.29) < 0.01
Cumulative Effects (Assuming no Trenchless Crossings by Proposed Project)												
Total Cumulative Instream Disturbance (Existing+Project+Likely Future)	(7.96) 0.13	(1.42) 0.10	(17.58) 0.38	(2.87) 0.11	(25.22) 0.45	(24.76) 0.60	(19.79) 0.72	(22.59) 1.06	(25.73) 0.48	(25.20) 0.34	(3.78) 0.51	(176.90) 0.41
Total Cumulative Instream Disturbance without Project (Existing+Likely Future)	(7.48) 0.12	(1.25) 0.09	(15.37) 0.33	(2.62) 0.10	(24.63) 0.44	(23.58) 0.57	(19.63) 0.71	(21.53) 1.01	(24.78) 0.46	(24.71) 0.33	(3.73) 0.50	(169.31) 0.39
Total Cumulative Instream Disturbance Without Reasonably Foreseeable Development (Existing+Project)	(7.79) 0.13	(1.42) 0.10	(17.58) 0.38	(2.87) 0.11	(25.22) 0.45	(24.76) 0.60	(19.79) 0.72	(22.52) 1.06	(24.95) 0.47	(25.06) 0.34	(3.65) 0.49	(175.61) 0.41
Cumulative Effects (Assuming all Proposed Project Trenchless Crossings are Constructed)												
Total Cumulative Instream Disturbance (Existing+Project+Likely Future)	(7.96) 0.13	(1.42) 0.10	(15.89) 0.34	(2.62) 0.10	(25.15) 0.45	(23.64) 0.57	(19.79) 0.72	(23.34) 1.05	(25.53) 0.48	(25.20) 0.34	(3.78) 0.51	(173.32) 0.40
Total Cumulative Instream Disturbance without Project (Existing+Likely Future)	(7.48) 0.12	(1.25) 0.09	(15.37) 0.33	(2.62) 0.10	(24.63) 0.44	(23.58) 0.57	(19.63) 0.71	(21.53) 1.01	(24.78) 0.46	(24.71) 0.33	(3.73) 0.50	(169.31) 0.39
Total Cumulative Instream Disturbance Without Reasonably Foreseeable Development (Existing+Project)	(7.79) 0.13	(1.42) 0.10	(15.89) 0.34	(2.62) 0.10	(25.15) 0.45	(23.64) 0.57	(19.79) 0.72	(22.27) 1.04	(24.75) 0.46	(25.06) 0.34	(3.65) 0.49	(172.03) 0.40

Notes:

1. The Lower Fraser River and Squamish watersheds are not included because Project instream disturbance in these watersheds is located within the LMDA, and the LMDA has been excluded from the quantitative analysis (Section 8.1.5).

   The Similkameen watershed is not included because there is no Project instream disturbance in this watershed.

2. Calculations based on footprint disturbances provided in Table 8.1-1 and are approximate.

Potential instream disturbance currently ranges from 0.09-1.06 % with the highest proportion in the Lower North Saskatchewan River watershed, as was the case for riparian disturbance. The Project (assuming no trenchless crossings) and reasonably foreseeable developments would increase instream disturbance incrementally in all watersheds (*i.e.*, increase of 0.04% in Alberta and 0.02% in BC), with greatest total disturbance predicted to remain highest in the Lower North Saskatchewan watershed. The Project's overall contribution to combined instream habitat disturbance would be < 0.01% in Alberta and 0.02% in BC; the Project's contribution to instream disturbance is projected to be highest in the Upper North Thompson and Lower Nicola river watersheds at 0.05%. The Project's effect on instream disturbance would be reduced if all proposed trenchless crossings are constructed, particularly in BC, to approximately 0.01% of available habitat.

Trenched pipeline crossings, the installation, use and removal of temporary vehicle crossings, and hydrostatic testing associated with the Project will likely result in a temporary disruption of instream habitat function; however, some existing and reasonably foreseeable developments can be expected to cause long-term, continuous effects on water quality and flow characteristics. The Project's contribution to changes in instream habitat function will be reduced through the use of trenchless crossings where practical, and the implementation of industry-standard mitigation measures provided in Section 7.0 and the Pipeline EPP (Volume 6B), which have been recommended by industry as well as provincial and federal agencies (*e.g.*, CAPP *et al.* 2005) as effective measures to reduce the loss and alteration of instream habitat. A fish habitat compensation/offset plan may be developed to ensure serious harm to fish or any permanent alteration to, or destruction of, fish habitat does not result. Water quality monitoring will be conducted to document potential sediment loading from instream activities where sensitive fish habitat is present. In addition, it is anticipated that many other land users will implement mitigation measures prescribed by legislation or identified in federal and provincial guidance documents to reduce incremental effects of their activities (refer to Section 8.6.3.1 above). No mitigation measures beyond the Project-specific mitigation already proposed in Section 7.0 and the Pipeline and Facilities EPPs (Volumes 6B and 6D) are deemed to be warranted to reduce the potential for cumulative effects on instream disturbance.

Given that the Project's contribution to combined instream disturbance is 0.01%, federal and provincial guidance recommendations will be implemented, and trenchless crossings constructed where practical, the Project's contribution to total watershed instream loss is concluded to be of low magnitude. The Project's contribution to cumulative effects on instream habitat loss and alteration is considered to be reversible in the medium to long-term, depending on the pre-existing channel structure, channel composition, seasonal flow characteristics and potential continued off-highway vehicle activity (Table 8.6-5, point 2[a]). A summary of the rationale for all of the significance criteria of combined cumulative effects on instream habitat is provided below.

- Spatial Boundary: Aquatics RSA – Project pipeline disturbance will be confined to the Fish and Fish Habitat LSA, but watershed-scale effects from overlapping disturbance could extend to the RSA.
- Duration: immediate to short-term – Project activities contributing to disturbance of instream habitat occur during the construction phase or maintenance during the operations phase (lasting 2 days to less than 1 year).
- Frequency: isolated to occasional – the Project events contributing to the cumulative changes to instream habitat occur during construction and then intermittently, but sporadically, over the assessment period during maintenance activities.
- Reversibility: medium to long-term – depending upon the pre-construction channel characteristics and future flow regime, and potential continued stream access by off-highway vehicles.
- Magnitude: low – in addition to the construction of trenchless crossings where practical, alignment along existing rights-of-way where possible, the Project will implement federal and provincial guidance recommendations (*e.g.*, timing window requirements, restoration of channel profile, bank stabilization measures, tree and shrub plantings to prevent access) and, consequently, will not substantially contribute to total instream disturbances in the Aquatics RSA.

- Probability: high – bank and instream activities at all trenched watercourse crossings and any existing activities and/or reasonably foreseeable developments within the Aquatics RSA occurring in proximity to watercourses have the potential to cause changes in instream habitat.
- Confidence: high – based on available research literature and the professional experience of the assessment team.

8.6.3.3 Fish and Fish Habitat Indicator – Fish Mortality and Injury

Combined Effects on Fish Mortality and Injury Due to Sedimentation and Access

Fish population dynamics reflect the combined influence of physical, chemical and biotic factors and harvest on growth, survival and reproduction. As a result, observed population size and parameters vary greatly among populations and years (Hayes *et al.* 1996, Kocovsky and Carline 2001, Mosindy *et al.* 1987). Human sources of fish mortality and injury in the Aquatics RSA include commercial, recreational, and subsistence harvest, water withdrawals, sedimentation (due to instream construction and off-road vehicle fordings), and acute and chronic effects from approved or accidental discharge of contaminants.

The construction of new rights-of-way (*e.g.*, pipeline or transmission line) can result in increased access along the resulting corridors for a variety of other resource user groups (*e.g.*, off-highway vehicles, anglers). In turn, this can potentially result in negative effects on fishes and their habitat either through direct harvesting or indirect effects such as fish habitat degradation and sediment input resulting from vehicle fording. The introduction of fine sediment to watercourses, right-of-way runoff and erosion can have sub-lethal (*e.g.*, irritation of gill tissues) and lethal (*e.g.*, suffocation of developing embryos) effects on fish and can also cause downstream sediment deposition that alters substrate composition and modifies the availability and suitability of habitat (Anderson *et al.* 1996, Newcombe and MacDonald 1991).

Species of special concern or sensitive watersheds and fish populations are at a greater risk of over exploitation. Increased access may contribute to angler overharvest, which has been reported as one of the primary sources of fisheries declines in western Canada (Post and Johnston 2002). Restrictive harvest regulations are implemented in BC to protect sensitive species and reduce the potential for overharvest by anglers (BC MFLNRO 2011b). Stream crossing density was used as a quantifiable measure of erosion, habitat loss, and access hazard for aquatic ecosystems; thereby, allowing the Project's contribution to cumulative effects on fish injury and mortality to be estimated. Quantitative analyses were completed for each watershed crossed by the proposed pipeline corridor using readily available data sources as described in Section 8.1.5.1. Stream crossing density due to existing activities, the Project and reasonably foreseeable developments were calculated.

Stream crossings in the RSA resulting from existing activities include railways, transmission lines, oil and gas features (*e.g.*, cutlines, pipelines), and primary, secondary, and tertiary roads. It is expected that the Project and reasonably foreseeable linear developments (as identified in Tables 8A.1-1 and 8A.1-2 of Appendix 8.1) will have the potential to act cumulatively to increase the stream crossing density within the Aquatics RSA.

As mentioned in Section 8.1.5, larger municipalities, such as the City of Edmonton and the LMDA, were excluded from the quantitative analysis with the exception of the portion of the Golden Ears Connector development through a City of Surrey greenbelt. However, no streams in the greenbelt are affected by this reasonably foreseeable development or the Project. Effects of the Project on fish mortality and injury were addressed in Section 7.2.7.

Results of the stream crossing density estimates are provided in Table 8.6.10 and 8.6.11 for each watershed crossed by the Project.

TABLE 8.6-10

ESTIMATED EXISTING AND FUTURE STREAM CROSSING DENSITY WITHIN THE ALBERTA AQUATICS RSA

Disturbance Assessment Scenario	Stream Crossing Density for Each Watershed[1] in Alberta Aquatics RSA (No. Crossings/km² WS)						
	Sturgeon River	Upper N. Saskatchewan River	Pembina River	Upper McLeod River	Lower McLeod River	Athabasca River	Alberta Aquatics RSA
Existing Disturbance							
Existing Stream Crossing Density	1.34	2.11	1.52	1.76	2.07	2.66	1.85
Future Disturbance							
Stream Crossing Density Attributed to the Project (Project)	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.02	< 0.01
Stream Crossing Density Attributed to Reasonably Foreseeable Developments (Likely Future)	< 0.01	0.01	0.01	0.01	< 0.01	0.01	0.01
Cumulative Effects							
Total Cumulative Stream Crossing Density (Existing+Project+Likely Future)	1.35	2.12	1.54	1.77	2.08	2.69	1.87
Total Cumulative Stream Crossing Density without Project (Existing+Likely Future)	1.35	2.12	1.53	1.77	2.08	2.67	1.86
Total Cumulative Stream Crossing Density Without Reasonably Foreseeable Development (Existing+Project)	1.35	2.11	1.53	1.76	2.07	2.68	1.86

Notes: 1 The Middle North Saskatchewan River watershed is not included because Project disturbance in this watershed is located within the city of Edmonton, and the city of Edmonton has been excluded from the quantitative analysis (Section 8.1.5).

The Lower North Saskatchewan River watershed is not included because there are no new stream crossing locations as a result of the Project in this watershed.

TABLE 8.6-11

ESTIMATED EXISTING AND FUTURE STREAM CROSSING DENSITY WITHIN THE BC AQUATICS RSA

Disturbance Assessment Scenario	Stream Crossing Density for each Watershed[1] in the BC Aquatics RSA (No. Crossings / km² WS)												
	Upper Fraser River	Canoe Reach	Upper North Thompson River	Clearwater River	Lower North Thompson River	Thompson River	South Thompson River	Lower Nicola River	Similkameen	Fraser Canyon	Harrison River	Chilliwack River	BC Aquatics RSA
Existing Disturbance													
Existing Stream Crossing Density	0.40	0.32	1.00	0.38	1.97	2.23	2.38	1.95	1.45	1.53	1.68	1.78	1.35
Future Disturbance													
Stream Crossing Density Attributed to the Project (Project)	0.01	0.01	0.05	< 0.01	0.02	< 0.01	0.01	0.05	0.01	0.01	0.02	< 0.01	0.02
Stream Crossing Density Attributed to Reasonably Foreseeable Developments (Likely Future)	0.03	0	0	0	0	< 0.01	0	0.04	0.02	0.06	0.07	0.07	0.02
Cumulative Effects													
Total Cumulative Stream Crossing Density (Existing+Project+Likely Future)	0.44	0.33	1.05	0.38	1.99	2.24	2.39	2.04	1.48	1.60	1.77	1.86	1.39
Total Cumulative Stream Crossing Density without Project (Existing+Likely Future)	0.44	0.32	1.00	0.38	1.97	2.24	2.38	1.99	1.47	1.59	1.75	1.85	1.37
Total Cumulative Stream Crossing Density Without Reasonably Foreseeable Development (Existing+Project)	0.41	0.33	1.05	0.38	1.99	2.24	2.39	2.00	1.46	1.54	1.70	1.79	1.37

Notes: 1 The Lower Fraser River and Squamish watersheds are not included because Project disturbance in these watersheds is located within the LMDA, and the LMDA has been excluded from the quantitative analysis (Section 8.1.5).

Estimated fish mortality hazard, as measured using stream crossing density, currently ranges from 0.32 crossings/km^2 in the Canoe Reach watershed to 2.66 crossings/km^2 in the Athabasca River watershed, with an overall average of 1.54 crossings/km^2. Tertiary roads and cutlines account for more than 50% of the existing stream crossing density (Table 8.6-3). The Project and reasonably foreseeable developments would incrementally increase the stream crossing density in all watersheds (*i.e.*, an increase of 0.01 crossings/km^2 in Alberta and 0.04 crossings/km^2 in BC), with combined values predicted to remain the highest in Athabasca watershed. In the BC Aquatics RSA, the Project and reasonably foreseeable developments contribute equally to this increase, whereas in Alberta, reasonably foreseeable developments have a greater effect. The Project contributes 0.01 crossings/km^2 to the combined stream crossing density in the watersheds in the Aquatic RSA. The mitigation measures outlined in Table 7.2.7.4 and provided in the Pipeline and Facilities EPPs (Volume 6B and 6C), including limiting the release of suspended sediment during instream activities and implementing access control measures on the pipeline right-of-way, will limit the potential cumulative effects arising from the Project. The alignment of the proposed pipeline corridor along existing rights-of-way as much as practical (*i.e.*, 89% of the total length) further limits the Project's contribution to increased access.

It is expected that many other land users will implement similar measures recommended in federal and provincial guidelines and best management practice documents identified in earlier sections. No mitigation measures beyond the Project-specific mitigation already proposed in Section 7.0 and the Pipeline and Facilities EPPs (Volume 6B and 6C) are deemed warranted (Table 7.2.7.4) to address the potential cumulative effects of fish injury and mortality.

The Project will apply mitigation to reduce construction-related effects, and will be located adjacent to existing linear disturbances and clearings where practical, which will create minimal new access for recreational fishermen and harvesters. For these reasons, the Project's contribution to total fish mortality and injury within the Aquatics RSA is of low magnitude. The Project's contribution to cumulative effects on fish mortality and injury is considered to be reversible in the long-term since harvester access will potentially continue along the right-of-way throughout operations (Table 8.6-5, point 3[a]). A summary of the rationale for all of the significance criteria of combined cumulative effects on fish mortality and injury due to sedimentation and access is provided below.

- Spatial Boundary: Aquatics RSA – Project disturbance will be confined to the Fish and Fish Habitat LSA, but watershed-scale effects from overlapping disturbance could extend to the RSA.
- Duration: immediate to long-term – Project activities affecting fish mortality occur during construction (trench dewatering and sedimentation) and operations (access).
- Frequency: occasional to periodic – Project-related access changes to the combined effects on fish mortality occur intermittently and sporadically to repeatedly over the assessment period, depending on waterbody location and species present.
- Reversibility: long-term – harvester access will potentially continue throughout operations.
- Magnitude: low – the Project will be located adjacent to existing linear disturbances and clearings where practical which will create minimal new access for recreational fishermen and harvesters.
- Probability: high – it is likely that cumulative effects on fish mortality and injury will occur at the watershed scale.
- Confidence: high – based on available research literature and the professional experience of the assessment team.

Combined Effects Associated with Temporary Blockage of Fish Movements

Fish populations, particularly migrant populations, may pass through a number of distinct habitats while moving between feeding, breeding and overwintering areas. Consequently, migration corridors can be important habitat features (Meehan 1991).

Complete or partial blockage of fish movements has been documented for rail and road watercourse crossings (*e.g.*, 10-47% of culvert installations depending on the species; Burford *et al.* 2009, MacPherson *et al.* 2012, Park *et al.* 2008). Temporary localized blockage of fish movements may occur during instream construction and affect the ability of fish to migrate upstream or downstream of crossings. Delays in the ability of fish to migrate can affect spawning migrations, increase likelihood of stress or injury, increase competition for food, and limit spatial separation between competing species (Lang *et al.* 2004). The timing (*i.e.*, an appropriate timing window and short duration) of the temporary stream blockage can limit the nature/extent of these potential effects.

Stream crossings contributing to this effect include existing and reasonably foreseeable road, rail and pipeline developments, the Project and those existing culverts that represent complete or partial movement barriers. Figures 8.6-1a, 8.6-1b and 8.6-1c show the Project, reasonably foreseeable development stream crossings and existing crossing locations.

As mentioned in Section 8.1.5, larger municipalities, such as the City of Edmonton and the LMDA, were excluded from the quantitative analysis with the exception of the portion of the Golden Ears Connector development through a City of Surrey greenbelt. However, no streams in the greenbelt are affected by this reasonably foreseeable development or the Project. Effects of the Project on fish mortality and injury were addressed in Section 7.2.7.

Given the short duration of a blockage event associated with a stream crossing, (*e.g.*, less than 2 days), the likelihood of overlap between such events (*i.e.*, between the Project and a reasonably foreseeable activity) within a watershed is limited. The Project's activities, including potential fish blockage at temporary vehicle crossings along temporary access and power lines, can also act cumulatively with existing crossings in the blockage of fish movement; however, the Project's contribution to fish passage barriers will be reduced by the mitigation measures outlined in Section 7.0 and the Pipeline and Facilities EPPs (Volumes 6B and 6C). In addition, it is expected that many other land users will implement similar measures, as recommended in federal and provincial guidelines and best management practice documents (refer to Section 8.6.3.1 above). No mitigation measures beyond the Project-specific mitigation already proposed in Section 7.0 and the Pipeline and Facilities EPPs (Volume 6B and 6C) are deemed warranted.

The Project will apply mitigation to reduce construction-related effects, which include following least risk timing window recommendations and limiting the duration of fish blockage; consequently the Project's contribution to potential cumulative effects associated with blockage of fish movement within the Aquatics RSA is considered to be of low magnitude and reversible in the immediate to short-term (*i.e.*, once construction is completed) (Table 8.6-5, point 3[b]). A summary of the rationale for all of the significance criteria of combined cumulative effects on fish blockage is provided is provided below.

- Spatial Boundary: Aquatics RSA – Project disturbance will be confined to the Fish and Fish Habitat LSA, but watershed-scale effects from overlapping disturbance could extend to the RSA.
- Duration: immediate to short-term – Project activities contributing to the potential cumulative effect occur during the construction phase (*i.e.*, instream pipeline construction and temporary vehicle crossings).
- Frequency: isolated – Project-related changes to the combined effects on fish movement occur during construction.
- Reversibility: immediate to short-term – once Project construction is complete; the temporary blockage will be removed (*i.e.*, immediate), and any blockage due to temporary vehicle crossings would be removed (*i.e.*, short-term).
- Magnitude: low – the Project's contribution to cumulative effects is expected to be low, because federal and provincial guidance recommendations will be implemented and permanent habitat loss will not occur.
- Probability: low – the potential for the Project's instream construction to act in a cumulative manner with other reasonably foreseeable developments is low.

- Confidence: high – based on available research literature and the professional experience of the assessment team.

8.6.3.4 Fish and Fish Habitat Indicator – Indicator Species

Indicator species were identified for Alberta and BC which would reflect the regional differences in fish community composition, species abundance, and species of recreational, commercial and cultural importance, that could reasonably be encountered within watercourses in the Aquatics RSA. Six indicator species were selected for Alberta (*i.e.*, Arctic grayling, Athabasca rainbow trout, bull trout, burbot, northern pike and walleye), and five for BC (*i.e.*, bull trout/Dolly Varden, Chinook salmon, coho salmon, cutthroat trout and rainbow trout/steelhead). A brief description of these species and their habitat requirements is provided in Section 5.7 as well as in Section 4.3 of the Fisheries (Alberta) Technical Report and Section 4.3 of the Fisheries (BC) Technical Report (Volume 5C). Distribution of indicator species within the Aquatics RSA is provided in Section 5.7. Section 7.2.7.6 provides a general discussion on the indicator selection process, distribution, status and potential effects for each species.

The watershed disturbance measures (*i.e.*, riparian disturbance, instream disturbance and stream crossings) as discussed in previous sections, were considered in the evaluation of potential cumulative effects on each indicator species allowing the Project's contribution to this potential cumulative effect to be estimated. Combined disturbance that has occurred due to existing activities within the Aquatic RSA as well as the expected disturbance attributed to the construction of the Project and reasonably foreseeable developments were identified by watershed in Tables 8.6-6 to 8.6-11 in the previous sections.

<u>Arctic Grayling (Alberta Indicator Species)</u>

As Section 7.2.7.6 indicates, some potential effects to Arctic grayling are likely (*e.g.*, alteration of riparian and instream habitat) while others are less likely to occur (*e.g.*, injury or mortality of Arctic grayling as a result of increased sedimentation). The distribution of Arctic grayling includes the Pembina, Lower McLeod and Upper McLeod river watersheds.

Cumulative effects hazard resulting from riparian disturbance is currently High in the Pembina and Lower McLeod river watersheds and Moderate in the Upper McLeod River watershed, ranging from 11.97-45.06%; a similar trend is apparent with instream disturbance. The Project and reasonably foreseeable developments would increase riparian disturbance incrementally in the three watersheds (*i.e.*, from 0.06-1.32%); this increase is largely due to reasonably foreseeable development. Project specific riparian disturbance ranges from 0.01-0.05% and is projected to be highest in the Pembina watershed.

The Project (assuming no trenchless crossings) and reasonably foreseeable developments would increase instream disturbance incrementally by < 0.01-0.08%. The projected Project-specific contribution ranges from < 0.01-0.01% and would be further reduced by the implementation of trenchless crossings in the Pembina and Lower McLeod watersheds.

The Project's contribution to the potential cumulative effects on Arctic grayling will be reduced through the implementation of mitigation measures recommended in Section 7.0 and the Pipeline and Facilities EPPs (Volumes 6B and 6C). In addition, it is expected that many other land users will implement similar measures, as recommended in federal and provincial guidelines and best management practices (refer to Section 8.6.3.1 above). No mitigation measures beyond the Project-specific mitigation already proposed in Section 7.0 and the Pipeline and Facilities EPPs (Volumes 6B and 6C) are deemed warranted to address the potential cumulative effects on indicator species.

Given the comparatively small increase in riparian and instream disturbance due to the Project as noted above, the alignment along existing rights-of-way where practical, and the implementation of mitigation to reduce construction and operation-related effects, including proposed trenchless crossings, the Project's contribution to potential cumulative effects associated with Arctic grayling within the Aquatics RSA is of low magnitude. The cumulative effect of disturbance is considered to be reversible in the medium to long-term, depending upon the pre-construction channel characteristics and pre-construction riparian vegetation community (Table 8.6-5, point 4[a]). A summary of the rationale for all of the significance criteria of the combined cumulative effects of the Project on Arctic grayling is provided below.

- Spatial Boundary: Aquatics RSA – Project pipeline disturbance will be confined to the Fish and Fish Habitat LSA, but watershed-scale effects from overlapping disturbance could extend to the RSA.
- Duration: immediate to short-term – Project activities affecting Arctic grayling occur during the construction phase or maintenance during the operations phase (and lasting 2 days to less than 1 year).
- Frequency: isolated to occasional – the Project events contributing to the cumulative changes to instream and riparian habitat occur during construction and then intermittently, but sporadically, over the assessment period during maintenance activities.
- Reversibility: medium to long-term – depending upon the pre-construction channel characteristics and pre-construction riparian vegetation community, and the extent of clearing or alteration of riparian vegetation required for maintenance activities.
- Magnitude: low – in addition to the construction of trenchless crossings where practical, the Project will implement federal and provincial guidance recommendations (*e.g.*, timing window requirements, restoration of channel profile, bank stabilization measures, tree and shrub plantings to prevent access) and, consequently, the Project's contribution to cumulative effects on Arctic grayling is expected to be low.
- Probability: high – it is likely that cumulative effects on Arctic grayling will occur.
- Confidence: high – based on available research literature and the professional experience of the assessment team.

Athabasca Rainbow Trout and Bull Trout (Alberta Indicator Species)

In the indicator species discussions in Section 7.2.7.6, the loss or alteration of instream habitat is identified as the greatest contributor to combined effects for both Athabasca rainbow trout and bull trout. These species are present primarily in the western half of the Alberta RSA, namely the Lower McLeod, Upper McLeod and Athabasca river watersheds, though bull trout is distributed within the Pembina River watershed as well.

Current levels of disturbance of instream habitat ranging from 0.24-0.37%, with the highest level in the Pembina River watershed. The Project (assuming no trenchless crossings) and reasonably foreseeable development would increase instream disturbance incrementally by < 0.01-0.08%. The highest increase is projected to occur in the Pembina River watershed, and is due primarily to reasonably foreseeable development. The predicted Project-specific contribution ranges from < 0.01-0.01% and would be further reduced by the implementation of proposed trenchless crossings in the Pembina and Lower McLeod watersheds.

The Project's contribution to the potential cumulative effects on Athabasca rainbow trout and bull trout will be reduced through the implementation of mitigation measures recommended in Section 7.0 and the Pipeline and Facilities EPPs (Volumes 6B and 6C). In addition, it is expected that many other land users will implement similar measures, as recommended in federal and provincial guidelines and best management practices (refer to Section 8.6.3.1 above). No mitigation measures beyond the Project-specific mitigation already proposed in Section 7.0 and the Pipeline and Facilities EPPs (Volumes 6B and 6C) are deemed warranted to address the potential cumulative effects on indicator species.

Given that the Project's contribution to combined instream disturbance is < 0.1-0.01%, federal and provincial guidance recommendations will be implemented, and trenchless crossings constructed where practical, the Project's contribution to cumulative effects on Athabasca rainbow trout and bull trout is of low magnitude. The Project's contribution is considered to be reversible in the medium to long-term, depending on the pre-existing channel structure, channel composition, seasonal flow characteristics and potential continued off-highway vehicle activity (Table 8.6-5, point 4[b]). A summary of the rationale for all of the significance criteria of combined cumulative effects on Athabasca rainbow trout and bull trout is provided below.

- Spatial Boundary: Aquatics RSA – Project pipeline disturbance will be confined to the Fish and Fish Habitat LSA, but watershed-scale effects from overlapping disturbance could extend to the RSA.
- Duration: immediate to short-term – Project activities affecting Athabasca rainbow trout and bull trout occurs during the construction phase or maintenance during the operations phase (lasting 2 days to less than 1 year).
- Frequency: isolated to occasional – the Project's contribution to the combined effects on Athabasca rainbow trout and bull trout occur during construction and then intermittently, but sporadically, over the assessment period during maintenance activities.
- Reversibility: medium to long-term – depending upon the pre-construction channel characteristics and future flow regime, and potential continued stream access by off-highway vehicles.
- Magnitude: low – in addition to the construction of trenchless crossings where practical, the Project will implement federal and provincial guidance recommendations (*e.g.*, timing window requirements, restoration of channel profile, bank stabilization measures, tree and shrub plantings to prevent access) and, consequently, Project's contribution to cumulative effects on Athabasca rainbow trout and bull trout is expected to be low.
- Probability: high – it is likely that cumulative effects on Athabasca rainbow trout and bull trout will occur.
- Confidence: high – based on available research literature and the professional experience of the assessment team.

Burbot (Alberta Indicator Species)

As discussed in Section 7.2.7.6, burbot have become more susceptible to natural and anthropogenic habitat disturbance than in the past (Stapanian *et al.* 2010), however, mortality or injury is the greatest contributor to combined effects for this species. Burbot is distributed across all Alberta watersheds in the Aquatics RSA.

Estimated fish injury and mortality hazard, as measured using stream crossing density, currently ranges from 1.52 crossings/km^2 in the Pembina River watershed to 2.66 crossings/km^2 in the Athabasca River watershed, with an overall average of 1.85 crossings/km^2 in the Alberta Aquatics RSA. The Project and reasonably foreseeable developments would slightly increase the stream crossing density in all watersheds (*i.e.*, an increase of 0.01 crossings/km^2), with combined values predicted to remain the highest in Athabasca watershed.

The Project's contribution to the potential cumulative effects on burbot will be reduced through the implementation of mitigation measures recommended in Section 7.0 and the Pipeline and Facilities EPPs (Volumes 6B and 6C). In addition, it is expected that many other land users will implement similar measures, as recommended in federal and provincial guidelines and best management practices (refer to Section 8.6.3.1 above). No mitigation measures beyond the Project-specific mitigation already proposed in Section 7.0 and the Pipeline and Facilities EPPs (Volumes 6B and 6C) are deemed warranted to address the potential cumulative effects on indicator species.

The Project will apply mitigation to reduce construction-related effects and will be located adjacent to existing linear disturbances and clearings where practical, which will create minimal new access for recreational fishermen and harvesters. For these reasons, the Project's contribution to effects associated with burbot within the Alberta Aquatics RSA is of low magnitude. The Project's contribution to cumulative effects on burbot is considered to be reversible in the long-term since harvester access will potentially continue throughout operations (Table 8.6-5, point 4[c]). A summary of the rationale for all of the significance criteria of combined cumulative effects on burbot is provided below.

- Spatial Boundary: Aquatics RSA – Project pipeline disturbance will be confined to the Fish and Fish Habitat LSA, but watershed-scale effects from overlapping disturbance could extend to the RSA.

- Duration: immediate to long-term – Project activities affecting burbot occur during construction (*e.g.*, trench dewatering) and operations (access).
- Frequency: isolated to periodic – Project-related access changes to the combined effects on burbot occur intermittently and sporadically to repeatedly over the assessment period, depending on waterbody location.
- Reversibility: long-term – harvester access will potentially continue throughout operations.
- Magnitude: low – the Project will be located adjacent to existing linear disturbances and clearings where practical which will create minimal new access for recreational fishermen and harvesters, and, consequently, the Project's contribution to cumulative effects on burbot is expected to be low.
- Probability: high – it is likely that cumulative effects on burbot will occur.
- Confidence: high – based on available research literature and the professional experience of the assessment team.

Northern Pike and Walleye (Alberta Indicator Species)

Section 7.2.7.6 indicates that for both northern pike and walleye, weedy shoreline areas represent important habitat. Consequently, loss or alteration of riparian habitat is the greatest contributor to combined effects for these two species. Northern pike is distributed across all Alberta watersheds in the Aquatics RSA, whereas walleye is located in all but the Athabasca and Upper McLeod river watersheds.

The cumulative effects hazard based on riparian disturbance is currently moderate in the Upper McLeod River watershed (*i.e.*, 11.79%) and high in the rest of the Alberta Aquatics RSA, ranging from 19.03-75.63%. The highest level of existing riparian disturbance is in the Lower North Saskatchewan River watershed, and is due primarily to agriculture. Future aquatic cumulative effects hazard (including Project and reasonably foreseeable developments) incrementally increases in all watersheds, ranging from 0.06-1.32%, though the hazard levels will not be affected. The Project incrementally contributes to riparian disturbance from 0.01-0.10%, or an average of 0.03%.

The mitigation measures outlined in Section 7.2.7.4 (*e.g.*, seeding disturbed riparian areas with the appropriate native seed mix along with a quick establishing cover crop, and additional revegetation efforts, such as planting trees or shrubs at select locations), will limit the Project's contribution to cumulative effects. In addition, it is expected that many other land users will implement similar measures, as recommended in federal and provincial guidelines and best management practices (refer to Section 8.6.3.1 above). No mitigation measures beyond the Project-specific mitigation already proposed in Section 7.0 and the Pipeline and Facilities EPPs (Volumes 6B and 6C) are deemed warranted to address the potential cumulative effects on indicator species.

The Project's contribution to cumulative effects associated with northern pike and walleye is of low magnitude given that the Project's contribution is 0.03% of combined riparian disturbance and federal and provincial guidance recommendations will be implemented. The cumulative effect of clearing riparian vegetation is considered to be reversible in the medium to long-term, depending on the pre-existing vegetation community (Table 8.6-5, point 4[d]). A summary of the rationale for all of the significance criteria of combined cumulative effects on northern pike and walleye is provided below.

- Spatial Boundary: Aquatics RSA – Project pipeline disturbance will be confined to the Fish and Fish Habitat LSA, but watershed-scale effects from overlapping disturbance could extend to the RSA.
- Duration: immediate to short-term – Project activities affecting northern pike and walleye occur during the construction phase or maintenance during the operations phase (lasting 2 days to less than 1 year).
- Frequency: isolated to occasional – the Project's contribution to the events causing cumulative effects on northern pike and walleye occurs during construction and then intermittently, but sporadically, over the assessment period during maintenance activities.

- Reversibility: medium to long-term – depending upon the pre-construction vegetation community (*e.g.*, grasses and shrubs regenerate within several years, however, tree canopy regrowth is expected to extend into the long-term) and the extent of clearing or alteration of riparian vegetation required for maintenance activities.
- Magnitude: low – the Project's incremental contribution is 0.05% of the combined riparian disturbance and the Project will implement federal and provincial guidance recommendations to avoid permanent habitat loss, consequently the Project's contribution to cumulative effects on northern pike and walleye is expected to be low.
- Probability: high – it is likely that cumulative effects on northern pike and walleye will occur.
- Confidence: high – based on available research literature and the professional experience of the assessment team.

Bull Trout/Dolly Varden (BC Indicator Species)

As discussed in Section 7.2.7.6, bull trout are susceptible to degraded water and habitat conditions from land disturbance such as roads and oil and gas disturbance (Alberta Sustainable Resource Development [ASRD] 2012, Brewin *et al.* 2001, Hammond 2004) and obstructions to movement (Hammond 2004) which makes contamination, loss or alteration of instream habitat the greatest contributor to combined effects for the bull trout/Dolly Varden indicator. This species has a broad distribution across the BC Aquatics RSA, being present in all but the South Thompson, Harrison and Squamish river watersheds.

Current levels of disturbance of instream habitat range from 0.09-1.01%, with the highest level in the Lower Nicola River watershed. The Project (assuming no trenchless crossings) and reasonably foreseeable development would increase instream disturbance incrementally by 0.02-0.05%. The highest increase is projected to occur in Lower Nicola and Upper North Thompson river watersheds, due primarily to the Project in both cases. The projected Project-specific contribution ranges from 0.01-0.05%, or an average of 0.02%, and the overall average would be further reduced to 0.01% with the implementation of trenchless crossings.

The Project's contribution to the potential cumulative effects on bull trout will be reduced through the implementation of mitigation measures recommended in Section 7.0 and the Pipeline and Facilities EPPs (Volumes 6B and 6C). In addition, it is expected that many other land users will implement similar measures, as recommended in federal and provincial guidelines and best management practices (refer to Section 8.6.3.1 above). No mitigation measures beyond the Project-specific mitigation already proposed in Section 7.0 and the Pipeline and Facilities EPPs (Volumes 6B and 6C) are deemed warranted to address the potential cumulative effects on indicator species.

Given that the Project's contribution to combined instream disturbance is 0.02% in the BC Aquatics RSA, federal and provincial guidance recommendations will be implemented, and trenchless crossings constructed where practical, the Project's contribution to cumulative effects associated with bull trout/Dolly Varden is of low magnitude. The Project's contribution to cumulative effects on this species is considered to be reversible in the medium to long-term, depending on the pre-existing channel structure, channel composition, seasonal flow characteristics and potential for continued off-highway vehicle activity (Table 8.6-5, point 4[e]). The significance rationale of combined effects on bull trout/Dolly Varden is considered to be similar to the rationale for combined effects provided above under the Athabasca rainbow trout and bull trout indicator.

Chinook and Coho Salmon and Cutthroat Trout (British Columbia Indicator Species)

Section 7.2.7.6 indicates that contamination, loss or alteration of instream and riparian habitat are equal contributors to combined effects for these three species, given their sensitivity to habitat degradation. Chinook and coho salmon have a broad distribution across the BC Aquatics RSA though cutthroat trout are limited to the western portion, from the Fraser Canyon westwards.

Cumulative effects hazard resulting from riparian disturbance is currently low in the Upper Fraser River, Canoe Reach and Clearwater River watersheds, moderate in the Upper North Thompson, Fraser

Canyon, Harrison, and Chilliwack river watersheds and high in all remaining watersheds, a similar trend is apparent with instream disturbance. The Project and reasonably foreseeable developments would increase riparian disturbance incrementally in all watersheds, from 0.0-0.48%, though will not affect the hazard level of any of the watersheds. Project-specific riparian disturbance ranges from < 0.01-0.15% and is projected to be highest in the Lower Nicola River watershed. The Project (assuming no trenchless crossings) and reasonably foreseeable developments would increase instream disturbance incrementally by 0.01-0.05% across the watersheds in the BC Aquatics RSA. The projected Project-specific contribution ranges from 0.01-0.05%, for an average of 0.02 and would be further reduced by 0.01% with the implementation of trenchless crossings. The Project's contribution is highest in the Upper North Thompson and Lower Nicola river watersheds (0.05%), though trenchless crossings are proposed in both of these watersheds which would reduce the Project's influence if implemented.

The Project's contribution to the potential cumulative effects on Chinook and coho salmon and cutthroat trout will be reduced through the implementation of mitigation measures recommended in Section 7.0 and the Pipeline and Facilities EPPs (Volumes 6B and 6C). In addition, it is expected that many other land users will implement similar measures, as recommended in federal and provincial guidelines and best management practices (refer to Section 8.6.3.1 above). No mitigation measures beyond the Project-specific mitigation already proposed in Section 7.0 and the Pipeline and Facilities EPPs (Volumes 6B and 6C) are deemed warranted to address the potential cumulative effects on indicator species.

Given the level of riparian and instream disturbance due to the Project as noted above, alignment along existing rights-of-way where possible, and mitigation to reduce construction and operation-related effects, including trenchless crossings where practical, the Project's contribution to potential cumulative effects associated with Chinook and coho salmon and cutthroat trout within the Aquatics RSA is of low magnitude. The cumulative effect of disturbance is considered to be reversible in the medium to long-term, depending upon the pre-construction channel characteristics and pre-construction riparian vegetation community (Table 8.6-5, point 4[f]). The significance rationale of combined effects on Chinook and coho salmon and cutthroat trout is considered to be similar to the rationale for combined effects provided above under the Arctic grayling indicator.

Rainbow Trout/Steelhead (British Columbia Indicator Species)

As discussed in Section 7.2.7.6, rainbow trout are migratory in nature and will move to new areas should habitat conditions change (Natural Resources Conservation Service 2000), therefore, mortality or injury is the greatest contributor to combined effects for this species. Rainbow trout is distributed across all BC watersheds in the Aquatics RSA.

Estimated fish injury and mortality hazard, as measured using stream crossing density, currently ranges from 0.32 crossings/km^2 in the Canoe Reach watershed to 2.38 crossings/km^2 in the South Thompson River watershed, with an overall average of 1.35 crossings/km^2 in the BC Aquatics RSA. The Project and reasonably foreseeable developments would incrementally increase the stream crossing density in all watersheds (*i.e.*, an increase of 0.04 crossings/km^2 across the BC Aquatics RSA), with combined values estimated to remain highest in South Thompson River watershed. The Project contributes 0.02 crossings/km^2 to the combined stream crossing density in the watersheds in the BC Aquatic RSA, with the largest contribution projected in the Upper North Thompson and Lower Nicola river watersheds.

The Project's contribution to the potential cumulative effects on rainbow trout will be reduced through the implementation of mitigation measures recommended in Section 7.0 and the Pipeline and Facilities EPPs (Volumes 6B and 6C). In addition, it is expected that many other land users will implement similar measures, as recommended in federal and provincial guidelines and best management practices (refer to Section 8.6.3.1 above). No mitigation measures beyond the Project-specific mitigation already proposed in Section 7.0 and the Pipeline and Facilities EPPs (Volumes 6B and 6C) are deemed warranted to address the potential cumulative effects on indicator species.

The Project will apply mitigation to reduce construction-related effects and will be located adjacent to existing linear disturbances and clearings where practical, which will create minimal new access for recreational fishermen and harvesters. For these reasons, the Project's contribution to cumulative effects associated with rainbow trout within the BC Aquatics RSA is of low magnitude. The Project's contribution to cumulative effects on rainbow trout is considered to be reversible in the long-term since harvester access will potentially continue throughout operations (Table 8.6-5, point 4[g]). The significance rationale of combined effects on rainbow trout is considered to be similar to the rationale for combined effects provided above under the burbot indicator.

8.6.3.5 Combined Cumulative Effects on Fish and Fish Habitat

Disturbance from Project activities (*i.e.*, alteration of riparian habitat, alteration of instream habitat, effects on fish mortality and injury) may act in combination with existing and reasonably foreseeable developments to affect fish and fish habitat in the Aquatics RSA, as described above for species of management and public concern. The impact balance is considered negative. The implementation of mitigation measures recommended in Section 7.0 and the Pipeline and Facilities EPPs (Volumes 6B and 6C) will reduce the severity of cumulative effects arising from the Project and other reasonably foreseeable developments. The combined cumulative effect of the Project on fish and fish habitat is of low magnitude, reversible in the immediate to long-term and of high probability (Table 8.6-5, point 5[a]). A summary of the rationale for all the significance criteria for Project's contribution to cumulative effects on the fish and fish habitat indicators is provided below.

- Spatial Boundary: Aquatics RSA – Project pipeline disturbance will be confined to the Fish and Fish Habitat LSA and, but watershed-scale effects from overlapping disturbance could extend to the RSA.
- Duration: immediate to long-term – Project activities contributing to combined cumulative effects on fish and habitat occur during the construction phase (*e.g.*, sedimentation from instream activity) and extend to the operations phase (*e.g.*, access).
- Frequency: isolated to periodic – Project related activities contributing to combined cumulative effects on fish and habitat range from isolated activities (*e.g.*, blockage of fish movement during construction) to intermittent, but repeated events over the assessment period (*e.g.*, access related effects).
- Reversibility: immediate to long-term – certain Project effects are reversed immediately, such as removal of a temporary blockage event upon completion of instream work, while other Project-effects, such as disturbance of riparian areas, depend on the preconstruction-vegetation community (*e.g.*, grasses and shrubs regenerate within several years, however, tree canopy re-growth is expected to extend into the long-term).
- Magnitude: low – the Project's contribution to combined cumulative effects on fish and fish habitat is expected to be low because the project will be located along existing linear disturbance where practical, will implement trenchless crossings where practical, and will implement recommended federal and provincial industry standard guidelines.
- Probability: high – it is likely that these cumulative combined effects will occur.
- Confidence: high – based on available research literature and the professional experience of the assessment team.

8.6.4 Summary

As identified in Table 8.6-5, there are no situations where there is a high probability of occurrence of a permanent or long-term cumulative effect of high magnitude that cannot be technically or economically mitigated. Consequently, the Project's contribution to cumulative effects on fish and fish habitat within the Aquatics RSA will be not significant.

8.7 Wetlands

The below subsection outlines how the Project may contribute to cumulative effects on the wetland loss or alteration indicator in combination with existing activities and reasonably foreseeable developments.

8.7.1 Reasonably Foreseeable Developments

Tables 8A.1-1, 8A.1-2, 8A.1-3 and 8A.1-4 of Appendix 8.1 provide a list of the certain and reasonably foreseeable developments located within the Wetland RSA considered in the evaluation of cumulative effects on the wetland loss or alteration indicator. Description of these developments is provided in Section 8.1.4 and shown on Figures 8.1-1a, 8.1-1b and 8.1-1c. In the Wetland RSA, there are approximately 68 mapped reasonably foreseeable developments either fully within the Wetland RSA or, for some transmission lines and pipelines, partially within the Wetland RSA (Table 8A.1-1 of Appendix 8.1). In addition, there are approximately 2,387 mapped reasonably foreseeable minor oil and gas developments in Alberta: 502 pipelines; 1,617 facilities; and 268 wells (Tables 8A.1-2 to 8A.1-4 of Appendix 8.1).

As indicated in Section 8.1, other reasonably foreseeable developments with the potential to act in combination with the Project were excluded from quantitative evaluations since development details (*e.g.*, approval status, location) were either lacking or the development was located within previously disturbed areas of municipal boundaries, such as the city limits of the City of Edmonton and LMDA. Descriptions of these developments are provided in Section 8.1.4 and Table 8A.1-5 for Alberta and Table 8A.1-6 for BC of Appendix 8.1.

The current level of disturbance due to existing activities within the Wetland RSA as well as the anticipated disturbance attributed to the Project and reasonably foreseeable developments is provided in Tables 8.7-1 and 8.7-2. A hierarchy table was applied during the cumulative effects assessment quantitative analysis to determine priority of overlapping land use features (*i.e.*, features with greater indirect footprint and assumed effects potential are assigned higher priority).

TABLE 8.7-1

EXISTING AND NEW AREAL DISTURBANCE IN THE WETLAND RSA – ALBERTA

Land Use Feature	Existing Areal Disturbance (ha)	New Areal Disturbance (ha)			Total Areal Disturbance (ha)
		Proposed Project	Reasonably Foreseeable Developments	Total	
Oil and Gas Pipelines	940.3	11.9	66	77.9	1,018.2
Primary Roads	252.8	0	0	0	252.8
Secondary Roads	476.2	0	0	0	476.2
Tertiary/Access Roads	174.5	0	0	0	174.5
Trails (Recreation/Wildlife)	0	0	0	0	0
Railways	22	0	0	0	22
Cut lines, Seismic Lines	2,488.8	0	0	0	2,488.8
Transmission/Power Lines	212	0	11.8	11.8	223.8
Oil and Gas Well Sites	558.2	0	4.9	4.9	563.1
Buried Utility Lines	20.8	0	0	0	20.8
Commercial/Industrial Features	717.4	0	112.1	112.1	829.5
Cities/Towns/Communities	672.1	0	0	0	672.1
Cutblocks	1,799.6	0	0	0	1,799.6
Quarries/Mines/Aggregates	969.3	0	183.9	183.9	1,153.2
Crop/Pasture Land	15,022.3	0	0	0	15,022.3
Buildings	369.9	0	0	0	369.9
Airports/Airfields	0.1	0	0	0	0.1
Recreation	7.1	0	0	0	7.1
Hydroelectric Infrastructure	0	0	0	0	0
Total	24,703.4	11.9	378.7	390.6	25,094.0
Total Area of Wetland RSA: 161,125.9 ha					

TABLE 8.7-2

EXISTING AND NEW AREAL DISTURBANCE IN THE WETLAND RSA – BC

Land Use Feature	Existing Areal Disturbance (ha)[1]	New Areal Disturbance (ha)			Total Areal Disturbance (ha)
		Proposed Project	Reasonably Foreseeable Developments	Total	
Oil and Gas Pipelines	27.1	39.5	2.2	41.7	68.8
Primary Roads	24.5	0	0.1	0.1	24.6
Secondary Roads	28.5	0	0	0	28.5
Tertiary/Access Roads	19.7	0	0	0	19.7
Trails (Recreation/Wildlife)	0	0	0	0	0
Railways	18.8	0	0	0	18.8
Cut Lines, Seismic Lines	3.4	0	0	0	3.4
Transmission/Power Lines	39.3	0.4	3.5	3.9	43.2
Oil and Gas Well Sites	0	0	0	0	0
Buried Utility Lines	5.3	0	0	0	5.3
Commercial/Industrial Features	11.2	0	0.9	0.9	12.1
Cities/Towns/Communities	168.6	0	0	0	168.6
Cutblocks	940.1	0	0	0	940.1
Quarries/Mines/Aggregates	47.2	0	35.6	35.6	82.8
Crop/Pasture Land	455.9	0	0	0	455.9
Buildings	2.3	0	0	0	2.3
Airports/Airfields	0.4	0	0	0	0.4
Recreation	9.3	0	0	0	9.3
Hydroelectric Infrastructure	0	0	0	0	0
Total	1,801.5	39.9	41.0	80.9	1,882.4
Total Area of Wetland LSA: 32,755.8 ha					

Note: 1 Existing Areal Disturbance does not include the LMDA, but does include the Surrey Greenbelt.

8.7.2 Potential Cumulative Effects

The potential and likely combined environmental residual effects associated with the construction and operation of the Project on the wetland loss or alteration indicator were identified in Section 7.11.1.8 and are listed in Table 8.7-3 along with the identification of existing activities and reasonably foreseeable developments that could act in combination with the Project.

TABLE 8.7-3

POTENTIAL RESIDUAL EFFECTS OF THE PROJECT ON WETLAND LOSS OR ALTERATION CONSIDERED FOR THE CUMULATIVE EFFECTS ASSESSMENT

Potential Residual Project Effect on Indicator	Spatial Boundary[1]	Project Component(s)	Temporal Boundary	Potential Cumulative Effect	Existing Activities/Reasonably Foreseeable Developments with Residual Effects Acting in Combination with the Project
1. Combined effects of the Project on wetland loss or alteration.	RSA	Pipeline Temporary Facilities Pump Stations Pipeline Reactivation	Past Development to Operation	Project contribution to cumulative increase in wetland disturbance.	• Existing activities including: agriculture and livestock grazing, forestry, rural and urban residential and commercial development, transportation and infrastructure development, utilities activities, oil and gas exploration and development and mineral resource exploration and development. • Reasonably foreseeable developments within the RSA listed in Tables 8A.1-1 to 8A.1-6 of Appendix 8.1 and discussed in Section 8.1.4. • Project-related activities that could interact with the above activities including wetland substrate (*i.e.*, peat) salvaging, trenching, backfilling and reclamation, vehicle traffic, and temporary access road and shoo-fly installation and removal, and potential partial wetland infilling (*i.e.*, power line structures).

Note: 1 RSA = Wetland RSA.

8.7.3 Significance Evaluation of Potential Cumulative Effects

A quantitative analysis was conducted to evaluate the significance of the Project's contribution to cumulative environmental effects for the wetland function indicator as these changes over the existing data within the Footprint Study Area were quantifiable. However, as there are no standards, guidelines, objectives or other established and accepted ecological thresholds to define quantitative rating criteria, a qualitative was used for determining the significance of the Project's contribution to cumulative environmental effects. The qualitative assessment for the wetland loss or alteration indicator relied on the professional judgment of the assessment team.

Table 8.7-4 provides a summary of the significance evaluation of the Project's contribution to potential cumulative effects on the wetland loss or alteration indicator. The rationale used to evaluate the significance of the cumulative effect is provided below.

TABLE 8.7-4

SIGNIFICANCE EVALUATION OF THE PROJECT'S CONTRIBUTION TO CUMULATIVE EFFECTS ON WETLAND LOSS OR ALTERATION

Potential Cumulative Effects	Impact Balance	Spatial Boundary[1]	Temporal Context: Duration	Temporal Context: Frequency	Temporal Context: Reversibility	Magnitude	Probability	Confidence	Significance[2]
1. Wetland Loss or Alteration Indicator – Wetland Function									
1(a) Project contribution to cumulative increase in wetland disturbance.	Negative	RSA	Short to long-term	Periodic	Medium to long-term	Low to medium	High	High	Not significant

Notes: 1 RSA = Wetland RSA.

2 Significant Contribution to a Cumulative Environmental Effect: A high probability of occurrence of a permanent or long-term cumulative effect of high magnitude that cannot be technically or economically mitigated.

8.7.3.1 Wetland Function

The proposed pipeline corridor travels through 4 ecozones and 11 ecoregions of Canada (Agriculture and Agri-Food Canada 2013, Ecological Stratification Working Group 1995), 5 wetland regions of Canada (Government of Canada 1986), 5 natural subregions of Alberta (Natural Regions Committee 2006) and 9 biogeoclimatic (BGC) zones of BC (BC MFLNRO 2012e, Meidinger and Pojar 1991). Wetlands within the wetland regions comprise between 5% and 40% of the land area (Natural Resources Canada [NRCan] 2009).

A quantitative cumulative effects approach was taken to determine the Project's wetland function disturbance. The wetland area determined for the Wetland LSA and RSA was based on the approximate area of wetlands. The quantitative assessment utilized existing databases (*i.e.*, CanVec for Alberta and the FWA for BC) in order to estimate the area of wetlands potentially disturbed by existing activities, Project-related and reasonably foreseeable developments.

CanVec is a data set that combines information from many databases such as the National Topographic Database, National Road Network and the National Hydrographic Network. CanVec maps approximately 90 different topographical entities. The hydrography level features include lakes, rivers and wetlands (NRCan 2012). When the wetlands identified through satellite imagery interpretation (1:10,000 scale) are overlaid by the CanVec wetland layer it appears that CanVec tends to pick up on larger wetland features that are wetter but misses smaller and often drier wetlands, which may underestimate the number of wetlands without standing water. The satellite imagery interpretation also suggested that CanVec may overestimate the area of some of these wetlands.

The BC FWA is a data set that maps the province's hydrologic features, based on the Terrain Resource Information Management base maps (1:20,000 scale). The BC FWA maps hydrologic features including streams, lakes and wetlands and is intended to be an authoritative source for inventory of freshwater resources in BC (Integrated Land Management Bureau 2010). Interpretation of satellite imagery (1:10,000 scale) overlaid by a BC FWA wetlands layer indicates that although the BC FWA classifies wetlands into only two categories (swamp and marsh), wetland classes such as fens are also captured within the two categories. Satellite imagery interpretation also suggested that the BC FWA underestimates wetland area. Wetlands identified through satellite imagery interpretation were typically at the same location as those in the BC FWA layer but the BC FWA consistently delineated a smaller area of wetland or missed smaller wetlands entirely. The BC FWA wetland features also tended to be centred on open water features or very wet areas, which potentially underestimates wetland areas without standing water.

It should be noted that these comparisons only focused on the areas within the Wetland LSA and not beyond.

As mentioned in Section 8.1.5, larger municipalities, such as the City of Edmonton and the LMDA, were excluded from the quantitative analysis. The portion of the Golden Ears Connector development through a City of Surrey greenbelt was considered, but since no wetlands in the greenbelt are affected by this reasonably foreseeable development or the Project, it was also excluded from the analysis. Effects of the Project on wetlands were addressed in Section 7.2.8. Wetland function was evaluated at each wetland ecosystem encountered during the ground-based field work. Wetland functions documented during the existing (*i.e.*, pre-construction) evaluation will be compared to wetland functions observed along the reclaimed (*i.e.*, post-construction) construction right-of-way. The results of this comparison will be used to confirm the effectiveness and efficiency of mitigation and reclamation measures, and confirm the determination of loss or "no net loss" of wetland function included in the ESA.

Details on each of the wetland functional categories (*i.e.*, High, High-Moderate, Low-Moderate and Low Functional Conditions) can be found in Section 7.2.8.1.

Functional condition categories were documented for all wetlands ground-truthed during the 2012 and 2013 field programs. The sampling intensity determined to be appropriate for this Project is 100%. Of the wetlands identified to be crossed by the proposed pipeline corridor, 59% were ground-truthed during the 2012 and 2013 field programs. Functional assessments will be conducted at the remaining wetlands during supplemental studies. Based on the results of the functional assessments conducted during the

2012 and 2013 field programs and the professional judgment of the wetland assessment team, the functional condition categories were estimated for remaining wetlands within each segment along the proposed pipeline corridor. Categories are to be confirmed during the 2014 supplemental field program. The results of wetland functional condition categories along the proposed pipeline corridor were extrapolated out to the Wetland RSA to approximate wetland coverage and potential functional condition within this study area (Tables 8.7-5 and 8.7-6). Quantitative assessments were conducted for all pipeline segments. Following wetland surveys in 2014, once a final pipeline route has been determined, the assessment will be verified by comparing the 2014 field results to what was estimated during imagery review for the purposes of the cumulative effects assessment.

TABLE 8.7-5

FREQUENCY OF OCCURRENCE OF WETLANDS WITHIN THE PROPOSED PIPELINE CORRIDOR

Metric	Alberta	Alberta (minus Edmonton)	BC[1]	BC (minus LMDA)
Number and area of wetlands encountered (potential and ground-truthed)[2]	339; 382.5 ha	313; 364.8 ha	299; 206.9 ha	256; 191.8 ha
Number and area of wetlands encountered (ground-truthed)[2]	261; 318.2 ha	238; 300.8 ha	115; 122.1 ha	110; 120.1 ha
Number and area of wetlands of High Functional Condition	78; 176.9 ha	77; 174.8 ha	23; 59.3 ha	23; 59.3 ha
Frequency of wetlands of High Functional Condition (%)	29.9	32.4	20.0	20.9
Potential total number and area of wetlands of High Functional Condition	101; 75.7 ha	101; 118.2 ha	59; 41.0 ha	53; 39.7 ha
Number and area of wetlands of High-Moderate Functional Condition	142; 126.2 ha	125; 286.5 ha	74; 49.1 ha	74; 49.1 ha
Frequency of wetlands of High-Moderate Functional Condition (%)	54.4	52.5	64.3	67.3
Potential total number and area of wetlands of High-Moderate Functional Condition	184; 20.8 ha	164; 191.5 ha	191; 132.0 ha	171; 127.9 ha
Number and area of wetlands of Low-Moderate Functional Condition	41; 15.1 ha	396; 12.6 ha	17; 13.6 ha	12; 11.6 ha
Frequency of wetlands of Low-Moderate Functional Condition (%)	15.7	15.1	14.8	10.9
Potential total number and area of wetlands of Low-Moderate Functional Condition	53; 60.1 ha	47; 55.1 ha	44; 30.4 ha	28; 20.7 ha
Number and area of wetlands of Low Functional Condition[4,5]	0[5]; 0.0 ha	0; 0.0 ha	1; 0.1 ha	1; 0.1 ha
Frequency of wetlands of Low Functional Condition (%)[4,5]	0.0	0.0	0.9	0.9

TABLE 8.7-5 Cont'd

Metric	Alberta	Alberta (minus Edmonton)	BC[1]	BC (minus LMDA)
Potential total number and area of wetlands of Low Functional Condition	0; 0.0 ha	0.0	3; 1.9 ha	2; 1.7 ha

Notes:
1 Due to the low sampling frequency experienced along the BC segments as a result of limited land access, the number of wetlands has been combined together for this assessment.
2 Total number of wetlands encountered by the proposed pipeline corridor including potential wetlands and wetlands that have been ground-truthed during the 2012 and 2013 field programs.
3 Ground-truthing and functional assessments were conducted at wetlands where land access permission was available in 2012 and 2013.
4 Based on the results of the ground-based field surveys it is anticipated that wetlands with Low Functional Condition along the Edmonton to Hinton Segment are not common.
5 Wetlands of Low Functional Condition were not documented during the 2012 and 2013 field program. These observations do not conclude that wetlands with this functional condition are not present. These values will be updated following the 2014 supplemental surveys.

TABLE 8.7-6

AREA OF WETLANDS WITHIN THE WETLAND RSA

Province	Area of Wetland RSA (ha)[1]	Area of Wetland RSA (excluding Edmonton and LMDA) (ha)	Area of Wetlands of High Functional Condition (ha)	Area of Wetlands of High-Moderate Functional Condition (ha)	Area of Wetlands of Low-Moderate Functional Condition (ha)	Area of Wetlands of Low Functional Condition (ha)
Alberta	161,125.9	160,998.8	52,163.6	84,524.4	24,310.8	0.0
BC	32,755.8	28,959.4	5,994.6	19,315.9	3,127.6	260.6
Total	193,881.7	189,958.2	58,158.2	103,840.3	27,438.4	260.6

Note: 1 Areas of wetlands with the four functional conditions was determined based on the frequency of occurrence percentage documented in Table 8.7-5.

Permanent loss of wetland function is not anticipated to result from either the construction or operations phases of the proposed pipeline in trenched wetlands or at the pump stations; however, potential permanent loss of wetland function may occur as a result of the construction of the proposed power lines (*e.g.*, Kingsvale) if the placement of power line structures are within wetland boundaries and at a location that compromises overall wetland function The in-wetland structure placement will permanently reduce wetland area and this reduction may result in the overall loss of wetland function depending on the size of wetland and the type of lost habitat. Temporary alteration of wetland function may result during pipeline construction; however, best practices and mitigation measures will be employed to assist with the goal that no long-term or permanent alteration of wetland function will occur. No permanent disturbance to wetlands is anticipated to occur at pump stations.

At locations where wetland function may be lost due to the installation of the Kingsvale power line (*e.g.*, structures placed in wetlands), potential compensation will be discussed with Environment Canada.

Since surface disturbances affect wetland function, existing activities and the Project will act cumulatively to increase disturbance to wetland function in the Wetland RSA. The results of the quantitative analysis of disturbance of wetlands are summarized in Tables 8.7-7 and 8.7-8.

Within the Wetland RSA, approximately 24,576.3 ha (15.3%) of the wetlands have been affected through surface disturbance associated with existing activities in Alberta. It is estimated that 7,962.7 ha of these are wetlands of High Functional Condition, 12,902.6 ha of High-Moderate Functional Condition, 3,711 ha of Low-Moderate Functional Condition and 0.0 ha of Low Functional Condition. In combination with the Project and other reasonably foreseeable developments, the total cumulative disturbance of wetlands within the Wetland RSA in Alberta is predicted to be approximately 24,966.9 ha. This increases the percentage of disturbance of wetlands in the Wetland RSA to 15.5% of which the Project contributes to 0.05% of the total cumulative disturbance of wetlands in the Wetland RSA in Alberta.

Within the Wetland RSA in BC, approximately 1,801.5 ha (6.2%) of the wetlands have been affected through surface disturbance associated with existing activities. It is estimated that 372.9 ha of these are wetlands of High Functional Condition, 1,201.6 ha of High-Moderate Functional Condition, 194.6 ha of Low-Moderate Functional Condition and 16.2 ha of Low Functional Condition. In combination with the Project and other reasonably foreseeable developments, the total cumulative disturbance of wetlands within the Wetland RSA in BC is predicted to be approximately 1,882.4 ha. This increases the percentage of disturbance of wetlands in the Wetland RSA to 6.5% of which the Project contributes to 2.1% of the total cumulative disturbance of wetlands in the Wetland RSA in BC.

TABLE 8.7-7

CUMULATIVE DISTURBANCE OF WETLANDS IN THE WETLAND LSA AND RSA EXCLUDING EDMONTON AND THE LMDA – ALBERTA

Wetland Disturbance Assessment Scenario	Total Area[2]	Area of Wetland RSA			
		High Functional Condition	High-Moderate Functional Condition	Low-Moderate Functional Condition	Low Functional Condition[3]
Existing Disturbance to Wetlands					
Area of Wetlands	160,998.8 ha	52,163.6ha	84,524.4 ha	24,310.8 ha	0.0 ha
Area of Wetland Disturbance Attributed to Existing Activities (Existing) [1]	24,576.3 ha (15.3%)	7,962.7 ha	12,902.6 ha	3,711.0 ha	0.0 ha
Estimated Future Wetland Disturbance					
Area of Wetland Disturbance Attributed to the Project (Project)	11.9 ha (0.01%)	3.9 ha	6.2 ha	1.8 ha	0.0 ha
Area of Wetland Disturbance Attributed to Reasonably Foreseeable Developments (Likely Future) [1]	378.7 ha (0.2%)	122.7 ha	198.8 ha	57.2 ha	0.0 ha
Predicted Cumulative Wetland Disturbance					
Total Cumulative Wetland Disturbance (Existing + Project + Likely Future)	24,966.9 ha (15.5%)	8,089.3 ha	13,107.6 ha	3,770.0 ha	0.0 ha
% Contribution of Project to Cumulative Wetland Disturbance	0.05%	--	--	--	--

Notes: 1 Calculations based on footprint disturbances provided in Tables 8.7-1 to 8.7-2 and are approximate.
2 Total Area excludes the City of Edmonton and LMDA.
3 Wetlands of Low Functional Condition were not documented during the 2012 and 2013 field program in Alberta. However, wetlands of this functional condition are expected to occur within the Wetland LSA and RSA. These values will be updated following the 2014 supplemental surveys.

TABLE 8.7-8

CUMULATIVE DISTURBANCE OF WETLANDS IN THE WETLAND LSA AND RSA EXCLUDING EDMONTON AND THE LMDA – BC

Wetland Disturbance Assessment Scenario	Total Area[2]	Area of Wetland RSA			
		High Functional Condition	High-Moderate Functional Condition	Low-Moderate Functional Condition	Low Functional Condition[3]
Existing Disturbance to Wetlands					
Area of Wetlands	28,959.4 ha	5,994.6 ha	19,315.9 ha	3,127.6 ha	260.6 ha
Area of Wetland Disturbance Attributed to Existing Activities (Existing) [1]	1,801.5 ha (6.2%)	372.9 ha	1,201.6 ha	194.6 ha	16.2 ha
Estimated Future Wetland Disturbance					
Area of Wetland Disturbance Attributed to the Project (Project)	39.9 ha (0.1%)	8.3 ha	26.6 ha	4.3 ha	0.4 ha
Area of Wetland Disturbance Attributed to Reasonably Foreseeable Developments (Likely Future) [1]	41 ha (0.1%)	8.5 ha	27.3 ha	4.4 ha	0.4 ha
Predicted Cumulative Wetland Disturbance					
Total Cumulative Wetland Disturbance (Existing + Project + Likely Future)	1,882.4 ha (6.5%)	389.7 ha	1255.5 ha	203.3 ha	17 ha
% Contribution of Project to Cumulative Wetland Disturbance	2.1%	--	--	--	--

Notes: 1 Calculations based on footprint disturbances provided in Tables 8.7-1 to 8.7-2 and are approximate.
2 Total Area excludes the City of Edmonton and LMDA.
3 Wetlands of Low Functional Condition were not documented during the 2012 and 2013 field program in Alberta. However, wetlands of this functional condition are expected to occur within the Wetland LSA and RSA. These values will be updated following the 2014 supplemental surveys.

The proposed standard and effective mitigation measures to be implemented during construction through wetlands crossed by the Project will reduce cumulative effects on wetland function. No mitigation measures beyond the Project-specific mitigation already proposed under the Wetland Loss or Alteration element in Section 7.0 and the Pipeline and Facilities EPPs (Volumes 6B and 6C) are deemed warranted to reduce cumulative effects on wetland function.

For any reasonably foreseeable developments that will also affect wetlands, it is anticipated that mitigation measures that are in accordance with industry standards and provincial and federal guidelines will be implemented by many proponents. In those instances where permanent disturbance to wetland function may be a result of these developments, it is anticipated that compensation would be conducted and will comply with provincial (*i.e.*, Alberta *Water Act*, the new Alberta *Wetland Policy* and the BC *Water Act*) and federal (*i.e.*, *Federal Policy on Wetland Conservation*) legislation.

The Project's contribution to combined disturbance of wetland function is considered to have a negative impact balance. The reversibility of this contribution on wetlands is considered medium to long-term depending on the recoverability of wetland function (*i.e.*, invasive plant species could potentially delay the recovery of native wetland species, and biogeochemical processes and hydrology may be adversely affected until vegetation cover is re-established). It is anticipated that the Project's contribution to cumulative effects on wetland function will be of low to medium magnitude and that the function of wetlands will be restored to the functional condition documented prior to disturbance (*i.e.*, High, High-Moderate, Low-Moderate and Low) (Table 8.7-6, point 1[a]). A summary of the rationale for all of the significance criteria of the Project's contribution to combined cumulative effects on wetland function is provided below.

- Spatial Boundary: Wetland RSA – Project disturbance will be confined to the LSA, but may overlap with other reasonably foreseeable disturbances to extend to the RSA.
- Duration: short to long-term – Project activities that disturb wetlands and contribute to cumulative wetland function loss are anticipated to be conducted during the construction phase or completed within any one year during the operations phase (*i.e.*, short-term) except along segments of the proposed pipeline corridor where activities within wetlands will be prolonged beyond the first year of the operations phase (*e.g.*, potential disturbances to wetlands resulting from power line structure placement) or be initiated during the operations phase and extends for the life of the Project.
- Frequency: periodic – Project activities contributing to cumulative effects on wetland loss or alteration could occur intermittently, but repeatedly over the assessment period (*i.e.*, both construction and maintenance activities).
- Reversibility: medium to long-term – depending on the type of wetland (*e.g.*, shrubby vs. graminoid) and its resilience (*e.g.*, graminoid will quickly recover to graminoid whereas shrubby swamps will regenerate as emergent graminoid-dominant marshes initially), wetland function will be reduced until vegetation can be re-established, grade and natural flow patterns are restored, and sedimentation is controlled. The incremental effects of the power lines (*e.g.*, Kingsvale) on wetland function are expected to be reversible in the long-term following the potential completion of wetland compensation efforts, if required.
- Magnitude: low to medium – the Project's contribution to cumulative wetland disturbance is considered to be within environmental standards since industry standard, and federal and provincial recommended guidelines and/or mitigation measures will be implemented, as well the loss of wetland function resulting from the proposed power lines (*i.e.*, power line structures) may be potentially compensated and will be discussed with Environment Canada.
- Probability: high – disturbance of wetlands is likely to occur as a result of the Project acting in combination with existing activities and reasonably foreseeable developments.
- Confidence: high – based on experience with similar projects within the Wetland RSA, the results of the wetland surveys and the professional experience of the assessment team.

8.7.4 Summary

As identified in Table 8.7-6, there are no situations where there is a high probability of occurrence of a permanent or long-term cumulative effect of high magnitude that cannot be technically or economically mitigated. Consequently, the Project's contribution to cumulative effects on wetland function within the Wetland RSA will be not significant.

8.8 Vegetation

This subsection discusses how the Project could act in combination with existing activities and reasonably foreseeable developments to contribute to cumulative effects on vegetation indicators that were anticipated to have an adverse combined Project-specific residual effect (*i.e.*, vegetation communities of concern, plant and lichen communities of concern, and presence of Infestations of Provincial Weed Species and Other Invasive Non-Native Species Identified as a Concern).

Relevant regulatory guidelines, ATK, TEK, ecological context and residual Project effects were considered in the characterization of potential cumulative effects for vegetation indicators. TEK participants identified the potential long-term and cumulative impacts of pipeline construction on vegetation as a concern. Additional information on vegetation TEK collected during field studies for the Project is provided in the Vegetation Technical Report of Volume 5C.

8.8.1 Reasonably Foreseeable Developments

Tables 8A.1-1 to 8A.1-4 of Appendix 8.1 provide a list of the reasonably foreseeable developments located within the Vegetation RSA considered in the evaluation of quantitative cumulative effects on the vegetation indicators. Descriptions of these developments are provided in Section 8.1.4 and shown on Figures 8.1-1a, 8.1-1b and 8.1-1c. In the Vegetation RSA, there are approximately 15 mapped reasonably foreseeable developments either fully within the Vegetation RSA or, for some transmission lines and pipelines, partially within the Vegetation RSA (Table 8A.1-1 of Appendix 8.1). In addition, there are approximately 42 mapped minor oil and gas developments proposed in Alberta: 14 pipelines; 21 facilities; and 7 wells (Tables 8A.1-2 to 8A.1-4 of Appendix 8.1).

As indicated in Section 8.1, other reasonably foreseeable developments with the potential to act in combination with the Project were excluded from quantitative evaluations since development details (*e.g.*, approval status, location) were either lacking or the development was located within previously disturbed areas of municipal boundaries, such as the city limits of the City of Edmonton and LMDA. Descriptions of these developments are provided in Section 8.1.4 and Table 8A.1-5 for Alberta and Table 8A.1-6 for BC of Appendix 8.1.

The current level of vegetation disturbance due to existing activities within the Vegetation RSA as well as the anticipated disturbance attributed to the Project and reasonably foreseeable developments is provided in Tables 8.8-1 and 8.8-2. A hierarchy table was applied during the cumulative effects assessment quantitative analysis to determine priority of overlapping land use features (*i.e.*, features with greater indirect footprint and assumed effects potential are assigned higher priority).

TABLE 8.8-1

EXISTING AND NEW DISTURBANCE IN THE VEGETATION RSA – ALBERTA

Land Use Feature	Existing Disturbance (ha)	New Disturbance (ha)			Total Disturbance (ha)
		Proposed Project	Reasonably Foreseeable Developments	Total	
Cities/Towns/Communities	12,558.5	0	0	0	12,558.5
Airports/Airfields	9.7	0	37.4	37.4	47.1
Primary Roads	1,866	0	0	0	1,866
Quarries/Mines/Aggregates	684.8	0	12.8	12.8	697.6
Commercial/Industrial Features	546.1	1	47.7	48.7	594.8
Secondary Roads	564	0	0	0	564
Railways	229.6	0	0	0	229.6
Oil and Gas Well Sites	285.5	0	2.5	2.5	288

TABLE 8.8-1 Cont'd

Land Use Feature	Existing Disturbance (ha)	New Disturbance (ha)			Total Disturbance (ha)
		Proposed Project	Reasonably Foreseeable Developments	Total	
Tertiary/Access Roads	195.5	0	0	0	195.5
Buildings	2,336.5	0	0	0	2,336.5
Recreation	110	0	0	0	110
Crop/Pasture Land	19,000.5	0	0	0	19,000.5
Cutlines, Seismic Lines	402.5	0	0	0	402.5
Transmission/Power Lines	650.6	0	113.9	113.9	764.5
Buried Utility Lines	107.2	0	0	0	107.2
Oil and Gas Pipelines	642.8	455	41.6	496.6	1,139.4
Hydroelectic Infrastructure	0	N/A	0	0	0
Trails (Recreation)	0	N/A	0	0	0
Cutblocks	1,260.6	0	0[1]	0	1,260.6
Total	41,450.4	456	255.9	711.9	42,162.3

Note: 1 Future harvesting activities are detailed in the Managed Forest Areas and Forest Health Technical Report of Volume 5D but were not estimated here.

TABLE 8.8-2

EXISTING AND NEW DISTURBANCE IN THE VEGETATION RSA – BC

Land Use Feature	Existing Disturbance (ha)[1]	New Disturbance (ha)			Total Disturbance (ha)
		Proposed Project	Reasonably Foreseeable Developments	Total	
Cities/Towns/Communities	5,012.6	0	0	0	5,012.6
Airports/Airfields	21.6	0	0	0	21.6
Primary Roads	2,282.4	0	0.9	0.9	2,283.3
Quarries/Mines/Aggregates	916.2	0	258.4	258.4	1,174.6
Commercial/Industrial Features	90.8	3.6	3	6.6	97.4
Secondary Roads	943.1	0	0	0	943.1
Railways	884.8	0	0	0	884.8
Oil and Gas Well Sites	0	0	0	0	0
Tertiary/Access Roads	1,102.2	0	0	0	1,102.2
Buildings	111.6	0	0	0	111.6
Recreation	102.3	0	0	0	102.3
Crop/Pasture Land	4,891.5	0	0	0	4,891.5
Cutlines, Seismic Lines	22.1	0	0	0	22.1
Transmission/Power Lines	1,091.5	161.5	39.5	201	1,292.5
Buried Utility Lines	159.2	0	0	0	159.2
Oil and Gas Pipelines	841.5	1,437.2	6.1	1,443.3	2,284.8
Hydroelectric Infrastructure	0	0	4.1	4.1	4.1
Trails (Recreation)	0	0	0	0	0
Cutblocks	15,391.2	0	0[2]	0	15,391.2
Total	33,864.6	1,602.3	312	1,914.3	35,778.9

Notes: 1 The disturbance in the above table does not include the LMDA in BC, but does include the Surrey Greenbelt proposed disturbance.

2 Future harvesting activities are detailed in the Managed Forest Areas and Forest Health Technical Report of Volume 5D.

8.8.2 Potential Cumulative Effects

The potential and likely combined environmental residual effects associated with the construction and operation of the Project on vegetation indicators were identified in Section 7.11.1.9 and are listed in Table 8.8-3 along with the identification of existing activities and reasonably foreseeable developments that could act in combination with the Project.

TABLE 8.8-3

POTENTIAL RESIDUAL EFFECTS OF THE PROJECT ON VEGETATION CONSIDERED FOR THE CUMULATIVE EFFECTS ASSESSMENT

Potential Residual Project Effect on Indicator	Spatial Boundary[1]	Project Component(s)	Temporal Boundary	Potential Cumulative Effect	Existing Activities/Reasonably Foreseeable Developments with Residual Effects Acting in Combination with the Project
1. Combined effects of the Project on vegetation communities of concern.	RSA	Pipeline Temporary Facilities Pump Stations (Gainford, Hinton, Blackpool, Rearguard, Darfield, Black Pines, Kingsvale) Power lines (Black Pines, Kingsvale) Tanks (Sumas, Burnaby) Pipeline Reactivation	Construction to Operation	Project contribution to incremental increase in alteration or disturbance of native vegetation. Project contribution to incremental increase in alteration or disturbance of rare ecological communities. Project contribution to incremental increase in alteration or disturbance of grassland communities in the Bunchgrass (BG) BGC Zone.	• Existing activities including: agriculture and livestock grazing, forestry, recreation, rural and urban residential and commercial development, transportation and infrastructure development, utilities activities, oil and gas exploration and development, and mineral resource exploration and development. • Reasonably foreseeable developments within the RSA are listed in Tables 8A.1-1 to 8A.1-6 of Appendix 8.1 and discussed in Section 8.1.4. • Project-related activities that could interact with the above activities including clearing, topsoil/root zone material salvaging, storing and replacement, grading, backfilling, seed mix selection, reclamation and operation (vegetation control, monitoring and maintenance).
2. Combined effects of the Project on plant and lichen species of concern.	RSA	Pipeline Temporary Facilities Pump Stations (Blackpool, Rearguard, Kamloops, Black Pines, Kingsvale) Pines, Kingsvale) Tanks (Sumas, Burnaby) Pipeline Reactivation	Construction to Operation	Project contribution to incremental increase in alteration or disturbance of rare plant and rare lichen populations, if mitigation does not completely protect the site.	• Existing activities including: agriculture and livestock grazing, forestry, recreation, rural and urban residential and commercial development, transportation and infrastructure development, utilities activities, oil and gas exploration and development, and mineral resource exploration and development. • Reasonably foreseeable developments within the RSA listed in Tables 8A.1-1 to 8A.1-6 of Appendix 8.1 and discussed in Section 8.1.4. • Project-related activities that could interact with the above activities including clearing, topsoil/root zone material salvaging, storing and replacement, grading, backfilling, seed mix selection and reclamation.
3. Combined effects of the Project on weeds and other non-native species.	RSA	Pipeline Temporary Facilities Pump Stations Tanks Westridge Marine Terminal Pipeline Reactivation	Construction to Operation	Project contribution to weed introduction or spread.	• Existing activities including: agriculture and livestock grazing, forestry, recreation, rural and urban residential and commercial development, transportation and infrastructure development, utilities activities, oil and gas exploration and development, and mineral resource exploration and development. • Reasonably foreseeable developments within the RSA listed in Tables 8A.1-1 to 8A.1-6 of Appendix 8.1 and discussed in Section 8.1.4. • Project-related activities that could interact with the above activities where equipment will operate or travel in areas lacking a vegetative cover including clearing, topsoil/root zone material salvaging, storing and replacement, seed mix selection, reclamation and operation (vegetation control, monitoring and maintenance).

Note: 1 RSA = Vegetation RSA.

8.8.3 Significance Evaluation of Potential Cumulative Effects

A quantitative approach was selected to determine the cumulative effect of the Project on the vegetation communities of concern indicator since the change to this parameter over existing conditions can be quantified. However, as there are no standards, guidelines, objectives or other established and accepted ecological thresholds to define quantitative rating criteria, a qualitative method for determining the significance of the anticipated Project's contribution to cumulative environmental effects was applied. This qualitative evaluation of significance relied on the professional judgment of the assessment team.

Table 8.8-4 provides a summary of the significance evaluation of the Project's contribution to potential cumulative effects on vegetation indicators. The rationale used to evaluate the significance of each of the cumulative effects is provided below.

TABLE 8.8-4

SIGNIFICANCE EVALUATION OF THE PROJECT'S CONTRIBUTION TO CUMULATIVE EFFECTS ON VEGETATION

	Potential Cumulative Effects	Impact Balance	Spatial Boundary[1]	Temporal Context			Magnitude	Probability	Confidence	Significance[2]
				Duration	Frequency	Reversibility				
1.	Vegetation Indicator – Vegetation Communities of Concern									
1(a)	Project contribution to incremental increase in alteration or disturbance of native vegetation.	Negative	RSA	Short-term	Isolated to periodic	Medium to long-term	Low to medium	High	High	Not significant
1(b)	Project contribution to incremental increase in alteration or disturbance of rare ecological communities.	Negative	RSA	Short-term	Isolated	Medium to long-term	Medium	High	High	Not significant
1(c)	Project contribution to incremental increase in alteration or disturbance of grassland communities in the BG BGC Zone.	Negative	RSA	Short-term	Isolated to periodic	Short to long-term	Medium	High	High	Not significant
1(d)	Project contribution to combined incremental increase in alteration or disturbance of vegetation communities of concern.	Negative	RSA	Short-term	Isolated to periodic	Medium to long-term	Medium	High	High	Not significant
2.	Vegetation Indicator – Plant and Lichen Species of Concern									
2(a)	Project contribution to incremental increase in alteration or disturbance of rare plant and rare lichen populations, if mitigation does not completely protect the site.	Negative	RSA	Short-term	Isolated to periodic	Medium to long-term	Medium	High	High	Not significant
3.	Vegetation Indicator – Presence of Infestations of Provincial Weed Species and Other Invasive Non-Native Species Identified as a Concern									
3(a)	Project contribution to weed introduction or spread.	Negative	RSA	Short-term	Isolated to periodic	Short to medium-term	Low to medium	High	High	Not significant
4.	Project Contribution to Combined Cumulative Effects on Vegetation									
4(a)	Project contribution to cumulative effects on the vegetation indicators (1[d], 2[a] and 3[a]).	Negative	RSA	Short-term	Isolated to periodic	Short to long-term	Low to medium	High	High	Not significant

Notes: 1 RSA = Vegetation RSA.

2 Significant Contribution to a Cumulative Environmental Effect: A high probability of occurrence of a permanent or long-term cumulative effect of high magnitude that cannot be technically or economically mitigated.

8.8.3.1 Vegetation Indicator – Vegetation Communities of Concern

The following provides the evaluation of significance of the Project's contribution to cumulative effects on the vegetation communities of concern indicator.

Project Contribution to Incremental Increase in Alteration or Disturbance of Native Vegetation

Although some previous clearing has occurred in the Vegetation RSA for the Project, most of the vegetation communities within the Vegetation RSA in BC remain intact. The Project parallels existing disturbance for 89% of its length. The east and west ends of the Project are areas with a high level of anthropogenic disturbance (*i.e.*, Edmonton and LMDA). The land use in the Vegetation RSA along the Edmonton to Hinton Segment is mostly anthropogenic (*e.g.*, cultivation, pasture, roads) with between 25% and 39% native vegetation. The amount of native vegetation in the Vegetation RSA in BC is much higher than Alberta, with between 63% and 76% native vegetation. There are agricultural areas around Kamloops, but the degree of anthropogenic disturbance in the Vegetation RSA is comparatively low along the BC segments of the Project.

Since clearing activities involve the removal of trees, existing activities, the Project and reasonably foreseeable developments (as identified in Appendix 8.1) will act cumulatively to affect vegetation communities in the Vegetation RSA.

Existing activities that have resulted in the alteration of the composition of native vegetation include agriculture (including grazing), rural and urban residential and commercial development, transportation and infrastructure development (*e.g.*, road and rail networks), utility activities, forestry, mineral resource exploration and development, ongoing recreational activities as well as oil and gas exploration and development (*e.g.*, seismic cutlines, pipelines). The amount of disturbance to native vegetation and clearing in the area as a result of the Project is reduced by paralleling existing pipeline rights-of-way for approximately 89% of the Project length. Trans Mountain is expected to further reduce the amount of disturbance to native vegetation by using existing rights-of-way as temporary workspace and siting temporary facilities such as work camps and stockpile sites on existing disturbances, where feasible.

Reasonably foreseeable developments which involve clearing activities in the Vegetation RSA are identified in Tables 8A.1-1 to 8A.1-4 of Appendix 8.1 and include oil and gas pipelines, facilities (*e.g.*, batteries, satellites) and wells. In Alberta, reasonably foreseeable developments are mostly minor oil and gas developments, with a few major developments such as the Vista Project. In BC, reasonably foreseeable developments are mostly proposed hydroelectric projects (*e.g.*, Deneau Creek project), with a few major developments such as the Ajax Project. Reasonably foreseeable developments in the Vegetation RSA, which may result a change to native vegetation, include the Edmonton to Hardisty Pipeline Project, the proposed Parkland Airport (Phase 1), the Vista Project, the Kingsvale – Oliver Natural Gas Pipeline Reinforcement Project, the Interior-Lower Mainland Transmission Project, the Merritt Area Transmission Project, the Deneau Creek Hydroelectric Project, the Emory Creek Hydroelectric Project, the Patterson Creek Nano Hydro Project, the Peers Creek Hydroelectric Project, the Ajax Project and the Gateway Program – Port Mann Bridge/Highway 1 Improvements – Golden Ears Connector (see Table 8A.1-1 of Appendix 8.1 for details). Construction activities for the Project and reasonably foreseeable developments will require clearing of lands supporting native vegetation. Consequently, existing activities, the Project and reasonably foreseeable developments will act cumulatively to affect the native vegetation community composition within the Vegetation RSA.

The results of the quantitative analysis of vegetation disturbance are summarized in Tables 8.8-1 and 8.8-2. The areas of disturbance were calculated using a disturbance layer on GIS imagery. Within the Vegetation RSA, approximately 41,450.4 ha in Alberta and 33,864.6 ha in BC, for a total of 75,315 ha of the vegetation has been removed or altered by disturbances associated with existing activities.

The Project is predicted to create approximately 456 ha of new disturbance in Alberta and 1,602 ha in BC, for a total of 2,058 ha of new disturbance. Disturbance attributable to reasonably foreseeable developments in Alberta is predicted to be approximately 256 ha and 312 ha in BC, for a total of 568 ha. Total predicted new disturbance is 2,626 ha. The Project is predicted to contribute 78% of the predicted total new disturbance of vegetation in the Vegetation RSA. This analysis is limited by the number of reasonably foreseeable developments with spatial data available (for example, cutblocks which are a large source of existing disturbance but for no spatial data were available for anticipated future tree harvest).

When existing disturbance is combined with the Project and reasonably foreseeable developments, the total cumulative disturbance of vegetation in the Vegetation RSA is predicted to be approximately

42,162 ha in Alberta and 35,779 ha in BC, for a total of 77,941 ha. The Project is predicted to contribute 3% of the predicted total cumulative (*i.e.*, existing plus Project and reasonably foreseeable developments) disturbance of vegetation.

The amount of disturbance to native vegetation as a result of the Project will be reduced by paralleling existing linear disturbances for approximately 89% of the proposed pipeline corridor and confining facility expansions to previously disturbed lands where feasible. Vegetation communities located along the Project Footprint will have the potential to be altered such that their overall abundance may be reduced, although different native vegetation communities (*e.g.*, early seral stage communities [forb and shrub]) will be established following revegetation.

Although proposed facilities for the Project have been located on previously disturbed lands to the greatest extent practical, clearing of approximately 166.1 ha of native vegetation will be necessary at the Gainford, Hinton, Rearguard, Kingsvale and Black Pines pump stations, as well as at the Sumas Terminal and along the Kingsvale and Black Pines power lines.

Many of the reasonably foreseeable developments are large-scale projects and are anticipated to be constructed and operated adopting best management practices and mitigation similar to those recommended for the Project. There are smaller-scale reasonably foreseeable developments, such as the hydroelectric projects, that are anticipated to be constructed using best management practices with similar objectives as the Project's mitigation. These small-scale projects will likely use equivalent mitigation that is appropriate to their size and scale. Consequently, most cumulative effects of the Project and reasonably foreseeable developments are primarily attributed to an alteration, rather than complete removal, of native vegetation.

TABLE 8.8-5

CUMULATIVE DISTURBANCE OF NATIVE VEGETATION IN THE VEGETATION RSA

Native Vegetation Disturbance Assessment Scenario	Area and Percentage of Vegetation RSA[1]
Existing Native Vegetation	
Area of the Vegetation RSA	202,722.2 ha
Amount of Native Vegetation	127,407.2 ha (63%)
Estimated Future Native Vegetation Disturbance	
Amount of Native Vegetation Disturbance Attributed to the Proposed Pipeline[2]	1,892.2 ha
Amount of Native Vegetation Disturbance Attributed to Proposed Above Ground Facilities for the Project	4.6 ha
Amount of Native Vegetation Disturbance Attributed to Proposed Power Lines for the Project	161.5 ha
Amount of Native Vegetation Disturbance Attributed to Reasonably Foreseeable Developments (Likely Future)[3]	567.9 ha
Predicted Cumulative Native Vegetation Degradation	
Total Remaining Native Vegetation Following Cumulative Disturbance (Existing+Project+Likely Future)	124,781 ha
Total Remaining Native Vegetation Following Cumulative Disturbance without Project (Existing+Likely Future)	126,839 ha
% Contribution of Project to Cumulative Native Vegetation Disturbance in the Vegetation RSA	3%

Sources: Refer to Table 8.1-1 for data sources used for land use features.

Notes:
1 Calculations based on footprint disturbances provided in Tables 8.8-1 and 8.8-2 and are approximate.
2 Calculation based on TEM.
3 The estimated area resulting from the construction of reasonably foreseeable developments within the Vegetation RSA for the Project (see Tables 8A.1-1 through 8A.1-4 of Appendix 8.1).

Cumulative change (*i.e.*, disturbance) estimates for native vegetation in the Vegetation RSA are summarized in Table 8.8-5. Native vegetation currently comprises approximately 127,407 ha (63%) of the Vegetation RSA. The total cumulative disturbance to native vegetation attributed to existing activities, the Project and reasonably foreseeable developments is predicted to be approximately 77,941 ha. Native vegetation disturbance from reasonably foreseeable developments is likely underestimated because spatial disturbance data were not available for most developments. The Project accounts for an incremental decrease of 3% to the remaining native vegetation in the Vegetation RSA.

None of the most affected native vegetation communities discussed in the Vegetation sections of Sections 5.0 through 7.0 are predicted to be affected by reasonably foreseeable developments. None of the reasonably foreseeable developments with spatial information available are located on any of the ecosites or variants identified in Tables 7.2.9-5 and 7.2.9-6. Therefore, the Project will be the only contribution to incremental alteration or disturbance of native vegetation within the identified ecosites or variants.

By preserving native vegetation using the mitigation suggested in Section 7.2.9 and the Pipeline and Facilities EPPs (Volumes 6B and 6C), the Project will achieve the objectives of the land use plans for the areas traversed by the Project. Objectives of the management plans include maintaining natural vegetation throughout the development process, preserving natural vegetation including trees in all undeveloped and riparian areas and discouraging further clearing or development in areas where native vegetation is important for soil conservation, water resources protection or wildlife habitat (City of Kamloops 2004, 2011, Inter-Agency Planning Team 2009, Strathcona County 2007, TNRD 2000, 2011, Town of Edson 2006, Yellowhead County 2005, 2006, 2007). See Appendix 7.1 of Section 7.0 for more details of the land use plan objectives related to vegetation.

Disturbed areas through native vegetation will be allowed to naturally revegetate or will be seeded with the appropriate seed mix. The proposed standard and effective mitigation measures to be implemented during construction, through native vegetation crossed by the construction right-of-way, will reduce cumulative effects on native vegetation. Consequently, the Project's contribution to cumulative are primarily related to a change in vegetation rather than a loss of vegetation.

Permanent loss of native vegetation is not anticipated to result from either the construction or operation of the proposed pipeline; however, long-term loss of native vegetation may occur during the construction of the proposed pump stations (*e.g.*, Gainford, Hinton, Rearguard, Kingsvale and Black Pines), terminals (*i.e.*, Sumas) and associated power lines (*i.e.*, Black Pines, Kingsvale) depending on the placement of the pump stations, terminals and the power line towers. Temporary alteration of native vegetation may result during pipeline construction; however, mitigation measures described in Section 7.2.9 will be implemented to ensure that no long-term or permanent alteration of native vegetation will occur. Reasonably foreseeable developments in the Vegetation RSA which may result in long-term loss of native vegetation include the Vista Project, the Ajax Project, the Interior-Lower Mainland Transmission Project, the Merritt Area Transmission Project, the Deneau Creek Hydroelectric Project, the Emory Creek Hydroelectric Project, the Patterson Creek Nano Hydro Project, the Peers Creek Hydroelectric Project and the Gateway Program – Port Mann Bridge/Highway 1 Improvements – Golden Ears Connector depending on the placement of the pump stations, terminals and the power line towers. Permanent loss of native vegetation is not anticipated to result from either the construction or operation of the Edmonton to Hardisty Pipeline Project, the proposed Parkland Airport (Phase 1) (which is predicted to be located on agricultural lands) or the Kingsvale – Oliver Natural Gas Pipeline Reinforcement Project (see Table 8A.1-1 of Appendix 8.1 for details). No additional mitigation measures beyond the Project-specific mitigation already proposed in Section 7.2.9 and the Pipeline and Facilities EPPs (Volumes 6B and 6C) are warranted.

The overall cumulative effects of the Project and reasonably foreseeable developments on native vegetation within the Vegetation RSA are considered to be reversible in the medium-term (*e.g.*, effects of proposed pipelines such as the Kingsvale/Oliver Natural Gas Pipeline Reinforcement Project or transmission lines) to long-term or permanent (*e.g.*, effects of facility developments), depending on the affected area (*e.g.*, forb versus tree) and of low to medium magnitude.

The Project is predicted to have a limited (3%) incremental contribution to cumulative alteration of native vegetation in the Vegetation RSA. Consequently, the Project's contribution to cumulative incremental change of native vegetation community composition within the Vegetation RSA is considered to be of low to medium magnitude and is considered reversible in the medium to long-term, depending on the associated land use, the type of activity (*i.e.*, temporary facility, power line, pump station) and the time required for various native species to regenerate following disturbance (Table 8.8-4, point 1[a]). A summary of the rationale for all the significance criteria of combined cumulative effects on native vegetation is provided below.

- Spatial Boundary: Vegetation RSA – the Project's contribution to cumulative effects on native vegetation may interact with reasonably foreseeable developments within the Vegetation RSA to cause a cumulative alteration to vegetation composition in the RSA.
- Duration: short-term – Project's activities that contribute to cumulative changes to native vegetation composition would occur during the construction phase or be completed within any one year during the operations phase. Maintenance activities (*i.e.*, vegetation management on power line rights-of-way) may occur throughout the life of the Project.
- Frequency: isolated to periodic – the Project's contribution to cumulative changes in the composition of native vegetation will occur during construction and intermittently but repeatedly during operations and maintenance activities.
- Reversibility: medium to long-term – depending upon the associated land use, the type of activity (*i.e.*, temporary facility, power line, pump station) and the growth time required for species in each affected area (*e.g.*, forb versus tree), the Project's contribution to changes to native vegetation community composition are considered reversible in the medium to long-term.
- Magnitude: low to medium – the Project's contribution to incremental cumulative change to native vegetation community composition is 3% of the Vegetation in the Vegetation RSA, which is considered to be within environmental standards given that best practices, objectives and provincial guidelines are being followed.
- Probability: high – it is likely that proposed clearing activities for the Project will combine with reasonably foreseeable developments and past clearing for existing activities to affect native vegetation.
- Confidence: high – based on experience from past pipeline projects and the professional experience of the assessment team.

Project Contribution to Incremental Increase in Alteration or Disturbance of Rare Ecological Communities

Rare ecological communities with potential to occur in the Vegetation RSA are found on lands supporting native vegetation. The desktop review conducted prior to the vegetation surveys identified several previously identified rare ecological communities within the Vegetation RSA. Areas of native vegetation with high potential to support rare ecological communities are known to occur in the Vegetation RSA, and a low number of records of previously identified rare ecological communities may be a result of low survey effort in the area rather than an actual lack of rare ecological communities (Alberta Conservation Information Management System [ACIMS] 2013 or the BC Conservation Data Centre [BC CDC] 2012).

Rare plant surveys were conducted during the growing season in 2013 on lands where access was granted as a component of the vegetation surveys. Supplemental ground-based rare plant surveys are planned to be conducted prior to construction in some areas with high potential habitat for rare ecological communities that were not surveyed in 2013, as well as in some areas where access was not available and sites where rare ecological communities need to be confirmed (see Section 9.0).

During the 2013 vegetation surveys, 25 occurrences of ACIMS and BC CDC-listed rare ecological communities (12 distinct rare ecological community types) were documented, as well as one unique ecological community not listed by ACIMS or the BC CDC. Protection measures and environmental management techniques for these rare ecological communities and any others discovered during supplemental studies are provided in Appendix C of the Pipeline and Facilities EPPs (Volumes 6B and 6C).

Indirect alteration of rare ecological communities adjacent to the Project may occur due to soil erosion. Since the areas with greatest erosion risk will be seeded with native species or an annual cover crop (or otherwise stabilized with mulch, straw, crimping), the indirect alteration of native vegetation as a result of erosion will not measurably contribute to the overall effect of the Project on the alteration of rare ecological communities.

Given that indirect effects are, in part, caused by disturbance to vegetation structure associated with clearing activities, allowing disturbed areas to naturally revegetate may not alleviate indirect effects where vegetation management is conducted or long-term persistence of the disturbance exists. Consequently, indirect effects to vegetation are expected to persist until the pre-existing vegetation composition and structure is restored.

Since ground disturbance will be associated with the Project and reasonably foreseeable developments (as identified in Table 8.8-1), combined future disturbance could act cumulatively with existing activities to affect rare ecological communities in the Vegetation RSA.

Lands within the Vegetation RSA include approximately 127,407 ha (63%) of native vegetation, while the remaining areas have previously been converted to non-native cover types where rare ecological communities are unlikely to persist. Loss or alteration of native vegetation attributed to existing activities associated with land use change (*i.e.*, agricultural activities, rural and urban residential development) precludes the ability to determine the extent to which previously existing or remnant rare ecological communities in the Vegetation RSA have been altered. However, the potential for rare ecological communities is highest on lands with contiguous native vegetation and, therefore, construction activities for the Project and reasonably foreseeable developments may act cumulatively to alter remaining or previously unaffected rare ecological communities in the Vegetation RSA. Details of reasonably foreseeable developments that may act cumulatively with construction of the proposed pipeline and facilities are provided in Section 8.1.4 and Tables 8A.1-1 to 8A.1-6 of Appendix 8.1.

The presence and abundance of rare ecological communities along the proposed pipeline corridor were assessed during early and late-season vegetation surveys in 2013 (see the Vegetation Technical Report of Volume 5C). Implementation of site and species-specific mitigation measures outlined in Section 7.2.9 and the Pipeline EPP of Volume 6B is expected to reduce the magnitude and shorten the period of reversibility for residual effects to known rare ecological communities. Mitigation measures that were implemented during construction of the TMX Anchor Loop Project are similar to those that have been recommended for construction of this Project. Additionally, disturbed areas supporting native vegetation or wetlands will be left to naturally regenerate or will be seeded with an appropriate native seed mixture. Many of the reasonably foreseeable developments are large-scale projects and are anticipated to be constructed and operated adopting best practices and mitigation similar to those recommended for the Project. There are smaller-scale reasonably foreseeable developments, such as the hydroelectric projects, that are anticipated to be constructed using best management practices with similar objectives as the Project's mitigation. These small-scale projects will likely use equivalent mitigation that is appropriate to their size and scale. Consequently, additional mitigation measures to reduce combined cumulative effects are not warranted.

For any rare ecological communities identified along the proposed pipeline corridor during future rare plant surveys (see Section 9.0), appropriate site-specific protection measures outlined in the Plant Species and Ecological Communities of Concern Discovery Contingency Plan (Appendix B of the Pipeline EPP [Volume 6B]) will be implemented. The appropriate mitigation will be selected so that the rare ecological communities, particularly S1 communities if identified, are not placed at risk. To this end, Trans Mountain will report any rare ecological communities identified to the provincial conservation data centre (*i.e.*, BC CDC or ACIMS).

With proper implementation of the industry-accepted standard mitigation practices that are proposed, disruption of surface flow patterns and light levels following construction or maintenance activities is expected to be minor along the proposed pipeline corridor. However, construction activities may contribute to some localized alteration of sunlight levels and natural surface drainage patterns until trench settlement is complete and seeded vegetation has matured. No additional mitigation measures beyond the Project-specific mitigation already proposed in Section 7.2.9 and the Pipeline EPP of Volume 6B are deemed warranted.

Overall cumulative effects on rare ecological communities within the Vegetation RSA are considered to be reversible in medium to long-term and of medium magnitude. It may take more than one year plus adequate precipitation levels in order for the trench crown to settle and natural drainage patterns to be restored to pipeline corridors (*e.g.*, Edmonton to Hardisty Pipeline Project), and it will take several years (medium-term) for vegetation to grow back to former heights, which will prevent increased light from reaching surrounding plants in the ecological community. It may take more than 10 years (long-term) for natural drainage patterns to be restored to mine projects (*e.g.*, Ajax Project, Vista Project) and vegetation may not grow back for the life of these projects.

The Project's contribution to cumulative effects on rare ecological communities is considered to be reversible in the medium to long-term, depending on the species/communities affected and of medium magnitude (Table 8.8-4, point 1[b]). A summary of the rationale for all the significance criteria of combined cumulative effects on rare ecological communities is provided below.

- Spatial Boundary: Vegetation RSA – residual Project effects on rare ecological communities could interact with reasonably foreseeable developments within the Vegetation RSA to cause a cumulative alteration to vegetation composition in the RSA.
- Duration: short-term – the Project's contribution to cumulative changes to disturbance or alteration of rare ecological communities would occur during the construction phase or be completed within any one year during the operations phase. Maintenance activities (*i.e.*, vegetation management on power line rights-of-way) may occur throughout the life of the Project, but once the native vegetation (which provides potential habitat for rare ecological communities) is cleared, there is a low probability of rare ecological communities revegetating the area. Therefore, maintenance activities completed more than one year after construction will not further disturb or alter rare ecological communities.
- Frequency: isolated – the Project's contribution to cumulative changes in the disturbance or alteration of rare ecological communities will occur during construction (*e.g.*, clearing native vegetation, which provides habitat for rare ecological communities).
- Reversibility: medium to long-term – depending on the component species (*e.g.*, western redcedar and amabilis fir [amabilis fir - western redcedar/devil's club community] will take years to grow to mature trees, compared to common cattails [common cattail marsh] or beaked sedge [beaked sedge marsh] which can recolonize or re-establish in one growing season if the seed bank and habitat is available), the type of development (*e.g.*, facility, power line, pipeline) and associated land use.
- Magnitude: medium – the Project's contribution to combined disturbance or alteration of a rare ecological community is of medium magnitude because best practices and past precedents typically require additional mitigation like those proposed for the Project to avoid unacceptable effects and reduce cumulative effects.
- Probability: high – the proposed pipeline corridor crosses 25 known occurrences of rare ecological communities and reasonably foreseeable developments are likely to cross areas of native vegetation with potential to support rare ecological communities.
- Confidence: high – based on past pipeline projects, the professional experience of the assessment team and the results of post-construction environmental monitoring of past pipeline projects under similar conditions.

Project Contribution to Incremental Increase in Alteration or Disturbance of Grassland Communities in the Bunchgrass Biogeoclimatic Zone

The proposed pipeline corridor was routed along the existing TMPL right-of-way and other linear disturbance to the extent practical. No pump stations or facilities are currently proposed in the Bunchgrass Biogeoclimatic Zone. The Merritt Area Transmission Project is the only reasonably foreseeable development with known spatial information located within the Vegetation RSA in the BG BGC Zone.

Since ground disturbance will be associated with the Project and reasonably foreseeable developments (*i.e.*, the Merritt Area Transmission Project), these combined future disturbances would act cumulatively with existing activities to affect bunchgrass vegetation communities in the Vegetation RSA (Table 8.8-6).

TABLE 8.8-6

CUMULATIVE DISTURBANCE OF NATIVE VEGETATION IN THE VEGETATION RSA WITHIN THE BG BGC ZONE

Native Vegetation Disturbance Assessment Scenario	Area of Vegetation RSA[1]
Existing Native Vegetation	
Amount of Native Grassland Vegetation (Variants BGxh1 and BGxh2) within the BG BGC Zone[2]	6,372.9 ha
Estimated Future Native Vegetation Disturbance	
Amount of Native Vegetation Disturbance Attributed to the Proposed Pipeline[2]	88.6 ha
Amount of Native Vegetation Disturbance Attributed to Proposed Above Ground Facilities for the Project	0 ha
Amount of Native Vegetation Disturbance Attributed to Proposed Power Lines for the Project	0 ha
Amount of Native Vegetation Disturbance Attributed to Reasonably Foreseeable Developments (Likely Future) [3]	5.9 ha
Predicted Cumulative Native Vegetation Degradation	
Total Existing Disturbance in the BG BGC	2,069.4 ha
Total Remaining Native Vegetation Following Cumulative Disturbance (Existing+Project+Likely Future)	4,209.0 ha
Total Remaining Native Vegetation Following Cumulative Disturbance without Project (Existing+Likely Future)	4,297.6 ha
% Contribution of Project to Cumulative Native Vegetation Disturbance in the Vegetation RSA	4%

Source: Refer to Table 8.1-1 for data sources used for land use features.

Notes:
1 Calculations based on footprint disturbances provided in Tables 8.8-1 and 8.8-2 and are approximate.
2 Calculation based on TEM.
3 The estimated area resulting from the construction of reasonably foreseeable developments within the Vegetation RSA for the Project (see Tables 8A.1-1 through 8A.1-4 of Appendix 8.1).

Cumulative change (*i.e.*, disturbance) estimates for native grassland vegetation in the Vegetation RSA within the BG BGC Zone are summarized in Table 8.8-6. Native grassland vegetation currently comprises approximately 6,372.9 ha of the Vegetation RSA in the BG BGC Zone. The total cumulative disturbance to native grassland vegetation in the BG BGC Zone attributed to existing activities, the Project and reasonably foreseeable developments is predicted to be approximately 2,163.9 ha. Native grassland vegetation disturbance from reasonably foreseeable developments is likely underestimated because spatial disturbance data were not available for most developments. The Project accounts for an incremental decrease of 4% to the remaining native grassland vegetation in the Vegetation RSA.

Although areas disturbed during construction and occasional maintenance activities will be allowed to naturally regenerate or revegetate with the appropriate native species, species composition in the disturbed Footprint will likely be altered as a result of the Project and the Merritt Area Transmission Project. The extent of altered vegetation communities from the Project will be limited by the implementation of mitigation measures outlined in Table 7.2.9-2 and reclamation measures will speed the recovery of grassland communities. The Merritt Area Transmission Project is expected to follow best practices and regional land use guidance and objectives. No additional mitigation measures beyond the Project-specific mitigation already proposed in Section 7.2.9 and the Pipeline EPP (Volume 6B) are deemed warranted. Consequently, the overall cumulative effects on grassland communities within the BG BGC Zone is considered to be of medium magnitude given there are no standards or thresholds that would otherwise indicate loss or alteration of native grassland vegetation is unacceptable.

The Project's contribution to cumulative effects on grassland communities within the BG BGC Zone is limited to the Vegetation RSA, reversible in the short to long-term and of medium magnitude since indirect effects following mitigation will not be acute and the Project is routed along other linear corridors to the extent practical (Table 8.8-4, point 1[c]). A summary of the rationale for all the significance criteria of combined cumulative effects on grassland communities within the BG BC Zone is provided below.

- Spatial Boundary: Vegetation RSA – Project effects on grassland communities in the BG BGC Zone could interact with reasonably foreseeable developments (*i.e.*, the Merritt Area Transmission Project) within the Vegetation RSA to cause a cumulative alteration to grassland communities in the RSA.
- Duration: short-term – Project activities contributing to cumulative disturbance or alteration of bunchgrass vegetation communities will occur during the construction phase or be completed within any one year during the operations phase of the Project and reasonably foreseeable developments.

- Frequency: isolated to periodic – the Project's contribution to cumulative changes in the composition of native vegetation in the BG BGC Zone will occur during construction and intermittently but repeatedly during operations or maintenance activities.

- Reversibility: short to long-term – the regeneration period for native vegetation depends on the growth time required for species in each area. Weed introduction can take years of management to remediate, depending on the non-native species (*i.e.*, non-native grasses) and the specificity of the herbicide.

- Magnitude: medium –the Project will contribute to a combined loss or alteration of native grassland vegetation, however, there are no standards or thresholds that would otherwise indicate loss or alteration of native grassland vegetation is unacceptable. Best practices, objectives and provincial guidelines will be followed. Minimal indirect impacts to vegetation communities will be caused by the Project since the Project parallels existing linear features to the extent practical.

- Probability: high – it is likely that proposed clearing activities for the Project will combine with reasonably foreseeable developments and past clearing for existing activities to affect bunchgrass vegetation communities.

- Confidence: high – based on experience from past pipeline projects and the professional experience of the assessment team.

Project Contribution to Combined Incremental Increase in Alteration or Disturbance of Vegetation Communities of Concern

The following potential cumulative effects are likely to act in combination to result in overall effects on native vegetation:

- Project contribution to incremental increase in alteration or disturbance of native vegetation;

- Project contribution to incremental increase in alteration or disturbance of rare ecological communities; and

- Project contribution to incremental increase in alteration or disturbance of grassland communities in the BG BGC Zone.

The Project will contribute to a comparatively small loss or alteration of native vegetation (approximately 2,058 ha) when combined with existing activities (75,315 ha) plus reasonably foreseeable developments (approximately 568 ha for those for which spatial data could be located).

Alteration of remnant or previously unaffected rare ecological communities and grassland communities may primarily be attributed to construction of the Project acting cumulatively with reasonably foreseeable developments in areas of native vegetation. The Project is predicted to contribute the largest amount of clearing of native vegetation in the Vegetation RSA when compared with other reasonably foreseeable developments, including in the BG BGC Zone. Since rare ecological communities were observed in areas of native vegetation during 2013 surveys, the number of rare ecological communities affected by construction of the Project may be relatively more numerous than those potentially affected by reasonably foreseeable developments. Consequently, the number of rare ecological communities and grassland communities affected by the Project and reasonably foreseeable developments acting cumulatively may not be much greater than those predicted to be altered by the Project alone.

Standard industry practices will be applied by the Project in areas of native vegetation, including grasslands and rare ecological communities, to prevent the introduction and spread of weeds. Similar practices are anticipated for reasonably foreseeable developments, so no mitigation measures beyond the Project-specific mitigation already proposed in Section 7.2.9 and the Pipeline EPP (Volume 6B) are deemed to be warranted. The overall combined cumulative effects on vegetation communities of concern within the Vegetation RSA are considered to be of medium magnitude because combined cumulative effects are anticipated to be largely mitigated during construction and post-construction environmental monitoring.

While the Project's contribution to combined alteration and loss of native vegetation and rare ecological communities is considered to be comparatively limited in extent (3% of the native vegetation in the Vegetation RSA will be cleared due to the Project), this is considered to be of medium magnitude because some of these communities, such as grasslands and Red or Blue-listed communities, are of management concern and generally require site-specific mitigation. Depending on the development type and species affected, the Project's contribution to combined cumulative effects on vegetation communities of concern is considered to be reversible in the medium to long-term. The probability of the above-listed cumulative effects acting in combination is high (Table 8.8-4, point 1[d]). A summary of the rationale for all the significance criteria for the Project's contribution to combined cumulative effects on the vegetation communities of concern indicator is provided below.

- Spatial Boundary: Vegetation RSA – residual Project effects on native vegetation and ecological communities of concern could interact with reasonably foreseeable developments within the Vegetation RSA to cause a cumulative alteration to native vegetation and ecological communities in the RSA.
- Duration: short-term – the Project's contribution to cumulative changes to native vegetation composition and alteration of rare ecological communities would occur during the construction phase or be completed within any one year during the operations phase.
- Frequency: isolated to periodic – the Project's contribution to cumulative changes in the disturbance or alteration of native vegetation and rare ecological communities will occur during construction and intermittently but repeatedly during operations for maintenance activities.
- Reversibility: medium to long-term – depending on the associated land use and the growth time required for species in each affected area (*e.g.*, forb versus tree), it may take more than 10 years to return to existing conditions depending on the types of communities affected. The incremental effects of the proposed pump stations (*e.g.*, Black Pines) and power lines (*i.e.*, Black Pines, Kingsvale) on native vegetation and rare ecological communities are expected to be prolonged beyond the first year of the operations phase (*e.g.*, disturbances resulting from pump station expansions or power lines) or may extend for the life of the Project (*i.e.*, long-term).
- Magnitude: medium – the Project's contribution to cumulative changes in the disturbance or alteration of native vegetation and rare ecological communities are anticipated to be largely mitigated during construction and post-construction environmental monitoring. The Project is located adjacent to existing disturbances where practical and the construction of the Project will result in the clearing of approximately 2,058 ha of native vegetation, which is considered to be within environmental standards given that best practices, objectives and provincial guidelines are being followed.
- Probability: high – the proposed pipeline corridor encounters known locations of rare ecological communities, grasslands and native vegetation. No rare ecological communities were identified during the 2013 field surveys at pump stations or power lines, though these proposed activities encounter native vegetation. In addition, grasslands in the BG BGC Zone are not affected by any proposed pump stations or terminals associated with the Project. Reasonably foreseeable developments are located on native vegetation lands with the potential to support rare ecological communities, so the probability is high for the Project and reasonably foreseeable developments to act cumulatively to affect vegetation communities of concern.
- Confidence: high – based on experience from past pipeline projects and the professional experience of the assessment team.

8.8.3.2 Vegetation Indicator – Plant and Lichen Species of Concern

The following provides the evaluation of significance of potential residual effects on the plant and lichen species of concern indicator.

Project Contribution to Incremental Increase in Alteration or Disturbance of Rare Plant and Rare Lichen Populations, if Mitigation Does Not Completely Protect the Site

Most of the rare plant and rare lichen species with potential to occur in the Vegetation RSA are found on lands supporting native vegetation (see the Vegetation Technical Report of Volume 5C). Alteration or disturbance of native vegetation reduces the potential habitat for rare plant and lichen species of concern, therefore, effects to native vegetation also affect rare plant and lichen species of concern.

The desktop review conducted prior to the vegetation surveys identified several previously identified populations of rare plants within the Vegetation RSA. Areas of native vegetation with high potential to support rare plants or lichens are known to occur in the Vegetation RSA and a low number of records of previously identified rare plants or lichens in some areas of the RSA may be a result of low survey effort in the area rather than an actual lack of rare plant or lichen populations (ACIMS 2013, BC CDC 2012).

Rare plant surveys were conducted during the growing season in 2013 on lands where access was granted as a component of the vegetation surveys. Supplemental ground based rare plant surveys are planned to be conducted prior to construction in some areas with high potential habitat for rare plant or lichen species that were not surveyed in 2013, new lands as a result of reroutes, as well as in some areas where access was not available and sites where rare plant or lichen species need to be confirmed (see Section 9.0). In the event that additional rare plant or lichen populations are identified for the Project during supplemental surveys, mitigation will be determined using the Rare Ecological Community and Rare Plant Population Management Plan (Pipeline EPP of Volume 6B).

In addition to those populations of rare plants and rare lichens previously identified as occurring in the Vegetation RSA, vegetation surveys conducted for the Project documented 151 occurrences of ACIMS and BC CDC-listed rare plant and lichen species, including 10 liverwort populations (5 unique species), 2 moss species, 133 vascular plant populations (39 unique species) and 6 rare lichen populations (6 unique species) (see the Vegetation Technical Report of Volume 5C). Due to potential connectivity among populations associated with an Element Occurrence (see Section 7.2.9), alteration of known or previously unidentified populations of rare plants or lichens may affect the viability of other populations in the Vegetation RSA.

Increased distance of light penetration due to clearing associated with for the Project and reasonably foreseeable developments will result in an indirect alteration of native vegetation (*i.e.*, the native plant species making up the habitat for rare plant and lichen populations). If part of a treed community is cleared, the light penetrating to the understory will change the species composition along the edges of the community where clearing occurred. However, this effect will not substantially contribute to the cumulative effects on rare plant or lichen populations beyond the direct effects on these populations caused by the clearing of native vegetation. Additionally, during the course of reclamation for the Project and reasonably foreseeable developments, as revegetation progresses, light penetration will generally decrease over time.

Indirect alteration of rare plant or lichen populations adjacent to the Project and reasonably foreseeable developments may occur due to soil erosion and disruption of surface flow patterns. Since the areas with greatest erosion risk will be seeded with native species or an annual cover crop (or otherwise stabilized with mulch, straw, crimping), the indirect alteration of native vegetation (*i.e.*, the native species making up the habitat for rare plant and lichen populations) as a result of erosion will not measurably contribute to overall effects on rare plant or lichen populations.

During all phases of the Project and reasonably foreseeable developments, vehicle traffic may increase dust deposition onto native vegetation adjacent to the development area which could include rare lichen populations. During reclamation and operations, dust due to development traffic could also result in minor cumulative effects to rare lichens located adjacent to the right-of-way.

With proper implementation of the industry-accepted standard mitigation practices, disruption of surface flow patterns and light levels following construction or maintenance activities is expected to be minor for the Project and reasonably foreseeable developments. However, construction activities may contribute to some localized alteration of light levels and natural surface drainage patterns until settlement is complete and seeded vegetation has matured.

Some lichens are found only in very specific habitats, living within a very narrow range of humidity, light and moisture regimes. For example, soil crust lichens may be sensitive to changes in moisture regimes, drainage patterns or erosion. Another example is arboreal lichens which may be sensitive to humidity and air flow patterns, which are affected by clearing in forested areas. If a lichen species only grows on trees, then any effect of the Project or reasonably foreseeable developments on trees or forested areas will in turn affect these lichen species.

Combined ground disturbance from the Project and reasonably foreseeable developments (as identified in Table 8.8-1) will act cumulatively with existing activities to affect rare plant and lichen populations in the Vegetation RSA.

Lands within the Vegetation RSA include approximately 127,407 ha (63%) of native vegetation, while the remaining areas have previously been converted to non-native cover types that provide little to no habitat value for rare plants and rare lichens. Loss or alteration of native vegetation attributed to existing activities associated with land use change (*i.e.*, agricultural activities, rural and urban residential development) precludes the ability to determine the extent to which previously existing or remnant populations of rare plants and rare lichens in the Vegetation RSA have been altered. However, the potential for rare plant and rare lichen populations is highest on lands supporting native vegetation and, therefore, construction activities for the Project and reasonably foreseeable developments may act cumulatively to alter remaining or previously unaffected rare plant and lichen populations in the Vegetation RSA. Details of reasonably foreseeable developments that may act cumulatively with construction of the proposed pipeline and facilities are provided in Section 8.1.4 and Tables 8A.1-1 through 8A.1-6 of Appendix 8.1.

The presence and abundance of rare plant and lichen populations along the proposed pipeline corridor were assessed during early and late-season rare plant surveys in 2013 (see the Vegetation Technical Report of Volume 5C). Implementation of site and species-specific mitigation measures outlined in Section 7.2.9 and the Pipeline EPP of Volume 6B is expected to reduce the magnitude and shorten the period of reversibility for residual effects to known rare plant populations. Mitigation measures that were implemented during construction of other major pipeline projects including the TMX Anchor Loop Project are similar to those that have been recommended for construction of this Project. Additionally, disturbed areas supporting native vegetation or wetlands will be left to naturally regenerate or will be seeded with an appropriate native seed mixture. Due to the size and scope of reasonably foreseeable developments in the Vegetation RSA, it is anticipated that implemented site and species-specific mitigation measures for potentially affected rare plant and rare lichen populations will be similar to those recommended for the Project. Consequently, the number of rare plant and rare lichen populations affected by the Project and reasonably foreseeable developments acting cumulatively may not be much greater than those predicted to be altered by the Project alone. Specifically, the Project is predicted to contribute to 78% of the projected total new disturbance to native vegetation (which provides habitat for rare plant and lichen species). For any rare plant or rare lichen populations identified for the Project during future rare plant surveys (see Section 9.0), appropriate site-specific protection measures outlined in the Plant Species and Ecological Communities of Concern Discovery Contingency Plan (Pipeline EPP of Volume 6B) will be implemented. The appropriate mitigation will be selected so that the rare plant and lichen populations, particularly S1 species if identified, are not placed at risk. To this end, Trans Mountain will report any rare plants or rare lichens identified to the provincial conservation data centre (*i.e.*, BC CDC or ACIMS). No additional mitigation measures beyond the Project-specific mitigation already proposed in Section 7.2.9 and the Pipeline EPP of Volume 6B are deemed warranted.

Given that indirect effects are, in part, caused by disturbance to vegetation structure associated with clearing activities, allowing disturbed areas to naturally revegetate may not alleviate indirect effects where vegetation management is conducted or long-term persistence of the disturbance exists. Consequently, cumulative effects resulting from indirect effects to vegetation are expected to persist until the pre-existing vegetation composition and structure is restored. The overall cumulative effects on plant and lichen species of concern within the Vegetation RSA are considered to be of medium magnitude because combined cumulative effects are anticipated to be largely mitigated during construction and post-construction environmental monitoring.

The Project's contribution to cumulative effects on rare plant and rare lichen populations is considered to be reversible in the medium to long-term, depending on the species affected and of medium magnitude (Table 8.8-4, point 2[a]). A summary of the rationale for all the significance criteria for the Project's contribution to combined cumulative effects on the plant and lichen species of concern indicator is provided below.

- Spatial Boundary: Vegetation RSA – Project effects on rare plant and rare lichen populations could interact with reasonably foreseeable developments within the Vegetation RSA to cause a cumulative alteration to rare plant and lichen populations in the RSA.
- Duration: short-term – the Project's contribution to cumulative alteration of rare plant or lichen populations would occur during the construction phase or be completed within any one year during the operations phase.
- Frequency: isolated to periodic – the Project's contribution to cumulative changes in the disturbance or alteration of rare plant or lichen populations will occur during construction and intermittently but repeatedly during operations for maintenance activities.
- Reversibility: medium to long-term – depending on the lichen or plant species (*e.g.*, forb vs. tree), and associated land use. It may take more than one year plus adequate precipitation levels in order for the trench crown to settle and natural drainage patterns to be restored, and it will take several years for vegetation to grow back to former heights, which will prevent increased light from reaching surrounding rare plant and rare lichen populations. Based on post-construction environmental monitoring results from the TMX Anchor Loop Project, effects on rare plants and lichens were generally resolved in three to five years (*i.e.*, it was obvious in three to five years of post-construction environmental monitoring whether the population would recover or die) (TERA 2011c). However, effects from facilities and pump stations may result in a somewhat extended period of reversibility.
- Magnitude: medium – the Project's contribution to cumulative effects on rare plant or lichen species of concern is of medium magnitude since established regulatory standards typically require additional mitigation like those proposed for the Project to avoid unacceptable effects and reduce potential cumulative effects.
- Probability: high – the proposed pipeline corridor crosses 151 known occurrences of rare plant and lichen populations, and some of the reasonably foreseeable developments are predicted to be in areas of native vegetation with potential to support rare plant and rare lichen populations.
- Confidence: high – based on past pipeline projects, the professional experience of the assessment team and the results of post-construction environmental monitoring of past pipeline projects under similar conditions.

8.8.3.3 Vegetation Indicator – Presence of Infestations of Provincial Weed Species and Other Invasive Non-Native Species Identified as a Concern

The following provides the evaluation of significance of potential residual effects on the presence of infestations of provincial weed species and other invasive non-native species identified as a concern indicator.

<u>Project Contribution to Weed Introduction or Spread</u>

Weeds typically establish in areas that have been previously disturbed. Existing activities resulting in ground disturbance that contributes to introduction and spread of weeds include agriculture and livestock grazing, forestry, recreation, rural and urban residential and commercial development, transportation and infrastructure development, utilities activities, oil and gas exploration and development and mineral resource exploration and development. Since construction activities for the Project and reasonably foreseeable developments will require ground disturbance they could act cumulatively to cause weed introduction and spread within the Vegetation RSA. For example, the Parkland Airport (Phase 1) is predicted to be constructed on agricultural lands adjacent to the Project near Edmonton, Alberta and may contribute to weed introduction and spread within the Vegetation RSA.

Given the mitigation measures that will be implemented to control weed introduction and spread during both construction and operation of the Project, it is expected that the Project would contribute less to the introduction and spread of weeds when compared to existing activities (*e.g.*, agriculture, highway developments) within the Vegetation RSA.

Vegetation surveys conducted in 2013 included incidental weed observations in areas of native vegetation selected for survey (see the Vegetation Technical Report of Volume 5C). The proposed weed-related mitigation outlined in Section 7.2.9 and in the Pipeline EPP of Volume 6B will reduce the potential for cumulative effects. Weed presence and abundance on the Footprint will be assessed during a pre-construction weed survey in 2015. Other developers within the Vegetation RSA are expected to implement similar industry standard mitigation to control weeds (*e.g.*, AENV 2003, BC OGC 2010, Government of Alberta 2011, 2013b). Further to this, it is anticipated that best management practices will be implemented by many farmers, ranchers, forestry companies and municipal areas to reduce introduction of weeds associated with anthropogenic activities within the Vegetation RSA. No additional weed mitigation beyond the Project-specific mitigation already proposed in Section 7.2.9 and the Pipeline EPP of Volume 6B is deemed to be warranted. The overall cumulative effect on weeds and other invasive non-native species of concern within the Vegetation RSA is considered to be of low to medium magnitude because combined cumulative effects are anticipated to be largely mitigated during construction and post-construction environmental monitoring.

The Project's contribution to cumulative effects on weed introduction and spread within the Vegetation RSA is reversible in the short to medium-term depending on the species and the size of the infestation and of low to medium magnitude (Table 8.8-4, point 3[a]). A summary of the rationale for all the significance criteria of the Project's contribution to cumulative effects on weeds and other invasive non-native species of concern is provided below.

- Spatial Boundary: Vegetation RSA – residual Project effects on weed introduction and spread could interact with reasonably foreseeable developments within the Vegetation RSA to cause an incremental increase in weed distribution and abundance in the RSA.
- Duration: short-term – the Project's contribution to cumulative spread or introduction of weed species would occur during the construction phase or be completed within any one year during the operations phase.
- Frequency: isolated to periodic – the Project's contribution to cumulative weed introduction and spread will occur during construction and intermittently but repeatedly during operations for maintenance activities.
- Reversibility: short to medium-term – depending on the species, associated land use and the density/distribution of the occurrence.
- Magnitude: low to medium – the Project's contribution to combined weed introduction or spread is of low to medium magnitude since established regulatory standards typically require additional mitigation like those proposed for the Project to avoid unacceptable effects.
- Probability: high – weeds and invasive, non-native species are known to occur along the proposed pipeline corridor and likely to occur throughout the Vegetation RSA.
- Confidence: high – based on past pipeline projects and the professional experience of the assessment team.

8.8.3.4 Project Contribution to Combined Cumulative Effects on Vegetation

A number of potential effects (*i.e.*, Project contribution to combined incremental increase in alteration or disturbance of native vegetation, grasslands and rare ecological communities, incremental increase in alteration or disturbance of rare plant and rare lichen populations and weed introduction and spread) contribute to cumulative effects on vegetation in the Vegetation RSA, as described above for vegetation communities and populations of rare species.

The implementation of mitigation measures recommended in Section 7.2.9 and the Pipeline and Facilities EPPs (Volumes 6B and 6C) will reduce the severity of cumulative effects arising from the Project. It is anticipated that many operators of other reasonably foreseeable developments would implement similar mitigation according to industry standards and provincial regulatory guidelines.

The Project's contribution to cumulative effects on the vegetation indicators is of low to medium magnitude, reversible in the short to long-term and of high probability (Table 8.8-4, point 4[a]). A summary of the rationale for all the significance criteria of the Project's contribution to cumulative effects on the vegetation indicators is provided below.

- Spatial Boundary: Vegetation RSA – the Project's contribution to combined cumulative effects on vegetation may interact with reasonably foreseeable developments within the Vegetation RSA to cause a cumulative effect on vegetation resources in the RSA.
- Duration: short-term – the Project's contribution to combined cumulative effects on vegetation would occur during the construction phase or be completed within any one year during the operation phase.
- Frequency: isolated to periodic – the Project's contribution to combined cumulative effects on vegetation will occur during construction and intermittently but repeatedly during operations for maintenance activities.
- Reversibility: short to long-term – depending on the species, the pre-existing vegetation community (*e.g.*, grasses and shrubs regenerate within several years, however, tree canopy regrowth is expected to extend into the long-term) and the type of activity (*i.e.*, temporary facility, power line, pump station).
- Magnitude: low to medium – the Project's contribution to combined cumulative effects on vegetation is considered to be within environmental standards given the implementation of industry standard guidelines and federal and provincial recommended mitigation.
- Probability: high – it is likely that these cumulative combined effects will occur.
- Confidence: high – based on experience from past pipeline projects and the professional experience of the assessment team.

8.8.4 Summary

As identified in Table 8.8-4, there are no situations where there is a high probability of occurrence of a permanent or long-term cumulative effect of high magnitude that cannot be technically or economically mitigated. Consequently, the Project's contribution to cumulative effects on vegetation within the Vegetation RSA will be not significant.

8.9 Wildlife and Wildlife Habitat

This subsection discusses how the Project could act in combination with existing activities and reasonably foreseeable developments to contribute to cumulative effects on wildlife and wildlife habitat indicators that were anticipated to have an adverse combined Project-specific residual effect (*i.e.*, mammal, bird, and amphibian and reptile indicators).

Relevant regulatory guidelines, ATK, TEK, ecological context and residual Project effects were considered in the characterization of potential cumulative effects for wildlife and wildlife habitat indicators. TEK participants identified the potential long-term and cumulative effects of pipeline construction on wildlife as a concern. Additional information on wildlife TEK collected during field studies for the Project is provided in the Wildlife Technical Report of Volume 5C.

8.9.1 Reasonably Foreseeable Developments

Inclusion lists of the reasonably foreseeable developments located within the Wildlife RSA, Caribou RSA and Grizzly Bear RSA are provided in Appendix 8.1 (Tables 8A.1-1 to 8A.1-4), and Figures 8.1-1a to 8.1-1c. Developments with spatial information (Tables 8A.1-1 to 8A.1-4) were considered quantitatively in the evaluation of cumulative effects on the wildlife indicators.

As indicated in Section 8.1, additional reasonably foreseeable developments with the potential to act in combination with the Project were excluded from quantitative evaluations where development details (*e.g.*, approval status, location) were either lacking or the development is planned within previously disturbed areas of municipal boundaries, such as the City of Edmonton and LMDA. Descriptions of these developments are provided in Section 8.1.4 and Appendix 8.1 (Tables 8A.1-5 and 8A.1-6). These developments were considered qualitatively, where relevant, in the assessment of cumulative effects on wildlife and wildlife habitat.

The current level of disturbance due to existing activities within the Wildlife RSA, as well as the predicted disturbance attributed to the Project and reasonably foreseeable developments is summarized in Tables 8.9-1 (Alberta) and 8.9-2 (BC). The Project Footprint used in the quantitative analysis is defined in Section 7.2.10.2. A hierarchy table was applied to quantitative analyses to determine priority of overlapping land use features (*i.e.*, features with greater indirect footprint and assumed effects potential are assigned higher priority); thereby avoiding double-counting of overlapping disturbances.

TABLE 8.9-1

EXISTING AND NEW AREAL DISTURBANCE IN THE WILDLIFE REGIONAL STUDY AREA IN ALBERTA

Land Use Feature	Existing Areal Disturbance (ha)	New Areal Disturbance (ha)			Total Areal Disturbance (ha)
		Proposed Project	Other Activities	Total	
Cities/Towns/Communities	96,328.1	--	--	--	96,328.1
Airports/Airfields	217.6	--	37.4	37.4	255.0
Primary Roads	13,315.1	--	--	--	13,315.1
Quarries/Mines/Aggregates	12,144.7	--	949.0	949.0	13,093.7
Commercial/Industrial Features	6,842.9	1.0	839.0	840.0	7,682.9
Secondary Roads	7,957.3	--	--	--	7,957.3
Railways	1,147.9	--	--	--	1,147.9
Oil and Gas Well Sites	4,874.6	--	52.8	52.8	4,927.4
Tertiary/Access Roads	2,754.4	--	--	--	2,754.4
Buildings	28,922.5	--	--	--	28,922.5
Recreation	526.2	--	--	--	526.2
Crop/Pasture Land	259,679.1	--	--	--	259,679.1
Cutlines, Seismic Lines	8,810.7	--	--	--	8,810.7
Transmission/Power Lines	2,274.3	--	113.9	113.9	2,388.2
Buried Utility Lines	418.5	--	--	--	418.5
Oil and Gas Pipelines	5,949.3	455.0	350.0	805.0	6,754.3
Hydroelectric Infrastructure	--	--	--	--	--
Cities/Towns/Communities	96,328.1	--	--	--	96,328.1
Trails	--	--	--	--	--
Cutblocks[1]	65,386.1	--	22,608.8	22,608.8	87,994.9
Fire (< 40 years)	6,949.7	--	--	--	6,949.7
Total Areal Disturbance (ha)	524,499.0	456.0	24,950.9	25,406.9	548,905.9
Percent of Wildlife RSA Disturbed	50.30	0.04	2.39	2.44	52.74

Note: 1 Spatial data for future cutblocks was not available at the time of assessment. The area of future forest harvest in the Wildlife RSA was estimated based on available annual harvest information (*e.g.*, annual allowable cut) and projected to the end of 2017 (anticipated in-service date of the Project).

TABLE 8.9-2

EXISTING AND NEW AREAL DISTURBANCE IN THE WILDLIFE REGIONAL STUDY AREA IN BC

Land Use Feature	Existing Areal Disturbance (ha)	New Areal Disturbance (ha)			Total Areal Disturbance (ha)
		Proposed Project	Other Activities	Total	
LMDA/Cities/Towns/Communities	229,171.4	--	--	--	229,171.4
Airports/Airfields	43.1	--	--	--	43.1
Primary Roads	9,310.3	--	0.9	0.9	9,311.2
Quarries/Mines/Aggregates	5,454.2	--	6,078.2	6,078.2	11,532.4
Commercial/Industrial Features	1,085.9	3.6	26.9	30.5	1,116.4
Secondary Roads	10,271.4	--	--	--	10,271.4
Railways	1,897.8	--	--	--	1,897.8
Oil and Gas Well Sites	---	--	--	--	--
Tertiary/Access Roads	13,867.8	--	2.9	2.9	13,870.7
Buildings	916.8	--	--	--	916.8
Recreation	815.5	--	--	--	815.5
Crop/Pasture Land	27,999.5	--	--	--	27,999.5
Cutlines, Seismic Lines	165.7	--	--	--	165.7
Transmission/Power Lines	4,529.7	161.5	422.5	584.0	5,113.7
Buried Utility Lines	296.1	--	--	--	296.1
Oil and Gas Pipelines	1,238.4	1,437.2	47.7	1,484.9	2,723.3
Hydroelectric Infrastructure	--	--	40.6	40.6	40.6
Trails	0.1	--	--	--	0.1
Cutblocks[1]	307,122.3	--	75,113.6	75,113.6	382,235.9
Fire (< 40 years)	26,767.3	--	--	--	26,767.3
Total Areal Disturbance (ha)	640,953.3	1,602.3	81,733.3	83,335.6	724,288.9
Percent of Wildlife RSA Disturbed	31.66	0.08	4.04	4.12	35.77

Note: 1 Spatial data for future cutblocks was not available at the time of assessment. The area of future forest harvest in the Wildlife RSA was estimated based on available annual harvest information (*e.g.*, annual allowable cut) and projected to the end of 2017 (anticipated in-service date of the Project).

The Project is likely to interact with the existing and reasonably foreseeable developments to contribute to cumulative effects on wildlife and wildlife habitat through all three identified effects pathways: changes in habitat (Section 8.9.2); changes in movement (Section 8.9.3); and increased mortality risk (Section 8.9.4).

8.9.2 Cumulative Changes in Habitat

Habitat loss or alteration resulting from natural disturbances, existing activities and reasonably foreseeable developments will act cumulatively with the Project to affect wildlife habitat. Existing activities and reasonably foreseeable developments also have or will alter wildlife habitat by changing or removing vegetation. In addition to anthropogenic disturbance, natural disturbance was considered in the evaluation of cumulative habitat change in the Wildlife RSA. Wildfires alter wildlife habitat by interrupting successional sequences and producing landscape-level mosaics in forest maturity that include regenerating, immature and late successional stands (*i.e.*, mature and old forest) (Johnson *et al.* 1995). Abundance and species composition of wildlife communities change post-wildfire in response to the succession of vegetation from early initiation stages, through establishment and intermediate stages into mature and old forests (Fisher and Wilkinson 2005, Hobson and Schieck 1999). Approximately 33,717 ha (1.1%) of the Wildlife RSA has been altered by forest fires that have burned in the last 40 years. Natural fire patterns have been substantially modified in the Wildlife RSA as a result of fire suppression and vegetation modification (*e.g.*, agriculture, developed lands). Most of the fires occurred in the Black Pines to Hope Segment (over 100 documented fires with an average size and standard deviation of 234.4 ha ± 1,088.2 ha). A notable number of fires also occurred in the Edmonton to Hinton and Hargreaves to Darfield segments (over 70 fires in each with an average size and standard deviation of 324.6 ha ± 1,145.0 ha and 119.4 ha ± 303.3 ha, respectively). Fire was less common in the Hinton to Hargreaves, Darfield to Black Pines, Hope to Sumas and Sumas to Burnaby segments (*i.e.*, less than 15 fires in each); this is to be expected given the relative abundance of agricultural and developed land, as well as the naturally lower fire interval of the wetter coastal region (compared to dry interior regions) in these segments.

In most cases, endemic biotic disturbance (*e.g.*, biotic and abiotic forest health factors) is a natural ecosystem process; however, human activity can interfere with these processes to potentially cause unnatural disturbance events and exacerbate the issue (Managed Forest Areas and Forest Health Technical Report of Volume 5C). The mountain pine beetle infestation has caused substantial natural disturbance in some areas of BC. The clearings and roads associated with salvage harvest of pine beetle infested stands have contributed further to cumulative effects on wildlife and wildlife habitat. The quantitative analysis of habitat change and disturbance in the Wildlife RSA incorporates changes associated with fire, mountain pine beetle, forest harvest and roads to the extent possible with the available regional habitat and disturbance data.

A critical threshold for habitat loss may be defined as an abrupt, non-linear change that occurs in some parameter (*e.g.*, behaviour, abundance, community composition) across a small range of habitat loss (Swift and Hannon 2010) (*e.g.*, the abundance of a species in a landscape declines more or less linearly as suitable habitat is lost, but may decline more rapidly once the amount of remaining habitat in the landscape falls below a certain proportion of the total landscape area). Critical threshold relationships between habitat loss and various ecological responses have been suggested in numerous simulation models and, to a lesser degree, empirical landscape-scale studies (Swift and Hannon 2010). Although highly variable, depending on species or landscape characteristics or other conditions, most of the observed critical thresholds for cumulative habitat loss occur between 10% and 50% of remaining habitat (*i.e.*, when 50% to 90% of suitable habitat has been lost) (Swift and Hannon 2010). The available scientific literature indicates that cumulative effects risk is highest when total habitat loss measured at the landscape (*i.e.*, regional) scale is high (> 70%), as discussed in more detail below.

Habitat loss or alteration by both the Project and existing activities and reasonably foreseeable developments may act cumulatively to cause habitat fragmentation. Habitat fragmentation results when complete or partial barriers to movement cause functional separation of habitats into smaller, isolated habitat patches (Andrén 1994, Jalkotzy *et al.* 1997). The three main components of habitat fragmentation are habitat loss, reduced habitat patch size and increased isolation of patches (Andrén 1994). Habitat fragmentation has the potential to alter species abundance and distribution over the landscape by affecting predation and brood parasitism, altering microclimate, decreasing food, and reducing ability of animals to move between habitat patches within a landscape (Swift and Hannon 2010). Species that have late age of first reproduction, low population densities, low reproductive rates, large home-ranges, low fecundity, and move over large distances to disperse, find food and mate, display low resilience to habitat fragmentation (Dunne and Quinn 2009).

Several studies suggest that cumulative effects risk and the influence of patch size and spatial arrangement is highest when habitat loss measured at the landscape (*i.e.*, regional) scale is high (> 70%). For example, a modelling-based study by Flather and Bevers (2002) concluded that the amount of habitat accounted for > 96% of total variation in wildlife abundance compared to < 1% for arrangement of habitat, over a broad range of habitat types and arrangements. They also concluded that when total habitat loss was less than 50-70%, the effects were simply habitat loss effects; with higher total loss, habitat arrangement effects became more important. These findings are consistent with conclusions from other meta-analyses and modeling studies (Andrén 1994, Fahrig 1997, Forman and Collinge 1997, Rich *et al.* 1994, Schmiegelow and Mönkkönen 2002, Swift and Hannon 2010). Andrén (1994) suggests that in landscapes with more than 30% of suitable habitat remaining (*i.e.*, less than 70% of suitable habitat is disturbed), the total area of suitable habitat is of greater importance than its spatial arrangement (*e.g.*, patch size and isolation). As habitat loss increases, the remaining habitat becomes increasingly fragmented or the habitat patches are increasingly isolated, which may compound the effects of habitat loss (Swift and Hannon 2010). The proportion of the Wildlife RSA in Alberta that is disturbed is predicted to increase from 50.3% under existing conditions to 52.7% with the Project and foreseeable future developments (Table 8.9-1). In the Wildlife RSA in BC, the proportionate disturbance increases from 31.7% under existing conditions, to 35.8% with the Project and foreseeable future developments (Table 8.9-2). In some areas of the Wildlife RSA such as the LMDA, the existing cumulative disturbance level is high, and fragmentation effects can be expected. However, based on the above research findings, this level of cumulative disturbance suggests that the cumulative effects risk is likely moderate at the scale of the Wildlife RSA, and substantial fragmentation (*i.e.*, habitat spatial arrangement) effects are not anticipated.

The predicted change in wildlife habitat types from existing conditions to future conditions (*i.e.*, cumulative scenario) is summarized in Tables 8.9-3 (Alberta) and 8.9-4 (BC). Ecosystem units for the RSA in Alberta were based on the Alberta Ground Cover Classification (AGCC) data (ASRD 2010). AGCC land cover classes were combined into ecologically relevant higher order groupings (“habitat types”) to simplify the analysis and increase accuracy. Ecosystem units in BC were derived from the Broad Ecosystem Inventory (BEI) data (BC MOE 2003). The BEI provides mapping of broad ecosystem units (BEUs), which describe the vegetation communities that a given location can support based on geological or climatic conditions. BEUs have been used previously by government-supported projects in BC to evaluate wildlife habitat, and are included as a component of the provincial wildlife accounts (BC Ministry of Water, Lands and Air Protection [MWLAP] 2004), which facilitates determining the BEUs that are likely to represent suitable habitat for a given species. The predicted change in habitat from existing to cumulative future conditions was estimated by incorporating updated disturbance information for existing activities, the Project, and reasonably foreseeable developments into the available regional-scale habitat data (AGCC in Alberta, BEI in BC).

Tables 8.9-3 and 8.9-4 summarize the predicted changes in habitat from existing conditions to Project and cumulative conditions within the Wildlife RSA. For ease of description, anthropogenic disturbance is grouped into broad categories: agriculture, cutblock, vegetated linear anthropogenic (defined to include linear disturbances that are typically reclaimed to a vegetated state, such as pipeline, power line and utility rights-of-way, and seismic lines), and other anthropogenic disturbance (includes the remaining disturbance types such as urban, industrial, commercial and transportation developments). Detailed disturbance information is provided in Tables 8.9-1 and 8.9-2. Figures 8.9-1 and 8.9-2 illustrate the relative proportion of each habitat type within the Natural Subregions (Alberta) and Ecoprovinces (BC) in the Wildlife RSA, and the predicted change from existing conditions to Project and cumulative conditions. Disturbance in the Wildlife RSA in Alberta is primarily associated with agriculture. Cutblocks and other anthropogenic disturbance (mostly urban and transportation development) are the primary disturbance types in the Wildlife RSA in BC.

TABLE 8.9-3

PREDICTED HABITAT CHANGE IN THE WILDLIFE REGIONAL STUDY AREA IN ALBERTA

Habitat Type	Ecosystem Unit[1]	Existing Condition	Project Condition[2]		Cumulative Condition[3]	
		Area (ha)	Area (ha)	% Change[4]	Area (ha)	% Change[4]
Barren Lands	Barren	11,837.4	11,834.7	0.02 ↓	11,808.8	0.24 ↓
Grassland	Grassland	21,668.0	21,646.5	0.10 ↓	21,600.7	0.31 ↓
Shrubland	Shrubland	9,563.6	9,554.5	0.10 ↓	9,551.1	0.13 ↓
Forested	Pine	107,509.9	107,406.0	0.10 ↓	107,091.7	0.39 ↓
	Coniferous	145,927.3	145,875.7	0.04 ↓	145,481.8	0.31 ↓
	Deciduous	88,059.5	87,981.0	0.09 ↓	87,867.2	0.22 ↓
	Mixed	31,054.0	31,042.9	0.04 ↓	31,025.9	0.09 ↓
Wet Areas	Open Water	43,167.3	43,162.1	0.01 ↓	43,141.0	0.06 ↓
	Graminoid Wetland	223.4	223.4	0	223.3	0.02 ↓
	Shrubby Wetland	8,159.1	8,157.3	0.02 ↓	8,151.4	0.09 ↓
	Bog	8,709.7	8,708.2	0.02 ↓	8,702.6	0.08 ↓
	Unclassified Wetland	51,877.0	51,809.5	0.13 ↓	51,704.8	0.33 ↓
Anthropogenic	Agriculture	271,049.2	271,013.9	0.01 ↓	270,725.9	0.12 ↓
	Cutblock	68,323.2	68,259.3	0.09 ↓	67,684.1	0.94 ↓
	Vegetated Linear Anthropogenic	15,509.9	15,964.8	2.93 ↑	16,376.3	5.59 ↑
	Other Anthropogenic	158,464.7	158,464.0	< 0.01 ↓	159,967.0	0.95 ↑
No Data	Unclassified	1,601.5	1,601.2	0.02 ↓	1,601.0	0.03 ↓

Notes:
1 Ecosystem units are derived from Land Cover Classes, using AGCC data (ASRD 2010). Disturbance units are incorporated using disturbance data compiled for the Project.
2 Project Condition includes existing activities (with available spatial data) + Project.
3 Cumulative Condition includes existing activities + Project + reasonably foreseeable developments (with available spatial data).
4 Percent change is calculated as the change from existing conditions. ↓ represents a decrease and ↑ represents an increase.

TABLE 8.9-4

PREDICTED CHANGE IN HABITAT IN THE WILDLIFE REGIONAL STUDY AREA IN BC

Habitat Type	Ecosystem Unit[1]	Existing Condition	Project Condition[2]		Cumulative Condition[3]	
		Area (ha)	Area (ha)	% Change[4]	Area (ha)	% Change[4]
Alpine and Subalpine	Alpine Meadow	6,570.8	6,570.8	0	6,570.8	0
	Alpine Tundra	16,860.1	16,860.1	0	16,860.1	0
	Alpine Unvegetated	64,941.5	64,941.5	0	64,941.5	0
	Engelmann Spruce – Subalpine Fir Parkland	33,932.8	33,932.8	0	33,908.6	0.07 ↓
	Mountain Hemlock Parkland	627.0	627.0	0	627.0	0
	Subalpine Meadow	6,141.9	6,141.9	0	6,125.7	0.26 ↓
	Subalpine Fir – Mountain Hemlock Wet Parkland	1,313.9	1,313.9	0	1,313.9	0
Natural Non-Forested	Rock	4,951.2	4,951.2	0	4,950.7	0.01 ↓
	Glacier	13,381.4	13,381.4	0	13,381.4	0
Shrub and Herb Ecosystems	Avalanche Track	24,035.0	24,016.7	0.08 ↓	24,015.3	0.08 ↓
	Bunchgrass Grassland	91,727.4	91,632.3	0.10 ↓	90,751.5	1.06 ↓
	Big Sagebrush Shrub/Grassland	14,506.0	14,465.2	0.28 ↓	14,333.1	1.19 ↓
Coastal Forest Ecosystems	Coastal Douglas-Fir	27,414.0	27,397.1	0.06 ↓	27,356.4	0.21 ↓
	Coastal Western Hemlock – Western Redcedar	7,023.2	7,023.2	0	7,009.0	0.20 ↓
	Coastal Western Hemlock – Douglas-Fir	50,833.9	50,741.3	0.18 ↓	50,660.3	0.34 ↓
	Amabilis Fir – Western Hemlock	72,740.6	72,705.7	0.05 ↓	72,664.9	0.10 ↓
	Mountain Hemlock – Amabilis Fir	59,297.1	59,285.9	0.02 ↓	59,277.5	0.03 ↓
Southern Interior Forest Ecosystems	Interior Douglas-Fir Forest	23,899.4	23,841.1	0.24 ↓	23,834.8	0.27 ↓
	Douglas-Fir – Lodgepole Pine	153,879.5	153,556.4	0.21 ↓	153,404.3	0.31 ↓
	Douglas-Fir – Ponderosa Pine	61,749.0	6,1631.0	0.19 ↓	61,430.5	0.52 ↓
	Engelmann Spruce – Subalpine Fir Dry Forest	270,959.2	270,942.5	0.01 ↓	268,387.6	0.95 ↓
	Interior Western Hemlock – Douglas-Fir	81,380.0	81,230.3	0.18 ↓	81,151.2	0.28 ↓
	Interior Western Hemlock – White Spruce	26,431.8	26,422.9	0.03 ↓	26,422.9	0.03 ↓
	Ponderosa Pine	26,608.6	26,558.8	0.19 ↓	26,470.7	0.52 ↓
	Western Redcedar – Paper Birch	9,310.7	9,310.7	0	9,310.7	0
	Western Redcedar – Douglas Fir	24,484.9	24,448.6	0.15 ↓	24,448.6	0.15 ↓
	Spruce - Douglas-Fir	4,871.9	4,853.4	0.38 ↓	4,853.4	0.38 ↓
Central and Northern Forest Ecosystems	Lodgepole Pine	6,213.7	6,198.8	0.24 ↓	6,198.8	0.24 ↓
	Subalpine Fir – Mountain Hemlock Wet Forest	19,890.1	19,890.1	0	19,890.1	0
	Spruce – Douglas Fir	4,871.9	4,853.4	0.38 ↓	4,853.4	0.38 ↓
	White Spruce –- Subalpine Fir	53,304.5	53,286.3	0.03 ↓	53,282.0	0.04 ↓
	Subboreal White Spruce – Lodgepole Pine	45,270.9	45,209.8	0.14 ↓	45,192.7	0.17 ↓
Riparian	Black Cottonwood Riparian	62.8	62.8	0	62.8	0
	Engelmann Spruce Riparian	458.5	458.5	0	458.5	0
	Sitka Spruce – Black Cottonwood Riparian	3,082.4	3,037.2	1.47 ↓	3,036.0	1.50 ↓
	Western Redcedar – Black Cottonwood Riparian	5,431.1	5,377.0	1.00 ↓	5,377.0	1.00 ↓
	White Spruce – Black Cottonwood Riparian	8,381.7	8,300.2	0.97 ↓	8,300.2	0.97 ↓
Wetland/Watercourse	Flooded Channel	13.2	13.2	0	13.2	0
	Lake	28,569.8	28,569.0	0	28,547.5	0.08 ↓
	Marsh	8,596.6	8,593.0	0.04 ↓	8,580.1	0.19 ↓
	Marine	1,874.4	1,874.4	0	1,874.4	0
	Reservoir	31.5	31.5	0	31.5	0
	River	15,934.5	15,924.9	0.06 ↓	15,922.1	0.08 ↓
	Slow Perennial Stream	701.0	700.7	0.03 ↓	700.7	0.03 ↓
	Sphagnum Bog	429.3	429.3	0	429.3	0
	Swamp	4,801.9	4,798.2	0.08 ↓	4,796.2	0.12 ↓
	Unclassified Wetland	44.9	44.9	0	44.9	< 0.01 ↓
Anthropogenic	Cultivated Field	37,886.4	37,864.5	0.06 ↓	37,859.8	0.07 ↓
	Cutblock	307,102.1	306,888.7	0.07 ↓	304,775.0	0.76 ↓
	Vegetated Linear Anthropogenic	5,900.4	7,498.6	27.09 ↑	7,967.6	35.03 ↑
	Other Anthropogenic	266,397.5	266,412.3	0.01 ↑	272,445.7	2.27 ↑

Notes:
1. Ecosystem units are derived from BEUs, using BEI data (BC MOE 2003). Disturbance units are incorporated using disturbance data compiled for the Project.
2. Project Condition includes existing activities (with available spatial data) + Project.
3. Cumulative Condition includes existing activities + Project + reasonably foreseeable developments (with available spatial data).
4. Percent change is calculated as the change from existing conditions. ↓ represents a decrease and ↑ represents an increase.

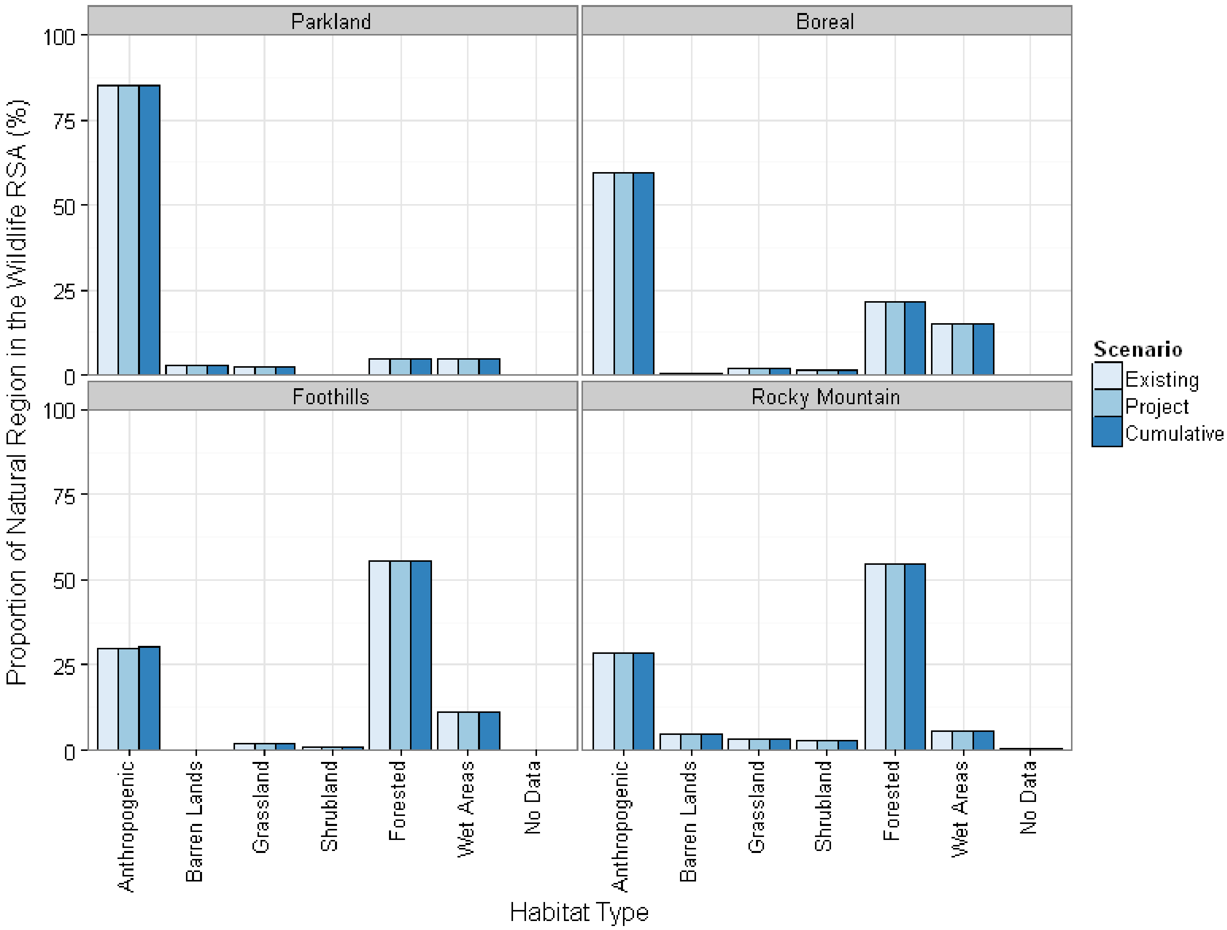


Figure 8.9-1 Predicted Change in Habitat Types in the Wildlife RSA in Alberta
Change in habitat types is presented as the proportion of the Natural Region within the Wildlife RSA represented by each habitat type at existing, Project and cumulative conditions. The ecosystem units that comprise the habitat types are presented in Table 8.9-3.

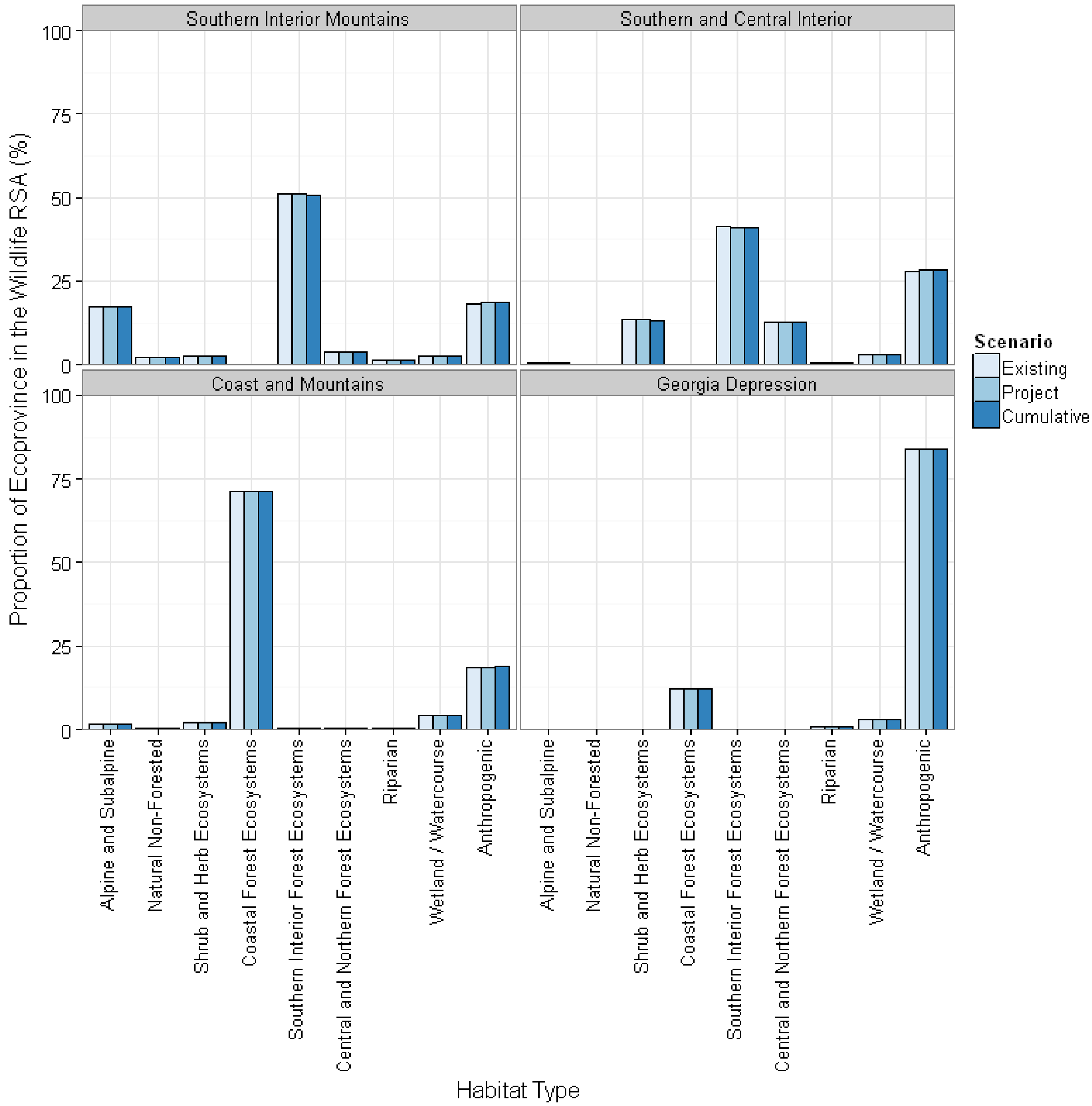


Figure 8.9-2 Predicted Change in Habitat Types in the Wildlife RSA in BC
Change in habitat types is presented as the proportion of the Ecoprovince within the Wildlife RSA represented by each habitat type at existing, Project and cumulative conditions. The ecosystem units that comprise the habitat types are presented in Table 8.9-4.

8.9.3 Cumulative Changes in Wildlife Movement

The Project may contribute to cumulative effects in combination with existing activities and reasonably foreseeable developments to increase filters or barriers (partial or complete barriers respectively) to movement for some wildlife species. Wildlife movement patterns vary between species, with species-specific attributes such as size and life stage, and other factors such as time of day and season. Many species alter their movements to avoid areas with high levels of human activity and development. However, some species may be less affected by, or are attracted to, anthropogenic disturbance and habitually use established trails for movement, regardless of proximity to human activity and development. In some cases, linear developments have been shown to block, delay or deflect ungulate movements, potentially restricting or reducing access to some parts of their range (Harper *et al.* 2001). Studies on small mammal movements in forested habitat have concluded that pipeline rights-of-way may act as barriers or filters to movement of flying squirrels, red squirrels and marten (Marklevitz 2003). Changes in movement patterns can also occur since some wildlife species may be attracted to linear corridors as travel routes. For example, wolverines have been found to diverge from their line of travel under forest cover when linear corridors with compacted snow were encountered, in order to follow the linear corridors, which provided easier travel routes (Wright and Ernst 2004). Changes in movement patterns may also occur as some species are attracted to early seral vegetation in regenerating areas. Species that prefer edges and habitat generalists are most likely to use disturbed areas (Jalkotzy *et al.* 1997). Sensory disturbance of wildlife resulting from Project construction activities may also act cumulatively with existing sources of auditory and visual disturbances, such as industrial development and traffic, to cause wildlife to alter their movement patterns (*i.e.*, reduced use or avoidance).

8.9.4 Cumulative Risk of Wildlife Mortality

Wildlife mortality risk may increase due to the cumulative effects of the Project, existing activities (*e.g.*, recreational and subsistence hunting and trapping, traffic) and reasonably foreseeable developments. Increased mortality risk may result from habitat disturbance (*e.g.*, clearing and soil handling has potential to disturb active nests, dens, hibernacula, overwintering sites), sensory disturbance, vehicle/wildlife collisions, and increased predation, hunting or trapping as a result of increased access or habitat alteration. Trapping, hunting and poaching are often associated with roads or other linear corridors that create access (Collister *et al.* 2003, Wiacek *et al.* 2002). Linear corridors can also increase the risk of mortality for some species by attracting prey species to early seral vegetation establishing on the disturbance, where the improved access and increased sight-lines may lead to increased predator efficiency. Linear corridors are attractive to predators as easy travel routes (James 1999, Stuart-Smith *et al.* 1997, Thurber *et al.* 1994) and may affect predator-prey dynamics (Bergerud *et al.* 1984, Edmonds and Bloomfield 1984, Rohner and Kuzyk 2000).

8.9.5 Potential Cumulative Effects on Wildlife and Wildlife Habitat Indicators

The potential and likely residual effects associated with the construction and operation of the Project on wildlife indicators were identified in Section 7.2.10.7 and are listed in Table 8.9-5, along with existing activities and reasonably foreseeable developments that could act in combination with the Project.

TABLE 8.9-5

POTENTIAL RESIDUAL EFFECTS OF THE PROJECT ON WILDLIFE AND WILDLIFE HABITAT CONSIDERED FOR THE CUMULATIVE EFFECTS ASSESSMENT

Potential Residual Project Effect on Indicator	Spatial Boundary	Project Component(s)	Temporal Boundary	Potential Cumulative Effect	Existing Activities/Reasonably Foreseeable Developments with Residual Effects Acting in Combination with the Project
1. Combined Project effects on grizzly bear resulting from habitat loss or alteration, changes in movement and increased mortality risk.	Grizzly Bear RSA	Edmonton to Hinton Segment Hargreaves to Darfield Segment Black Pines to Hope Segment Temporary Facilities	Construction to Operations	Project contribution to cumulative effects on grizzly bear.	• Existing activities/disturbance including natural disturbance, settlement, agriculture and livestock grazing, natural resource extraction (*i.e.*, forestry, oil and gas, mineral), recreation and tourism, rural and urban development, transportation and infrastructure, hunting/trapping. • Reasonably foreseeable developments within the Grizzly Bear RSA listed in Tables 8A.1-1 to 8A.1-6 of Appendix 8.1 and discussed in Section 8.1.4. • Project-related activities that could interact with the above activities include clearing, topsoil/root zone material salvage, grading, trenching, blasting, materials storage, installation of Project components, camps, temporary access, construction traffic, reclamation, operational activities (vegetation control, access, traffic, human activity, monitoring and maintenance).
2. Combined Project effects on woodland caribou resulting from habitat loss or alteration, changes in movement and increased mortality risk.	Caribou RSA	Hargreaves to Darfield Segment Temporary Facilities	Construction to Operations	Project contribution to cumulative effects on woodland caribou.	• Existing activities including natural disturbance, settlement, agriculture and livestock grazing, natural resource extraction (*i.e.*, forestry, oil and gas, mineral), recreation and tourism, rural and urban development, transportation and infrastructure. • Reasonably foreseeable developments within the RSA listed in Tables 8A.1-1 and 8A.1-6 of Appendix 8.1 and discussed in Section 8.1.4. • Project-related activities that could interact with the above activities include clearing, topsoil/root zone material salvage, grading, trenching, blasting, materials storage, installation of Project components, camps, temporary access, construction traffic, reclamation, operational activities (vegetation control, access, traffic, human activity, monitoring and maintenance).
3. Combined Project effects on moose resulting from habitat loss or alteration, changes in movement and increased mortality risk.	Wildlife RSA	Edmonton to Hinton Segment Hargreaves to Darfield Segment Black Pines to Hope Segment Temporary Facilities Pump Stations (Black Pines Pump Station and power line, Kingsvale Pump Station and power line)	Construction to Operations	Project contribution to cumulative effects on moose.	• Existing activities including natural disturbance, settlement, agriculture and livestock grazing, natural resource extraction (*i.e.*, forestry, oil and gas, mineral), recreation and tourism, rural and urban development, transportation and infrastructure, hunting. • Reasonably foreseeable developments within the RSA listed in Tables 8A.1-1 to 8A.1-6 of Appendix 8.1 and discussed in Section 8.1.4. • Project-related activities that could interact with the above activities include clearing, topsoil/root zone material salvage, grading, trenching, blasting, materials storage, installation of Project components, camps, temporary access, construction traffic, reclamation, operational activities (vegetation control, access, traffic, human activity, monitoring and maintenance).

TABLE 8.9-5 Cont'd

Potential Residual Project Effect on Indicator	Spatial Boundary	Project Component(s)	Temporal Boundary	Potential Cumulative Effect	Existing Activities/Reasonably Foreseeable Developments with Residual Effects Acting in Combination with the Project
4. Combined Project effects on forest furbearers resulting from habitat loss or alteration, changes in movement and increased mortality risk.	Wildlife RSA	Edmonton to Hinton Segment Hargreaves to Darfield Segment Black Pines to Hope Segment Hope to Burnaby Segment Temporary Facilities Pump Stations (Black Pines Pump Station and power line, Kingsvale Pump Station and power line)	Construction to Operations	Project contribution to cumulative effects on forest furbearers.	• Existing activities including natural disturbance, settlement, agriculture and livestock grazing, natural resource extraction (*i.e.*, forestry, oil and gas, mineral), recreation and tourism, rural and urban development, transportation and infrastructure, trapping. • Reasonably foreseeable developments within the RSA listed in Tables 8A.1-1 to 8A.1-6 of Appendix 8.1 and discussed in Section 8.1.4. • Project-related activities that could interact with the above activities include clearing, topsoil/root zone material salvage, grading, trenching, blasting, materials storage, installation of Project components, camps, temporary access, construction traffic, reclamation, operational activities (vegetation control, access, traffic, human activity, monitoring and maintenance).
5. Combined Project effects on coastal riparian small mammals resulting from habitat loss or alteration, changes in movement and increased mortality risk.	Wildlife RSA	Black Pines to Hope Segment Hope to Burnaby Segment Burnaby to Westridge Segment Temporary Facilities Tanks (Sumas) Westridge Marine Terminal	Construction to Operations	Project contribution to cumulative effects on coastal riparian small mammals.	• Existing activities including natural disturbance, settlement, agriculture and livestock grazing, natural resource extraction (*i.e.*, forestry, oil and gas, mineral), recreation and tourism, rural and urban development, transportation and infrastructure. • Reasonably foreseeable developments within the RSA listed in Tables 8A.1-1 and 8A.1-6 of Appendix 8.1 and discussed in Section 8.1.4. • Project-related activities that could interact with the above activities include clearing, topsoil/root zone material salvage, grading, trenching, blasting, materials storage, installation of Project components, camps, temporary access, construction traffic, reclamation, operational activities (vegetation control, access, traffic, human activity, monitoring and maintenance).
6. Combined Project effects on bats resulting from habitat loss or alteration, changes in movement and increased mortality risk.	Wildlife RSA	All Components	Construction to Operations	Project contribution to cumulative effects on bats.	• Existing activities including natural disturbance, settlement, agriculture and livestock grazing, natural resource extraction (*i.e.*, forestry, oil and gas, mineral), recreation and tourism, rural and urban development, transportation and infrastructure. • Reasonably foreseeable developments within the RSA listed in Tables 8A.1-1 to 8A.1-6 of Appendix 8.1 and discussed in Section 8.1.4. • Project-related activities that could interact with the above activities include clearing, blasting, installation of Project components, camps, temporary access, construction traffic, reclamation, operational activities (vegetation control, access, traffic, human activity, monitoring and maintenance).

TABLE 8.9-5 Cont'd

Potential Residual Project Effect on Indicator	Spatial Boundary	Project Component(s)	Temporal Boundary	Potential Cumulative Effect	Existing Activities/Reasonably Foreseeable Developments with Residual Effects Acting in Combination with the Project
7. Combined Project effects on grassland/ shrub-steppe birds resulting from habitat loss or alteration, changes in movement and increased mortality risk.	Wildlife RSA	Hargreaves to Darfield Segment Black Pines to Hope Segment Temporary Facilities Pump Stations (Black Pines Pump Station and power line)	Construction to Operations	Project contribution to cumulative effects on grassland/shrub-steppe birds.	• Existing activities including natural disturbance, settlement, agriculture and livestock grazing, natural resource extraction (*i.e.*, forestry, oil and gas, mineral), recreation and tourism, rural and urban development, transportation and infrastructure. • Reasonably foreseeable developments within the RSA listed in Tables 8A.1-1 to 8A.1-6 of Appendix 8.1 and discussed in Section 8.1.4. • Project-related activities that could interact with the above activities include clearing, blasting, installation of Project components, camps, temporary access, construction traffic, reclamation, operational activities (vegetation control, access, traffic, human activity, monitoring and maintenance).
8. Combined Project effects on mature/old forest birds resulting from habitat loss or alteration, changes in movement and increased mortality risk.	Wildlife RSA	All Components	Construction to Operations	Project contribution to cumulative effects on mature/old forest birds.	• Existing activities including natural disturbance, settlement, agriculture and livestock grazing, natural resource extraction (*i.e.*, forestry, oil and gas, mineral), recreation and tourism, rural and urban development, transportation and infrastructure. • Reasonably foreseeable developments within the RSA listed in 8A.1-1 to 8A.1-6 of Appendix 8.1 and discussed in Section 8.1.4. • Project-related activities that could interact with the above activities include clearing, blasting, installation of Project components, camps, temporary access, construction traffic, reclamation, operational activities (vegetation control, access, traffic, human activity, monitoring and maintenance).
9. Combined Project effects on early seral forest birds resulting from habitat loss or alteration, changes in movement and increased mortality risk.	Wildlife RSA	All Components	Construction to Operations	Project contribution to cumulative effects on early seral forest birds.	• Existing activities including natural disturbance, settlement, agriculture and livestock grazing, natural resource extraction (*i.e.*, forestry, oil and gas, mineral), recreation and tourism, rural and urban development, transportation and infrastructure. • Reasonably foreseeable developments within the RSA listed in Tables 8A.1-1 to 8A.1-6 of Appendix 8.1 and discussed in Section 8.1.4. • Project-related activities that could interact with the above activities include clearing, blasting, installation of Project components, camps, temporary access, construction traffic, reclamation, operational activities (vegetation control, access, traffic, human activity, monitoring and maintenance).

TABLE 8.9-5 Cont'd

Potential Residual Project Effect on Indicator	Spatial Boundary	Project Component(s)	Temporal Boundary	Potential Cumulative Effect	Existing Activities/Reasonably Foreseeable Developments with Residual Effects Acting in Combination with the Project
10. Combined Project effects on riparian and wetland birds resulting from habitat loss or alteration, changes in movement and increased mortality risk.	Wildlife RSA	All Components	Construction to Operations	Project contribution to cumulative effects on riparian and wetland birds.	• Existing activities including natural disturbance, settlement, agriculture and livestock grazing, natural resource extraction (*i.e.*, forestry, oil and gas, mineral), recreation and tourism, rural and urban development, transportation and infrastructure. • Reasonably foreseeable developments within the RSA listed in Tables 8A.1-1 to 8A.1-6 of Appendix 8.1 and discussed in Section 8.1.4. • Project-related activities that could interact with the above activities include clearing, blasting, installation of Project components, camps, temporary access, construction traffic, reclamation, operational activities (vegetation control, access, traffic, human activity, monitoring and maintenance).
11. Combined Project effects on wood warblers resulting from habitat loss or alteration, changes in movement and increased mortality risk.	Wildlife RSA	Edmonton to Hinton Segment Temporary Facilities	Construction to Operations	Project contribution to cumulative effects on wood warblers.	• Existing activities including natural disturbance, settlement, agriculture and livestock grazing, natural resource extraction (*i.e.*, forestry, oil and gas, mineral), recreation and tourism, rural and urban development, transportation and infrastructure. • Reasonably foreseeable developments within the RSA listed in Tables 8A.1-1 to 8A.1-5 of Appendix 8.1 and discussed in Section 8.1.4. • Project-related activities that could interact with the above activities include clearing, blasting, installation of Project components, camps, temporary access, construction traffic, reclamation, operational activities (vegetation control, access, traffic, human activity, monitoring and maintenance).
12. Combined Project effects on short-eared owl resulting from habitat loss or alteration, changes in movement and increased mortality risk.	Wildlife RSA	Edmonton to Hinton Segment Hargreaves to Darfield Segment Black Pines to Hope Segment Hope to Burnaby Segment Burnaby to Westridge Segment Temporary Facilities Pump Stations (Black Pines Pump Station and power line)	Construction to Operations	Project contribution to cumulative effects on short-eared owl.	• Existing activities including natural disturbance, settlement, agriculture and livestock grazing, natural resource extraction (*i.e.*, forestry, oil and gas, mineral), recreation and tourism, rural and urban development, transportation and infrastructure. • Reasonably foreseeable developments within the RSA listed in Tables 8A.1-1 to 8A.1-6 of Appendix 8.1 and discussed in Section 8.1.4. • Project-related activities that could interact with the above activities include clearing, blasting, installation of Project components, camps, temporary access, construction traffic, reclamation, operational activities (vegetation control, access, traffic, human activity, monitoring and maintenance).

TABLE 8.9-5 Cont'd

Potential Residual Project Effect on Indicator	Spatial Boundary	Project Component(s)	Temporal Boundary	Potential Cumulative Effect	Existing Activities/Reasonably Foreseeable Developments with Residual Effects Acting in Combination with the Project
13. Combined Project effects on rusty blackbird resulting from habitat loss or alteration, changes in movement and increased mortality risk.	Wildlife RSA	Edmonton to Hinton Segment Hargreaves to Darfield Segment Black Pines to Hope Segment Hope to Burnaby Segment Temporary Facilities Pump Stations (Black Pines Pump Station and power line, Kingsvale Pump Station and power line)	Construction to Operations	Project contribution to cumulative effects on rusty blackbird.	• Existing activities including natural disturbance, settlement, agriculture and livestock grazing, natural resource extraction (*i.e.*, forestry, oil and gas, mineral), recreation and tourism, rural and urban development, transportation and infrastructure. • Reasonably foreseeable developments within the RSA listed in Tables 8A.1-1 to 8A.1-6 of Appendix 8.1 and discussed in Section 8.1.4. • Project-related activities that could interact with the above activities include clearing, blasting, installation of Project components, camps, temporary access, construction traffic, reclamation, operational activities (vegetation control, access, traffic, human activity, monitoring and maintenance).
14. Combined Project effects on flammulated owl resulting from habitat loss or alteration, changes in movement and increased mortality risk.	Wildlife RSA	Black Pines to Hope Segment Temporary Facilities Pump Stations (Black Pines Pump Station and power line, Kingsvale Pump Station and power line)	Construction to Operations	Project contribution to cumulative effects on flammulated owl.	• Existing activities including natural disturbance, settlement, agriculture and livestock grazing, natural resource extraction (*i.e.*, forestry, oil and gas, mineral), recreation and tourism, rural and urban development, transportation and infrastructure. • Reasonably foreseeable developments within the RSA listed in Tables 8A.1-1 and 8A.1-6 of Appendix 8.1 and discussed in Section 8.1.4. • Project-related activities that could interact with the above activities include clearing, blasting, installation of Project components, camps, temporary access, construction traffic, reclamation, operational activities (vegetation control, access, traffic, human activity, monitoring and maintenance).
15. Combined Project effects on Lewis's woodpecker resulting from habitat loss or alteration, changes in movement and increased mortality risk.	Wildlife RSA	Black Pines to Hope Segment Temporary facilities Pump Stations (Black Pines Pump Station and power line, Kingsvale Pump Station and power line)	Construction to Operations	Project contribution to cumulative effects on Lewis's woodpecker.	• Existing activities including natural disturbance, settlement, agriculture and livestock grazing, natural resource extraction (*i.e.*, forestry, oil and gas, mineral), recreation and tourism, rural and urban development, transportation and infrastructure. • Reasonably foreseeable developments within the RSA listed in Tables 8A.1-1 and 8A.1-6 of Appendix 8.1 and discussed in Section 8.1.4. • Project-related activities that could interact with the above activities include clearing, blasting, installation of Project components, camps, temporary access, construction traffic, reclamation, operational activities (vegetation control, access, traffic, human activity, monitoring and maintenance).

TABLE 8.9-5 Cont'd

Potential Residual Project Effect on Indicator	Spatial Boundary	Project Component(s)	Temporal Boundary	Potential Cumulative Effect	Existing Activities/Reasonably Foreseeable Developments with Residual Effects Acting in Combination with the Project
16. Combined Project effects on Williamson's sapsucker resulting from habitat loss or alteration, changes in movement and increased mortality risk.	Wildlife RSA	Black Pines to Hope Segment Temporary facilities Pump Stations (Black Pines Pump Station and power line, Kingsvale Pump Station and power line)	Construction to Operations	Project contribution to cumulative effects on Williamson's sapsucker.	• Existing activities including natural disturbance, settlement, agriculture and livestock grazing, natural resource extraction (*i.e.*, forestry, oil and gas, mineral), recreation and tourism, rural and urban development, transportation and infrastructure. • Reasonably foreseeable developments within the RSA listed in Tables 8A.1-1 and 8A.1-6 of Appendix 8.1 and discussed in Section 8.1.4. • Project-related activities that could interact with the above activities include clearing, blasting, installation of Project components, camps, temporary access, construction traffic, reclamation, operational activities (vegetation control, access, traffic, human activity, monitoring and maintenance).
17. Combined Project effects on western screech-owl resulting from habitat loss or alteration, changes in movement and increased mortality risk.	Wildlife RSA	Black Pines to Hope Segment Hope to Burnaby Segment Burnaby to Westridge Segment Temporary Facilities Pump Stations (Black Pines Pump Station and power line, Kingsvale Pump Station and power line) Tanks (Sumas) Westridge Marine Terminal	Construction to Operations	Project contribution to cumulative effects on western screech-owl.	• Existing activities including natural disturbance, settlement, agriculture and livestock grazing, natural resource extraction (*i.e.*, forestry, oil and gas, mineral), recreation and tourism, rural and urban development, transportation and infrastructure. • Reasonably foreseeable developments within the RSA listed in Tables 8A.1-1 and 8A.1-6 of Appendix 8.1 and discussed in Section 8.1.4. • Project-related activities that could interact with the above activities include clearing, blasting, installation of Project components, camps, temporary access, construction traffic, reclamation, operational activities (vegetation control, access, traffic, human activity, monitoring and maintenance).
18. Combined Project effects on great blue heron resulting from habitat loss or alteration, changes in movement and increased mortality risk.	Wildlife RSA	All Components	Construction to Operations	Project contribution to cumulative effects on great blue heron.	• Existing activities including natural disturbance, settlement, agriculture and livestock grazing, natural resource extraction (*i.e.*, forestry, oil and gas, mineral), recreation and tourism, rural and urban development, transportation and infrastructure. • Reasonably foreseeable developments within the RSA listed in Tables 8A.1-1 to 8A.1-6 of Appendix 8.1 and discussed in Section 8.1.4. • Project-related activities that could interact with the above activities include clearing, blasting, installation of Project components, camps, temporary access, construction traffic, reclamation, operational activities (vegetation control, access, traffic, human activity, monitoring and maintenance).

TABLE 8.9-5 Cont'd

Potential Residual Project Effect on Indicator	Spatial Boundary	Project Component(s)	Temporal Boundary	Potential Cumulative Effect	Existing Activities/Reasonably Foreseeable Developments with Residual Effects Acting in Combination with the Project
19. Combined Project effects on spotted owl resulting from habitat loss or alteration, changes in movement and increased mortality risk.	Wildlife RSA	Black Pines to Hope Segment Temporary Facilities	Construction to Operations	Project contribution to cumulative effects on spotted owl.	• Existing activities including natural disturbance, settlement, agriculture and livestock grazing, natural resource extraction (*i.e.*, forestry, oil and gas, mineral), recreation and tourism, rural and urban development, transportation and infrastructure. • Reasonably foreseeable developments within the RSA listed in Tables 8A.1-1 and 8A.1-6 of Appendix 8.1 and discussed in Section 8.1.4. • Project-related activities that could interact with the above activities include clearing, blasting, installation of Project components, camps, temporary access, construction traffic, reclamation, operational activities (vegetation control, access, traffic, human activity, monitoring and maintenance).
20. Combined Project effects on bald eagle resulting from habitat loss or alteration, changes in movement and increased mortality risk.	Wildlife RSA	All Components	Construction to Operations	Project contribution to cumulative effects on bald eagle.	• Existing activities including natural disturbance, settlement, agriculture and livestock grazing, natural resource extraction (*i.e.*, forestry, oil and gas, mineral), recreation and tourism, rural and urban development, transportation and infrastructure. • Reasonably foreseeable developments within the RSA listed in Tables 8A.1-1 to 8A.1-6 of Appendix 8.1 and discussed in Section 8.1.4. • Project-related activities that could interact with the above activities include clearing, blasting, installation of Project components, camps, temporary access, construction traffic, reclamation, operational activities (vegetation control, access, traffic, human activity, monitoring and maintenance).
21. Combined Project effects on common nighthawk resulting from habitat loss or alteration, changes in movement and increased mortality risk.	Wildlife RSA	All Components	Construction to Operations	Project contribution to cumulative effects on common nighthawk.	• Existing activities including natural disturbance, settlement, agriculture and livestock grazing, natural resource extraction (*i.e.*, forestry, oil and gas, mineral), recreation and tourism, rural and urban development, transportation and infrastructure. • Reasonably foreseeable developments within the RSA listed in Tables 8A.1-1 to 8A.1-6 of Appendix 8.1 and discussed in Section 8.1.4. • Project-related activities that could interact with the above activities include clearing, blasting, installation of Project components, camps, temporary access, construction traffic, reclamation, operational activities (vegetation control, access, traffic, human activity, monitoring and maintenance).

TABLE 8.9-5 Cont'd

Potential Residual Project Effect on Indicator	Spatial Boundary	Project Component(s)	Temporal Boundary	Potential Cumulative Effect	Existing Activities/Reasonably Foreseeable Developments with Residual Effects Acting in Combination with the Project
22. Combined Project effects on northern goshawk resulting from habitat loss or alteration, changes in movement and increased mortality risk.	Wildlife RSA	Hope to Burnaby Segment Burnaby to Westridge Segment Temporary Facilities Tanks (Sumas) Westridge Marine Terminal	Construction to Operations	Project contribution to cumulative effects on northern goshawk.	• Existing activities including natural disturbance, settlement, agriculture and livestock grazing, natural resource extraction (*i.e.*, forestry, oil and gas, mineral), recreation and tourism, rural and urban development, transportation and infrastructure. • Reasonably foreseeable developments within the RSA listed in Tables 8A.1-1 and 8A.1-6 of Appendix 8.1 and discussed in Section 8.1.4. • Project-related activities that could interact with the above activities include clearing, blasting, installation of Project components, camps, temporary access, construction traffic, reclamation, operational activities (vegetation control, access, traffic, human activity, monitoring and maintenance).
23. Combined Project effects on olive-sided flycatcher resulting from habitat loss or alteration, changes in movement and increased mortality risk.	Wildlife RSA	All Components	Construction to Operations	Project contribution to cumulative effects on olive-sided flycatcher.	• Existing activities including natural disturbance, settlement, agriculture and livestock grazing, natural resource extraction (*i.e.*, forestry, oil and gas, mineral), recreation and tourism, rural and urban development, transportation and infrastructure. • Reasonably foreseeable developments within the RSA listed in Tables 8A.1-1 to 8A.1-6 of Appendix 8.1 and discussed in Section 8.1.4. • Project-related activities that could interact with the above activities include clearing, blasting, installation of Project components, camps, temporary access, construction traffic, reclamation, operational activities (vegetation control, access, traffic, human activity, monitoring and maintenance).
24. Combined Project effects on pond-dwelling amphibians resulting from habitat loss or alteration, changes in movement and increased mortality risk.	Wildlife RSA	All Components	Construction to Operations	Project contribution to cumulative effects on pond-dwelling amphibians.	• Existing activities including natural disturbance, settlement, agriculture and livestock grazing, natural resource extraction (*i.e.*, forestry, oil and gas, mineral), recreation and tourism, rural and urban development, transportation and infrastructure. • Reasonably foreseeable developments within the RSA listed in Tables 8A.1-1 to 8A.1-6 of Appendix 8.1 and discussed in Section 8.1.4. • Project-related activities that could interact with the above activities include clearing, topsoil/root zone material salvage, grading, trenching, blasting, materials storage, installation of Project components, camps, temporary access, construction traffic, reclamation, operational activities (vegetation control, access, traffic, human activity, monitoring and maintenance).

TABLE 8.9-5 Cont'd

Potential Residual Project Effect on Indicator	Spatial Boundary	Project Component(s)	Temporal Boundary	Potential Cumulative Effect	Existing Activities/Reasonably Foreseeable Developments with Residual Effects Acting in Combination with the Project
25. Combined Project effects on stream-dwelling amphibians resulting from habitat loss or alteration, changes in movement and increased mortality risk.	Wildlife RSA	Black Pines to Hope Segment Hope to Burnaby Segment Temporary Facilities Tanks (Sumas)	Construction to Operations	Project contribution to cumulative effects on stream-dwelling amphibians.	• Existing activities including natural disturbance, settlement, agriculture and livestock grazing, natural resource extraction (*i.e.*, forestry, oil and gas, mineral), recreation and tourism, rural and urban development, transportation and infrastructure. • Reasonably foreseeable developments within the RSA listed in Tables 8A.1-1 and 8A.1-6 of Appendix 8.1 and discussed in Section 8.1.4. • Project-related activities that could interact with the above activities include clearing, topsoil/root zone material salvage, grading, trenching, blasting, materials storage, installation of Project components, camps, temporary access, construction traffic, reclamation, operational activities (vegetation control, access, traffic, human activity, monitoring and maintenance).
26. Combined Project effects on arid habitat snakes resulting from habitat loss or alteration, changes in movement and increased mortality risk.	Wildlife RSA	Black Pines to Hope Segment Temporary Facilities	Construction to Operations	Project contribution to cumulative effects on arid habitat snakes.	• Existing activities including natural disturbance, settlement, agriculture and livestock grazing, natural resource extraction (*i.e.*, forestry, oil and gas, mineral), recreation and tourism, rural and urban development, transportation and infrastructure. • Reasonably foreseeable developments within the RSA listed in Tables 8A.1-1 and 8A.1-6 of Appendix 8.1 and discussed in Section 8.1.4 and discussed in Section 8.1.4. • Project-related activities that could interact with the above activities include clearing, topsoil/root zone material salvage, grading, trenching, blasting, materials storage, installation of Project components, camps, temporary access, construction traffic, reclamation, operational activities (vegetation control, access, traffic, human activity, monitoring and maintenance).

8.9.6 Significance Evaluation of Potential Cumulative Effects on Mammals

The Project is likely to interact with existing and reasonably foreseeable disturbances to have an incremental cumulative effect on habitat, movement and mortality risk of mammals within the Grizzly Bear, Caribou and Wildlife RSAs. Table 8.9-6 provides a summary of the significance evaluation of the Project's contribution to cumulative effects on mammal indicators. The assessment rationale is provided below.

TABLE 8.9-6

SUMMARY OF SIGNIFICANCE EVALUATION OF THE PROJECT'S CONTRIBUTION TO CUMULATIVE EFFECTS ON MAMMAL INDICATORS

	Potential Cumulative Effects	Impact Balance	Spatial Boundary	Temporal Context			Magnitude	Probability	Confidence	Significance[1]
				Duration	Frequency	Reversibility				
1.	Wildlife Indicator – Grizzly Bear									
1(a)	Project contribution to cumulative effects on grizzly bear.	Negative	Grizzly RSA	Short-term	Periodic	Long-term	Medium	High	Moderate	Not significant
2.	Wildlife Indicator – Woodland Caribou									
2(a)	Project contribution to cumulative effects on woodland caribou.	Negative	Caribou RSA	Short-term	Periodic	Long-term	Medium	High	Moderate	Not significant
3.	Wildlife Indicator – Moose									
3(a)	Project contribution to cumulative effects on moose.	Negative	Wildlife RSA	Short-term	Periodic	Long-term	Low	High	Moderate	Not significant
4.	Wildlife Indicator – Forest Furbearers									
4(a)	Project contribution to cumulative effects on forest furbearers.	Negative	Wildlife RSA	Short-term	Periodic	Long-term	Low	High	Moderate	Not significant
5.	Wildlife Indicator – Coastal Riparian Small Mammals									
5(a)	Project contribution to cumulative effects on coastal riparian small mammals.	Negative	Wildlife RSA	Short-term	Periodic	Long-term	Medium	High	Low	Not significant
6.	Wildlife Indicator – Bats									
6(a)	Project contribution to cumulative effects on bats.	Negative	Wildlife RSA	Short-term	Periodic	Long-term	Low	High	Low	Not significant

Note: 1 Significant Contribution to a Cumulative Environmental Effect: A high probability of occurrence of a permanent or long-term cumulative effect of high magnitude that cannot be technically or economically mitigated.

8.9.6.1 Cumulative Change in Habitat for Mammal Indicators

The Project will contribute to combined loss or alteration of mammal habitat resulting from natural disturbance, existing activities and foreseeable future disturbances. Table 8.9-7 and Figure 8.9-3 summarize the predicted changes in availability of potential habitat for mammal indicators as a result of combined disturbance from the Project and reasonably foreseeable developments within the Wildlife RSA.

TABLE 8.9-7

PREDICTED CHANGE IN POTENTIAL HABITAT FOR MAMMAL INDICATORS IN THE WILDLIFE REGIONAL STUDY AREA

Wildlife Indicator[1]	Habitat Potential[2]	Area (ha) of Potential Habitat in the Wildlife RSA						
			Project Conditions[3]			Cumulative Conditions[4]		
		Existing Conditions	Project Conditions	Incremental Change[5]	% Change[5]	Cumulative Conditions	Incremental Change[5]	% Change[5]
Moose	Potential	1,679,902.4	1,680,159.1	256.7 ↑	0.02 ↑	1,674,156.6	5745.8 ↓	0.34 ↓
Marten (forest furbearers indicator)	Potential	1,262,477.8	1,261,204.0	1,273.8 ↓	0.10 ↓	1,257,508.3	4969.5 ↓	0.39 ↓
Fisher (forest furbearers indicator)	Potential	873,839.9	873,067.5	772.4 ↓	0.09 ↓	869,593.1	4246.8 ↓	0.49 ↓
Mountain Beaver (coastal riparian small mammals indicator)	Potential	212,887.1	212,651.1	236.1 ↓	0.11 ↓	212,501.7	385.4 ↓	0.18 ↓
Pacific Water Shrew[6] (coastal riparian small mammals indicator)	Potential	159,202.0	159,057.6	144.3 ↓	0.09 ↓	158,880.2	321.7 ↓	0.20 ↓

TABLE 8.9-7 Cont'd

Wildlife Indicator[1]	Habitat Potential[2]	Area (ha) of Potential Habitat in the Wildlife RSA						
			Project Conditions[3]			Cumulative Conditions[4]		
		Existing Conditions	Project Conditions	Incremental Change[5]	% Change[5]	Cumulative Conditions	Incremental Change[5]	% Change[5]
Bats	Potential	1,462,419.1	1,460,964.0	1,455.1 ↓	0.10 ↓	1,456,795.6	5,623.5 ↓	0.38 ↓

Notes: 1 Quantitative analyses for grizzly bear and caribou habitat change were completed with different methods. Results are provided in Tables 8.9-8 and 8.9-9.

2 Refer to the Wildlife Modelling and Species Accounts Technical Report of Volume 5C for definition of habitat potential.

3 Project Conditions includes existing activities (with available spatial data + Project.

4 Cumulative Conditions includes existing activities + Project + reasonably foreseeable disturbances (with available spatial data).

5 Incremental and percent change is calculated as the change from existing conditions. ↓ represents a decrease and ↑ represents an increase.

6 Pacific water shrew is modeled using a habitat capability model provided by provincial regulatory agency. Because the model is a capability model (not suitability), only disturbances that were expected to affect habitat capability were included. These disturbances are ones where permanent changes take place, or where normal succession will not be permitted to proceed for an extended period (*e.g.*, pipeline, transmission line, and commercial/industrial footprints). The results indicate the current or future capacity of the habitat to support water shrews. Refer to the Wildlife Modelling and Species Accounts Technical Report of Volume 5C for additional information.

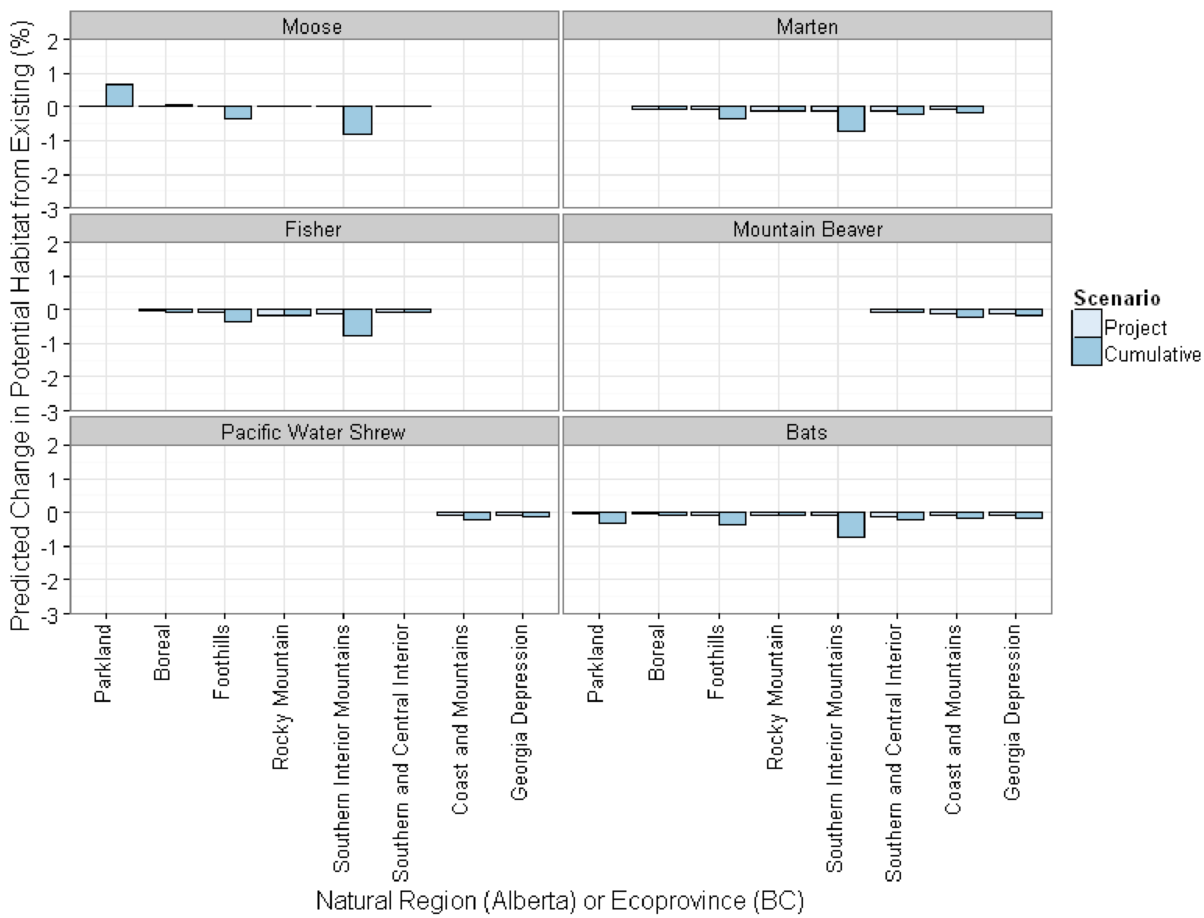


Figure 8.9-3 Predicted Change in Potential Habitat for Mammal Indicators
The predicted change in potential habitat is presented as the percent change from existing conditions to Project conditions and cumulative conditions for each Natural Region (Alberta) and Ecoprovince (BC) within the Wildlife RSA.

Project-specific mitigation measures that will be implemented to reduce regional-scale habitat effects are summarized in Section 7.2.10.6. By implementing the proposed mitigation, the Project's contribution to cumulative effects on mammal habitat will be reduced. It is expected that most other operators in the Grizzly Bear, Caribou and Wildlife RSAs will implement similar best practices and standard mitigation to reduce the contribution of existing and reasonably foreseeable developments to cumulative effects. For the mammal indicators, the predicted change in potential habitat at the regional scale as a result of the Project indicates a very low contribution to cumulative effects. Therefore, mitigation in addition to the measures already proposed in Section 7.0 is not warranted. The commitments outlined in Section 7.2.10.6 to implement additional mitigation beyond the standard measures to address the Project's residual effect on woodland caribou habitat, and to work with regulatory authorities to address potential incremental effects on the proposed/candidate critical habitats for coastal riparian small mammals (*i.e.*, Pacific water shrew, Townsend's mole), are expected to adequately address the Project's contribution to cumulative effects on these sensitive habitats for mammal indicators.

Additional quantitative analyses were completed to inform the assessment of the Project's contribution to cumulative effects on grizzly bear and caribou. These are discussed in the following subsections.

Grizzly Bear

Grizzly bear core (or "core security") habitats are locations with high habitat value and low mortality risk, and are an important component of grizzly bear management (Gibeau *et al.* 2001, Mace and Waller 1998). Core areas can vary in size; 10 km^2 (1,000 ha) is a generally accepted benchmark for defining suitable core roadless areas for grizzly bears (Hamilton pers. comm.). An analysis of grizzly bear core areas was completed using the 'roadless' reciprocal of the moving window motorized access density analysis described below under the mortality risk evaluation for grizzly bear. Grizzly bear core areas were defined as areas ≥ 10 km^2 with a motorized access density of 0 km/km^2, and excluding large lakes, exposed rock and ice (*e.g.*, glaciers).

Results of the grizzly bear core area analysis indicate that the Project will intersect 12 of the core security habitat patches for grizzly bear available under existing conditions in the Grizzly Bear RSA. The Project does not change the number of core patches from existing conditions (Table 8.9-8). The number of core patches is predicted to increase in the North Cascades Grizzly Bear Population Unit (GBPU) (Table 8.9-8) as a result of reasonably foreseeable developments, which is a function of large patches being fragmented into multiple smaller patches that are still of suitable size (*i.e.*, > 10 km/km^2). The number of core security patches in the Robson GBPU decreases from existing conditions as a result of reasonably foreseeable developments (Table 8.9-8), indicating some patches are fragmented into areas too small to be considered core habitat (*i.e.*, < 10 km/km^2). The Project does not have an incremental contribution to cumulative disturbance in grizzly bear core habitat in the Grande Cache, Yellowhead and Columbia-Shuswap GBPUs (*i.e.*, there is no reduction in the total area of core habitat from existing to Project conditions [Figure 8.9-4]). The Project's contribution to cumulative effects on grizzly bear core habitat in the Wells Gray, Robson and North Cascades GBPUs is negligible (Figure 8.9-4).

Management targets for grizzly bear include maintaining a maximum number (*i.e.*, as many as possible) of linked core security habitat patches larger than 10 km^2 within the landscape (Hamilton pers. comm.). The Project is not expected to affect the potential for this target to be achieved. The proposed mitigation in Section 7.0 to reduce the Project's residual effect on grizzly bear habitat is expected to adequately address the Project's contribution to cumulative effects on grizzly bear. No additional mitigation is deemed warranted specifically for cumulative effects on grizzly bear habitat.

TABLE 8.9-8

PREDICTED CHANGE IN GRIZZLY BEAR CORE HABITAT PATCHES

GBPU	Existing Conditions		Project Conditions[2]			Cumulative Conditions[3]		
	Number of Patches	Mean Patch Size (km^2) ± SD	Number of Patches	Number of Patches Intersected[1]	Mean Patch Size (km^2) ± SD	Number of Patches	Number of Patches Intersected[1]	Mean Patch Size (km^2) ± SD
Grande Cache	79	154.618 ± 962.015	79	0	154.618 ± 962.015	79	17	154.573 ± 962.018
Yellowhead	47	167.875 ± 684.172	47	0	167.875 ± 684.172	47	6	167.874 ± 648.172
Columbia-Shuswap	32	184.525 ± 577.870	32	0	184.525 ± 577.870	32	0	184.525 ± 577.870
Wells Gray	27	321.154 ± 1,490.591	27	4	321.1005 ± 1,490.380	27	4	320.910 ± 1,489.392
Robson	33	571.291 ± 1,509.199	33	1	571.257 ± 1,509.033	30	4	570.402 ± 1,507.374
North Cascades	40	112.096 ± 174.287	40	7	112.064 ± 174.298	41	19	108.7136 ± 172.366

Notes: 1 Indicates the number of core patches available under existing conditions that are intersected by the Project and reasonably foreseeable developments. Patches that overlap more than one GBPU are quantified in their entirety for each relevant GBPU.

2 Project conditions include existing activities (with available spatial data + Project).

3 Cumulative conditions include existing activities + Project + reasonably foreseeable developments (with available spatial data).

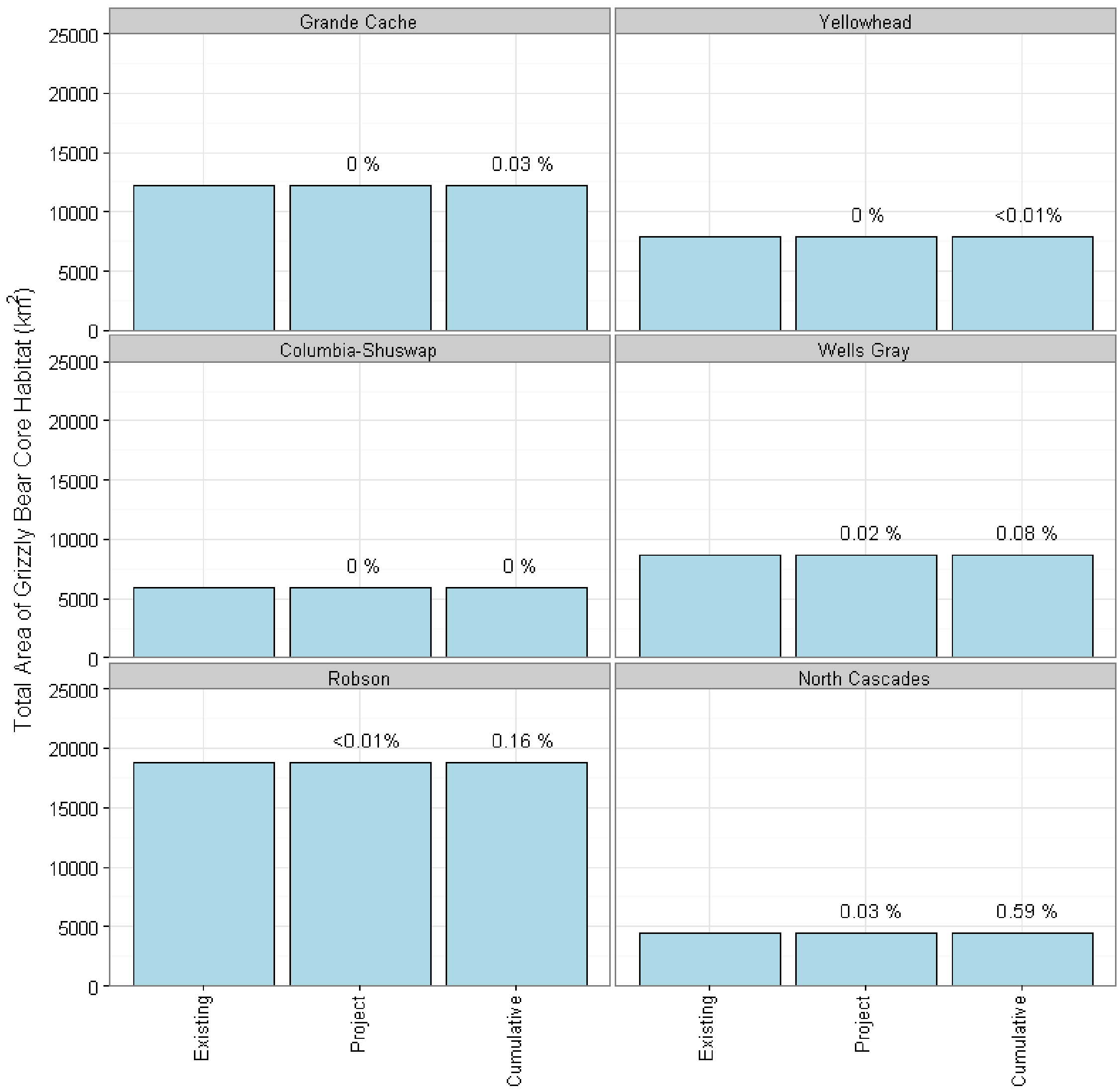


Figure 8.9-4 Predicted Change in Total Area of Grizzly Bear Core Habitat
The total area (km²) of core habitat is the sum of the area of all core habitat patches within each GBPU. The percent change from existing conditions to Project and cumulative conditions is provided numerically above each relevant bar.

Caribou

The Caribou RSA is approximately 1,098,884 ha in size and includes the Wells Gray and Groundhog caribou ranges and associated UWR and WHA (illustrated in the Wildlife Technical Report of Volume 5C). Direct habitat disturbance within the Caribou RSA was quantified based on available existing disturbance data (anthropogenic and fire < 40 years). Functional habitat disturbance incorporates the direct disturbance and the potential zone of influence (reduced habitat effectiveness) within 500 m of anthropogenic disturbance.

Using the method developed for the federal *Recovery Strategy for the Woodland Caribou* (*Rangifer tarandus* caribou)*, Boreal population, in Canada* (Environment Canada 2012), undisturbed caribou habitat is defined as the habitat remaining within the range that has not been burned in the last 40 years and is greater than 500 m from land use features such as clearings and corridors. This method was developed to delineate critical habitat for boreal woodland caribou across Canada (Environment Canada 2008, 2011, 2012). In the absence of current models, measures or thresholds specific to mountain caribou, this approach was adopted for this cumulative effects assessment because it is considered to reflect the widest range of woodland caribou life history conditions. Limitations associated with differences in mountain and boreal caribou life history and spatial segregation of seasonal ranges (especially high value winter ranges) for mountain but not boreal caribou, are acknowledged. The Environment Canada (2012) method for assessing boreal caribou range condition is currently considered the best available quantitative approach for assessing potential cumulative effects on caribou habitat, and allows the expected incremental contribution of existing disturbance, the Project and reasonably foreseeable developments to cumulative effects on caribou habitat to be differentiated.

There is a moderate level (approximately 31.6%) of existing functional habitat disturbance within the Caribou RSA. Cutblocks are the only reasonably foreseeable development identified within the Caribou RSA. Spatial data were not available for future cutblocks at the time of the assessment; therefore, the quantitative assessment of functional disturbance includes only the interaction of the Project with existing activities in the Caribou RSA (Table 8.9-9). Future forest harvest is considered qualitatively in the significance assessment of cumulative effects on caribou habitat. The Project is predicted to contribute to the cumulative functional disturbance in the Caribou RSA by a negligible amount (< 0.01% [Table 8.9-9]).

Environmental Protection and Management Regulation under the BC *Oil and Gas Activities Act* states that operating areas should not be located in a designated UWR unless the operating area will not have a material adverse effect on the ability of the wildlife habitat within the UWR to provide for the survival, within the UWR, of the wildlife species for which the UWR was established. Within the intersected UWR, the proposed pipeline corridor parallels the existing TMPL right-of-way, Highway 5, and an existing railway. Results of the quantitative analysis of caribou habitat change in the Caribou RSA indicate there is no increase in functional habitat disturbance in the caribou UWR as a result of the Project. Despite the relatively low value of the habitat within the proposed pipeline corridor for caribou (due to its low elevation location and existing disturbances), the Project is expected to improve habitat conditions for moose forage and for wolves (prey availability, ease of travel). Wolves have been documented travelling during winter along the existing TMPL in the Caribou RSA (Sturgenor pers. comm.). Wolves are suggested as a primary factor in the decline of mountain caribou in the Caribou RSA. Changes in moose-wolf-caribou interactions are likely the primary mechanism by which the Project will potentially contribute to cumulative effects on caribou. As noted above, mitigation beyond standard measures is warranted to address the Project's residual and incremental contribution to cumulative effects on woodland caribou (*e.g.*, planting conifer seedlings in strategic locations within the Project Footprint, and potentially the existing TMPL). Trans Mountain will work with provincial regulatory authorities, tenure holders and other stakeholders to identify opportunities to address potential residual Project effects on caribou habitat. Implementation of appropriate mitigation is expected to address the Project's residual effect and contribution to cumulative effects (Table 8.9-6 point 2[a]).

TABLE 8.9-9

PREDICTED CHANGE IN HABITAT IN THE CARIBOU REGIONAL STUDY AREA

Caribou Habitat Boundary	Area (ha)	Habitat Disturbance[1]	Existing Conditions (ha)	Project Conditions[2]		
				Project (ha)	Incremental Change (ha)[3]	% Change[3]
Caribou RSA	1,098,884.4	Direct Anthropogenic Disturbance	84,322.1	84,406.8	84.6↑	0.10↑
		Fire < 40 years	15,776.0	15,776.0	0	0
		Functional Disturbance	347,011.8	347,014.2	2.3	< 0.01↑
		Undisturbed	751,872.6	751,870.2	2.3↓	< 0.01↓
UWR	283,467.7	Direct Anthropogenic Disturbance	4,0245.8	40,253.4	7.6↑	0.02↑
		Fire < 40 years	2,769.3	2,769.3	0	0
		Functional Disturbance	147,269.9	147,269.9	0	0
UWR	283,467.7	Undisturbed	136,197.8	136,197.8	0	0

Notes: 1 Direct anthropogenic disturbance: area of anthropogenic disturbance (direct footprint).
Functional disturbance: area of anthropogenic disturbance buffered by 500 m, and fire < 40 years.
Undisturbed: area of caribou range outside of functional disturbance.
2 Cumulative conditions are not presented since there are no reasonably foreseeable developments with available spatial data in the Caribou RSA.
3 Incremental and percent change is calculated as the change from existing conditions. ↓ represents a decrease and ↑ represents an increase.

8.9.6.2 Cumulative Change in Movement of Mammal Indicators

The Project is expected to contribute to cumulative effects on movement of mammal indicators, in combination with existing and reasonably foreseeable future disturbances. Sections 7.2.10.5 and 7.2.10.9 provide discussion of the potential effects mechanisms of the Project on mammal movement. Existing activities and reasonably foreseeable developments and activities are expected to affect mammal movement, in particular high-traffic roads, urban (commercial, residential) and industrial development, and resource extraction (*e.g.*, recent forestry cutblocks, mines). Where the proposed pipeline corridor parallels existing linear features, the incremental increase in the width of the corridor is likely to affect movement of some mammal indicators. Noise and activity during construction and operations will interact with existing activities and reasonably foreseeable developments to affect mammal movement patterns (*e.g.*, barriers, filters, sensory displacement).

To meet management objectives for grizzly bear, one target outcome is to maintain the maximum number of linked core security patches (Hamilton pers. comm.). During the operations phase of the Project, early seral natural vegetation will regenerate over the Project Footprint, access control measures will be implemented to discourage motorized access, and human presence for operational activities (*e.g.*, for monitoring/maintenance activities) is expected to be infrequent. As a result, it is considered unlikely that the proposed pipeline right-of-way will create a barrier to grizzly bear movement that would isolate habitats. Therefore, it is assumed that the grizzly bear habitat fragmented by the Project footprint will remain functionally linked.

Mitigation measures to address the expected Project effects on wildlife movement are provided in Section 7.2.10.6. It is expected that most other operators in the Grizzly Bear, Caribou and Wildlife RSAs will implement similar best practices and standard mitigation. No mitigation measures beyond the Project-specific mitigation are deemed warranted to address the incremental cumulative effect on mammal movement.

8.9.6.3 Cumulative Risk of Mortality for Mammal Indicators

The Project is expected to contribute to incremental mammal mortality risk in combination with existing and reasonably foreseeable disturbances. Improved access for predators and humans, clearing, blasting, traffic and human-wildlife conflicts are likely mechanisms of Project incremental cumulative effects on mammal mortality risk that will interact with existing and reasonably foreseeable disturbances and activities. Application of the proposed mitigation to avoid wildlife mortality associated with traffic, machinery and human-wildlife conflict is expected to reduce the Project's incremental contribution to cumulative mortality risk to negligible levels.

Sections 7.2.10.9 and 8.9.4 discuss the cause-effect relationship between access and wildlife mortality risk from hunting, trapping and predation. Given the linear nature of the primary components of the Project, effects on mammal mortality risk during operations are expected to result largely from access. Linear feature density is a metric that can be used to provide insight into the potential cumulative effects of development on habitat effectiveness and mortality risk (Salmo *et al.* 2003). Linear feature density is a measure of the concentration of linear features (*e.g.*, roads, transmission lines, railways and pipelines) on the landscape. Since road density thresholds are available for grizzly bear, a quantitative analysis was completed to inform the assessment of cumulative effects on grizzly bear mortality risk.

The BC Identified Wildlife Species Account for grizzly bear recommends an open road density of less than 0.6 km/km² to meet access management objectives in grizzly bear areas (BC MWLAP 2004). The Alberta Grizzly Bear Recovery Plan identifies objectives that would limit the rate of human-caused mortality per Bear Management Area (or GBPU) by maintaining open road densities at or below 0.6 km/km² in Grizzly Bear Priority Areas, and at or below 1.2 km/km² in all remaining grizzly bear range (ASRD 2008).

Open road density thresholds are inconsistently applied to various combinations of linear feature data sets in different management regions. For example, some jurisdictions use open road density to mean only primary and secondary roads, while other jurisdictions include all anthropogenic linear features for which spatial data are available. The validity of including seismic lines as access is uncertain, since there is a large amount of variation in the ability of these features to facilitate motorized access during the growing season, and the available spatial data does not differentiate between seismic lines of varying width, continuity and vegetation regeneration. For the purposes of this assessment, the analysis of access density used a combination of linear feature data to represent motorized access, as identified in Table 8.9-10.

TABLE 8.9-10

ACCESS DENSITY PARAMETERS

Parameter	Details
Performance Measure	Motorized Access Density (km/km²)
Definition	Access routes (without closures/restrictions) that receive conventional and/or off-road vehicle (*e.g.*, ATV) use
Threshold	0.6 km/km²
Spatial Data Features	• Primary Roads • Secondary Roads • Tertiary Roads • Transmission Lines • Power Lines • Pipelines

A moving window (sometimes called ‘roving window’) approach is often used in grizzly bear studies for calculating access density (Allen *et al.* 2011). The moving window approach calculates the density of linear features in the neighbourhood (‘window’) of each output raster cell (‘pixel’) in the middle of the window (ESRI 2012). Access density was computed using a moving window analysis in ArcGIS with a 500 m circular window radius (*i.e.*, a 1 km window) and 30 m^2 pixels. Results were provided by GBPU, and categorized into strata based on known access density thresholds for grizzly bear (Hamilton pers. comm.):

- 0 km/km²;
- > 0 to 0.6 km/km²;
- > 0.6 to 1.2 km/km²;
- > 1.2 to 2.4 km/km²; and
- > 2.4 km/km².

The proposed pipeline and power lines were included in the analysis of the Project’s contribution to motorized access density. The locations of access roads needed to construct and operate the Project are unknown at the time of assessment. It is understood that the majority of access will utilize existing access roads. Access is considered qualitatively in addition to the quantitative analysis in the characterization of effects and determination of significance.

Results of the moving window analysis (Table 8.9-11) indicate that the existing average motorized access density in the Columbia-Shuswap, Wells Gray, Robson and North Cascades GBPUs currently exceeds the threshold of 0.6 km/km², suggesting a high risk of grizzly bear mortality and displacement under current conditions in these GBPUs. The predicted cumulative contribution of the Project and reasonably foreseeable developments to motorized access density will not cause the average density to exceed 0.6 km/km² at the regional (*i.e.*, GBPU) scale for those GBPUs currently below this threshold under existing conditions (*i.e.*, Grande Cache and Yellowhead GBPUs). Figure 8.9-5 shows the predicted change in motorized access density, as a proportion of each GBPU, from existing to Project and cumulative conditions. The combined change in the proportion of each GBPU in each access density category as a result of the Project and reasonably foreseeable developments is minimal for all GPBUs (*i.e.*, < 0.4% change from existing conditions). In some instances, the Project has the apparent effect of reducing the access density (*e.g.*, Wells Gray and Robson GBPUs [Table 8.9-11]), since the proposed pipeline corridor is located between existing linear features and will effectively join currently separated corridors into a single wide corridor, thereby reducing the corridor density.

The results indicate that the average motorized access density at the GBPU scale does not change substantially as a result of the Project (Table 8.9-11). However, the proposed route and foreseeable future disturbances are predicted to have a localized effect on the motorized access density within each GBPU intersected by the Project, which will cause localized increases from baseline conditions below 0.6 km/km² to levels that exceed the threshold. Figures 8.9-6 to 8.9-11 illustrate the minor extent of the localized contribution to combined disturbance from the Project and reasonably foreseeable developments to the motorized access density in each GBPU intersected by the Project, whereby the density is predicted to exceed the 0.6 km/km² threshold for grizzly bear.

TABLE 8.9-11

PREDICTED CHANGE IN MOTORIZED ACCESS DENSITY FROM EXISTING CONDITIONS IN THE GRIZZLY BEAR REGIONAL STUDY AREA

	Existing Conditions	Project Conditions[1]		Cumulative Conditions[2]	
GBPU	Average Density ± Standard Deviation (km/km²)	Average Density ± Standard Deviation (km/km²)[3]	% Change in Average Density from Existing Conditions[3]	Average Density ± Standard Deviation (km/km²)	% Change in Average Density from Existing Conditions[3]
Grande Cache	0.34 ± 0.76	0.34 ± 0.76	< 0.01 ↑	0.34 ± 0.76	< 0.01 ↑
Yellowhead	0.27 ± 0.70	0.27 ± 0.70	< 0.01 ↑	0.27 ± 0.70	< 0.01 ↑
Columbia-Shuswap	1.07 ± 1.30	1.07 ± 1.30	< 0.01 ↑	1.07 ± 1.30	< 0.01 ↑
Wells Gray	0.66 ± 1.15	0.66 ± 1.15	< 0.01 ↓	0.66 ± 1.15	< 0.01 ↓
Robson	0.75 ±1.28	0.75 ± 1.28	< 0.01 ↓	0.75 ± 1.29	< 0.01 ↑
North Cascades	1.05 ± 1.38	1.05 ± 1.38	< 0.01 ↑	1.06 ± 1.40	0.01↑

Notes: 1 Project Conditions includes existing activities (with available spatial data) + Project disturbances.

2 Cumulative Conditions includes existing activities + Project + reasonably foreseeable developments (with available spatial data).

3 ↓ represents a decrease and ↑ represents an increase.

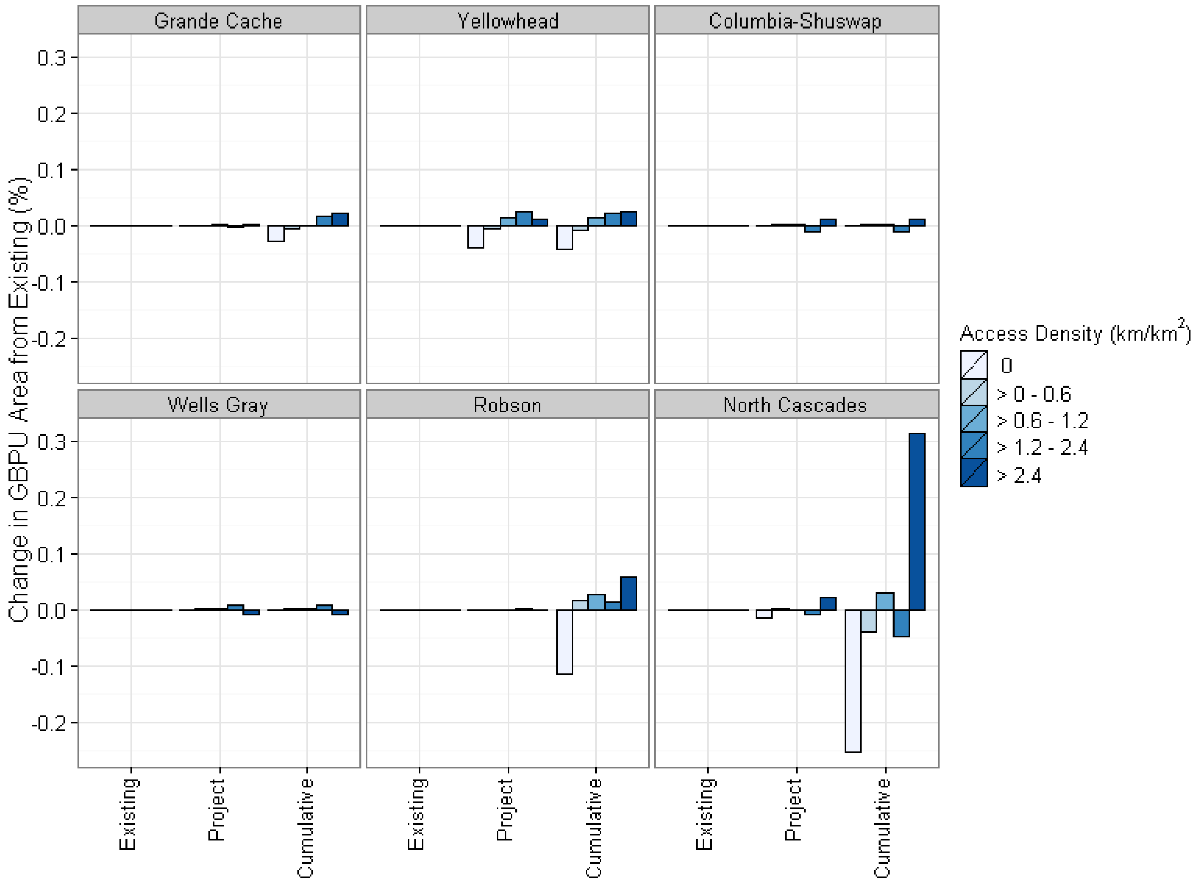
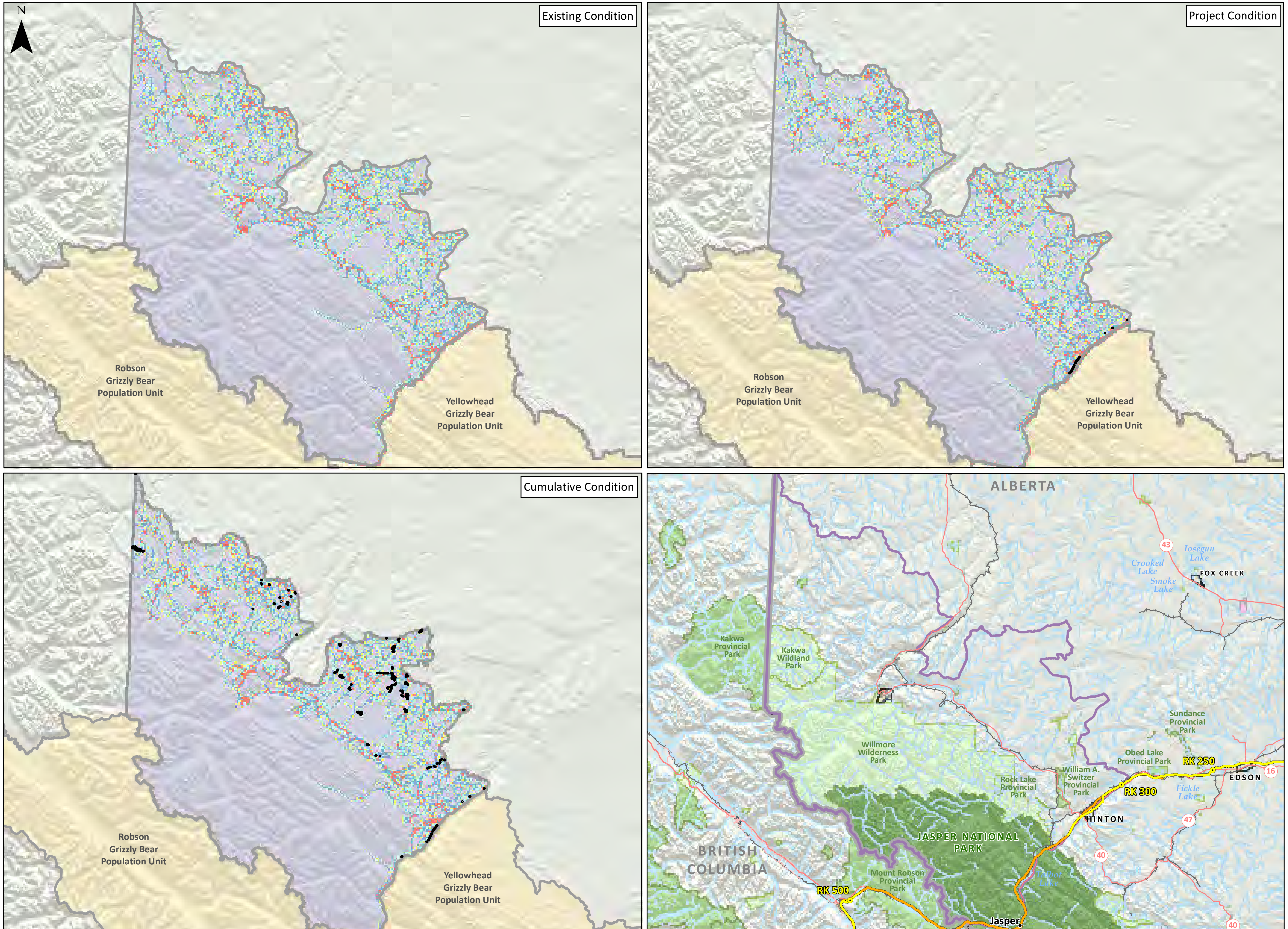


Figure 8.9-5 Predicted Change in Motorized Access Density by GBPU
Changes in motorized access density are presented as the percent change from existing conditions with respect to the proportion of the GBPU represented by each access density strata.



TRANS MOUNTAIN

FIGURE 8.9-6

MOTORIZED ACCESS DENSITY
GRANDE CACHE GBPU
ALBERTA

TRANS MOUNTAIN
EXPANSION PROJECT

Village / Hamlet
Reference Kilometre Post (RK)
Trans Mountain Pipeline (TMPL)
Trans Mountain Expansion Project Proposed Pipeline Corridor
Highway
Railway
City / Town / District Municipality
Indian Reserve / Métis Settlement
National Park
Provincial Park
Park / Protected Area
Provincial Boundary

Motorized Access Density (km/km²)
0
> 0 - 0.6
> 0.6 - 1.2
> 1.2 - 2.4
> 2.4
Change to > 0.6 from Existing

Projection: NAD83 UTM Zone 11N. Baseline TMPL & Facilities: provided by KMC 2012; Proposed Pipeline Corridor V6: provided by UPI Aug. 23, 2013; Transportation: IHS Inc., 2013, BC Forests, Lands and Natural Resource Operations, 2012 & Natural Resources Canada, 2012; Geopolitical Boundaries: Natural Resources Canada, 2003, AltaLIS, 2013, IHS Inc., 2011, BC FLNRO, 2007 & ESRI, 2005; First Nation Lands: Government of Canada, 2013, AltaLIS, 2010 & IHS Inc., 2011; Hydrology: Natural Resources Canada, 2007 & BC Crown Registry and Geographic Base Branch, 2008; Parks and Protected Areas: Natural Resources Canada, 2012, AltaLIS, 2012 & BC FLNRO, 2008; Grizzly Bear Population Units: Alberta Environment and Sustainable Resource Development 2013, BC Ministry of Environment 2012; Canadian Hillshade: TERA Environmental Consultants, 2008.

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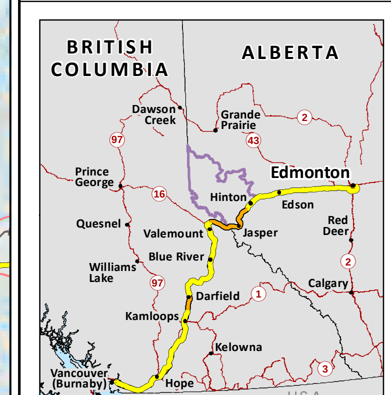

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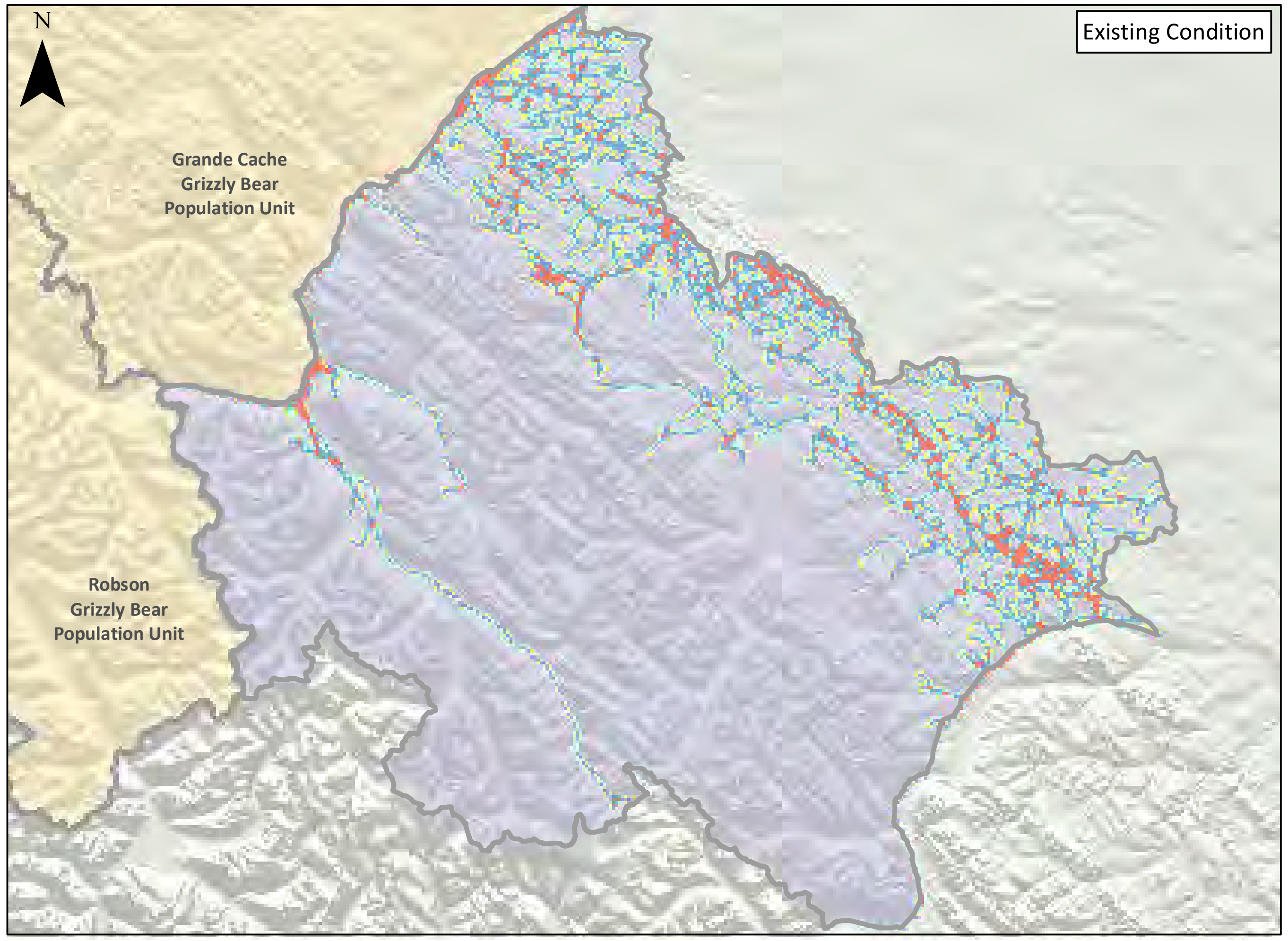

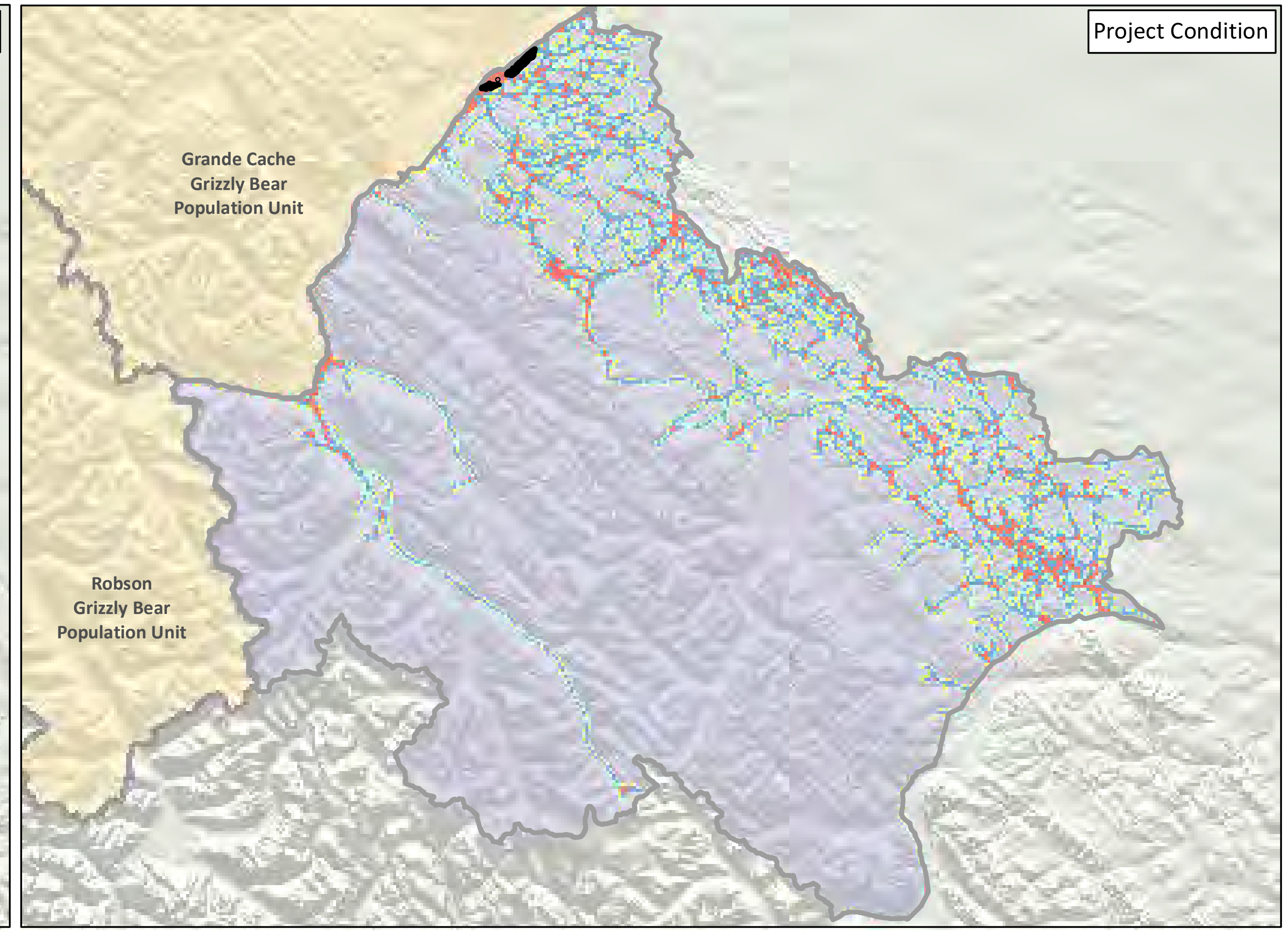

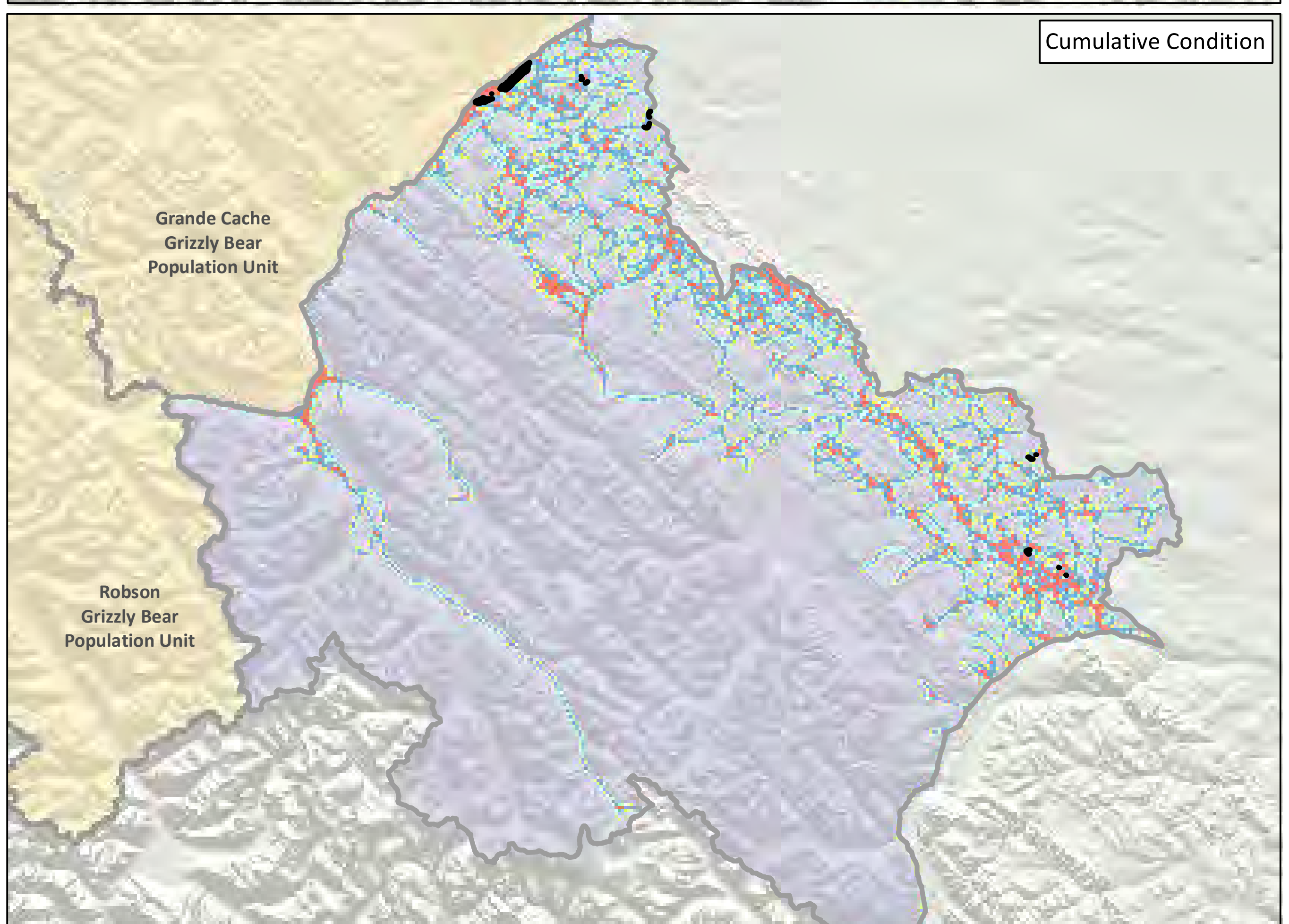

FIGURE 8.9-7

MOTORIZED ACCESS DENSITY
YELLOWHEAD GBPU
ALBERTA

TRANS MOUNTAIN
EXPANSION PROJECT

- Village / Hamlet
- Reference Kilometre Post (RK)
- Trans Mountain Pipeline (TMPL)
- Trans Mountain Expansion Project Proposed Pipeline Corridor
- Highway
- Railway
- City / Town / District Municipality
- Indian Reserve / Métis Settlement
- National Park
- Provincial Park
- Park / Protected Area
- Provincial Boundary

Motorized Access Density (km/km²)

- 0
- > 0 - 0.6
- > 0.6 - 1.2
- > 1.2 - 2.4
- > 2.4
- Change to > 0.6 from Existing

Projection: NAD83 UTM Zone 11N. Baseline TMPL & Facilities: provided by KMC 2012; Proposed Pipeline Corridor V6: provided by UPI Aug. 23, 2013; Transportation: IHS Inc., 2013, BC Forests, Lands and Natural Resource Operations, 2012 & Natural Resources Canada, 2012; Geopolitical Boundaries: Natural Resources Canada, 2003, AltaLIS, 2013, IHS Inc., 2011, BC FLNRO, 2007 & ESRI, 2005; First Nation Lands: Government of Canada, 2013, AltaLIS, 2010 & IHS Inc., 2011; Hydrology: Natural Resources Canada, 2007 & BC Crown Registry and Geographic Base Branch, 2008; Parks and Protected Areas: Natural Resources Canada, 2012, AltaLIS, 2012 & BC FLNRO, 2008; Grizzly Bear Population Units: Alberta Environment and Sustainable Resource Development 2013, BC Ministry of Environment 2012; Canadian Hillshade: TERA Environmental Consultants, 2008.

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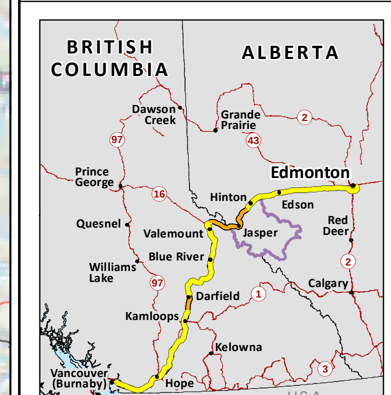
Although there is no reason to believe that there are any errors associated with the data used to generate this product or in the product itself, users of these data are advised that errors in the data may be present.



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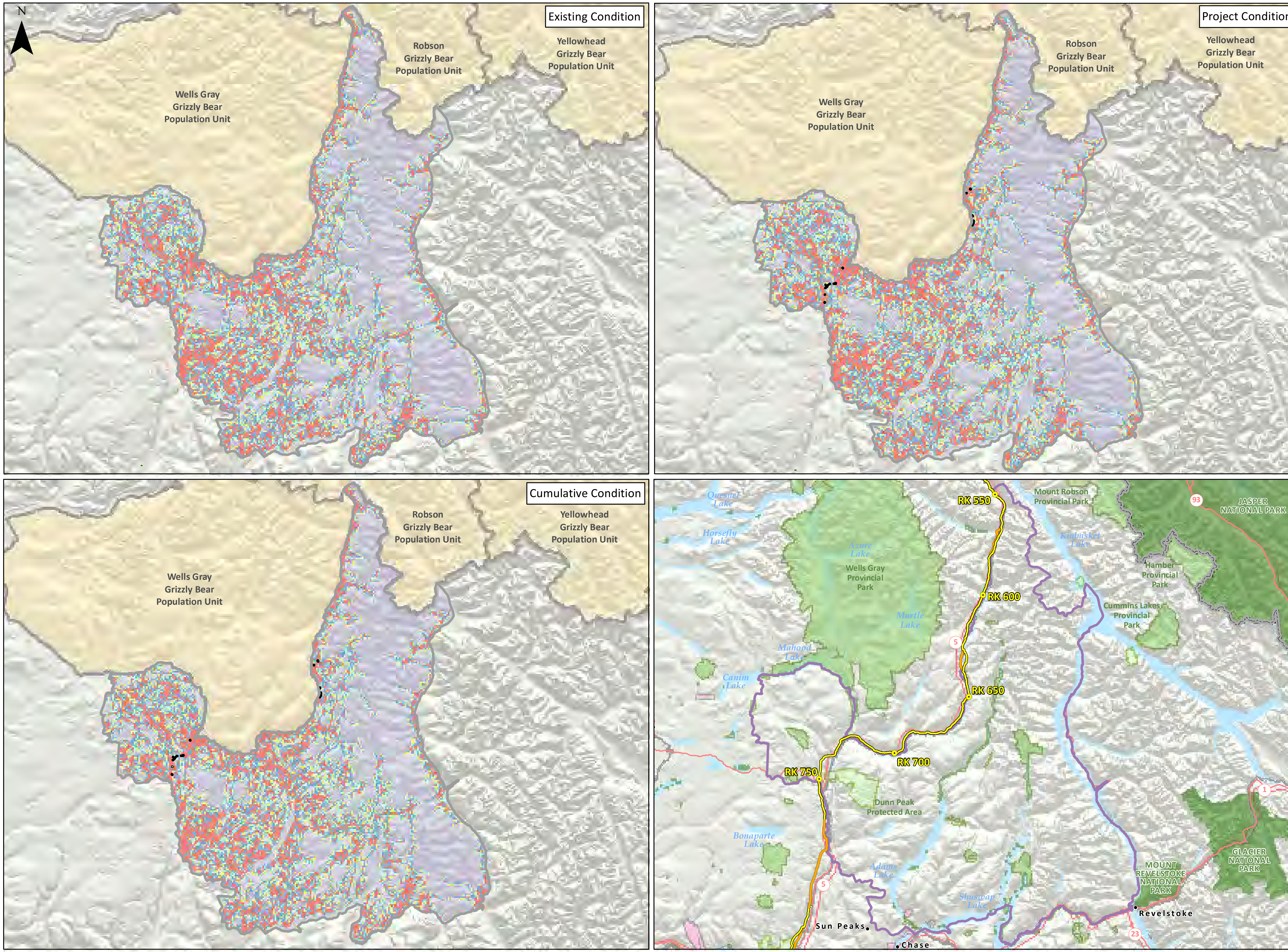

TRANS MOUNTAIN

FIGURE 8.9-8

MOTORIZED ACCESS DENSITY
COLUMBIA-SHUSWAP GBPU
BRITISH COLUMBIA

TRANS MOUNTAIN EXPANSION PROJECT

- Village / Hamlet
- Reference Kilometre Post (RK)
- Trans Mountain Pipeline (TMPL)
- Trans Mountain Expansion Project Proposed Pipeline Corridor
- Highway
- Railway
- City / Town / District Municipality
- Indian Reserve / Métis Settlement
- National Park
- Provincial Park
- Park / Protected Area
- Provincial Boundary

Motorized Access Density (km/km²)

- 0
- > 0 - 0.6
- > 0.6 - 1.2
- > 1.2 - 2.4
- > 2.4
- Change to > 0.6 from Existing

Projection: NAD83 UTM Zone 11N. Baseline TMPL & Facilities: provided by KMC 2012; Proposed Pipeline Corridor V6: provided by UPI Aug. 23, 2013; Transportation: IHS Inc., 2013, BC Forests, Lands and Natural Resource Operations, 2012 & Natural Resources Canada, 2012; Geopolitical Boundaries: Natural Resources Canada, 2003, AltaLIS, 2013, IHS Inc., 2011, BC FLNRO, 2007 & ESRI, 2005; First Nation Lands: Government of Canada, 2013, AltaLIS, 2010 & IHS Inc., 2011; Hydrology: Natural Resources Canada, 2007 & BC Crown Registry and Geographic Base Branch, 2008; Parks and Protected Areas: Natural Resources Canada, 2012, AltaLIS, 2012 & BC FLNRO, 2008; Grizzly Bear Population Units: Alberta Environment and Sustainable Resource Development 2013, BC Ministry of Environment 2012; Canadian Hillshade: TERA Environmental Consultants, 2008.

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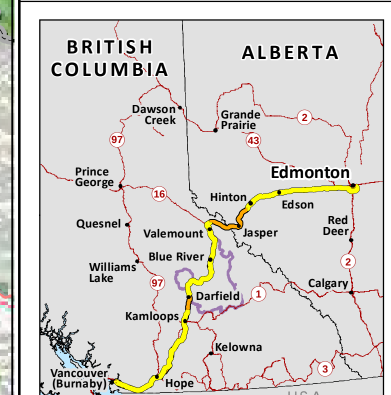

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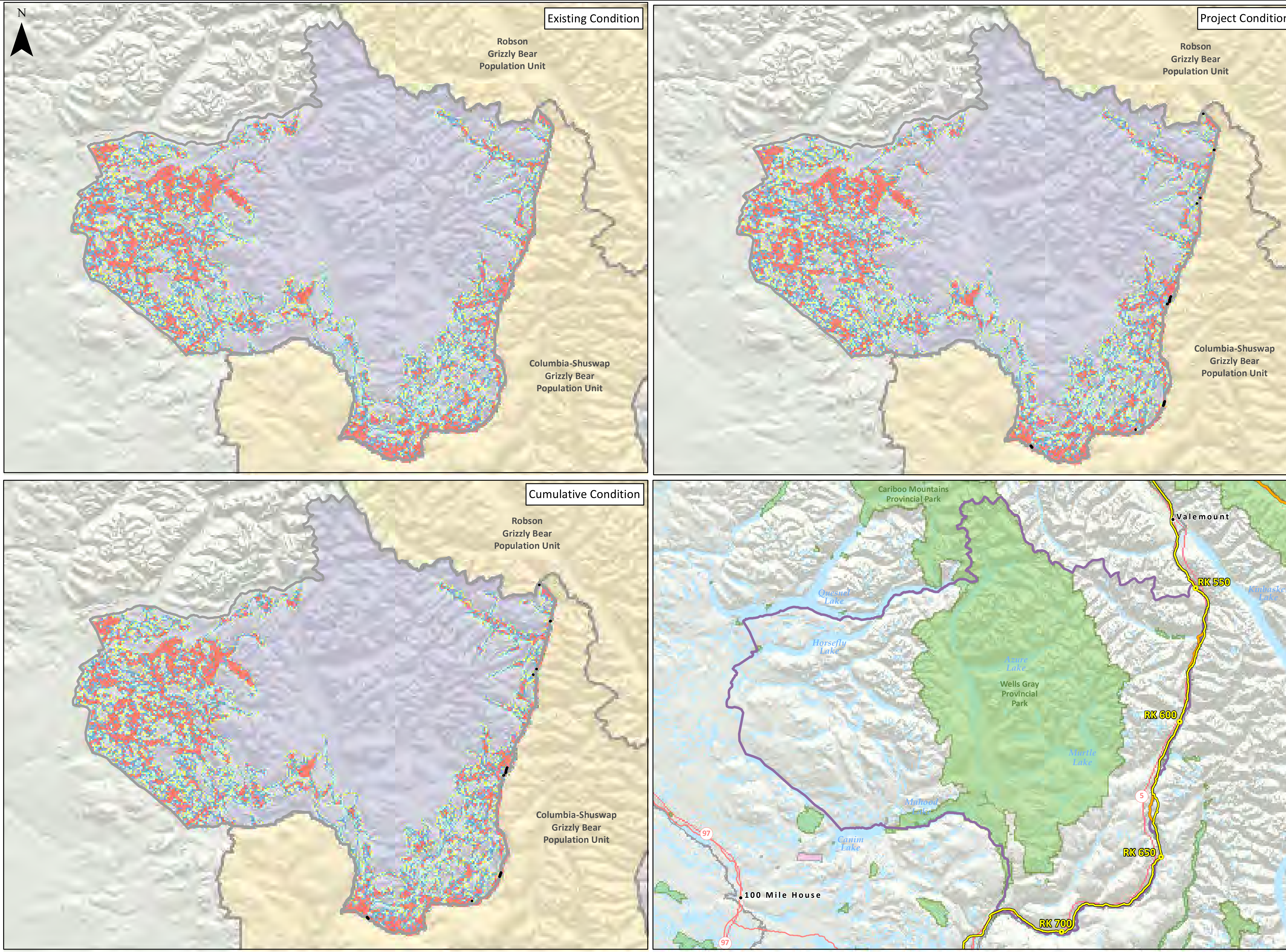

TRANS MOUNTAIN

FIGURE 8.9-9

MOTORIZED ACCESS DENSITY
WELLS GRAY GBPU
BRITISH COLUMBIA

TRANS MOUNTAIN
EXPANSION PROJECT

- Village / Hamlet
- Reference Kilometre Post (RK)
- Trans Mountain Pipeline (TMPL)
- Trans Mountain Expansion Project Proposed Pipeline Corridor
- Highway
- Railway
- City / Town / District Municipality
- Indian Reserve / Métis Settlement
- National Park
- Provincial Park
- Park / Protected Area
- Provincial Boundary

Motorized Access Density (km/km²)

- 0
- > 0 - 0.6
- > 0.6 - 1.2
- > 1.2 - 2.4
- > 2.4
- Change to > 0.6 from Existing

Projection: NAD83 UTM Zone 11N. Baseline TMPL & Facilities: provided by KMC 2012; Proposed Pipeline Corridor V6: provided by UPI Aug. 23, 2013; Transportation: IHS Inc., 2013, BC Forests, Lands and Natural Resource Operations, 2012 & Natural Resources Canada, 2012; Geopolitical Boundaries: Natural Resources Canada, 2003, AltaLIS, 2013, IHS Inc., 2011, BC FLNRO, 2007 & ESRI, 2005; First Nation Lands: Government of Canada, 2013, AltaLIS, 2010 & IHS Inc., 2011; Hydrology: Natural Resources Canada, 2007 & BC Crown Registry and Geographic Base Branch, 2008; Parks and Protected Areas: Natural Resources Canada, 2012, AltaLIS, 2012 & BC FLNRO, 2008; Grizzly Bear Population Units: Alberta Environment and Sustainable Resource Development 2013, BC Ministry of Environment 2012; Canadian Hillshade: TERA Environmental Consultants, 2008.

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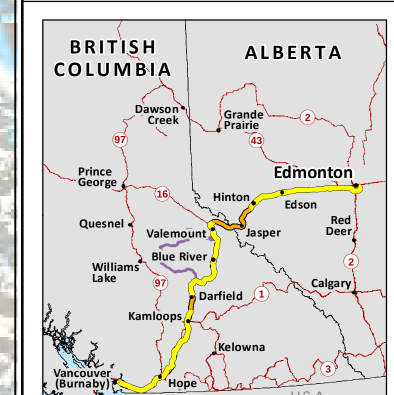

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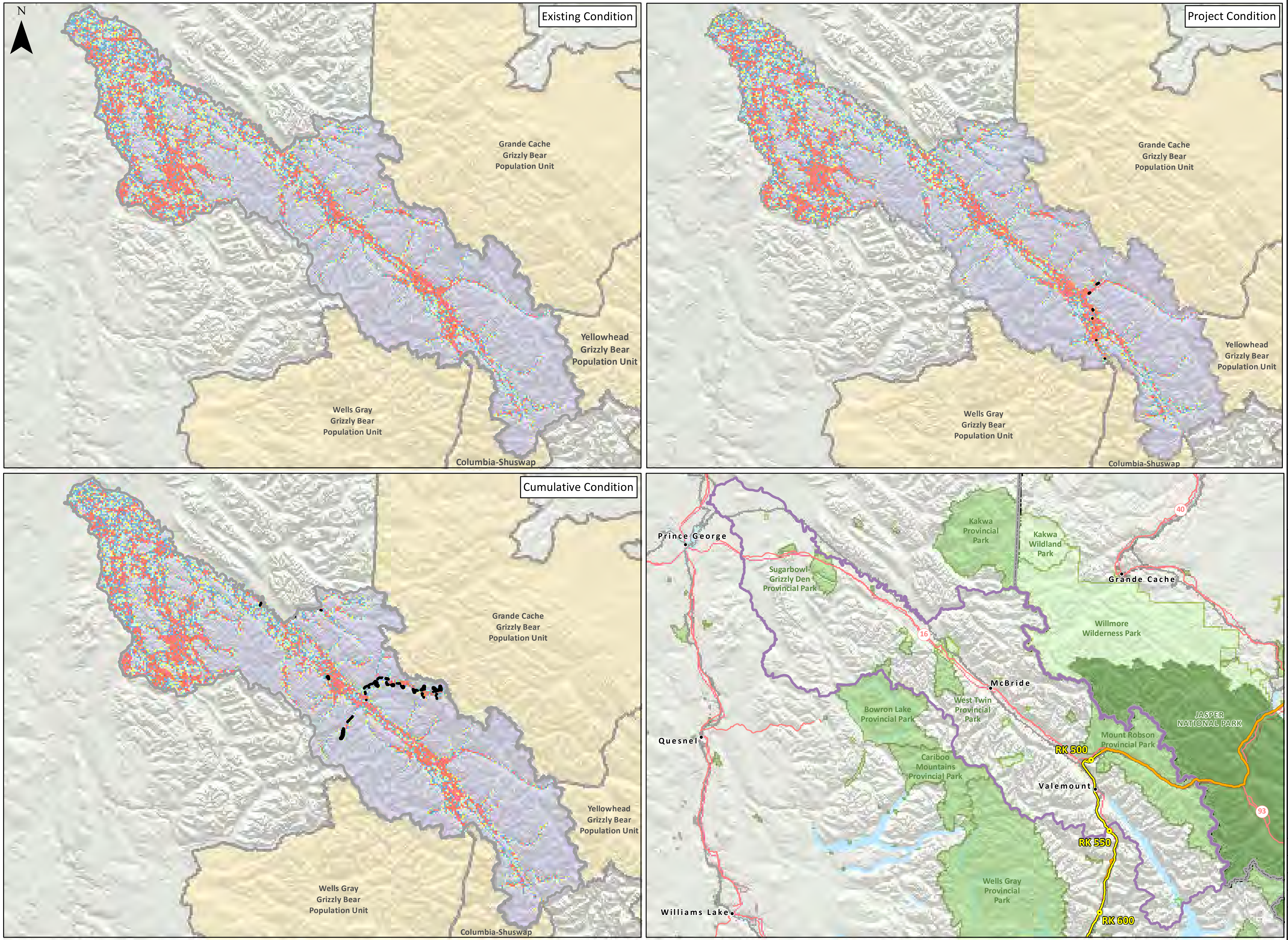

TRANS MOUNTAIN

FIGURE 8.9-10

MOTORIZED ACCESS DENSITY
ROBSON GBPU
BRITISH COLUMBIA

TRANS MOUNTAIN
EXPANSION PROJECT

- Village / Hamlet
- Reference Kilometre Post (RK)
- Trans Mountain Pipeline (TMPL)
- Trans Mountain Expansion Project Proposed Pipeline Corridor
- Highway
- Railway
- City / Town / District Municipality
- Indian Reserve / Métis Settlement
- National Park
- Provincial Park
- Park / Protected Area
- Provincial Boundary

Motorized Access Density (km/km²)

- 0
- > 0 - 0.6
- > 0.6 - 1.2
- > 1.2 - 2.4
- > 2.4
- Change to > 0.6 from Existing

Projection: NAD83 UTM Zone 11N. Baseline TMPL & Facilities: provided by KMC 2012; Proposed Pipeline Corridor V6: provided by UPI Aug. 23, 2013; Transportation: IHS Inc., 2013, BC Forests, Lands and Natural Resource Operations, 2012 & Natural Resources Canada, 2012; Geopolitical Boundaries: Natural Resources Canada, 2003, AltaLIS, 2013, IHS Inc., 2011, BC FLNRO, 2007 & ESRI, 2005; First Nation Lands: Government of Canada, 2013, AltaLIS, 2010 & IHS Inc., 2011; Hydrology: Natural Resources Canada, 2007 & BC Crown Registry and Geographic Base Branch, 2008; Parks and Protected Areas: Natural Resources Canada, 2012, AltaLIS, 2012 & BC FLNRO, 2008; Grizzly Bear Population Units: Alberta Environment and Sustainable Resource Development 2013, BC Ministry of Environment 2012; Canadian Hillshade: TERA Environmental Consultants, 2008.

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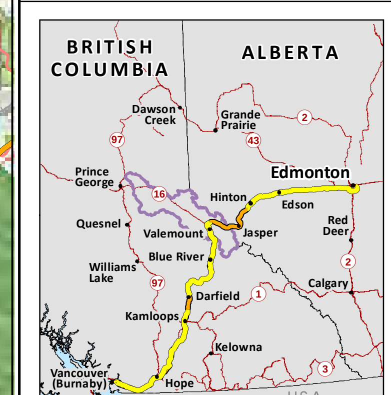

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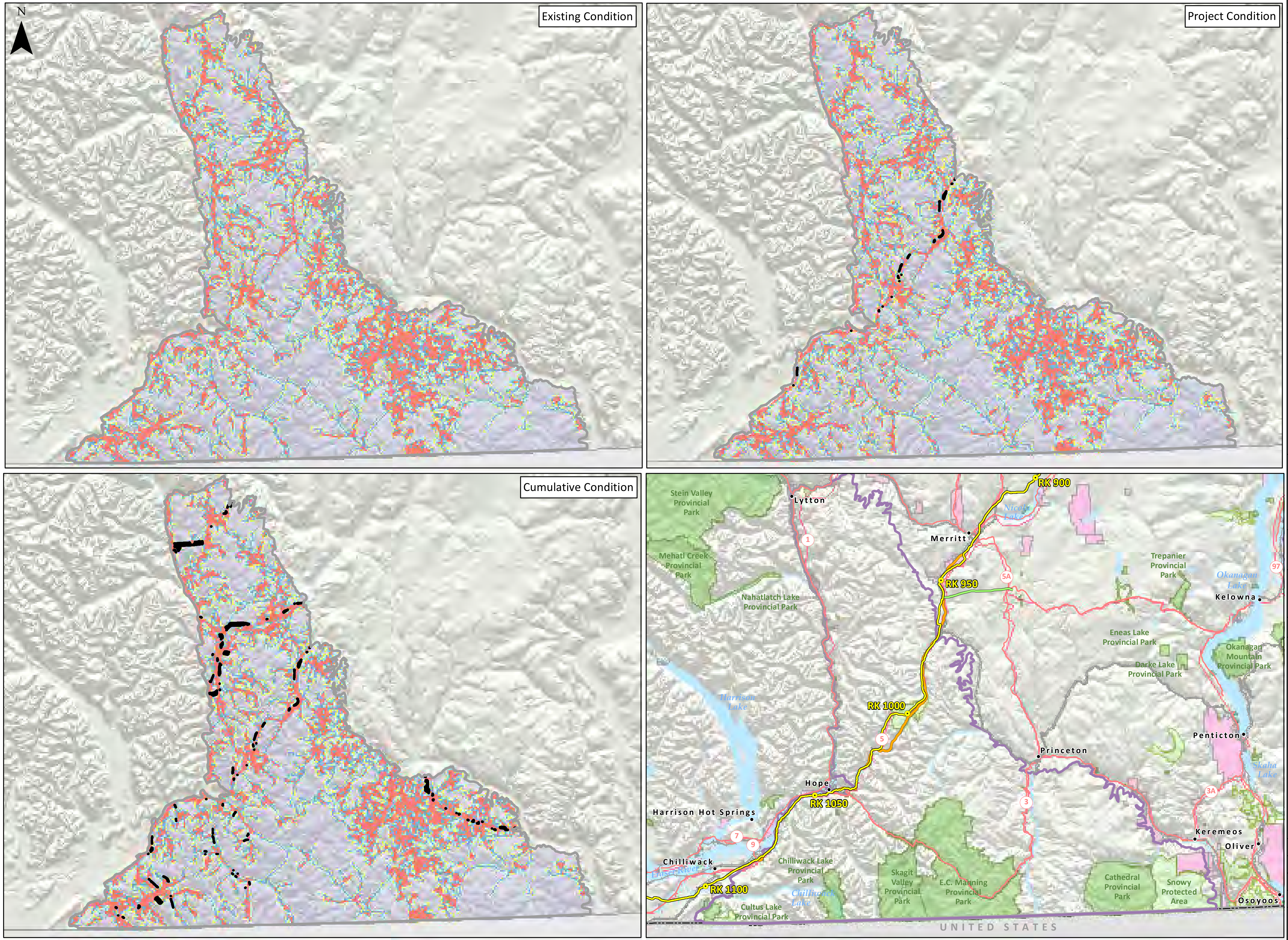

TRANS MOUNTAIN

FIGURE 8.9-11

MOTORIZED ACCESS DENSITY
NORTH CASCADES GBPU
BRITISH COLUMBIA

TRANS MOUNTAIN EXPANSION PROJECT

- Village / Hamlet
- Reference Kilometre Post (RK)
- Trans Mountain Pipeline (TMPL)
- Trans Mountain Expansion Project Proposed Pipeline Corridor
- Proposed Power Line
- Highway
- Railway
- City / Town / District Municipality
- Indian Reserve / Métis Settlement
- National Park
- Provincial Park
- Park / Protected Area
- Provincial Boundary

Motorized Access Density (km/km²)

- 0
- > 0 - 0.6
- > 0.6 - 1.2
- > 1.2 - 2.4
- > 2.4
- Change to > 0.6 from Existing

Projection: NAD83 UTM Zone 10N. Baseline TMPL & Facilities: provided by KMC 2012; Proposed Pipeline Corridor V6: provided by UPI Aug. 23, 2013; Transportation: IHS Inc., 2013, BC Forests, Lands and Natural Resource Operations, 2012 & Natural Resources Canada, 2012; Geopolitical Boundaries: Natural Resources Canada, 2003, AltaLIS, 2013, IHS Inc., 2011, BC FLNRO, 2007 & ESRI, 2005; First Nation Lands: Government of Canada, 2013, AltaLIS, 2010 & IHS Inc., 2011; Hydrology: Natural Resources Canada, 2007 & BC Crown Registry and Geographic Base Branch, 2008; Parks and Protected Areas: Natural Resources Canada, 2012, AltaLIS, 2012 & BC FLNRO, 2008; Grizzly Bear Population Units: Alberta Environment and Sustainable Resource Development 2013, BC Ministry of Environment 2012; Canadian Hillshade: TERA Environmental Consultants, 2008.

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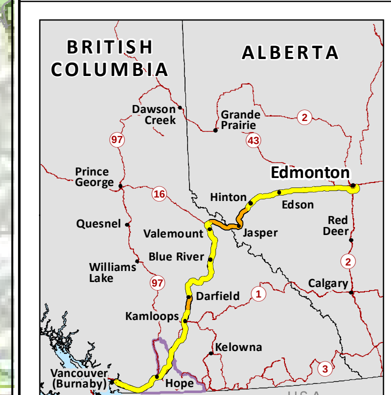
Although there is no reason to believe that there are any errors associated with the data used to generate this product or in the product itself, users of these data are advised that errors in the data may be present.



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DRAWN CAS	CHECKED AJS	DESIGN TGG

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ALL LOCATION APPROXIMATE

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The mitigation proposed in Section 7.2.10.6 to address the Project's residual effects on mammal indicators is expected to adequately address the Project's contribution to cumulative effects on mammal mortality risk with one exception. The Project will contribute to grizzly bear mortality risk in the North Cascades GBPU, causing an incremental effect on mortality risk for a threatened population. To address the Project's contribution to this cumulative effect, additional mitigation beyond that identified in Section 7.2.10.6 is warranted. This mitigation may include additional access control and habitat restoration both on the Project Footprint and the existing TMPL within the North Cascades GBPU (*e.g.*, barriers to block access, signs, planting woody vegetation) and allowing select segments of the Footprint to regenerate to natural vegetation across the width of the right-of-way. Trans Mountain will work with the appropriate regulatory authorities to develop a mitigation strategy to address the Project's incremental cumulative effect on grizzly bear in the North Cascades GBPU.

8.9.6.4 Summary of Significance Rationale for Incremental Cumulative Effects on Mammal Indicators

A summary of the significance criteria ratings for the mammal indicators is provided in Table 8.9-6. The criteria ratings and rationale for spatial boundary, duration, frequency, reversibility and probability are similar for all of the mammal indicators.

- Spatial boundary: RSA – cumulative effects on wildlife are best evaluated at the regional (landscape) scale. The Project's contribution to combined habitat loss and alteration, movement effects, and mortality risk may interact with existing and reasonably foreseeable development within the RSA relevant to the indicator (*i.e.*, Wildlife, Caribou or Grizzly Bear RSA) to cause cumulative effects on mammal indicators.
- Duration: short-term – Project construction (*e.g.*, clearing, creation of new access) and operational activities (*e.g.*, monitoring, vegetation management and site-specific maintenance) are short-term events that will interact with existing activities and reasonably foreseeable developments to have an incremental contribution to cumulative effects.
- Frequency: periodic – Project construction (*e.g.*, clearing, creation of new access) and operational activities (*e.g.*, monitoring, vegetation management and site-specific maintenance) will occur intermittently over the assessment period to interact with existing activities and reasonably foreseeable developments, causing an incremental contribution to cumulative effects.
- Reversibility: long-term – incremental cumulative effects of the Project will extend over the long-term, until the Project is decommissioned and abandoned, and habitat is restored within the Footprint.
- Probability: high – the Project will interact with existing activities and reasonably foreseeable developments to affect the indicator.

The criteria ratings and rationale for magnitude and confidence vary, and are provided below for each mammal indicator.

Grizzly Bear

- Magnitude: medium – grizzly bear is a species of conservation concern provincially and federally, largely due to extensive range and population reductions influenced by habitat development and fragmentation, and human-related conflicts and mortality. The Project will have a negligible contribution to cumulative effects on grizzly bear core habitat and mortality risk at the regional scale. Nonetheless, the Project and reasonably foreseeable disturbances will contribute to local increases in motorized access density in each GBPU crossed by the proposed pipeline corridor, causing a change in motorized access density from existing conditions below 0.6 km/km² to levels that exceed the threshold. The Project will contribute to grizzly bear mortality risk in the North Cascades GBPU, causing an incremental effect on mortality risk for a threatened population. To address this incremental cumulative effect, additional mitigation beyond that identified in Section 7.2.10 is warranted, which may include the measures noted above. Trans Mountain will work with the appropriate regulatory authorities to develop a mitigation strategy to address the Project's contribution to cumulative effects on grizzly bear in the North Cascades GBPU. With implementation of appropriate mitigation, the magnitude of the Project's contribution to cumulative effects on grizzly bear is concluded to be medium.

- Confidence: moderate – the assessment is based on a good understanding of cause-effect relationships and relevant data. Limitations and uncertainty associated with available data pertinent to the Project area reduce the confidence level to moderate.

Woodland Caribou

- Magnitude: medium – the Wells Gray and Groundhog caribou herds are Threatened under Schedule 1 of *SARA*. The Project is predicted to contribute to the cumulative disturbance of functional habitat in the Caribou RSA by a negligible amount (< 0.01%) and will not change the existing area of functional habitat disturbance in the UWR (Table 8.9-9). Although the Project is expected to have a negligible effect on caribou habitat value, caribou are sensitive to human disturbance, and research has demonstrated adverse interactions between linear disturbance, primary prey and predator response, and caribou mortality. Given the sensitivity of woodland caribou, regulatory guidelines and management objectives, mitigation beyond standard measures is warranted to address the Project's residual and incremental contribution to cumulative effects on woodland caribou. Measures may include additional access control and habitat restoration both on the Project Footprint and the existing TMPL right-of-way. Trans Mountain will develop an appropriate mitigation plan in consultation with regulatory authorities to address the Project's residual and cumulative effects on caribou. Implementation of the measures in the plan, in addition to the proposed mitigation provided in Section 7.2.10, is expected to reduce the magnitude of the Project's contribution to cumulative effects on caribou to medium.

- Confidence: moderate – the assessment is based on a reasonable understanding of cause-effect relationship; limitations are associated with the absence of models, measures or thresholds specific to mountain ecotype woodland caribou.

Moose

- Magnitude: low – moose are highly valued as a game species and for traditional and cultural purposes, but do not have conservation status designations of concern, either provincially or federally. Moose populations are considered more sensitive to overharvest and other sources of mortality than to habitat loss and fragmentation. Hunting is often the primary limiting factor of moose populations in areas accessible to humans. Predation by wolves is an important factor for moose mortality, and may be associated with declines in moose populations recently observed in the North Thompson region. BC MFLNRO actively monitors and manages moose populations. The Project's contribution to cumulative effects on moose is expected to be small at the regional scale, and with application of the proposed mitigation to address residual effects on habitat, movement and mortality risk, is concluded to be of low magnitude.

- Confidence: moderate – the assessment is based on a good understanding of cause-effect relationships and relevant data. Limitations and uncertainty associated with available data pertinent to the Project area reduce the confidence level to moderate.

Forest Furbearers

- Magnitude: low – the forest furbearer indicator group includes species of conservation concern (*e.g.*, fisher, wolverine). These species are managed as furbearers (*i.e.*, for harvest) in BC and Alberta. Habitat loss (forest clearing from human development) and trapping are primary threats to furbearer populations. The Project's contribution to cumulative effects on forest furbearers is expected to be small at the regional scale, and with application of the proposed mitigation to address residual effects on habitat, movement and mortality risk, is concluded to be of low magnitude.

- Confidence: moderate – the assessment is based on a good understanding of cause-effect relationships and relevant data. Limitations and uncertainty associated with available data pertinent to the Project area reduce the confidence level to moderate.

Coastal Riparian Small Mammals

- Magnitude: medium – the Project crosses proposed critical habitat for Pacific water shrew and early candidate critical habitat for Townsend's mole (Environment Canada 2013). The sensitive status of various coastal riparian small mammal species is attributable largely to the existing high level of cumulative habitat disturbance in the LMDA. The Project is predicted to have a small contribution to cumulative effects on coastal riparian small mammals at the regional scale. In addition to the Project-specific mitigation, Trans Mountain will work with regulatory authorities to address potential incremental effects on the proposed/candidate critical habitats for coastal riparian small mammals (*i.e.*, Pacific water shrew, Townsend's mole). Additional mitigation may include habitat restoration measures within disturbed riparian areas. With implementation of appropriate mitigation, the magnitude of the Project's contribution to cumulative effects on coastal riparian small mammals is concluded to be medium.

- Confidence: low – the assessment is based on an incomplete understanding of cause-effect relationships (*i.e.,* limited research and literature is available for these species), and limitations and uncertainty associated with the available data used to assess the Project's incremental cumulative effect.

Bats

- Magnitude: low - Several bat species with conservation status of concern occur in the LSA. Known threats to bat populations are limited (*e.g.*, wind energy development, white-nose syndrome). The potential effects of the Project (*e.g.*, change in habitat and mortality risk) may contribute to other existing and potential future threats to have a cumulative effect on bats. The Project's contribution to cumulative effects on bats is expected to be small at the regional scale, and with application of the proposed mitigation to address residual effects on habitat, movement and mortality risk, is concluded to be of low magnitude.

- Confidence: low - The assessment is based on an incomplete understanding of cause-effect relationships (*i.e.*, limited research and literature is available for these species), and limitations and uncertainty associated with the available data used to assess the Project's incremental cumulative effect.

8.9.7 Significance Evaluation of Potential Cumulative Effects on Birds

The Project is likely to interact with existing and reasonably foreseeable disturbances to contribute to cumulative effects on habitat, movement and mortality risk of birds within the Wildlife RSA (Table 8.9-5). Table 8.9-12 provides a summary of the significance evaluation of the Project's contribution to cumulative effects on bird indicators. The assessment rationale is provided below.

TABLE 8.9-12

SUMMARY OF SIGNIFICANCE EVALUATION OF THE PROJECT'S CONTRIBUTION TO CUMULATIVE EFFECTS ON BIRD INDICATORS

	Cumulative Effect	Impact Balance	Spatial Boundary[1]	Temporal Context			Magnitude	Probability	Confidence	Significance[2]
				Duration	Frequency	Reversibility				
1.	Wildlife Indicator – Grassland/Shrub-steppe Birds									
1(a)	Project contribution to cumulative effects on grassland/shrub-steppe birds.	Negative	RSA	Short-term	Periodic	Long-term	Medium	High	Moderate	Not significant
2.	Wildlife Indicator – Mature/Old Forest Birds									
2(a)	Project contribution to cumulative effects on mature/old forest birds.	Negative	RSA	Short-term	Periodic	Long-term	Low	High	Moderate	Not significant
3.	Wildlife Indicator – Early Seral Forest Birds									
3(a)	Project contribution to cumulative effects on early seral forest birds.	Negative	RSA	Short-term	Periodic	Long-term	Low	High	Moderate	Not significant

TABLE 8.9-12 Cont'd

Cumulative Effect		Impact Balance	Spatial Boundary[1]	Temporal Context			Magnitude	Probability	Confidence	Significance[2]
				Duration	Frequency	Reversibility				
4.	Wildlife Indicator – Riparian and Wetland Birds									
4(a)	Project contribution to cumulative effects on riparian and wetland birds.	Negative	RSA	Short-term	Periodic	Long-term	Low	High	Moderate	Not significant
5.	Wildlife Indicator – Wood Warblers									
5(a)	Project contribution to cumulative effects on wood warblers.	Negative	RSA	Short-term	Periodic	Long-term	Low	High	Moderate	Not significant
6.	Wildlife Indicator – Short-eared Owl									
6(a)	Project contribution to cumulative effects on short-eared owl.	Negative	RSA	Short-term	Periodic	Long-term	Negligible	High	Moderate	Not significant
7.	Wildlife Indicator – Rusty Blackbird									
7(a)	Project contribution to cumulative effects on rusty blackbird.	Negative	RSA	Short-term	Periodic	Long-term	Low	High	Moderate	Not significant
8.	Wildlife Indicator – Flammulated Owl									
8(a)	Project contribution to cumulative effects on flammulated owl.	Negative	RSA	Short-term	Periodic	Long-term	Low	High	Moderate	Not significant
9.	Wildlife Indicator – Lewis's Woodpecker									
9(a)	Project contribution to cumulative effects on Lewis's woodpecker.	Negative	RSA	Short-term	Periodic	Long-term	Medium	High	Moderate	Not significant
10.	Wildlife Indicator – Williamson's Sapsucker									
10(a)	Project contribution to cumulative effects on Williamson's sapsucker.	Negative	RSA	Short-term	Periodic	Long-term	Medium	High	Moderate	Not significant
11.	Wildlife Indicator – Western Screech-owl									
11(a)	Project contribution to cumulative effects on western screech-owl.	Negative	RSA	Short-term	Periodic	Long-term	Low	High	Moderate	Not significant
12.	Wildlife Indicator – Great Blue Heron									
12(a)	Project contribution to cumulative effects on great blue heron.	Negative	RSA	Short-term	Periodic	Long-term	Negligible	High	Moderate	Not significant
13.	Wildlife Indicator – Spotted Owl									
13(a)	Project contribution to cumulative effects on spotted owl.	Negative	RSA	Short-term	Periodic	Long-term	Medium	High	Moderate	Not significant
14.	Wildlife Indicator – Bald Eagle									
14(a)	Project contribution to cumulative effects on bald eagle.	Negative	RSA	Short-term	Periodic	Long-term	Negligible	High	Moderate	Not significant
15.	Wildlife Indicator – Common Nighthawk									
15(a)	Project contribution to cumulative effects on common nighthawk.	Negative	RSA	Short-term	Periodic	Long-term	Low	High	Moderate	Not significant
16.	Wildlife Indicator – Northern Goshawk									
16(a)	Project contribution to cumulative effects on northern goshawk.	Negative	RSA	Short-term	Periodic	Long-term	Low	High	Moderate	Not significant
17.	Wildlife Indicator – Olive-sided Flycatcher									
17(a)	Project contribution to cumulative effects on olive-sided flycatcher.	Negative	RSA	Short-term	Periodic	Long-term	Low	High	Moderate	Not significant

Notes: 1 RSA = Wildlife RSA.

2 Significant Contribution to a Cumulative Environmental Effect: A high probability of occurrence of a permanent or long-term cumulative effect of high magnitude that cannot be technically or economically mitigated.

8.9.7.1 Cumulative Change in Habitat for Bird Indicators

The Project will contribute to loss or alteration of habitat for the bird indicators in combination with natural disturbance, existing activities and reasonably foreseeable developments. Table 8.9-13 and Figures 8.9-12 and 8.9-13 summarize the predicted changes in potential and effective habitat for bird indicators as a result of cumulative disturbance within the Wildlife RSA.

TABLE 8.9-13

PREDICTED CHANGE IN POTENTIAL AND EFFECTIVE HABITAT FOR BIRD INDICATORS IN THE WILDLIFE REGIONAL STUDY AREA

Wildlife Indicator[1]	Potential/Effective Habitat[2]	Area (ha) of Potential Habitat in the Wildlife RSA						
			Project Conditions[3]			Cumulative Conditions[4]		
		Existing Conditions	Project Conditions	Incremental Change[5]	% Change[5]	Cumulative Conditions	Incremental Change[5]	% Change[5]
Grassland/Shrub-Steppe Birds	Potential	276,320.4	276,901.4	580.9 ↑	0.21 ↑	276,053.7	266.7 ↓	0.10 ↓
Mature/Old Forest Birds	Potential	1,464,837.6	1,463,377.3	1,460.3 ↓	0.10 ↓	1,459,218.0	5619.6 ↓	0.38 ↓
Early Seral Forest Birds	Potential	1,835,460.9	1,833,727.1	1,733.8 ↓	0.10 ↓	1,826,880.8	8580.1 ↓	0.47 ↓
Riparian and Wetland Birds	Effective	456,355.8	456,111.4	244.4 ↓	0.05 ↓	454,814.7	1,541.1 ↓	0.34 ↓
Cavity Nesting Wetland Birds (Riparian and Wetland Bird Indicator)	Effective	430,111.9	429,804.6	307.3 ↓	0.07 ↓	427,880.6	2,231.3 ↓	0.52 ↓
Wood Warblers	Potential	232,838.2	232,714.1	124.1 ↓	0.05 ↓	232,212.4	625.8 ↓	-0.27 ↓
Short-Eared owl	Potential	115,9742.1	1,160,251.4	509.2 ↑	0.04 ↑	1,161,317.9	1575.8 ↑	0.14 ↑
Rusty Blackbird	Potential	104,182.5	1,040,21.0	161.5 ↓	0.16 ↓	103,904.9	277.6 ↓	0.27 ↓
Flammulated Owl	Potential	95,008.2	94,836.4	171.8 ↓	0.18 ↓	94,541.5	466.6 ↓	0.49 ↓
Lewis's Woodpecker	Potential	203,110.7	202,800.6	310.1 ↓	0.15 ↓	201,489.0	1621.6 ↓	0.80 ↓
Williamson's Sapsucker	Effective	3,345.4	3,341.0	4.5 ↓	0.13 ↓	3,337.8	7.6 ↓	0.23 ↓
Western Screech-Owl (Coastal)	Potential	1,277.3	1,277.3	<0.1 ↓	<0.01 ↓	1,276.6	0.7 ↓	0.05 ↓
Western Screech-Owl (Interior)	Potential	8,090.4	8,042.9	47.5 ↓	-0.59 ↓	8,041.9	48.5 ↓	0.60 ↓
Spotted Owl	Effective	60,871.2	60,867.7	3.5 ↓	0.01 ↓	60,614.1	257.1 ↓	0.42 ↓
Common Nighthawk	Potential	1,144,941.8	1,146,126.4	1,184.6 ↑	0.10 ↑	1,142,202.8	2739.0 ↓	0.24 ↓
Northern Goshawk	Effective	24,630.5	24,624.8	5.7 ↓	0.02 ↓	24,569.5	60.9	0.25 ↓
Olive-Sided Flycatcher	Potential	2,274,754.0	2,274,890.2	136.2 ↑	0.01 ↑	2,268,441.8	6,312.2 ↓	0.28 ↓

Notes:
1. Potential contribution of the Project to cumulative effects on great blue heron and bald eagle is expected to be site-specific and mitigable with the proposed mitigation measures in Section 7.2.10. These indicators were not suited to quantification of potential habitat using available data.
2. Refer to the Wildlife Modeling and Species Accounts Technical Report of Volume 5C for definition of habitat potential. Where suitability models were applied for RSA-scale analysis, the change in effective habitat is indicated rather than potential habitat.
3. Project Condition includes existing activities (with available spatial data) + Project.
4. Cumulative Condition includes existing activities + Project + reasonably foreseeable developments (with available spatial data).
5. Percent change is calculated as the change from existing conditions. ↓ represents a decrease and ↑ represents an increase.

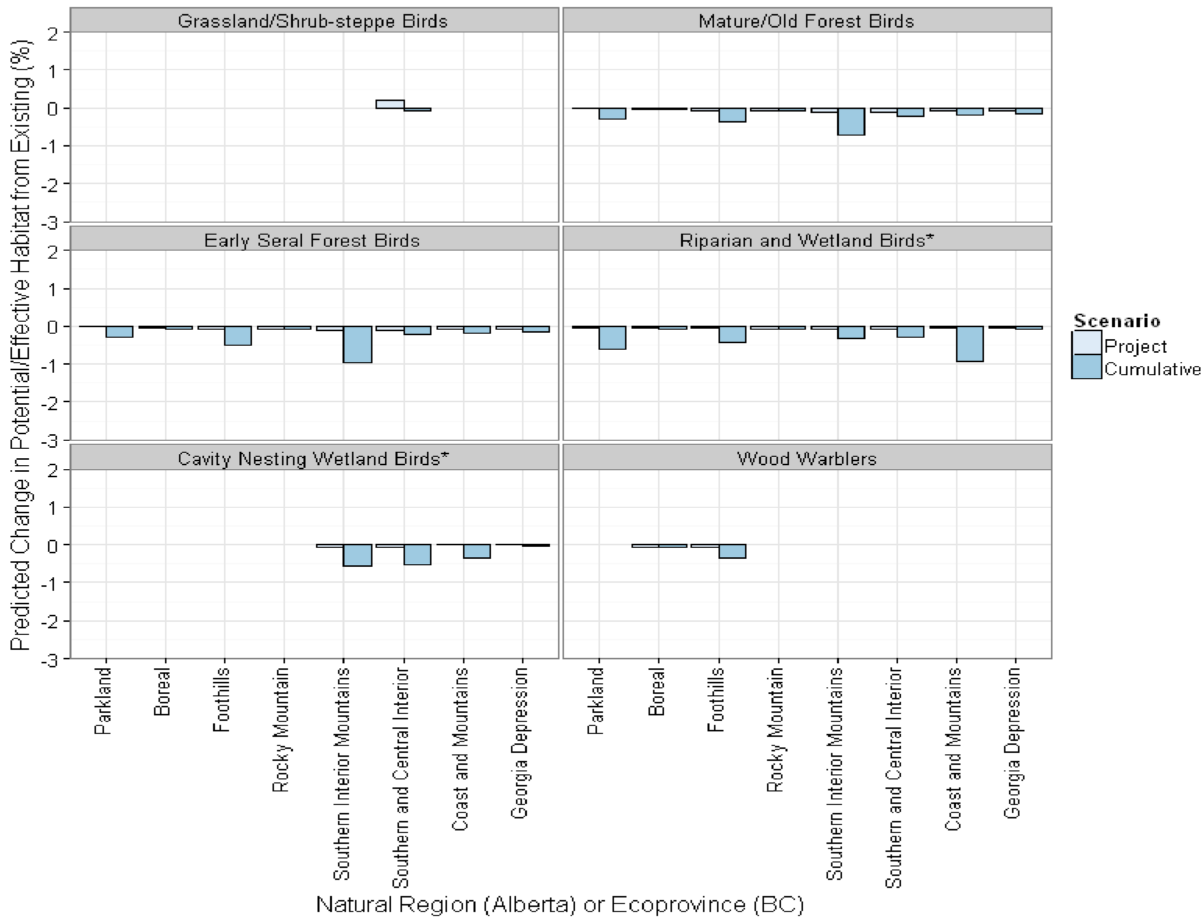

Figure 8.9-12 Predicted Change in Potential/Effective Habitat for Bird Community Indicators

The predicted change in habitat is presented as the percent change from existing conditions to Project conditions and cumulative conditions for each Natural Region (Alberta) and Ecoprovince (BC) within the Wildlife RSA. Change in effective habitat is indicated by an asterisk (*); change in potential habitat is presented for the other community indicators. Cavity nesting wetland birds were modeled separately as part of the riparian and wetland birds community indicator.

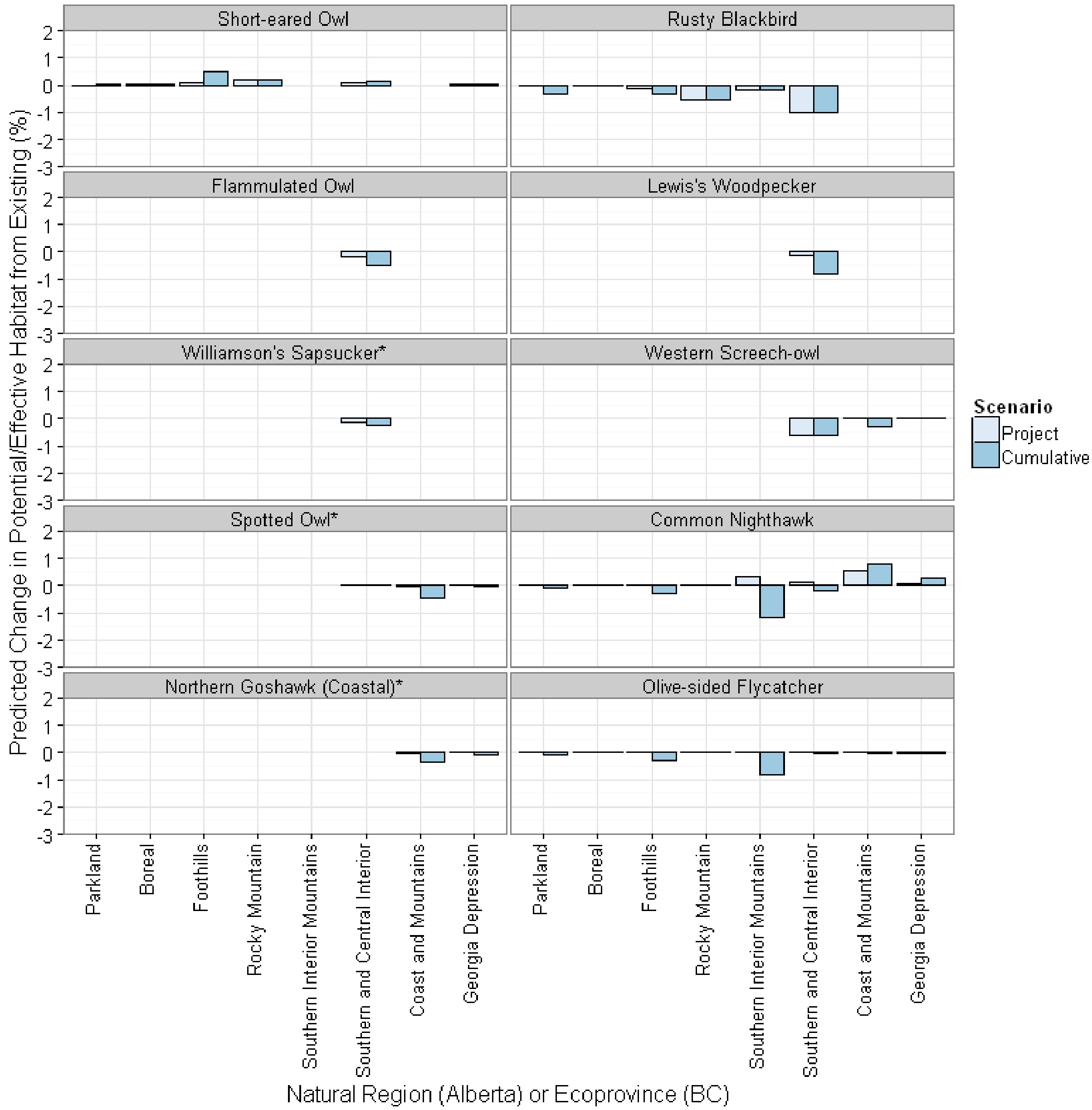

Figure 8.9-13 Predicted Change in Potential/Effective Habitat for Bird Indicators

The predicted change in habitat is presented as the percent change from existing conditions to Project conditions and cumulative conditions for each Natural Region (Alberta) and Ecoprovince (BC) within the Wildlife RSA. Change in effective habitat is indicated by an asterisk (*); change in potential habitat is presented for the other bird indicators. Both the interior and coastal western screech-owl are provided in the results at the species level, but can be distinguished by the Ecoprovince (*i.e.*, interior subspecies occurs within the Southern and Central Interior Ecoprovince; coastal subspecies occurs within the Coast and Mountains, and Georgia Depression Ecoprovince).

Project-specific mitigation measures that will be implemented to reduce regional-scale habitat effects are summarized in Section 7.2.10. By implementing the proposed mitigation, including working with regulatory authorities to address potential incremental effects on the proposed/candidate critical habitats for Lewis's woodpecker and Williamson's sapsucker, the Project's contribution to cumulative effects on bird habitat will be reduced. It is expected that many other operators in the Wildlife RSA will implement similar best practices and standard mitigation to reduce the contribution of existing and reasonably foreseeable developments to cumulative effects.

Given the species' sensitivity, regulatory guidelines (*e.g.*, no-net-loss policy for spotted owl habitat in the Sowaqua Spotted Owl Wildlife Habitat Area 2-498), management objectives, and existing levels of cumulative effects on spotted owl, additional mitigation beyond the standard measures is warranted to address the Project's residual and incremental cumulative effect within the WHA for spotted owl traversed by the proposed pipeline corridor. This additional mitigation commitment is included in the residual Project effects assessment (Section 7.2.10). A mitigation plan will be developed for the Project, which is anticipated to include measures to avoid, mitigate, restore and offset adverse effects on spotted owl habitat. Mitigation measures are anticipated to include efforts to minimize clearing, restore areas within the WHA that are not needed for long-term operations, and offsets. Consultation with BC MFLNRO regarding the Project's interaction with the WHA and an appropriate approach for mitigating effects has been initiated and is ongoing.

8.9.7.2 Cumulative Change in Movement and Mortality Risk for Bird Indicators

Construction and operations of the Project has potential to contribute to cumulative effects on bird movement and mortality risk. The Project's incremental effects are likely to interact with the identified existing activities and reasonably foreseeable developments in the Wildlife RSA (Table 8.9-5) to cause cumulative changes to bird movement, in particular where the proposed pipeline corridor parallels existing linear disturbance and will increase the corridor width. As discussed in Section 7.2.10.10, parallel forest openings can cause a cumulative barrier effect at the landscape scale for some bird species (Bélisle and St. Clair 2001).

Vegetation clearing for the Project will create new access and edges, which may combine with existing disturbance to have cumulative effects on bird mortality risk. Cumulative changes in access at the regional scale can affect hunting pressure for game birds such as grouse. Although numerous studies in forested landscapes have found no evidence of increased nest predation due to either forestry (Bayne and Hobson 1997, Cotterill and Hannon 1999, Ibarzabal and Desrochers 2001, Schmiegelow and Mönkkönen 2002) or roads (Ortega and Capen 1999), some species (*e.g.*, marbled murrelet) have substantially higher probability of nest disturbance in proximity to edges compared to forest interior (Section 7.2.10.10). Regional differences in predator communities can also influence the potential effects of fragmentation on nest predation (Chalfoun *et al.* 2002).

With implementation of the mitigation proposed in Section 7.2.10, the Project's contribution to cumulative effects on movement and mortality risk for the bird indicators is expected to be small at the regional scale. It is expected that many other operators in the Wildlife RSA will implement similar best practices and standard mitigation to reduce the contribution of existing activities and reasonably foreseeable developments to cumulative effects on bird mortality risk. No mitigation measures beyond the Project-specific mitigation proposed in Section 7.2.10 are deemed warranted.

8.9.7.3 Summary of Significance Rationale for Incremental Cumulative Effects on Bird Indicators

A summary of the significance criteria ratings for the Project's contribution to cumulative effects on bird indicators is provided in Table 8.9-12. The criteria ratings and rationale for spatial boundary, duration, frequency, reversibility and probability are similar for all of the bird indicators.

- Spatial boundary: Wildlife RSA – cumulative effects on birds are best evaluated at the regional (landscape) scale.
- Duration: short-term – Project construction and operational activities are short-term events that will interact with existing activities and reasonably foreseeable developments to contribute to cumulative effects.
- Frequency: periodic – Project construction and operational activities that could interact with existing activities and reasonably foreseeable developments will occur intermittently over the assessment period.
- Reversibility: long-term – the Project's contribution to cumulative effects will extend over the long-term until the Project is decommissioned and abandoned, and habitat is restored within the Footprint.

- Probability: high – the Project will interact with existing activities and reasonably foreseeable developments to affect bird indicators.
- Confidence: moderate – the assessment is based on a good understanding of cause-effect relationships and relevant data. Limitations and uncertainty associated with available data pertinent to the Wildlife RSA reduce the confidence level to moderate.

The criteria ratings and rationale for magnitude vary, and are provided below for each bird indicator.

Grassland/Shrub-Steppe Birds

- Magnitude: medium – the Project is likely to interact with existing and reasonably foreseeable developments in the grasslands region of interior BC. In particular, the Project will interact with the proposed Ajax open pit mine project and other existing (*e.g.*, City of Kamloops, agriculture) and reasonably foreseeable developments and activities in the grassland and shrub-steppe habitats within the Wildlife RSA traversing the interior of BC. Locally within this area, the overall cumulative effects from past and foreseeable future disturbance on the grassland/shrub-steppe bird community and other grassland dependent wildlife species is potentially high. However, the Project's contribution to cumulative effects on grassland/shrub-steppe birds is expected to be small at the regional scale, and with application of the proposed mitigation to address residual effects on habitat, movement and mortality risk, is concluded to be of medium magnitude.

Mature/Old Seral Forest Birds

- Magnitude: low – the Project's contribution to cumulative effects on mature/old seral forest birds is expected to be small at the regional scale, and with application of the proposed mitigation to address residual effects on habitat, movement and mortality risk, is concluded to be of low magnitude.

Early Seral Forest Birds

- Magnitude: low - the Project's contribution to cumulative effects on early seral forest birds is expected to be small at the regional scale, and with application of the proposed mitigation to address residual effects on habitat, movement and mortality risk, is concluded to be of low magnitude.

Riparian and Wetland Birds

- Magnitude: low – the Project's contribution to cumulative effects on riparian and wetland birds is expected to be small at the regional scale, and with application of the proposed mitigation to address residual effects on habitat, movement and mortality risk, is concluded to be of low magnitude.

Wood Warblers

- Magnitude: low – the Project's contribution to cumulative effects on wood warblers is expected to be small at the regional scale, and with application of the proposed mitigation to address residual effects on habitat, movement and mortality risk, is concluded to be of low magnitude.

Short-eared Owl

- Magnitude: negligible – the primary threat to the short-eared owl is loss of nesting habitat due to rapid urbanization, industrialization, intensive agriculture and human disturbance. Fragmentation of habitats may cause fluctuations in the population of their rodent prey base (COSEWIC 2008, Demarchi and Bently 2005). Short-eared owl may use disturbed sites, although anthropogenic habitats may have lower value than natural openings. Sensory disturbance and mortality risk during construction will potentially interact with other existing activities and reasonably foreseeable developments to cumulatively affect short-eared owl. The magnitude of the Project's contribution to cumulative effects on short-eared owl is concluded to be negligible at the regional scale.

Rusty Blackbird

- Magnitude: low – the Project's contribution to cumulative effects on rusty blackbird is expected to be small at the regional scale, and with application of the proposed mitigation to address residual effects on habitat, movement and mortality risk, is concluded to be of low magnitude.

Flammulated Owl

- Magnitude: low – the Project's contribution to cumulative effects on flammulated owl is expected to be small at the regional scale, and with application of the proposed mitigation to address residual effects on habitat, movement and mortality risk, is concluded to be of low magnitude.

Lewis's Woodpecker

- Magnitude: medium – Lewis's woodpecker is a species of conservation concern at both the provincial (BC) and federal levels. Small population size and low density makes the species vulnerable to disturbance and habitat loss, particularly the loss of nesting trees and snags. The Project crosses candidate critical habitat for Lewis's woodpecker. The Project's contribution to cumulative effects on Lewis's woodpecker is expected to be small at the regional scale, and with application of the proposed mitigation to address residual effects on habitat, movement and mortality risk (including working with regulatory authorities to address potential incremental effects on the candidate critical habitat), is concluded to be of medium magnitude.

Williamson's Sapsucker

- Magnitude: medium – Williamson's sapsucker is a species of conservation concern at both the provincial (BC) and federal levels. Small population size and low density makes the species vulnerable to disturbance and habitat loss, particularly the loss of nesting trees and snags. The Project crosses proposed critical habitat for Williamson's sapsucker. The Project's contribution to cumulative effects on Williamson's sapsucker is expected to be small at the regional scale, and with application of the proposed mitigation to address residual effects on habitat, movement and mortality risk (including working with regulatory authorities to address potential incremental effects on the proposed critical habitat), is concluded to be of medium magnitude.

Western Screech-Owl

- Magnitude: low – the Project's contribution to cumulative effects on western screech-owl is expected to be small at the regional scale, and with application of the proposed mitigation to address residual effects on habitat, movement and mortality risk is concluded to be of low magnitude.

Great Blue Heron

- Magnitude: negligible – with application of the proposed mitigation to address residual effects on great blue heron habitat, movement and mortality risk, the Project's contribution to cumulative effects on great blue heron is concluded to be negligible at the regional scale.

Spotted Owl

- Magnitude: medium – the Project is likely to interact with existing activities and reasonably foreseeable developments in the Wildlife RSA to affect spotted owl. In particular, the proposed Hope to Burnaby Segment of the Project is likely to interact with the high levels of existing urban and agricultural development, as well as the proposed Interior–Lower Mainland Transmission Project between Merritt and Coquitlam, which intersects identified spotted owl habitats (BC Hydro 2013c). Consultation with BC MFLNRO regarding the Project's interaction with the WHA and an appropriate approach for mitigating effects has been initiated and is ongoing. A mitigation plan will be developed in consultation with BC MFLNRO, which is anticipated to include measures to avoid, mitigate, restore and offset adverse effects on spotted owl habitat, as noted above. With application of appropriate mitigation, the Project's contribution to cumulative effects on spotted owl is concluded to be of medium magnitude.

Bald Eagle

- Magnitude: negligible – with application of the proposed mitigation to address residual effects on bald eagle habitat, movement and mortality risk, the Project's contribution to cumulative effects on bald eagle is concluded to be negligible at the regional scale.

Common Nighthawk

- Magnitude: low – declines in common nighthawk populations are attributed to various anthropogenic and natural causes, in particular changes in insect abundance, fire control and reductions in availability of suitable anthropogenic nesting habitat (*e.g.*, gravel rooftops). Construction and operations of the Project is unlikely to interact with these threats to have a detectable contribution to cumulative effects on common nighthawk. Common nighthawks are generally tolerant of habitat change and may use disturbed sites, although anthropogenic habitats may have lower value for nighthawk than natural openings. Sensory disturbance and mortality risk during construction will potentially interact with other existing activities and reasonably foreseeable developments to cumulatively affect common nighthawk. The magnitude of the Project's contribution to cumulative effects on common nighthawk is concluded to be low at the regional scale.

Northern Goshawk

- Magnitude: low – loss of mature forest (nesting and foraging habitat) may be the most important factor threatening goshawks in BC. Construction and operations of the Project will interact with existing and reasonably foreseeable disturbances to have cumulative effects on northern goshawk. The Project's contribution to cumulative effects on northern goshawk is expected to be small at the regional scale, and with application of the proposed mitigation to address residual effects on habitat, movement and mortality risk, is concluded to be of low magnitude.

Olive-Sided Flycatcher

- Magnitude: low – the Project's contribution to cumulative effects on olive-sided flycatcher is expected to be small at the regional scale, and with application of the proposed mitigation to address residual effects on habitat, movement and mortality risk, is concluded to be of low magnitude.

8.9.8 Significance Evaluation of Potential Cumulative Effects on Amphibian and Reptile Indicators

The Project is likely to interact with existing and reasonably foreseeable disturbances to contribute to cumulative effects on habitat, movement and mortality risk of amphibians and reptiles within the Wildlife RSA. Table 8.9-14 provides a summary of the significance evaluation of the Project's incremental cumulative effects on amphibian and reptile indicators. The assessment rationale is provided below.

TABLE 8.9-14

SUMMARY OF SIGNIFICANCE EVALUATION OF THE PROJECT'S CONTRIBUTION TO CUMULATIVE EFFECTS ON AMPHIBIAN AND REPTILE INDICATORS

	Cumulative Effect	Impact Balance	Spatial Boundary[1]	Temporal Context			Magnitude	Probability	Confidence	Significance[2]
				Duration	Frequency	Reversibility				
1.	Wildlife Indicator – Pond-dwelling Amphibians									
1(a)	Project contribution to cumulative effects on pond-dwelling amphibians.	Negative	RSA	Short-term	Periodic	Long-term	Low	High	Moderate	Not significant
2.	Wildlife Indicator – Stream-dwelling Amphibians									
2(a)	Project contribution to cumulative effects on stream-dwelling amphibians.	Negative	RSA	Short-term	Periodic	Long-term	Medium	High	Moderate	Not significant
3.	Wildlife Indicator – Arid Habitat Snakes									
3(a)	Project contribution to cumulative effects on arid habitat snakes.	Negative	RSA	Short-term	Periodic	Long-term	Low	High	Moderate	Not significant

Notes: 1 RSA = Wildlife RSA.

2 Significant Contribution to a Cumulative Environmental Effect: A high probability of occurrence of a permanent or long-term cumulative effect of high magnitude that cannot be technically or economically mitigated.

8.9.8.1 Cumulative Change in Habitat for Amphibian and Reptile Indicators

The Project will contribute to combined loss or alteration of amphibian and reptile habitat resulting from natural disturbance, existing activities and reasonably foreseeable developments. Table 8.9-15 and Figure 8.9-14 summarize the predicted combined changes in effective and potential habitat for amphibian and reptile indicators as a result of the Project and reasonably foreseeable developments to cumulative disturbance within the Wildlife RSA.

TABLE 8.9-15

PREDICTED CHANGE IN POTENTIAL HABITAT FOR AMPHIBIAN AND REPTILE INDICATORS IN THE WILDLIFE REGIONAL STUDY AREA

Wildlife Indicator	Potential/ Effective Habitat[1]	Area (ha) of Potential Habitat in the Wildlife RSA						
			Project Condition[2]			Cumulative Conditions[3]		
		Existing Conditions	Project Conditions	Incremental Change[4]	% Change[4]	Cumulative Conditions	Incremental Change[4]	% Change[4]
Pond-Dwelling Amphibians	Effective	269,976.0	269,855.1	121.0 ↓	0.04 ↓	269,485.4	490.6 ↓	0.18 ↓
Coastal Tailed Frog (Stream-Dwelling Amphibians Indicator)	Effective	145,828.6	145,707.4	121.2 ↓	0.08 ↓	145,598.8	229.9 ↓	0.16 ↓
Western Rattlesnake (Arid Habitat Snakes Indicator)	Potential	80,709.7	80,741.9	32.1 ↑	0.04 ↑	79,510.2	1,199.5 ↓	1.49 ↓

Notes: 1 Refer to the Wildlife Modeling and Species Accounts Technical Report of Volume 5C for definition of habitat potential. Where suitability models were applied for RSA-scale analysis, the change in effective habitat is indicated rather than potential habitat.

2 Project Condition includes existing activities (with available spatial data) + Project.

3 Cumulative Condition includes existing activities + Project + reasonably foreseeable developments (with available spatial data).

4 ↓ represents a decrease and ↑ represents an increase.

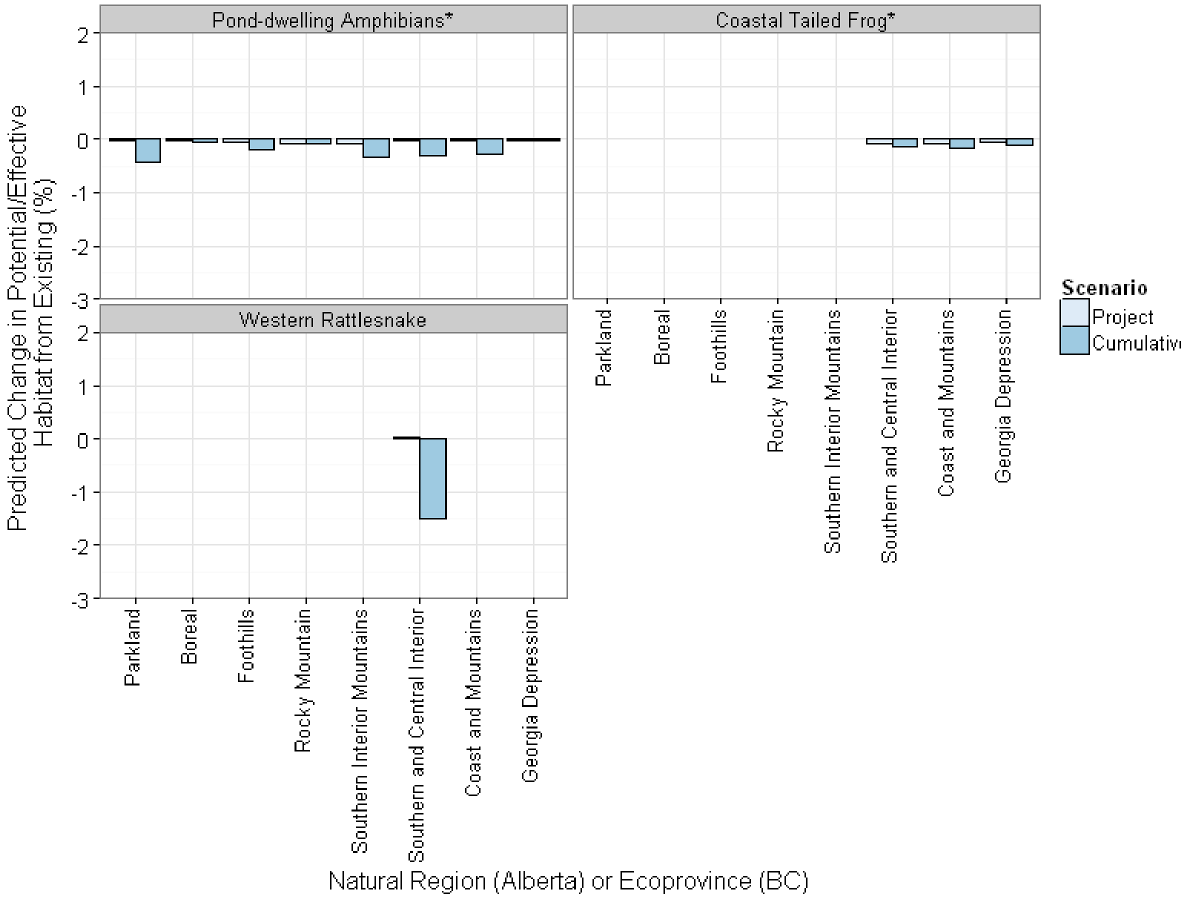

Figure 8.9-14 Predicted Change in Potential/Effective Habitat for Amphibian and Reptile Indicators
The predicted change in habitat is presented as the percent change from existing conditions to Project conditions and cumulative conditions for each Natural Region (Alberta) and Ecoprovince (BC) within the Wildlife RSA. Change in effective habitat is indicated by an asterisk (*) for pond-dwelling amphibians and coastal frog; change in potential habitat is presented for western rattlesnake living habitat.

Project-specific mitigation measures that will be implemented to reduce regional-scale habitat effects are summarized in Section 7.2.10.6. By implementing the proposed mitigation, including working with regulatory authorities to address potential incremental effects on the early candidate critical habitat for Pacific giant salamander, the Project's contribution to cumulative effects on amphibian and reptile habitat will be reduced. It is expected that many other operators in the Wildlife RSA will implement similar best practices and standard mitigation to reduce the contribution of existing activities and reasonably foreseeable developments to cumulative effects. No mitigation measures beyond the Project-specific mitigation proposed in Section 7.2.10 are deemed warranted.

8.9.8.2 Cumulative Change in Movement and Mortality Risk for Amphibian and Reptile Indicators

Construction and operations of the Project has potential to contribute to cumulative effects on amphibian and reptile movement and mortality risk. The Project's incremental effects are likely to interact with the identified existing activities and reasonably foreseeable developments in the Wildlife RSA (Table 8.9-5) to cause cumulative changes to movement and mortality risk for the amphibian and reptile indicators. With implementation of the mitigation proposed in Section 7.2.10, the Project's contribution to cumulative effects on amphibian and reptile movement and mortality risk is expected to be small at the regional scale. It is expected that many other operators in the Wildlife RSA will implement similar best practices and standard mitigation to reduce the contribution of existing activities and reasonably foreseeable developments to cumulative effects. No mitigation measures beyond the Project-specific mitigation proposed in Section 7.2.10 are deemed warranted.

8.9.8.3 Summary of Significance Rationale for Incremental Cumulative Effects on Amphibian and Reptile Indicators

A summary of the significance criteria ratings for the amphibian and reptile indicators is provided in Table 8.9-14. The criteria ratings and rationale for spatial boundary, duration, frequency, reversibility, probability and confidence are similar for all of the amphibian and reptile indicators.

- Spatial boundary: Wildlife RSA – cumulative effects on amphibians and reptiles are best evaluated at the regional (landscape) scale.
- Duration: short-term – Project construction and operational activities (*e.g.*, monitoring, vegetation management and site-specific maintenance) are short-term events that will interact with existing activities and reasonably foreseeable developments to contribute to cumulative effects.
- Frequency: periodic – Project construction and operational activities (*e.g.*, monitoring, vegetation management and site-specific maintenance) that could interact with existing activities and reasonably foreseeable developments will occur intermittently but repeatedly over the assessment period.
- Reversibility: long-term – some habitats suitable for amphibians and reptiles may be restored following reclamation of the Project Footprint in the medium-term. However, the reversibility is constrained by the time necessary to restore habitats that will take longer to regenerate to suitable conditions (*e.g.*, forested areas, sagebrush shrub-steppe), and Project components that will not be restored until decommissioning (*e.g.*, facilities). The Project's contribution to cumulative effects will extend over the long-term, until the Project is decommissioned and abandoned, and habitat is restored within the Footprint.
- Probability: high – the Project will interact with existing activities and reasonably foreseeable developments to affect amphibian and reptile indicators.
- Confidence: moderate – the assessment is based on a good understanding of cause-effect relationships and relevant data. Limitations and uncertainty associated with available data pertinent to the Wildlife RSA reduce the confidence level to moderate.

The criteria ratings and rationale for reversibility and magnitude vary, and are provided below for each amphibian and reptile indicator.

Pond-Dwelling Amphibians

- Magnitude: low – the pond-dwelling amphibians indicator includes several species with conservation status of concern. Pond-dwelling amphibians require wetland and upland habitats, and movement corridors between these areas. Amphibian populations are declining over much of North America, and primary threats include habitat loss and degradation, barriers to movement, and mortality risk (*e.g.*, from predation). Cumulative habitat loss, fragmentation by road networks and developments, and risks associated with roads during annual migrations are attributed to putting western toad at risk. The Project's contribution to cumulative effects on pond-dwelling amphibians is expected to be small at the regional scale, and with application of the proposed mitigation to address residual effects on habitat, movement and mortality risk, is concluded to be of low magnitude.

Stream-Dwelling Amphibians

- Magnitude: medium – siltation of streams and alteration of hydrological regime can adversely affect stream-dwelling amphibians. The Project has potential to interact with existing and future activities, in particular forest harvest and associated roads, to have cumulative effects on stream-dwelling amphibians. Clear-cuts can cause siltation of streams and alter the hydrological regime, both of which may negatively affect breeding success of tailed frogs (Dupuis and Steventon 1999, Wahbe *et al.* 2004). There is some evidence that the density of tailed frog tadpoles is greater in streams running through clear-cuts relative to those that do not, and that this may be linked to increased primary productivity in clear-cuts (Wahbe *et al.* 2004). The cumulative interaction of the Project on coastal tailed frog with future disturbance is considered qualitatively in the effects characterization and determination of significance. A series of run-of-river hydro developments are underway or proposed on streams in the Wildlife RSA. These developments divert water from the stream to produce hydro-electric power; however, run-of-the-river projects rely on stable, substantial stream flow (BC Ministry of Energy, Mines and Petroleum Resources 2011). For this reason, it is unlikely that these developments would interact with the Project to cumulatively affect quality habitat for stream-dwelling amphibians, which require step-pool stream morphology and lower, albeit year-round, water flow. The Project's contribution to cumulative effects on stream-dwelling amphibians is expected to be small at the regional scale, but will contribute to cumulative effects on sensitive species and habitats (*e.g.*, early candidate critical habitat for Pacific giant salamander). With application of the proposed mitigation to address residual effects on habitat, movement and mortality risk (including working with regulatory authorities to address potential effects on candidate critical habitat), the Project's contribution to cumulative effects on stream-dwelling amphibians is concluded to be of medium magnitude.

<u>Arid Habitat Snakes</u>

- Magnitude: low – arid snake species are particularly vulnerable to disturbance and local extirpation. Habitat loss and direct mortality due to road construction, utility development, agricultural expansion and urban expansion are the main threats to these species (Southern Interior Reptile and Amphibian Recovery Team 2008a,b). The Project's contribution to cumulative effects on arid habitat snakes is expected to be small at the regional scale, and with application of the proposed mitigation to address residual effects on habitat, movement and mortality risk, is concluded to be of low magnitude.

8.9.9 Summary

As identified in Tables 8.9-6, 8.9-12 and 8.9-14, there are no situations where there is a high probability of occurrence of a permanent or long-term cumulative effect of high magnitude that cannot be technically or economically mitigated. Consequently, the Project's contribution to cumulative effects on wildlife and wildlife habitat are concluded to be not significant.

8.10 Species at Risk

As discussed in Section 7.2.11, potential effects of the Project on species at risk are assessed through the use of indicators in Section 7.2.7 Fish and Fish Habitat, Section 7.2.9 Vegetation and Section 7.2.10 Wildlife and Wildlife Habitat. Consequently, the cumulative effects assessment on combined effects of the Project on indicator species at risk is conducted in Section 8.6 Fish and Fish Habitat, Section 8.8 Vegetation and Section 8.9 Wildlife and Wildlife Habitat.

Similar to Section 7.0, although not all species at risk are discussed explicitly under each indicator, potential cumulative effects were assessed in consideration of all species at risk. The indicators used to represent fish and fish habitat, vegetation and wildlife and wildlife habitat were carefully selected to ensure that the full range of potential Project effects and Project contribution to cumulative effects on species at risk was addressed and mitigations to reduce these effects will apply to all species at risk, not just the indicators. Sections 8.6 Fish and Fish Habitat, Section 8.8 Vegetation and Section 8.9 Wildlife and Wildlife Habitat provide the significance rationale for applicable indicator species. No significant adverse cumulative effects on species at risk have been identified as a result of the pipeline and facilities component of the Project.

8.11 Marine Sediment and Water Quality

This subsection discusses how the Project could act in combination with existing activities and reasonably foreseeable developments to cumulatively affect marine sediment and water quality indicators that were anticipated to have an adverse combined Project-specific residual effect (*i.e.*, marine sediment quality and marine water quality).

8.11.1 Reasonably Foreseeable Developments

Three certain and reasonably foreseeable developments are identified within the Marine RSA (Table 8A.1-1 of Appendix 8.1) that are considered in the evaluation of cumulative effects on marine sediment and water quality indicators. All three developments (Neptune Bulk Terminal Ltd., Richardson International Ltd. and Seaspan ULC expansion projects) are located in the Inner Harbour, west of the

Second Narrows, and distant from the Marine Sediment and Water Quality LSA. These developments are also summarized in Table 8.11-1.

TABLE 8.11-1

ANTICIPATED REASONABLY FORESEEABLE DEVELOPMENTS IN THE MARINE RSA

Project	Proponent	Description	Status
Coal Handling Infrastructure Upgrade and Expansion Project	Neptune Bulk Terminals Ltd.	Upgrade and expansion of metallurgical coal handling systems - increased vessel traffic expected to be approximately one vessel per week.	Under construction – in-service by late 2014.
Grain Storage Capacity Project	Richardson International Ltd.	Installation of approximately 494 open-ended steel wall piles and 315 timber piles, and construction of two 40,000 metric tonne concrete storage annexes.	Under construction – in-service by early 2015.
Shipyard Modernization Project	Seaspan ULC	Construction of a 53.56 m long x 31.8 m wide concrete load-out pier and installation of approximately 102 steel piles.	Under construction – in-service by early 2015..

The potential effects of increased vessel traffic, both Project and non-Project related, on marine water quality would be relevant to the marine transportation assessment (Section 4.3.2 of Volume 8A), however, the types of interactions expected would be limited to increases in potential for accidental release of bilge water from vessels, which is addressed in terms of accidents and malfunctions (Section 4.3.13 of Volume 8A).

Existing diffuse sources of contaminants in the Marine RSA, such as vessel traffic, marinas, port facilities, and stormwater discharges from urban areas and the effects of the 2007 accidental oil release from a ruptured Trans Mountain pipeline into Burrard Inlet have been accounted for in the baseline conditions described in the Marine Sediment and Water Quality – Westridge Marine Terminal Technical Report of Volume 5C.

8.11.2 Potential Cumulative Effects

The potential and likely environmental residual effects associated with construction and operation of the Westridge Marine Terminal on marine sediment and water quality indicators were identified in Section 7.11.1.10 and are listed in Table 8.11-2 along with existing activities and reasonably foreseeable developments that could act in combination with the Project.

TABLE 8.11-2

POTENTIAL RESIDUAL EFFECTS OF THE PROJECT ON MARINE SEDIMENT AND WATER QUALITY CONSIDERED FOR THE CUMULATIVE EFFECTS ASSESSMENT

Potential Residual Project Effect on Indicator	Spatial Boundary[1]	Project Component(s)	Temporal Boundary	Potential Cumulative Effect	Existing Activities/Reasonably Foreseeable Developments with Residual Effects Acting in Combination with the Project
1. Combined Project effects on marine sediment quality.	RSA	Westridge Marine Terminal	Construction to Operation	Project contribution to cumulative change in marine sediment quality.	• Vessel loading at Westridge Marine Terminal. • Existing activities: stormwater runoff into the Marine RSA and vessel traffic in the Marine RSA. • Reasonably foreseeable developments within the Marine RSA listed in Table 8A.1-6 of Appendix 8.1 and discussed in Section 8.1.4. • Project-related activities that could interact with the above activities including dredging for construction of the Westridge Marine Terminal.

TABLE 8.11-2 Cont'd

Potential Residual Project Effect on Indicator	Spatial Boundary[1]	Project Component(s)	Temporal Boundary	Potential Cumulative Effect	Existing Activities/Reasonably Foreseeable Developments with Residual Effects Acting in Combination with the Project
2. Combined Project effects on marine water quality.	RSA	Westridge Marine Terminal	Construction to Operation	Project contribution to cumulative change in marine water quality.	• Existing activities: discharge of treated stormwater from the existing Westridge Marine Terminal, vessel traffic in the Marine RSA, stormwater runoff in the Marine RSA. • Reasonably foreseeable developments within the Marine RSA listed in Table 8A.1-6 of Appendix 8.1 and discussed in Section 8.1.4. • Project-related activities that could interact with the above activities including discharges of treated stormwater from the expanded Westridge Marine Terminal.

Note: 1 RSA = Marine RSA.

8.11.3 Significance Evaluation of Potential Cumulative Effects

Table 8.11-3 provides a summary of the significance evaluation of the Project's contribution to potential cumulative effects on marine sediment and water quality indicators. The rationale used to evaluate the significance of each cumulative effect is provided below. Characterization of the Project's contribution to cumulative effects relied on available research literature and the professional judgment of the assessment team.

TABLE 8.11-3

SIGNIFICANCE EVALUATION OF THE PROJECT'S CONTRIBUTION TO CUMULATIVE EFFECTS ON MARINE SEDIMENT AND WATER QUALITY

Potential Cumulative Effects	Impact Balance	Spatial Boundary[1]	Temporal Context: Duration	Temporal Context: Frequency	Temporal Context: Reversibility	Magnitude	Probability	Confidence	Significance[2]
1. Marine Sediment and Water Quality Indicator – Marine Sediment Quality									
1(a) Project contribution to cumulative change in marine sediment quality.	Negative	LSA	Short-term	Isolated	Short-term	Low	Low	High	Not significant
2. Marine Sediment and Water Quality Indicator – Marine Water Quality									
2(a) Project contribution to cumulative change in marine water quality.	Negative	LSA	Long-term	Periodic	Short-term	Low	Low	High	Not significant
3. Combined Effects on Marine Sediment and Water Quality									
3(a) Project contribution to cumulative increase in effects on marine sediment and water quality indicators (1[a] and 2[a]).	Negative	LSA	Long-term	Periodic	Short-term	Low	Low	High	Not significant

Notes: 1 LSA = Marine Sediment and Water Quality LSA.
2 Significant Contribution to a Cumulative Environmental Effect: A high probability of occurrence of a permanent or long-term cumulative effect of high magnitude that cannot be technically or economically mitigated.

8.11.3.1 Marine Sediment and Water Quality Indicator – Marine Sediment Quality

Dredging of a limited area for the Westridge Marine Terminal may be required, and would occur within the Project Footprint. Dredging has the potential to disturb existing contaminants in sediment (*e.g.*, polycyclic aromatic hydrocarbons [PAHs], polychlorinated biphenyls [PCBs], metals), resulting in their suspension and resettling. Residual effects of dredging are considered to be low in magnitude and short-term in duration. The use of a clamshell dredge and, if practical, turbidity curtains around the dredge location will restrict sediment disturbance and resettling to the Marine Sediment and Water Quality LSA.

Construction and operation activities associated with the three reasonably foreseeable developments listed above and described in Table 8A.1-6 of Appendix 8.1 will not overlap in time or space with Project activities. Construction methods for these developments are not provided, and they may or may not involve sediment disturbance from dredging or other activities. However, these developments are scheduled for completion in 2014 or 2015, prior to the Project construction schedule, and are located well away (in the Inner Harbour, within the Marine RSA) from the Westridge Marine Terminal, such that any spatial or temporal overlap with Project construction activities is not anticipated. As a result, the probability of the Project contributing to cumulative effects on marine sediment quality is considered low and any cumulative effects that do arise are predicted to be low in magnitude (Table 8.11-3, point 1[a]). A summary of the rationale for all of the significance criteria of combined cumulative effects on marine sediment quality is provided below.

- Spatial Boundary: Marine Sediment and Water Quality LSA – no spatial or temporal overlap between Project activities within the LSA and other reasonably foreseeable developments in the RSA is anticipated.
- Duration: short-term – Project activities at the Westridge Marine Terminal that have the potential to contribute to cumulative effects on marine sediment quality are limited to the construction phase.
- Frequency: isolated – Project activities at the Westridge Marine Terminal that have the potential to contribute to cumulative effects on marine sediment quality are limited to the construction phase.
- Reversibility: short-term – sediment disturbed by in-water construction activities will resettle within hours to days following cessation of construction activities at the Westridge Marine Terminal.
- Magnitude: low – mitigation measures will be implemented to restrict dispersion of sediment during dredging; no change in sediment quality is predicted; existing sediment meets disposal at sea screening criteria for PAH and PCBs but not for metals (small exceedance of Environment Canada disposal at sea criteria for copper, lead, and cadmium, consistent with other parts of the Marine RSA).
- Probability: low – timing of reasonably foreseeable developments in the Marine RSA will not overlap with the construction schedule for the Westridge Marine Terminal.
- Confidence: high – there is a good understanding of the cause-effect relationships between in-water construction activities and the re-suspension of contaminants, the effectiveness of proposed mitigation measures, and the spatial extent of changes in marine sediment quality resulting from Project activities at the Westridge Marine Terminal.

8.11.3.2 Marine Sediment and Water Quality Indicator – Marine Water Quality

Construction of the expanded Westridge Marine Terminal has the potential to affect marine water quality through release of total suspended solids (TSS) during dredging. The use of a clamshell dredge and, if practical, turbidity curtains around the dredge location will restrict sediment disturbance and elevated TSS levels to the Marine Sediment and Water Quality LSA.

Operation of the expanded Westridge Marine Terminal has the potential to affect marine water and, indirectly, sediment, through release of surface water (stormwater) runoff from the site. Runoff may contain hydrocarbons, metals and suspended sediment. Of these, hydrocarbons are of particular concern at an oil shipping terminal. Increased concentrations of contaminants can lead to toxicity in marine biota. Given the many existing sources of stormwater contaminants in Burrard Inlet (Balanced Environmental Services Inc. 2010), it can be difficult to identify specific contaminant sources.

The reasonably foreseeable developments listed above and described in Table 8A.1-6 of Appendix 8.1 may release TSS during their construction phases; however, Project effects will be localized and there will be no temporal or spatial overlap of Project and non-Project related construction activities and effects. These projects may also release stormwater during their operation phases. However, discharges at industrial sites require permits and monitoring programs similar in extent to that required of the Westridge Marine Terminal and may require treatment (*e.g.*, settling of sediment, removal of oil). As a result, any effects on water quality from industrial stormwater discharges are expected to be localized and low in magnitude. Given that the reasonably foreseeable developments are located away from the Marine Sediment and Water Quality LSA, there is unlikely to be any spatial overlap with Project effects. As a result, the probability of the Project contributing to cumulative effects on marine water quality is considered low and any cumulative effects that do arise are predicted to be low in magnitude (Table 8.11-3, point 2[a]). A summary of the rationale for all of the significance criteria of combined cumulative effects on marine water quality is provided below.

- Spatial Boundary: Marine Sediment and Water Quality LSA – no spatial or temporal overlap between Project activities within the LSA and other reasonably foreseeable developments in the RSA is anticipated.
- Duration: long-term – stormwater discharges from the reasonably foreseeable developments may begin during the construction phase of the Westridge Marine Terminal and extend into the operations phase.
- Frequency: periodic – stormwater discharges will occur intermittently but repeatedly over the assessment period (during rainfall events).
- Reversibility: short-term – each event is reversible immediately after dredging ceases or stormwater is released; however, the overall effect of stormwater discharge will not cease until the end of operations at the Westridge Marine Terminal.
- Magnitude: low – site runoff from the Westridge Marine Terminal, existing industrial sites and reasonably foreseeable developments will be within permit requirements, which are set to protect marine aquatic biota.
- Probability: low – based on the lack of spatial overlap between the Project and reasonably foreseeable developments in the Marine RSA.
- Confidence: high – there is a good understanding of the cause-effect relationships between industrial operations and stormwater, effectiveness of stormwater treatment, and the spatial extent of changes in marine water quality resulting from Project activities at the Westridge Marine Terminal.

8.11.3.3 Combined Cumulative Effects on Marine Sediment and Water Quality

The potential cumulative effects (*i.e.*, change in marine sediment quality and change in marine water quality) may act in combination to affect marine sediment and water quality in the Marine RSA. However, given that there will be little if any spatial or temporal overlap between Project-specific effects on marine sediment and water quality and reasonably foreseeable developments in the Marine RSA, the probability of combined cumulative effects is considered low. Implementing mitigation measures described in Section 7.0 will reduce the spatial extent of Project-related changes in marine sediment and water quality, making combined cumulative effects even more unlikely. As a result, combined cumulative effects of the Project on marine sediment and water quality are predicted to be low in magnitude (Table 8.11-3, point 3[a]). A summary of the rationale for all of the significance criteria of combined cumulative effects on marine sediment and water quality indicators is provided below.

- Spatial Boundary: Marine Sediment and Water Quality LSA – no spatial or temporal overlap between Project activities within the LSA and other reasonably foreseeable developments in the RSA is anticipated.
- Duration: long-term – the events causing combined cumulative effects on marine sediment and water quality will extend through the construction and operations phases of the Project.
- Frequency: periodic – the events causing combined cumulative effects on marine sediment and water quality will occur intermittently but repeatedly over the assessment period.
- Reversibility: short-term – Project contribution to combined cumulative effects on marine sediment and water quality will reverse after each stormwater event soon after the discharge stops and will cease when the facility is decommissioned.

- Magnitude: low – the Project's contribution to combined cumulative effects on marine sediment and water quality is considered to be within environmental standards given the implementation of industry standard guidelines and recommended mitigations.
- Probability: low – based on the lack of spatial and temporal overlap between the Project and reasonably foreseeable developments.
- Confidence: high – there is a good understanding of the cause-effect relationships between Project activities and marine sediment and water quality, and effectiveness of proposed mitigation measures, and the spatial extent of changes in marine sediment and water quality resulting from Project activities.

8.11.4 Summary

As identified in Table 8.11-3, there are no situations where there is a high probability of occurrence of a permanent or long-term cumulative effect of high magnitude that cannot be technically or economically mitigated. Consequently, the Project's contribution to cumulative effects on marine sediment and water quality within the Marine RSA will be not significant.

8.12 Marine Fish and Fish Habitat

This subsection discusses how the Project could act in combination with existing activities and reasonably foreseeable developments to cumulatively affect marine fish and fish habitat indicators that were anticipated to have an adverse combined Project-specific residual effect (*i.e.*, intertidal habitat, subtidal habitat, Dungeness crab, inshore rockfish and Pacific salmon).

8.12.1 Reasonably Foreseeable Developments

Three certain and reasonably foreseeable developments were identified within the Marine RSA: the Neptune Terminals Coal Handling Expansion Project; the Richardson International Grain Storage Capacity Expansion Project; and the Seaspan Modernization Project. These developments are listed in Table 8A.1-6 of Appendix 8.1 and are described in Section 8.1.4. Only the Seaspan Modernization Project will involve in-water works; therefore, it is the only reasonably foreseeable development that has the potential to contribute to cumulative effects on marine fish and fish habitat.

8.12.2 Potential Cumulative Effects

The potential and likely combined environmental residual effects associated with construction and operation of the Westridge Marine Terminal on marine fish and fish habitat were identified in Section 7.11.1.11 and are listed in Table 8.12-1 along with existing activities and reasonably foreseeable developments that could act in combination with the Project.

Construction of the Westridge Marine Terminal will result in the loss of a small area of marine riparian habitat; however, this residual effect is not considered in the context of cumulative effects because none of the three reasonably foreseeable developments in the Marine RSA will affect marine riparian habitat. While construction of the Seaspan load-out pier will affect intertidal and subtidal habitats, the site is heavily industrialized and there is no marine riparian habitat present.

The assessment of potential Project effects on inshore rockfish and Pacific salmon resulting from construction of the Westridge Marine Terminal concluded that injury or mortality are unlikely (see Section 7.6.9.6). As a result, these effects are not considered in the context of cumulative effects. Operational activities at the Westridge Marine Terminal are not expected to affect marine fish and fish habitat; therefore, there is no potential for cumulative effects during the operations phase of the Project.

TABLE 8.12-1

POTENTIAL RESIDUAL EFFECTS OF THE PROJECT ON MARINE FISH AND FISH HABITAT CONSIDERED FOR THE CUMULATIVE EFFECTS ASSESSMENT

Potential Residual Project Effect on Indicator	Spatial Boundary[1]	Project Component(s)	Temporal Boundary	Potential Cumulative Effect	Existing Activities/Reasonably Foreseeable Developments with Residual Effects Acting in Combination with the Project
1. Loss of intertidal habitat due to construction activities.	RSA	Westridge Marine Terminal	Construction	Project contribution to cumulative loss of intertidal habitat.	• Historical changes to intertidal habitat in the Marine RSA due to past industrial and urban developments. • Seaspan Modernization Project described in Section 8.1.4 and listed in Table 8A.1-6 of Appendix 8.1.
2. Loss of subtidal habitat due to construction activities.	RSA	Westridge Marine Terminal	Construction	Project contribution to cumulative loss of subtidal habitat.	• Historical changes to subtidal habitat in the Marine RSA due to past industrial and urban developments. • Seaspan Modernization Project described in Section 8.1.4 and listed in Table 8A.1-6 of Appendix 8.1.
3. Combined Project effects on Dungeness crab.	RSA	Westridge Marine Terminal	Construction	Project contribution to cumulative increase in injury or mortality and cumulative decrease in productive capacity of suitable habitat.	• Historical changes to intertidal and subtidal habitat in the Marine RSA due to past industrial and urban developments. • Seaspan Modernization Project described in Section 8.1.4 and listed in Table 8A.1-6 of Appendix 8.1.
4. Decrease in productive capacity of suitable habitat for Pacific salmon.	RSA	Westridge Marine Terminal	Construction	Project contribution to cumulative decrease in productive capacity of suitable habitat.	• Historical changes to intertidal and subtidal habitat in the Marine RSA due to past industrial and urban developments. • Seaspan Modernization Project described in Section 8.1.4 and listed in Table 8A.1-6 of Appendix 8.1.
5. Decrease in productive capacity of suitable habitat for Pacific salmon.	RSA	Westridge Marine Terminal	Construction	Project contribution to cumulative decrease in productive capacity of suitable habitat.	• Historical changes to intertidal and subtidal habitat in the Marine RSA due to past industrial and urban developments. • Seaspan Modernization Project described in Section 8.1.4 and listed in Table 8A.1-6 of Appendix 8.1.

Note: 1 RSA = Marine RSA.

8.12.3 Significance Evaluation of Potential Cumulative Effects

Table 8.12-2 provides a summary of the significance evaluation of the Project's contribution to potential cumulative effects on marine fish and fish habitat indicators. The rationale used to evaluate the significance of each of the cumulative effects is provided below. Characterization of the Project's contribution to cumulative effects relied on studies of the historical changes to marine habitats in the Marine RSA, a qualitative assessment of the potential residual effects of the Seaspan Modernization Project on marine fish and fish habitat, and professional judgment of the assessment team.

TABLE 8.12-2

SIGNIFICANCE EVALUATION OF THE PROJECT'S CONTRIBUTION TO CUMULATIVE EFFECTS ON MARINE FISH AND FISH HABITAT

Potential Cumulative Effects	Impact Balance	Spatial Boundary[1]	Temporal Context			Magnitude	Probability	Confidence	Significance[2]
			Duration	Frequency	Reversibility				
1. Marine Fish and Fish Habitat Indicator – Intertidal Habitat									
1(a) Project contribution to cumulative loss of intertidal habitat.	Negative	RSA	Short-term	Isolated	Permanent	Low	High	High	Not significant

TABLE 8.12-2 Cont'd

	Potential Cumulative Effects	Impact Balance	Spatial Boundary[1]	Temporal Context			Magnitude	Probability	Confidence	Significance[2]
				Duration	Frequency	Reversibility				
2.	Marine Fish and Fish Habitat Indicator – Subtidal Habitat									
2(a)	Project contribution to cumulative loss of subtidal habitat.	Negative	RSA	Short-term	Isolated	Permanent	Low	High	High	Not significant
3.	Marine Fish and Fish Habitat Indicator – Dungeness Crab									
3(a)	Project contribution to cumulative decrease in productive capacity of suitable habitat for Dungeness crab.	Negative	RSA	Short-term	Isolated	Medium-term	Low	High	High	Not significant
3(b)	Project contribution to cumulative injury or mortality of Dungeness crab.	Negative	RSA	Short-term	Isolated	Medium-term	Low	High	High	Not significant
4.	Marine Fish and Fish Habitat Indicator – Inshore Rockfish									
4(a)	Project contribution to cumulative decrease in productive capacity of suitable habitat for inshore rockfish.	Negative	RSA	Short-term	Isolated	Medium-term	Low	High	High	Not significant
5.	Marine Fish and Fish Habitat Indicator – Pacific Salmon									
5(a)	Project contribution to cumulative decrease in productive capacity of suitable habitat for Pacific salmon.	Negative	RSA	Short-term	Isolated	Medium-term	Low	High	High	Not significant
6.	Combined Cumulative Effects on Marine Fish and Fish Habitat									
6(a)	Project contribution to combined cumulative effects on the marine fish and fish habitat indicators (1[a]-5[a]).	Negative	RSA	Short-term	Isolated	Medium-term to permanent	Low	High	High	Not significant

Notes: 1 RSA = Marine RSA.

2 Significant Contribution to a Cumulative Environmental Effect: A high probability of occurrence of a permanent or long-term cumulative effect of high magnitude that cannot be technically or economically mitigated.

8.12.3.1 Marine Fish and Fish Habitat Indicator – Intertidal Habitat

Intertidal habitats in Burrard Inlet have been extensively modified as a result of historical development. A study by Stantec Consulting Ltd. (Stantec) (2009) estimated that 69% of intertidal habitats in Burrard Inlet have been converted to riprap (52%) or retaining walls (17%). Natural rocky intertidal habitat, tidal flats/estuaries, and beaches comprise 13%, 11% and 7% of the shoreline, respectively.

Shoreline infilling for construction of the Westridge Marine Terminal will result in the loss of approximately 5,470 m^2 of intertidal habitat, most of which is riprap. This loss will be partially offset by the creation of an estimated 3,770 m^2 of new intertidal riprap habitat along the outer face of the fill area. All intertidal habitat affected by construction of the Westridge Marine Terminal has been classified as ‘man-made’ (BC Ministry of Forests 2005).

Of the three reasonably foreseeable developments that overlap with the Marine RSA, the Seaspan Modernization Project is the only one that will affect marine fish habitats. Construction of the load-out pier is expected to result in the loss of several hundred square metres of intertidal habitat. Shoreline at the development site has been classified as ‘man-made’ (BC Ministry of Forests 2005) and aerial imagery suggests that the intertidal habitat is composed entirely of riprap (PMV 2013i).

The cumulative effect of intertidal habitat loss in the Marine RSA resulting from historical development, Project construction and reasonably foreseeable developments is considered to have a negative impact balance and is predicted to be of medium magnitude. The major contributor to this effect is the legacy of industrial and urban development that has linearized much of the natural shoreline and replaced structurally complex habitats with riprap and retaining walls. The Project’s contribution to the cumulative loss of intertidal habitat is predicted to be of low magnitude (Table 8.12-2, point 1[a]) because only a small area of previously-modified intertidal habitat will be lost. Although this cumulative effect is permanent, the implementation of a marine fish habitat compensation/offset program will ensure that there is no net loss of the productive capacity of fish habitat. The intertidal riprap habitat created as a product of infilling will also function as marine fish habitat, and is expected to be colonized by a suite of marine organisms similar to what is currently found at the site. A summary of the rationale for all of the significance criteria of the Project's contribution to cumulative effects on intertidal habitat is provided below.

- Spatial Boundary: Marine RSA – the Project's contribution to intertidal habitat loss may interact with historical and reasonably foreseeable developments within the Marine RSA to cause a cumulative loss of intertidal habitat in the Marine RSA.
- Duration: short-term – the Project's contribution to a cumulative loss of intertidal habitat will result from shoreline infilling at the Westridge Marine Terminal, which is expected to take 1 to 2 months during the construction phase.
- Frequency: isolated – the Project's contribution to a cumulative loss of intertidal habitat will result from shoreline infilling at the Westridge Marine Terminal, which is confined to the construction phase.
- Reversibility: permanent – the Project's contribution to a cumulative loss of intertidal habitat is permanent.
- Magnitude: low – construction of the Westridge Marine Terminal will result in the loss of a relatively small amount of previously-modified intertidal habitat, which represents a small contribution to the overall cumulative effect.
- Probability: high – construction of the Westridge Marine Terminal will result in the loss of intertidal habitat and this will act cumulatively with historical and reasonably foreseeable in-water developments in the Marine RSA.
- Confidence: high – based on a good understanding of the historical changes to intertidal habitats within the Marine RSA, a good understanding of the residual Project effects on intertidal habitat and a good understanding of the reasonably foreseeable developments that have the potential to impact intertidal habitat in the Marine RSA.

8.12.3.2 Marine Fish and Fish Habitat Indictor – Subtidal Habitat

Historical development in Burrard Inlet has led to the loss of subtidal habitat, primarily through infilling of nearshore areas to increase useable land for industrial developments. Since the 1930s, approximately 363 ha of inlet area have been lost due to infilling (Stantec 2009). It is likely that earlier development in the late 1800s and early 1900s also contributed to the loss of natural subtidal habitats, although this has not been quantified.

Construction of the Westridge Marine Terminal will result in the loss of approximately 17,100 m^2 of subtidal habitat, primarily soft-sediment (sand and mud) with a small area of riprap. This loss will be partially offset by the creation of an estimated 5,550 m^2 of new subtidal riprap habitat along the outer face of the fill area. Rocky habitat is limited in Burrard Inlet, so although the subtidal riprap is anthropogenic, it will provide high value habitat for a variety of marine fish species, including rockfish, which associate with complex rocky habitats. Nevertheless, the Project's contribution to the cumulative loss of subtidal habitat is considered to have a negative impact balance.

A small amount of subtidal habitat will be lost due to construction of the Seaspan load-out pier. The proposed footprint of this in-water development is 1,720 m^2, most of which will be subtidal. Habitats in this area appear to be primarily soft-sediment, although aerial imagery suggests that subtidal riprap may also be present (PMV 2013i)

The cumulative effect of subtidal habitat loss in the Marine RSA resulting from historical development, Project construction and reasonably foreseeable developments is predicted to be of medium magnitude. While construction of the Westridge Marine Terminal and the Seaspan load-out pier will result in relatively small losses of subtidal habitat, historical developments in Burrard Inlet have reduced the inlet area by at least 363 ha (Stantec 2009). Although subtidal habitat loss is permanent, both Trans Mountain and Seaspan will implement fish habitat compensation/offset programs to ensure that their respective developments do not result in the loss of the productive capacity of fish habitats. Under the *Fisheries Act*, all unavoidable losses of fish habitat must be compensated/offset through the creation of new habitats or the restoration or enhancement of existing habitats.

The Project's contribution to the cumulative loss of subtidal habitat, therefore, is predicted to be of low magnitude (Table 8.12-2, point 2[a]). A summary of the rationale for all of the significance criteria of the Project's contribution to cumulative effects on subtidal habitat is provided below.

- Spatial Boundary: Marine RSA – the Project's contribution to subtidal habitat loss may interact with historical and reasonably foreseeable developments within the Marine RSA to cause a cumulative loss of subtidal habitat in the Marine RSA.
- Duration: short-term – the Project's contribution to a cumulative loss of subtidal habitat is limited to the construction phase, resulting from shoreline infilling at the Westridge Marine Terminal, which is expected to take 1 to 2 months, and pile installation, which will occur intermittently over a 2 year period.
- Frequency: isolated – the Project's contribution to a cumulative loss of subtidal habitat will result from shoreline infilling and pile installation at the Westridge Marine Terminal, which is confined to the construction phase.
- Reversibility: permanent – the Project's contribution to the cumulative loss of subtidal habitat is permanent.
- Magnitude: low – construction of the Westridge Marine Terminal will result in the loss of a relatively small amount of soft-sediment subtidal habitat, which will be offset by the creation of subtidal riprap habitat and the implementation of a marine fish habitat compensation/offset program.
- Probability: high – construction of the Westridge Marine Terminal will result in the loss of subtidal habitat and this will act cumulatively with historical and reasonably foreseeable in-water developments in the Marine RSA.
- Confidence: high – based on a good understanding of the historical changes to subtidal habitats within the Marine RSA, a good understanding of the residual Project effects on subtidal habitat and a good understanding of the reasonably foreseeable developments that have the potential to impact subtidal habitat in the Marine RSA.

8.12.3.3 Marine Fish and Fish Habitat Indictor – Dungeness Crab

<u>Cumulative Decrease in Productive Capacity of Suitable Habitat for Dungeness Crab</u>

Historical infilling and shoreline modification in Burrard Inlet has likely reduced the productive capacity of Dungeness crab habitat within the Marine RSA; however, the Inlet remains a productive area for Dungeness crab, supporting commercial, recreational and Aboriginal fisheries (DFO 2012). Marine habitat losses associated with construction of the Westridge Marine Terminal and the Seaspan load-out pier will act cumulatively with historical developments to reduce the overall availability of Dungeness crab habitat in the Marine RSA, and this is considered to have a negative impact balance. The associated loss of productive capacity will be temporary, as both Trans Mountain and Seaspan will implement fish habitat compensation/offset programs to ensure there is no net loss of productive capacity. Although specific compensation/offset measures have not yet been determined for the Project, the preferred option involves the construction of a series of subtidal rock reefs near the Westridge Marine Terminal. These reefs would provide rearing habitat for recently-settled Dungeness crab larvae and foraging habitat for sub-adult and adult crabs. A diverse community of algae and invertebrates would colonize the reefs within a period of two to three years after their construction, increasing productivity and prey availability in the local area.

With the implementation of a marine fish habitat compensation/offset program, the Project's contribution to the cumulative decrease in productive capacity of Dungeness crab habitat is predicted to be of low magnitude and reversible in the medium-term (Table 8.12-2, point 3[a]). A summary of the rationale for all of the significance criteria for the Project's contribution to cumulative effects on the productive capacity of Dungeness crab is provided below.

- Spatial Boundary: Marine RSA – the Project's contribution to marine habitat loss may interact with historical and reasonably foreseeable developments within the Marine RSA to cause a cumulative decrease in the productive capacity of suitable habitat for Dungeness crab in the Marine RSA.
- Duration: short-term – Project activities at the Westridge Marine Terminal that have the potential to contribute to a cumulative decrease in the productive capacity of suitable habitat for Dungeness crab are limited to the construction phase.
- Frequency: isolated – Project activities at the Westridge Marine Terminal that have the potential to contribute to a cumulative decrease in the productive capacity of suitable habitat for Dungeness crab are confined to the construction phase.
- Reversibility: medium-term – implementation of a marine fish habitat compensation/offset program will ensure there is no net loss of the productive capacity of Dungeness crab habitat; full recovery of productive capacity may take 2 to 3 years following the installation of compensation/offset features.
- Magnitude: low – construction of the Westridge Marine Terminal will decrease the productive capacity of Dungeness crab habitat in only a small portion of the Marine RSA and this effect will be offset through the implementation of a marine fish habitat compensation/offset program.
- Probability: high – construction of the Westridge Marine Terminal will affect Dungeness crab habitat resulting in a temporary decrease in productive capacity; this effect will act cumulatively with historical and reasonably foreseeable in-water developments in the Marine RSA.
- Confidence: high – based on a good understanding of the historical changes to intertidal and subtidal habitats within the Marine RSA, a good understanding of the residual Project effects on Dungeness crab habitat, and a good understanding of the reasonably foreseeable developments that have the potential to affect the productive capacity of Dungeness crab habitat in the Marine RSA.

Cumulative Injury or Mortality of Dungeness Crab

Shoreline infilling and dredging activities during construction of the Westridge Marine Terminal are expected to contribute to a cumulative loss of a small number of Dungeness crabs, and this is considered to have a negative impact balance. A crab salvage program will be implemented whereby adult crabs are collected from within the Project Footprint using baited traps and relocated to a suitable area outside of the Marine Fish and Fish Habitat LSA. Salvages will be conducted immediately prior to the commencement of infilling and dredging so as to reduce the number of crabs that could potentially relocate to within the construction area. It is unknown whether Seaspan will implement a similar salvage program for their load-out pier project; however, the in-water footprint of the development is small (~1,720 m^2), suggesting that few Dungeness crabs will be harmed or killed during construction. Given the abundance of Dungeness crabs within the Marine RSA, the abundance of suitable Dungeness crab habitat, and with consideration of the mitigation measures that will be implemented to specifically reduce injury or mortality to this species, the Project's contribution to the cumulative effect of injury or mortality of Dungeness crabs is predicted to be of low magnitude (Table 8.12-2, point 3[b]). This cumulative effect is considered to be reversible in the medium-term, as Dungeness crabs spawn annually and any local reduction in abundance is expected to be restored within 1 to 2 years of spawning and recruitment. A summary of the rationale for all of the significance criteria of the Project's contribution to cumulative injury or mortality of Dungeness crab is provided below.

- Spatial Boundary: Marine RSA – the Project's contribution to marine habitat loss may interact with historical and reasonably foreseeable developments within the Marine RSA to cause cumulative injury or mortality of Dungeness crab in the Marine RSA.
- Duration: short-term – the Project's contribution to cumulative injury or mortality of Dungeness crabs is limited to in-water construction activities at the Westridge Marine Terminal.

- Frequency: isolated – the Project's contribution to cumulative injury or mortality of Dungeness crabs will occur only during in-water works associated construction of the Westridge Marine Terminal.
- Reversibility: medium-term – a local reduction in the abundance of Dungeness crabs (*i.e.*, within the Project Footprint) is expected to be reversible within 1 to 2 years, as Dungeness crabs spawn and recruit on an annual basis.
- Magnitude: low – given the abundance of Dungeness crabs within Burrard Inlet, the loss of a relatively small number of individuals within the Project Footprint will not be detectable at the population level.
- Probability: high – construction of the Westridge Marine Terminal is likely to result in the loss of some Dungeness crabs, primarily juveniles that are too small to be captured and relocated by the proposed salvage program.
- Confidence: high – based on a good understanding of the in-water Project Footprint relative to the total available Dungeness crab habitat in the Marine RSA, a reasonable understanding of the distribution and abundance of Dungeness crabs in Burrard Inlet, and a good understanding of the reasonably foreseeable developments that have the potential to result in injury or mortality to Dungeness crab.

8.12.3.4 Marine Fish and Fish Habitat Indicator – Inshore Rockfish

Historical development in Burrard Inlet has likely reduced the availability of nearshore rocky habitat, resulting in a net decrease in the productive capacity of suitable habitat for inshore rockfish. However, the relatively low abundance of rockfish in Burrard Inlet and other developed areas of BC, including the Strait of Georgia, is primarily due to a history of overexploitation (Yamanaka and Logan 2010). The life history characteristics common to most rockfish, which include slow growth, late maturation and high site fidelity, make them particularly susceptible to rapid depletion in the face of heavy fishing pressure (Berkeley *et al.* 2004, Parker *et al.* 2000, Yamanaka and Logan 2010). The rockfish conservation area (RCA) located at the Westridge Marine Terminal is 1 of 164 such protected areas in BC, and is part of a broader conservation strategy for inshore rockfish (Yamanaka and Logan 2010).

Construction of the Westridge Marine Terminal will only temporarily diminish the productive capacity of inshore rockfish habitat. Once completed, the infill area will actually increase the availability of complex rocky habitat in the subtidal environment, and while the habitat is anthropogenic (riprap), it is expected to be of high value to species such as copper and quillback rockfish, which exhibit a strong preference for rocky substrates of high rugosity (Love *et al.* 2002). In addition, the implementation of a marine fish habitat compensation/offset program will ensure there is no net loss of productive capacity of inshore rockfish habitat. The preferred option for compensation/offsetting involves the construction of a series of subtidal rock reefs near the Westridge Marine Terminal, within the Eastern Burrard Inlet RCA. One of the primary objectives of this strategy would be to increase the availability and quality of rockfish habitat within the RCA.

Construction of the Seaspan load-out pier is not expected to result in a measurable effect on the productive capacity of inshore rockfish habitat. While a small amount of intertidal and subtidal riprap may be lost, most of the seafloor area affected is soft sediment, which has low value to most demersal rockfish species. In addition, the in-water footprint of the development (~1,720 m^2) is small and the affected habitat is in a highly industrialized area. Any loss of productive capacity resulting from construction of the load-out pier will be offset through fish habitat compensation/offsetting.

The Project's contribution to the cumulative decrease in productive capacity of suitable habitat for inshore rockfish is considered to have a negative impact balance. While rockfish abundance in Burrard Inlet is greatly reduced compared to historical levels, this is primarily due to a long history of overexploitation (Yamanaka and Logan 2010). With the implementation of a marine fish habitat compensation/offset program, the Project's contribution to the cumulative decrease in productive capacity of inshore rockfish habitat is predicted to be of low magnitude (Table 8.12-2, point 4[a]). This cumulative effect will be reversed once biotic communities have become fully established on the subtidal riprap and compensation/offset habitats, which is expected to take 2 to 3 years. A summary of the rationale for all of the significance criteria of the Project's contribution to cumulative effects on inshore rockfish is provided below.

- Spatial Boundary: Marine RSA – the Project's contribution to marine habitat loss may interact with historical and reasonably foreseeable developments within the Marine RSA to cause a cumulative decrease in the productive capacity of suitable habitat for inshore rockfish in the Marine RSA.
- Duration: short-term – Project activities at the Westridge Marine Terminal that have the potential to contribute to a cumulative decrease in productive capacity of suitable habitat for inshore rockfish are limited to the construction phase.
- Frequency: isolated – Project activities at the Westridge Marine Terminal that have the potential to contribute to a cumulative decrease in productive capacity of suitable habitat for inshore rockfish are confined to the construction phase.
- Reversibility: medium-term – implementation of a marine fish habitat compensation/offset program will ensure there is no net loss of the productive capacity of inshore rockfish habitat; full recovery of productive capacity may take 2 to 3 years following the installation of compensation/offsetting features.
- Magnitude: low – construction of the Westridge Marine Terminal will decrease the productive capacity of inshore rockfish habitat in only a small portion of the Marine RSA and this effect will be offset through the implementation of a marine fish habitat compensation/offset program.
- Probability: high – construction of the Westridge Marine Terminal will affect a small amount of existing rock (riprap) habitat resulting in a temporary decrease in productive capacity; this effect will act cumulatively with historical and reasonably foreseeable in-water developments in the Marine RSA.
- Confidence: high – based on a good understanding of the historical changes to intertidal and subtidal habitats within the Marine RSA, a good understanding of the residual Project effects on inshore rockfish habitat, and a good understanding of the reasonably foreseeable developments that have the potential to affect the productive capacity of inshore rockfish habitat in the Marine RSA.

8.12.3.5 Marine Fish and Fish Habitat Indicator – Pacific Salmon

Historical shoreline developments in Burrard Inlet, particularly in the Inner Harbour, have linearized much of the natural shoreline and replaced structurally complex habitats with riprap and retaining walls (Stantec 2009). This substantial habitat modification has reduced the productive capacity of Pacific salmon habitat within the Marine RSA, particularly for juveniles, which use nearshore habitats extensively for rearing prior to embarking on seaward migrations (Haggarty 2001).

Construction of the Westridge Marine Terminal will result in the loss of intertidal and subtidal habitats, and this will act cumulatively with the effects of historical developments in the Marine RSA. The Project-specific effects on the productive capacity of Pacific salmon habitat are, however, expected to be minimal. The shoreline within the Project Footprint is primarily anthropogenic and Project construction will effectively replace intertidal habitats like-for-like (*i.e.*, riprap with riprap). Nevertheless, the Project's contribution to the cumulative decrease in productive capacity of Pacific salmon habitat is considered to have a negative impact balance. The loss of productive capacity resulting from in-water construction activities will be offset through the implementation of a marine fish habitat compensation/offset program. The preferred option of subtidal rock reefs would provide high-value foraging and rearing habitat for juvenile salmon. The reefs would increase the structural complexity of nearshore habitats in the local area, enhance productivity (*i.e.*, algal growth) and increase prey availability for a variety of marine fish species, including Pacific salmon.

Construction of the Seaspan load-out pier may result in a small reduction in the productive capacity of Pacific salmon habitat; however, the small footprint of this development and the industrial nature of the site suggest that effects will be minimal. Similar to Trans Mountain, Seaspan will implement a fish habitat compensation/offset program to ensure there is no net loss of productive capacity of Pacific salmon habitat.

The cumulative effect of a decrease in the productive capacity of Pacific salmon habitat within the Marine RSA resulting from historical development, Project construction and reasonably foreseeable developments is predicted to be of medium magnitude. However, the major contributor to this effect is the legacy of industrial and urban development that has diminished the natural integrity of shoreline habitats throughout much of Burrard Inlet.

With the implementation of a marine fish habitat compensation/offset program, the Project's contribution to the cumulative decrease in productive capacity of Pacific salmon habitat is predicted to be of low magnitude (Table 8.12-2, point 5[a]). While the productive capacity of Pacific salmon habitat will be temporarily reduced as a result of Project construction, this cumulative effect will be reversed once biotic communities have become fully established on the intertidal and subtidal riprap and the compensation/offsetting habitats. A summary of the rationale for all of the significance criteria of the Project's contribution to cumulative effects on Pacific salmon is provided below.

- Spatial Boundary: Marine RSA – the Project's contribution to marine habitat loss may interact with historical and reasonably foreseeable developments within the Marine RSA to cause a cumulative decrease in the productive capacity of suitable habitat for Pacific salmon in the Marine RSA.
- Duration: short-term – Project activities at the Westridge Marine Terminal that have the potential to contribute to a cumulative decrease in productive capacity of suitable habitat for Pacific salmon are limited to the construction phase.
- Frequency: isolated – Project activities at the Westridge Marine Terminal that have the potential to contribute to a cumulative decrease in productive capacity of suitable habitat for Pacific salmon are confined to the construction phase.
- Reversibility: medium-term – implementation of a marine fish habitat compensation/offset program will ensure there is no net loss of the productive capacity of Pacific salmon; full recovery of productive capacity may take 2 to 3 years following the installation of compensation features.
- Magnitude: low – construction of the Westridge Marine Terminal will decrease the productive capacity of Pacific salmon habitat in only a small portion of the Marine RSA and this effect will be offset through the implementation of a marine fish habitat compensation program.
- Probability: high – construction of the Westridge Marine Terminal will affect intertidal and subtidal habitats used by Pacific salmon, primarily juveniles, resulting in a temporary decrease in productive capacity; this effect will act cumulatively with historical and reasonably foreseeable in-water developments in the Marine RSA.
- Confidence: high – based on a good understanding of the historical changes to intertidal and subtidal habitats within the Marine RSA, a good understanding of the residual Project effects on Pacific salmon habitat, and a good understanding of the reasonably foreseeable developments that have the potential to affect the productive capacity of Pacific salmon habitat in the Marine RSA.

8.12.3.6 Combined Cumulative Effects on Marine Fish and Fish Habitat

Over a century of development in Burrard Inlet has resulted in the modification of a substantial amount of shoreline habitat within the Marine RSA, as well as the infilling of a large area of subtidal habitat (Stantec 2009). These extensive changes to the Burrard Inlet marine ecosystem have undoubtedly reduced the productive capacity of fish habitat, with effects on a variety of marine organisms, including Dungeness crab, inshore rockfish and Pacific salmon. Natural shoreline habitats are still found in some areas of Burrard Inlet, particularly Indian Arm and to a lesser degree Port Moody Arm and the Central Harbour, and current best practices to manage project-specific effects will minimize additional loss of productive capacity of marine fish habitat.

Trans Mountain recognizes the ecological, economic and cultural importance of marine fish and their habitats, and is committed to minimizing adverse effects of the Project on the marine environment. Construction of the Westridge Marine Terminal will result in the loss of intertidal and subtidal habitat within the Project Footprint; however, the associated reduction of productive capacity will be offset through the implementation of a marine fish habitat compensation/offset program. This program will be developed in consultation with DFO, Aboriginal communities, local stewardship groups and other interested parties, and will ensure that there is 'no net loss' of the productive capacity of marine fish habitat. In fact, the goal of the compensation program will be to increase productive capacity so that the Project has a net benefit to marine fish and fish habitat.

Of the three reasonably foreseeable developments located within the Marine RSA, only the Seaspan Modernization Project involves in-water works that could affect marine fish and fish habitat. The footprint of the proposed load-out-pier is small (~1,720 m^2) and the site is heavily industrialized, suggesting that effects on marine fish and fish habitat will be minimal. However, like Trans Mountain, Seaspan will implement a fish habitat compensation program to ensure there is no net loss of the productive capacity of fish habitat.

In consideration of the history of development in the Marine RSA and the extensive changes to shoreline habitats, the combined cumulative effects of historical developments, Project construction, and reasonably foreseeable developments on marine fish and fish habitat are considered to be of medium magnitude.

With the implementation of a suite of mitigation measures designed to minimize adverse effects of the Project on marine fish and their habitats (see Section 7.6.9), the Project's contribution to combined cumulative effects on the marine fish and fish habitat indicators are predicted to be of low magnitude (Table 8.12-2, point 6[a]). A summary of the rationale for all of the significance criteria of the Project's contribution to cumulative effects on the marine fish and fish habitat indicators is provided below.

- Spatial Boundary: Marine RSA – the Project's contribution to marine habitat loss may interact with historical and reasonably foreseeable developments within the Marine RSA to cause combined cumulative effects on marine fish and fish habitat in the Marine RSA.
- Duration: short-term – Project activities at the Westridge Marine Terminal that have the potential to contribute to combined cumulative effects on marine fish and fish habitat are limited to the construction phase.
- Frequency: isolated – Project activities at the Westridge Marine Terminal that have the potential to contribute to combined cumulative effects on marine fish and fish habitat are confined to the construction phase.
- Reversibility: medium-term to permanent – while construction of the Westridge Marine Terminal will result in the permanent loss of some intertidal and subtidal habitat, implementation of a marine fish habitat compensation/offset program will ensure there is no net loss of the productive capacity of marine fish habitat.
- Magnitude: low – construction of the Westridge Marine Terminal will affect marine fish habitats in an area that has been previously modified by development (*i.e.*, most habitats are not natural); any and all losses of productive capacity will be offset through the implementation of a marine fish habitat compensation/offset program.
- Probability: high – construction of the Westridge Marine Terminal involves in-water works that will affect marine fish and fish habitat; these effects will act cumulatively with historical and reasonably foreseeable in-water developments in the Marine RSA.
- Confidence: high – based on a good understanding of the historical changes to marine fish habitats within the Marine RSA, a good understanding of the residual Project effects on marine fish and fish habitat, a good understanding of the effectiveness of habitat compensation/offsetting measures and a good understanding of the reasonably foreseeable developments that have the potential to affect marine fish and fish habitat in the Marine RSA.

8.12.4 Summary

As identified in Table 8.12-2, there are no situations where there is a high probability of occurrence of a permanent or long-term cumulative effect of high magnitude that cannot be technically or economically mitigated. Consequently, the Project's contribution to cumulative effects on marine fish and fish habitat within the Marine RSA will be not significant.

8.13 Marine Mammals

8.13.1 Reasonably Foreseeable Developments

Three certain and reasonably foreseeable developments are identified within the Marine RSA that were considered for the qualitative evaluation of cumulative effects on the marine mammals indicator: Neptune Terminals Coal Handling Infrastructure Upgrade and Expansion; Richardson International Grain Storage Capacity Expansion; and Seaspan Shipyard Modernization. These developments are further described in Section 8.1.4 and Table 8A.1-6 of Appendix 8.1. All three reasonably foreseeable developments are located in the Inner Harbour, west of the Second Narrows, and are distant from the Marine Mammals LSA.

The only Project that will involve in-water works is the Seaspan Shipyard Modernization. The other two projects (Neptune and Richardson) are limited to the construction and expansion of on-land infrastructure. The Seaspan project will produce underwater noise during construction. However, all three Projects will be completed by early 2015 and there will be no temporal overlap with construction of the Westridge Marine Terminal, which is scheduled to commence no earlier than September 2015.

8.13.2 Potential Cumulative Effects

The potential and likely environmental residual effects associated with construction of the Westridge Marine Terminal on the marine mammals indicator were identified in Section 7.11.1.13. As previously noted in Section 7.11.1.13, no pathways of effects to marine mammals associated with operational activities of the Westridge Marine Terminal were identified. Out of the three reasonably foreseeable developments identified in Section 8.1.4 above, only the Seaspan Shipyard Modernization Project is likely to result in residual effects on marine mammals. Given that there will be no temporal overlap between development of this project and construction of the Westridge Marine Terminal, it was determined that there is no potential for cumulative effects on marine mammals during the construction phase of the Project. Furthermore, operational activities at the Westridge Marine Terminal are not expected to affect marine mammals; therefore, there is no potential for cumulative effects during the operations phase of the Project.

8.14 Marine Birds

This subsection discusses how the Project could act in combination with existing activities and reasonably foreseeable developments to cumulatively affect marine bird indicators (*i.e.*, bald eagle, great blue heron, pelagic cormorant, Barrow's goldeneye, glaucous-winged gull and spotted sandpiper) that are anticipated to have an adverse combined Project-specific residual effect.

8.14.1 Reasonably Foreseeable Developments

Table 8A.1-6 of Appendix 8.1 provides a list of the reasonably foreseeable developments within BC and those located within the Marine RSA to be considered in the evaluation of cumulative effects on the Marine Bird indicators. There are three primary future developments located within the Marine RSA (Table 8.11-1) that would contribute to the cumulative effect of disturbance to marine birds from noise and activity during construction and operations: Neptune Bulk Terminals Ltd. Coal Handling Infrastructure Upgrade and Expansion Project; Richardson International Ltd. Grain Storage Capacity Project, and Seaspan Shipyard Modernization Project.

All three Projects are scheduled to be completed by spring 2015 and will have no temporal overlap with the construction of the Westridge Marine Terminal which is scheduled to commence no earlier than September 2015.

8.14.2 Potential Cumulative Effects

The three reasonably foreseeable Projects in Table 8.14-1 are scheduled to be completed prior to the onset of construction of the Westridge Marine Terminal on or after September 2015. Noise from construction of these projects will not be cumulative with noise from construction of the Westridge Marine Terminal. The cumulative effects assessment for the Westridge Marine Terminal will; therefore, only address the potential cumulative effect of disturbances during operations. Refer to Section 7.6.12 for a Project-specific assessment of potential effects associated with construction of the Westridge Marine Terminal on marine bird indicators.

One of the foreseeable developments will involve in-water construction; the load-out pier of the Seaspan Shipyard Modernization Project. With consideration for the extent of disturbance, commercial infrastructure and daily activity in the current terminal, it is unlikely that the inside docking areas are currently visited by seabirds, apart from gull species. The intertidal areas consist of non-productive substrate without vegetation, and there is limited value as a source of food for birds or fish prey. There are abundant opportunities for perching on the existing infrastructure which are not anticipated to change substantially after construction of the load-out pier. There is negligible potential for cumulative effects from loss of marine shoreline or intertidal habitat to marine birds, and this will not be assessed further.

The potential and likely combined environmental residual effects associated with the construction and operation of the Project on marine birds indicators were identified in Section 7.11.1.14 and are listed in Table 8.14-2 along with existing activities and reasonably foreseeable developments that could act in combination with the Project. Because there will not be cumulative effects associated with the risk of mortality or habitat loss, the cumulative effects assessment will consider only the potential for effects from the events of sensory disturbance.

TABLE 8.14-2

POTENTIAL RESIDUAL EFFECTS OF THE PROJECT ON MARINE BIRDS CONSIDERED FOR THE CUMULATIVE EFFECTS ASSESSMENT

Potential Residual Project Effect on Indicator	Spatial Boundary[1]	Project Component(s)	Temporal Boundary	Potential Cumulative Effect	Existing Activities/Reasonably Foreseeable Developments with Residual Effects Acting in Combination with the Project
1. Combined effects on bald eagle.	RSA	Westridge Marine Terminal	Operations	Project contribution to the cumulative effects of marine bird sensory disturbance in the form of stress, behavioural changes or avoidance of preferred or important habitats during operations.	• Existing activities including Marine Commercial, Recreational and Tourism Use. • Reasonably foreseeable developments within the RSA listed in Table 8A.1-6 of Appendix 8.1 and Project and non Project-related vessel traffic discussed in Section 8.1.4. • Project-related activities that could interact with the above activities including noise, terminal activity, lights, vessel berthing/deberthing during operations.
2. Combined effects on great blue heron.	RSA	Westridge Marine Terminal	Operations	Project contribution to the cumulative effects of marine bird sensory disturbance in the form of stress, behavioural changes or avoidance of preferred or important habitats during operations.	• Existing activities including Marine Commercial, Recreational and Tourism Use. • Reasonably foreseeable developments within the RSA listed in Table 8A.1-6 of Appendix 8.1 and Project and non Project-related vessel traffic discussed in Section 8.1.4. • Project-related activities that could interact with the above activities including noise, terminal activity, lights, vessel berthing/deberthing during operations.
3. Combined effects on pelagic cormorant.	RSA	Westridge Marine Terminal	Operations	Project contribution to the cumulative effects of marine bird sensory disturbance in the form of stress, behavioural changes or avoidance of preferred or important habitats during operations.	• Existing activities including Marine Commercial, Recreational and Tourism Use. • Reasonably foreseeable developments within the RSA listed in Table 8A.1-6 of Appendix 8.1 and Project and non Project-related vessel traffic discussed in Section 8.1.4. • Project-related activities that could interact with the above activities including noise, terminal activity, lights, vessel berthing/deberthing during operations.

TABLE 8.14-2 Cont'd

Potential Residual Project Effect on Indicator	Spatial Boundary[1]	Project Component(s)	Temporal Boundary	Potential Cumulative Effect	Existing Activities/Reasonably Foreseeable Developments with Residual Effects Acting in Combination with the Project
4. Combined effects on Barrow's goldeneye.	RSA	Westridge Marine Terminal	Operations	Project contribution to the cumulative effects of marine bird sensory disturbance in the form of stress, behavioural changes or avoidance of preferred or important habitats during operations.	• Existing activities including Marine Commercial, Recreational and Tourism Use. • Reasonably foreseeable developments within the RSA listed in Table 8A.1-6 of Appendix 8.1 and Project and non Project-related vessel traffic discussed in Section 8.1.4. • Project-related activities that could interact with the above activities including noise, terminal activity, lights, vessel berthing/deberthing during operations.
5. Combined effects on glaucous-winged gull.	RSA	Westridge Marine Terminal	Operations	Project contribution to the cumulative effects of marine bird sensory disturbance in the form of stress, behavioural changes or avoidance of preferred or important habitats during operations.	• Existing activities including Marine Commercial, Recreational and Tourism Use. • Reasonably foreseeable developments within the RSA listed in Table 8A.1-6 of Appendix 8.1 and Project and non Project-related vessel traffic discussed in Section 8.1.4. • Project-related activities that could interact with the above activities including noise, terminal activity, lights, vessel berthing/deberthing during operations.
6. Combined effects on spotted sandpiper.	RSA	Westridge Marine Terminal	Operations	Project contribution to the cumulative effects of marine bird sensory disturbance in the form of stress, behavioural changes or avoidance of preferred or important habitats during operations.	• Existing activities including Marine Commercial, Recreational and Tourism Use. • Reasonably foreseeable developments within the RSA listed in Table 8A.1-6 of Appendix 8.1 and Project and non Project-related vessel traffic discussed in Section 8.1.4. • Project-related activities that could interact with the above activities including noise, terminal activity, lights, vessel berthing/deberthing during operations.

Note: 1 RSA = Marine RSA.

8.14.3 Significance Evaluation of Potential Cumulative Effects

The Project's contribution to cumulative effects from the Westridge Marine Terminal operations include potential sensory disturbances from an increase in terminal noise, human activity, night lights, vessel berthing/deberthing activities, maintenance and inspection during operations, increased vessel activities and other local marine activities (*e.g.*, recreational boating, fishing and shoreline use), and the consequent alteration of normal distribution and patterns of marine bird habitat use to avoid particular foreshore areas. Previous research indicates that marine birds are disturbed by in-air noise levels greater than 90 dB per 20 µPa (Gladwin *et al.* 1988). Given the current context of dense marine foreshore development in Burrard Inlet, marine birds have been known to habituate to noise levels under 90 dB and to other sensory disturbances, such as marine activity, night-lighting, and vessel berthing and unberthing events that are periodic, predictable and not adverse experiences (Grubb *et al.* 2002, Steidl and Anthony 2000, Ward and Stehn 1989). Terminal operations are unlikely to have a substantial contribution to cumulative effects in the Marine RSA considering the context of high volume activity and marine industry within their current habitats.

Where there are no standards, guidelines, objectives or other established and accepted ecological thresholds to define quantitative rating criteria, or where quantitative thresholds are not relevant to the Marine RSA, the qualitative method that is based on information and guidance provided from available research literature, and the professional judgment of the assessment team. This qualitative approach is considered to be the appropriate method for evaluating and determining the significance of the anticipated Project's contribution to cumulative environmental effects.

Table 8.14-3 provides a summary of the significance evaluation of the Project's contribution to potential cumulative effects on marine bird indicators. The rationale used to evaluate the significance of each of the cumulative effects is provided below.

TABLE 8.14-3

SIGNIFICANCE EVALUATION OF THE PROJECT'S CONTRIBUTION TO CUMULATIVE EFFECTS ON MARINE BIRDS

	Potential Cumulative Effects	Impact Balance	Spatial Boundary[1]	Temporal Context			Magnitude	Probability	Confidence	Significance[2]
				Duration	Frequency	Reversibility				
1.	Marine Bird Indicator – Bald Eagle									
1(a)	Project contribution to cumulative increase in stress, behavioural changes or avoidance of preferred or important habitats, which may adversely affect species fitness and population sustainability.	Negative	RSA	Long-term	Periodic	Short-term	Low	High	High	Not significant
2.	Marine Bird Indicator – Great Blue Heron									
2(a)	Project contribution to cumulative increase in stress, behavioural changes or avoidance of preferred or important habitats, which may adversely affect species fitness and population sustainability.	Negative	RSA	Long-term	Periodic	Short-term	Low	High	High	Not significant
3.	Marine Bird Indicator – Pelagic Cormorant									
3(a)	Project contribution to cumulative increase in stress, behavioural changes or avoidance of preferred or important habitats, which may adversely affect species fitness and population sustainability.	Negative	RSA	Long-term	Periodic	Short-term	Low	High	Moderate	Not significant
4.	Marine Bird Indicator – Barrow's Goldeneye									
4(a)	Project contribution to cumulative increase in stress, behavioural changes or avoidance of preferred or important habitats, which may adversely affect species fitness and population sustainability.	Negative	RSA	Long-term	Periodic	Short-term	Low	High	Moderate	Not significant
5.	Marine Bird Indicator – Glaucous-winged Gull									
5(a)	Project contribution to cumulative increase in stress, behavioural changes or avoidance of preferred or important habitats, which may adversely affect species fitness and population sustainability.	Negative	RSA	Long-term	Occasional	Short-term	Low	High	High	Not significant
6.	Marine Bird Indicator – Spotted Sandpiper									
6(a)	Project contribution to cumulative increase in stress, behavioural changes or avoidance of preferred or important habitats, which may adversely affect species fitness and population sustainability.	Negative	RSA	Long-term	Periodic	Short-term	Low	High	Moderate	Not significant
7.	Combined Cumulative Effects on Marine Birds									
7(a)	Project contribution to combined cumulative effects on the marine birds indicators (1[a] to 6[a]).	Negative	RSA	Long-term	Periodic	Short-term	Low	High	High	Not significant

Notes: 1 RSA = Marine RSA.

2 Significant Contribution to a Cumulative Environmental Effect: A high probability of occurrence of a permanent or long-term cumulative effect of high magnitude that cannot be technically or economically mitigated.

8.14.3.1 Marine Birds Indicator – Bald Eagle

The bald eagle is a resident avian predator that feeds opportunistically on fish, waterbirds, small mammals and carrion in shallow water and along shorelines, and represents other raptor species which may also be using these shoreline and foreshore habitats. There are approximately 15 breeding pairs of bald eagle within the Marine RSA; however, there are also many more non-breeding individuals present during the fall and winter months (Cook 2008) when bald eagles are less territorial. Increased in-air noise, night-lighting and activity at the Westridge Marine Terminal may cause some individuals to avoid using preferred and/or important seasonal foraging or breeding habitats. Bald eagles have been documented to habituate to noise and human activity in developed areas (Grubb *et al.* 2002, McGarigal *et al.* 1991). Although it is difficult to assess the level of habituation in birds that reside in Burrard Inlet, some habituation is likely in such a busy industrial and commercially developed port where many breeding pairs currently reside. It is reasonable to assume bald eagle persistence is related to some level of anthropogenic tolerance, and this can be said for other raptor or foreshore species that the bald eagle, as an indicator, is representative of, such as vultures, osprey, Cooper's hawk, owls or great blue herons.

The Project's contribution to cumulative effects within the Marine RSA resulting from expansion of the Westridge Marine Terminal is not expected to be substantial beyond the Marine Birds LSA, and will be relatively minor proportion of the effects from existing and foreseeable developments. The Project's contribution to cumulative effects with respect to the bald eagle is primarily of concern in the area of overlap between the breeding territory of a pair of bald eagles, local tree roosts and intertidal zones, and the Westridge Marine Terminal; however, may potentially include the effects of increased vessel activity in the Marine RSA as a whole. Sensory disturbance (*i.e.*, terminal-related in-air noise and activity, increased vessel activity) is considered to have a negative impact balance through the potential for bald eagle avoidance of preferred hunting/foraging foreshore habitats; however, vessel activity is unlikely to present much of a concern for disturbance in the typical shoreline habitats used by this group of species. The potential for long-term periodic disturbances near the terminal may affect a small number of individuals outside the breeding season when eagles are less territorial. It is unlikely that there will be an adverse effect to the regional population which is abundant and stable.

The Project's contribution to the cumulative effects on bald eagles from sensory disturbance events is anticipated to be associated with the terminal and increased Project-related vessel activities within the Marine RSA will be temporary events Recommended mitigation measures in Section 7.6.12 and the Westridge Marine Terminal EPP (Volume 6D) will be implemented to reduce the effects from sensory disturbances. Consequently, with consideration for the existing highly developed environment within the Marine RSA, the stable and abundant local and regional bald eagle population, the likelihood of some level of habituation to local disturbances, and the professional judgment of the assessment team, the Project's contribution to cumulative effects on bald eagle will occur over the long-term and to be of low magnitude and short-term reversibility (Table 8.14-3, point 1[a]). A summary of the rationale for all of the significance criteria of the Project's contribution to cumulative effects on bald eagles is provided below.

- Spatial Boundary: Marine RSA – the Project's contribution to cumulative effects are assessed within the regional context of the Marine RSA with consideration for resident territories of bald eagles.
- Duration: long-term – the events causing sensory disturbance to bald eagles is the contribution to the cumulative effect of repeated and regular Project-related disturbances during terminal and vessel operations for the life of the Project.
- Frequency: periodic – the events causing sensory disturbance to bald eagles is the contribution to the cumulative effect of Project–related terminal and increased vessel activities occurring intermittently but repeatedly throughout the life of the Project.
- Reversibility: short-term – the cumulative effect of Project-related disturbances to bald eagles will be reversible shortly after each disturbance event.
- Magnitude: low – the effects from the Project will be detectable at the individual level but marginal on the bald eagle population in consideration of the high-volume of existing commercial and industrial activity in the Marine RSA and the potential for individual levels of habituation to disturbance.

- Probability: high – the Project is likely to contribute to the cumulative effect of increased sensory disturbances to bald eagles.
- Confidence: high – based on a good understanding by the assessment team of cause-effect relationships between Project-related and local development activities and bald eagles using data specific to the Marine RSA.

8.14.3.2 Marine Birds Indicator – Great Blue Heron

Great blue herons nest colonially in woodland forest. Stanley Park, which extends to the shoreline of the Marine RSA, has a large active nesting colony. A small colony of a few breeding pairs is also located upstream of the Westridge Marine Terminal site in the riparian zone of Heron Creek. The indicator, great blue heron, forages opportunistically on fish, small mammal and invertebrate prey primarily taken within the intertidal zone and, as such, represent the many species of intertidal foragers that occur within the Marine RSA (*e.g.*, sandpiper species, waterfowl species, common raven, migrating birds). Increased noise and activity during terminal and shipping operations could potentially result in the avoidance by some individuals of preferred foraging habitats at foreshore areas (Gebauer and Moul 2001, Vennesland 2000) or local perches in trees or on terminal structures. Extended or high-level disturbance events, such as loud maintenance activity, short-term construction projects, or safety alarms could cause stress in some individuals depending on their degree of prior exposure to noises or terminal-related activities (Carney and Sydeman 1999, 2000). Because primary habitat use is foreshore-based, it is unlikely that increased vessel activity from the Project or other foreseeable developments will present more than a marginal potential for sensory disruptions. Recent scientific literature documents the sensitivities of great blue heron colonies to various sources and types of disturbance (Carney and Sydeman 1999, 2000, Vennesland 2000), the seriousness of which is often dependent on the existing environmental conditions and the familiarity of natal colonies to these disturbances prior to their occurrence. However, habituation has been observed in some population groups (Vennesland 2000), again dependent on local conditions at breeding colonies and natal rearing sites. Operational noise from the terminal is unlikely to extend substantially beyond the Marine Birds LSA, although, unusual or loud vessel activities may occur anywhere within the Marine RSA. The establishment of mitigation measures provided in the Westridge Marine Terminal EPP (Volume 6D) will reduce or avoid potential future noise disturbances to marine life.

The Project's contribution to cumulative effects overall within the Marine RSA will be a relatively minor proportion of the effects from existing activities and reasonably foreseeable developments. The Project's contribution to cumulative effects with respect to the indicator, great blue heron, and other represented species, is concerned with the area of overlap between high suitability foraging sites in shallow areas, and forest or structural roosting sites within the Marine Bird LSA and the Marine RSA. Sensory disturbance (*i.e.*, terminal-related in-air noise and activity, increased vessel activity) is considered to have a negative impact balance by causing marine bird avoidance of preferred foraging habitats. The potential for long-term periodic disturbances, because they are primarily associated with nightly lighting of the terminal, scheduled docking and filling operations, and associated worker activities near the terminal, and 24-hour potential disturbances from increased marine vessel activity, will affect a small number of individuals, both adults and juveniles that have dispersed within the Marine RSA. There is unlikely to be an adverse effect to the regional breeding population because noise will be mitigated through measures established in the Westridge Marine Terminal EPP (Volume 6D), and the breeding colonies are distant enough from the terminal to presume there is likely to be no effect from sensory disturbance.

The Project's contributions to cumulative effects on great blue heron within the Marine RSA from increased sensory disturbance are anticipated to be associated with the terminal and increased Project-related vessel activities, and will be temporary events lasting for a limited time period. Recommended mitigation measures in Section 7.6.12 and the Westridge Marine Terminal EPP (Volume 6D) will be implemented to reduce events of sensory disturbance during operations. Consequently, with consideration for the existing highly developed environment within the Marine RSA, the potential for the local breeding population of great blue herons to have some level of habituation, and the professional judgment of the assessment team, the Project's contribution to cumulative effects on great blue herons is considered long-term in duration, to be of low magnitude effect and of short-term reversibility (Table 8.14-3, point 2[a]). A summary of the rationale for all of the significance criteria for the Project's contribution to cumulative effects on great blue herons is provided below.

- Spatial Boundary: Marine RSA – the Project's contribution to cumulative effects are assessed within the regional context of the Marine RSA with consideration for resident breeding territories of the great blue heron.
- Duration: long-term – the events causing sensory disturbance to great blue herons is the Project's contribution to the cumulative effect of repeated and regular Project-related disturbances during operations for the life of the Project.
- Frequency: periodic – the events causing sensory disturbance to great blue herons is the Project's contribution to the cumulative effect of terminal and increased vessel activities occurring intermittently but repeatedly throughout the life of the Project.
- Reversibility: short-term – the cumulative effect of Project-related disturbances to great blue herons will be reversible shortly after each disturbance event.
- Magnitude: low – the cumulative effects directly related to the Project will be detectable at the individual level but low on the regional population in consideration of the high-volume of existing commercial and industrial activity in the Marine RSA, and with consideration for some potential individual habituation to disturbance.
- Probability: high – the Project is likely to contribute to the cumulative effect of increased sensory disturbances to great blue herons.
- Confidence: high – based on a good understanding by the assessment team of cause-effect relationships between the Project-related activities and great blue herons, and using data specific to the Marine RSA.

8.14.3.3 Marine Birds Indicator – Pelagic Cormorant

Several pelagic cormorant breeding colonies are located within the Marine RSA on rocky islets and bridge structures (Moul and Gebauer 2002). Pelagic cormorants prey on fish within the littoral-benthic zone, including the nearshore areas of the Westridge Marine Terminal and within the Marine RSA. Increased terminal and vessel activity in the overall Marine RSA could potentially disturb individuals using preferred open water and foreshore areas to feed, and/or rocky shorelines and terminal structures to perch and preen. Pelagic cormorants are considered particularly sensitive to boats with a low disturbance threshold to human activities in less disturbed and more natural habitats (Carney and Sydeman 1999, 2000). This species, as an indicator, represents other larger piscivoruous and typically sensitive marine birds that occur within the Marine RSA, such as western grebes and common loons. Habituation is known to occur in some species of marine birds, such as bald eagles and glaucous-winged gulls, and cormorants often take advantage of man-made structures to rest and nest; however, the species represented, such as western grebes are unlikely to be habituated and, in fact, have substantially decreased in local population numbers. Although it is difficult to assess the level of habituation in groups that reside in Burrard Inlet without site-specific research and monitoring efforts; habituation might be assumed for cormorant species that reside in such a busy industrial and commercially developed port where many pairs currently breed.

The Project's contribution to cumulative effects will be a relatively minor proportion of the effects from Project-related and other reasonable foreseeable operations. The Project's contribution to cumulative effects with respect to the pelagic cormorant is concerned with the suitable preening and foraging sites in and near to the terminal and within the larger Marine RSA. Sensory disturbances (*i.e.*, terminal-related in-air noise and activity, and increased vessel activity) are considered to have a negative impact balance through pelagic cormorant avoidance of preferred foraging and roosting habitats. The potential for long-term periodic disturbances is greatest near the Westridge Marine Terminal and will affect a small number of individuals distributed within the eastern portion of the Marine RSA. There is unlikely to be an adverse effect to the regional breeding population because noise levels will be mitigated through established measures provided in the Westridge Marine Terminal EPP (Volume 6D) and will be attenuated with increasing distance between the terminal and breeding colonies that are greater than 5 km from the terminal. In addition, new berths that will be constructed as a part of terminal expansion will provide increased long-term substrates for the re-establishment of benthic invertebrates and vegetation.

The Project's contribution to cumulative effects on pelagic cormorant from increased sensory disturbances is anticipated to be associated with the terminal and increased Project-related vessel traffic, will be temporary events lasting for a limited time period. Recommended mitigation measures in Section 7.6.12 and the Westridge Marine Terminal EPP (Volume 6D) will be implemented to reduce the effects from operations. Adherence to established mitigation measures will reduce or avoid effects to marine life during operation of the Westridge Marine Terminal and associated increased vessel traffic. Consequently, with consideration for the context of the dynamic and highly developed environment of the Marine RSA, the potential for some level of pelagic cormorant habituation to industrial activities, the potential for increased opportunistic use of man-made structures to perch and nest, and the professional judgment of the assessment team, the Project's contribution to cumulative effects on pelagic cormorants will occur over the long-term and be of low magnitude effect and short-term reversibility (Table 8.14-3, point 3[a]). A summary of the rationale for all of the significance criteria of the Project's contribution to cumulative effects on pelagic cormorants is provided below.

- Spatial Boundary: Marine RSA – the Project's contribution to cumulative effects are assessed within the regional context of the Marine RSA with consideration for resident breeding territories of the pelagic cormorant.
- Duration: long-term – the events causing sensory disturbance to pelagic cormorant is the Project's contribution to the cumulative effect of repeated and regular Project-related disturbances during operations for the life of the Project.
- Frequency: periodic – the events causing sensory disturbance to pelagic cormorants is the Project's contribution to the cumulative effect of terminal and increased vessel activities occurring intermittently but repeatedly throughout the life of the Project.
- Reversibility: short-term – the cumulative effect of Project-related disturbances to pelagic cormorant will be reversible shortly after each disturbance event.
- Magnitude: low – the Project's contribution to cumulative effects will be detectable at the individual level but marginal on the population in consideration of the high-volume of existing commercial and industrial activity in the Marine RSA and consideration for potential individual habituation to disturbance.
- Probability: high – the Project is likely to contribute to the cumulative effect of increased sensory disturbances to pelagic cormorants.
- Confidence: moderate – based on a good understanding by the assessment team of cause-effect relationships between marine activities and pelagic cormorants but without sufficient data specific to the Marine RSA.

8.14.3.4 Marine Birds Indicator – Barrow's Goldeneye

Barrow's goldeneyes overwinter in the inlets and harbours of the Marine RSA using rocky shores to preen and rest. In subtidal areas, they feed on crustaceans and fish eggs. As such, they are indicators representing other resident and migrating marine birds that are benthic and invertebrate foragers within the Marine RSA, such as, surf scoters, common goldeneye and some waterfowl species. The existing Westridge Marine Terminal pilings provide a substrate for invertebrate prey. Increased in-air noise and activity at the terminal may disturb individuals that normally use these wharf habitats resulting in avoidance of preferred subtidal zones (Carney and Sydeman 1999, 2000) and consequent loss of foraging opportunities. Habituation is not common in seabird species, especially those that tend to use particular areas seasonally, such as goldeneye, alcids and other migratory species, and it is difficult to determine the potential for individual levels of habituation without site-specific monitoring. Constraints from obtaining important seasonal food requirements can result in reduced habitat effectiveness, energy budget constraints, and reduced individual fitness. The potential for long-term periodic disturbances from terminal activities and increased vessel operations will affect a seasonal number of individuals using the Marine RSA, especially at or near the terminal, and moving to and from preferred sheltered habitats in Indian Arm and Port Moody Arm. Noise and physical disturbances will attenuate with increase in distance of foraging birds, or rafts of birds, from the Westridge Marine Terminal and the central inlet.

The Project's contribution to cumulative effects within and near the Marine RSA will be a relatively minor proportion of the effects from marine activity associated with Project-related and other reasonably foreseeable marine terminal and vessel operations. The Project's contribution to cumulative effects with respect to the Barrow's goldeneye is concerned with suitable foraging and preening sites, primarily in and near the Marine Birds LSA but may extend to the Marine RSA with loud or unusual vessel activity. In-air noise and activity will potentially result in a negative impact balance through the avoidance of Barrow's goldeneye from productive nearshore foraging habitats. The potential for long-term periodic disturbances within the Marine RSA will affect a small number of individuals present on a seasonal basis (*i.e.,* overwintering); however, foraging capacity may improve over the life of the Project with the re-establishment of new benthic invertebrates, bi-valve populations and vegetation attached to the newly constructed wharfs.

The Project's contributions to cumulative effects on Barrow's goldeneye from increased sensory disturbance are anticipated to be associated with the terminal and increased Project-related vessel traffic and will be temporary events, lasting for a limited time period. Recommended mitigation measures in Section 7.6.12 and the Westridge Marine Terminal EPP (Volume 6D) will be implemented to reduce the effects from operations. Consequently, with consideration for the context of the highly developed environment of the Marine RSA, the potential for seasonal familiarity and some individual habituation to urban activity in overwintering areas, and the professional judgment of the assessment team, the Project's contribution to cumulative effects on Barrow's goldeneye will occur over the long-term and be of low magnitude effect and short-term reversibility (Table 8.14-3, point 4[a]). A summary of the rationale for all of the significance criteria for the Project's contribution to cumulative effects on Barrow's goldeneyes is provided below.

- Spatial Boundary: Marine RSA – the Project's contribution to cumulative effects are assessed within the regional context of the Marine RSA with consideration for preferred, seasonal, high suitability foraging habitats of the Barrow's goldeneye.
- Duration: long-term – the events causing sensory disturbance to Barrow's goldeneye is the Project's contribution to the cumulative effect of repeated and regular Project-related disturbances during operations for the life of the Project.
- Frequency: periodic – the events causing sensory disturbance to Barrow's goldeneye is the Project's contribution to the cumulative effect of terminal and increased vessel activities occurring intermittently but repeatedly throughout the life of the Project.
- Reversibility: short-term – the cumulative effect of Project-related disturbances to Barrow's goldeneye will be reversible shortly after each disturbance event.
- Magnitude: low – the Project's contribution to cumulative effects will be detectable at the individual level but negligible on the population in consideration of the high-volume of existing commercial and industrial activity in the Marine RSA and seasonal use by Barrow's goldeneyes.
- Probability: high – the Project is likely to contribute to the cumulative effect of increased sensory disturbances to Barrow's goldeneye.
- Confidence: moderate – based on a good understanding by the assessment team of cause-effect relationships between the Project activities and Barrow's goldeneye, without data pertinent to the Marine RSA and the potential for some individual familiarity with local disturbances.

8.14.3.5 Marine Birds Indicator – Glaucous-Winged Gull

An abundant population of glaucous-winged gulls opportunistically fish and scavenge within the marine and upland environments of the Marine RSA (Suraci and Dill 2011). There are several breeding colonies present within the Marine RSA including a site within 1 km of the Westridge Marine Terminal on the south shore of Port Moody Arm. Man-made commercial structures including the existing terminal pilings and berths currently provide shelter and roosting habitat which may later be enhanced by new wharf structures added during the expansion of the Westridge Marine Terminal. Glaucous-winged gulls are indicators of a wide range of other marine birds that forage and nest within the Marine RSA due their versatile habitat use and strong-association with human-influenced environments, and as in other species, their sensitivity during the breeding cycle, particularly during egg-laying and incubation.

Increased in-air noise, human activity, night-lighting and increased vessel movements may result in disturbance to individuals using these open water or shoreline habitats; however, for this species, habituation to anthropogenic disturbances is common and reasonable to assume in the urban and industrially developed context of marine habitats of Burrard Inlet. The Westridge Marine Terminal EPP (Volume 6D) has been developed to employ mitigation measures to avoid disturbance to marine life and includes consideration for sensitive wildlife periods (*i.e.*, the breeding period of glaucous-winged gulls from early May to late August at local breeding colonies). Noise levels capable of disturbing nesting birds will decrease with the distance of the nest sites from the source and are not expected to extend much beyond the Marine Birds LSA.

The Project's contribution to cumulative effects on glaucous-winged gulls within the Marine RSA will be a relatively minor proportion of the effects from combined sensory disturbance. The Project's contributions to cumulative effects on glaucous-winged gulls are anticipated to be associated with the terminal and increased Project-related vessel activity, and will be temporary events. Recommended mitigation measures in Section 7.6.12 and the Westridge Marine Terminal EPP (Volume 6D) will be implemented to reduce the effects from operations. Consequently, with consideration for the context of the highly developed environment of the Marine RSA, the likelihood of habituation and opportunistic advantages to gulls provided by urban developed marine areas, and the professional judgment of the assessment team, the Project's contribution to cumulative effects on glaucous-winged gulls will occur over the long-term and be of low magnitude effect and short-term reversibility (Table 8.14-3, point 5[a]). A summary of the rationale for all of the significance criteria of the Project's contribution to cumulative effects on glaucous-winged gulls is provided below.

- Spatial Boundary: Marine RSA – the Project's contribution to cumulative effects are assessed within the regional context of the Marine RSA with consideration for resident breeding territories of the glaucous-winged gull.
- Duration: long-term – the events causing sensory disturbance to glaucous-winged gulls is the Project's contribution to the cumulative effect of repeated and regular Project-related disturbances during operations for the life of the Project.
- Frequency: occasional – the events causing sensory disturbance to glaucous-winged gulls is the Project's contribution to the cumulative effect of terminal and increased vessel activities occurring intermittently and sporadically throughout the life of the Project.
- Reversibility: short-term – the cumulative effect of Project-related disturbances to glaucous-winged gulls will be reversible shortly after each disturbance event.
- Magnitude: low – the Project's contribution to cumulative effects will be detectable at the individual level but negligible to the population in consideration of the high-volume of existing commercial and industrial activity in the Marine RSA, the known anthropogenic association between gulls and human-influenced habitats, and the adherence to appropriate mitigation measures at the terminal.
- Probability: high – the Project is likely to contribute to the cumulative effects of increased sensory disturbances to glaucous-winged gulls.
- Confidence: high – based on a good understanding by the assessment team of cause-effect relationships between the Project activities and glaucous-winged gulls, the likelihood of some level of individual habituation to disturbance, and data pertinent to the Marine RSA.

8.14.3.6 Marine Birds Indicator – Spotted Sandpiper

Spotted sandpipers use a variety of aquatic habitats, nesting at shores under herbaceous ground cover and using mudflats, beaches, and breakwaters where they forage exclusively on invertebrates. The local population of spotted sandpipers is highest during migration and recent literature indicates the regional breeding population is stable (Gratto-Trevor *et al.* 2010). Like other sandpipers, they tend to flush easily during human disturbance events. Spotted sandpipers are indicators of a diversity of small and large migratory sandpiper species, and resident passerines (such as song sparrows), which use the intertidal and foreshore areas seasonally to forage on insects and other invertebrates, and to nest in shoreline vegetation, nest boxes (such as Purple martin) and debris. The additional in-air noise, light and activity at the Westridge Marine Terminal and the increased vessel activity during operations may stress individuals that are using preferred and/or important intertidal habitats to forage and upland shoreline habitats for breeding and nesting. Continued disturbance events may result in an alteration of patterns of habitat use to avoid those disturbed areas, and/or alterations to critical energy budgets during the breeding season. Noise or unusual activity at the terminal may have some measureable adverse effect on spotted sandpipers which as a bird group tend to be reactive to non-natural environmental inputs. Levels of habituation are not very well understood in this species. Disturbance can adversely affect habitat effectiveness, alter energy budgets and reduce individual fitness (Carney and Sydeman 1999, 2000). No nests have been documented at the shoreline or within the Westridge Marine Terminal footprint to-date; however, new nests can be initiated at any suitable location each year. The Westridge Marine Terminal EPP (Volume 6D) has been developed to reduce or eliminate potential harm or disturbance to marine life during operations to include environmental monitoring for wildlife and consideration of sensitive wildlife breeding periods. Noise and activity are not expected to extend much beyond the Marine Birds LSA.

The Project's contribution to cumulative effects on spotted sandpipers within the Marine RSA is expected to be a relatively minor proportion of total combined effects. However, habitat use is primarily in intertidal and shoreline areas; therefore, vessel activity is likely to be less of a concern except during unusual or loud activities. The Project's contributions to cumulative effects on spotted sandpipers are anticipated to be associated with the terminal and increased Project-related vessels, and disturbance events will be temporary. Recommended mitigation measures in Section 7.6.12 and the Westridge Marine Terminal EPP (Volume 6D) will be implemented to reduce the effects from operations. Consequently, with consideration for the context of the highly developed environment of the Marine RSA, seasonal breeding within the upper reaches of the Marine RSA, and the professional judgment of the assessment team, the Project's contribution to cumulative effects on spotted sandpipers will occur over the long-term and be of low magnitude effect and short-term reversibility (Table 8.14-3, point 6[a]). A summary of the rationale for all of the significance criteria of the Project's contribution to cumulative effects on spotted sandpipers is provided below.

- Spatial Boundary: Marine RSA – the Project's contribution to cumulative effects are assessed within the regional context of the Marine RSA with consideration for resident and migrating spotted sandpipers.
- Duration: long-term – the events causing sensory disturbance to spotted sandpipers is the Project's contribution to the cumulative effect of repeated and regular Project-related terminal and increased vessel activities during operations for the life of the Project.
- Frequency: periodic – the events causing sensory disturbance to spotted sandpipers is the Project's contribution to the cumulative effect of terminal and increased vessel activities occurring intermittently but repeatedly throughout the life of the Project.
- Reversibility: short-term – the cumulative effect of Project-related disturbances to spotted sandpipers will be reversible shortly after each disturbance event.
- Magnitude: low – the Project's contribution to cumulative effects will be detectable at the individual level but anticipated to be low on the population in consideration of the high-volume of existing commercial and industrial activity in the Marine RSA, and potential seasonable breeding within the Marine Birds LSA.
- Probability: high – the Project is likely to contribute to the cumulative effects of increased sensory disturbances to spotted sandpipers.
- Confidence: moderate – based on a good understanding by the assessment team of cause-effect relationships between marine activities and spotted sandpiper, sensitivity to disturbance events but without sufficient data specific to the Marine RSA.

8.14.3.7 Combined Effects on Marine Birds

The evaluation of the Project's contribution to the combined cumulative effects on the marine birds indicators from expansion of the Westridge Marine Terminal and increased Project-related vessels considers collectively the likelihood of potential residual effects on the following indicator species: bald eagle; great blue heron; pelagic cormorant; Barrow's goldeneye; glaucous-winged gull; and spotted sandpiper, and the larger diverse group of marine bird ecological guilds they represent. The potential Project-related cumulative effects are associated with sensory disturbance and consequent stress, behavioural alteration or changes in energy budget in each indicator. The potential cumulative effects of noise, human-activity, night-lighting, unusual events and increased vessel berthing/deberthing and movements within the Marine RSA may act in combination to affect marine birds as described above for each of the marine birds indicator species.

The potential impact balance to marine birds is considered negative. The implementation of mitigation measures described in Section 7.0 and the Westridge Marine Terminal EPP (Volume 6D) will reduce the severity of Project's contribution to cumulative effects arising from the Project and reasonably foreseeable developments. Burrard Inlet is one of the busiest ports on the Pacific Coast and effects are considered in the context of existing and predicted future high-volume industrial and commercial terminal and vessel activity within the Marine RSA, and the Project's modest contribution to that activity. The evaluation of effects takes into account that there is strict adherence to an existing regulatory framework for marine shipping operations. The combined contribution to cumulative effects on marine birds from the Project-related activities is considered to be of low magnitude, reversible in the short-term and of high probability (Table 8.14-3, point 7[a]). A summary of the rationale for all the significance criteria of the Project's contribution to cumulative effects on marine bird indicators is provided below.

- Spatial Boundary: Marine RSA – combined Project-related contribution to cumulative effects on marine birds are assessed within the context of projected future marine activities interacting with Project-related activities in the Marine RSA.
- Duration: long-term – the events causing the combined Project-related contribution to cumulative effects on marine birds will occur during operations for the life of the Project.
- Frequency: periodic – the events causing sensory disturbance to marine birds is the combined Project-related contribution to cumulative effects of the repeated and regular terminal and increased vessel activities which will occur intermittently for the life of the Project.
- Reversibility: short-term – the combined Project-related contribution to cumulative effects from sensory disturbance causing behavioural alterations will be reversible shortly after each disturbance event.
- Magnitude: low – the combined Project-related contribution to cumulative effects will be detectable at the individual level and may have low to negligible effects on populations, particularly during sensitive breeding periods, in consideration of the high-volume of existing marine activity and extent of shoreline development that currently exists within the Marine RSA, and some level of individual habituation to disturbance.
- Probability: high – the Project is likely to contribute to combined adverse cumulative effects on marine birds from sensory disturbance to varying degrees, during some energetically taxing seasons, such as migration or breeding, and under some environmental conditions.
- Confidence: high – based on a good understanding by the assessment team on pathways of cumulative effect between the increased Project-related activities and marine birds, and with data relevant to the Marine RSA.

8.14.4 Summary

As identified in Table 8.14-3, there are no situations where there is a high probability of the occurrence of a permanent or long-term residual cumulative effect of high magnitude on marine birds from the Project.

Consequently, it is concluded that the Project's contribution to the cumulative effects of the Project on marine birds in the Marine RSA will be not significant.

8.15 Marine Species at Risk

As discussed in Section 7.6.13, potential effects of the Project on marine species at risk are assessed through the use of indicators in Section 7.6.9 Marine Fish and Fish Habitat and Section 7.6.12 Marine Birds. Consequently, the cumulative effects assessment on combined effects of the Project on indicator species at risk is conducted in Section 8.12 Marine Fish and Fish Habitat and Section 8.14 Marine Birds.

Similar to Section 7.0, although not all species at risk are discussed explicitly under each indicator, potential cumulative effects were assessed in consideration of all species at risk. The indicators used to represent marine fish and fish habitat and marine birds were carefully selected to ensure that the full range of potential Project effects and Project contribution to cumulative effects on marine species at risk was addressed and mitigation measures to reduce these effects will apply to all marine species at risk, not just the indicators. Sections 8.12 Marine Fish and Fish Habitat and Section 8.14 Marine Birds provide the significance rationale for applicable indicator species. No significant adverse cumulative effects on marine species at risk have been identified as a result of the pipeline and facilities component of the Project.

8.16 Summary of the Assessment of Potential Cumulative Effects

An evaluation of the significance of the Project's contribution to cumulative effects was conducted for each indicator determined to have a likely combined residual effect associated with the Project, as identified in Section 7.11. Furthermore, an evaluation of the significance of the Project's contribution to cumulative effects was also conducted for each element where more than one likely cumulative effect may act in combination.

The cumulative effects assessment followed a standard approach for each likely combined residual effect associated with the Project. Effects resulting from existing activities and predicted for reasonably foreseeable developments were considered individually and in combination with those associated with the Project. Existing activities that have contributed to cumulative effects include agriculture and livestock grazing, forestry, rural and urban residential and commercial development, transportation and infrastructure development, utilities activities, oil and gas exploration and development and mineral resource exploration and development. Reasonably foreseeable developments that could contribute to cumulative effects include oil and gas developments (predominantly in Alberta), hydroelectric developments (in BC), transmission line developments, mining developments, transportation and infrastructure developments, utility activities, and marine developments and activities. Overall, the cumulative environmental effects associated with the construction and operation of the Project are similar to those routinely encountered during pipeline and facility construction in western Canada.

A number of potential cumulative effects associated with the following environmental elements were identified:

- physical elements such as soils and soil productivity, water quality and quantity, air emissions and acoustic environment;
- biological elements such as fish and fish habitat, wetland loss or alteration, vegetation, wildlife and wildlife habitat, and species at risk; and
- marine elements such as marine sediment and water quality, marine fish and fish habitat, marine birds and marine species at risk.

No potential cumulative effects were identified for marine mammals indicators since it was determined that there were no reasonably foreseeable developments that could act in combination with the Project to affect marine mammals in the Marine RSA.

The Project's contribution to a cumulative environmental effect is considered significant if the contribution is predicted to have a high probability of occurrence of a permanent or long-term cumulative effect of high magnitude that cannot be technically or economically mitigated. As identified in this cumulative effects assessment, with the implementation of mitigation measures in Section 7.0 and the Pipeline, Facilities and Westridge Marine Terminal EPPs (Volumes 6B, 6C and 6D), the Project's contribution to cumulative effects on the environmental indicators for the pipeline and facilities component of the Project is considered to be not significant.

8.17 References

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TERA wishes to acknowledge those people identified in the Personal Communications for their assistance in supplying information and comments incorporated in this report.

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Hopp, R. President and CEO, Run-of-river Power Inc. Delta, BC.

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Natland, J. Manager of Development Strategies, Port Metro Vancouver. Vancouver, BC.

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APPENDIX 8.1

REASONABLY FORESEEABLE DEVELOPMENTS

TABLE 8A.1-1

REASONABLY FORESEEABLE DEVELOPMENTS (MAPPED)

Mapping Number	Title	Location	Proponent	Type	Application Status	Description	Capital Cost	Construction Schedule	Element LSA or RSA	Sources
EDMONTON TO HINTON SEGMENT										
Proposed Pipeline Developments										
1	ACCESS Northeast Pipeline Expansion	Conklin area to Redwater area	ACCESS Pipeline Inc.	Oil Pipeline	Under review (ERCB application submitted June 15, 2012)	Proposed approximately 295 km 1,067 mm low vapour pressure bitumen blend pipeline from a pump station near Conklin at 1-16-77-5 W4M to the existing ACCESS Sturgeon Terminal at 4-18-56-21 W4M.	$1 billion	In-service by early 2015	Aquatics/ Wetland RSA	AER Application #1724272: website: http://www.ercb.ca/applications-and-hearings/notices/2012/1724272 ACCESS Northeast Pipeline Expansion website: http://accessexpansion.com/ Project Information Package: http://accessexpansion.com/docs/Access-Northeast-Expansion-Project-Information.pdf
2	Alberta Carbon Trunk Line	Near Fort Saskatchewan, Alberta to southeast of Lacombe	Enhance Energy Inc.	CO_2 Pipeline	Approved	A large-scale CO_2 enhanced oil recovery and storage project Near Fort Saskatchewan, Alberta to southeast of Lacombe.	$ unknown	Currently under construction, in-service by late 2013	Aquatics/ Wetland RSA	Enhance Energy Inc. website: http://www.enhanceenergy.com/actl
3	Edmonton to Hardisty Pipeline Project	Edmonton to Hardisty	Enbridge Pipelines Inc.	Oil Pipeline	Under review (NEB application submitted December 14, 2012)	A proposed 181 km new 914.4 mm (NPS 36) crude oil pipeline from the existing Enbridge Edmonton Terminal to the existing Enbridge Hardisty Terminal. The proposed pipeline right-of-way will be alongside and contiguous to an existing Enbridge pipeline right-of-way and other linear disturbances for approximately 96.6% of its length.	$286 million	Construction from Q3 2014 to Q1 2015	Air Quality RSA Aquatics/ Wetland RSA Acoustic RSA Soil LSA Vegetation RSA Wildlife RSA	NEB website: http://www.neb-one.gc.ca/clf-nsi/rthnb/pplctnsbfrthnb/nbrdgdmntnhrdsty/nbrdgdmntnhrdsty-eng.html#s1 Enbridge – Edmonton to Hardisty Pipeline Project website: http://www.enbridge.com/EdmontonHardistyPipeline.aspx
4	Grand Rapids Pipeline Project	Fort McMurray to Edmonton	TransCanada PipeLines Ltd. (Grand Rapids Pipeline GP Ltd.)	Oil and Diluent Pipeline	Under review (ERCB application submitted May 23, 2013)	Proposed pipeline project that includes both a crude oil and a diluent line to transport volumes approximately 500 km between the producing area northwest of Fort McMurray and the Edmonton / Heartland region.	$3 billion	Construction from summer 2014 to early 2017	Air Quality RSA Aquatics/ Wetland RSA Acoustic RSA Soil LSA Vegetation RSA Wildlife RSA	AER website: https://www3.eub.gov.ab.ca/eub/dds/iar_query/ApplicationAttachments.aspx?AppNumber=1763130 TransCanada PipeLines Ltd. website: http://www.transcanada.com/grand-rapids.html March 2013 – Project Update: http://www.transcanada.com/docs/Key_Projects/Grand-Rapids-Project-Update.pdf Right- of-way: https://www3.eub.gov.ab.ca/eub/dds/iar_query/ApplicationAttachments.aspx?AppNumber=1763130
5	Heartland Pipeline and TC Terminals Projects	Fort Saskatchewan to Hardisty	TransCanada PipeLines Ltd. (Heartland Pipeline GP Ltd. and TC Terminals GP Ltd.)	Oil Pipeline and Tank Storage Facility	Pre-application (AER filing planned in Q3 2013)	Split into two separate projects: a proposed approximately 200 km 914 mm (NPS 36) crude oil pipeline extending from 13 km northeast of Fort Saskatchewan to 7 km south of Hardisty, also entailing the construction of two pump stations; and a proposed tank storage facility near Fort Saskatchewan at SW/SE 28-55-21 W4M.	$900 million	Construction from summer 2014 to early 2015	Aquatics/ Wetland RSA	TransCanada PipeLines Ltd. website: http://www.transcanada.com/6215.html
6	Line 2 Replacement Project	Enbridge Edmonton Terminal to Joseph Lake	Enbridge Pipelines Inc.	Oil Pipeline	NEB approval granted on May 17, 2013	Proposed 38.2 km pipeline paralleling the alignment of the Edmonton to Hardisty Pipeline Project (above) from the Enbridge Edmonton Terminal at NE 32-52-23 W4M to a valve located near Joseph Lake at SW 1-50-22 W4M.	$ unknown	Construction from August 2013 to late 2013	Air Quality RSA Aquatics/ Wetland RSA Acoustic RSA Soil LSA Vegetation RSA Wildlife RSA	NEB website: https://www.neb-one.gc.ca/ll-eng/livelink.exe?func=ll&objId=893373&objAction=browse&sort=-name

TABLE 8A.1-1 Cont'd

Mapping Number	Title	Location	Proponent	Type	Application Status	Description	Capital Cost	Construction Schedule	Element LSA or RSA	Sources
7	Northern Gateway Project	Bruderheim, Alberta to Kitimat, BC	Northern Gateway Pipelines Limited Partnership	Oil and Condensate Pipeline	Under review (NEB application submitted May 2010)	Key components of the project include: • separate oil and condensate pipelines, each of about 1,172 km in length; • 10 pump stations; • all-weather road access and electrical power infrastructure for the pump stations and the Kitimat Terminal; • fourteen 496,000-barrel capacity tanks; • a utility berth; and • two marine loading and unloading berths. The project will generate approximately 62,694 person-years of employment during construction throughout the Canadian economy and 1,146 full-time jobs annually during operation.	$5.5 billion	Construction from 2014 to 2017	Aquatics/ Wetland RSA Grizzly Bear RSA	NEB website: https://www.neb-one.gc.ca/ll-eng/livelink.exe/fetch/2000/90464/90552/384192/620327/customview.html?func=ll&objId=620327&objAction=browse Northern Gateway Project website: http://www.northerngateway.ca/ Enbridge Northern Gateway Project Joint Review Panel website: http://gatewaypanel.review-examen.gc.ca/clf-nsi/hm-eng.html
8	Polaris Expansion Project – Edmonton Extension	Lamont to Sherwood Park	Inter Pipeline Inc.	Diluent Pipeline	Proposed	Installation of approximately 50 km of NPS 24 diluent pipeline and facilities from certain Edmonton area diluent receipt points to the Polaris Lamont Pump Station. The new pipeline will provide 111,290 m^3/d (700,000 bbl/d) of diluent supply capacity to the Lamont Station.	$80 million	Construction from 2013 to 2016	Air Quality RSA Aquatics/ Wetland RSA Acoustic RSA Wildlife RSA	Inter Pipeline Inc. website: http://www.interpipelinefund.com/operations/new-projects.cfm
9	Quest Carbon Capture and Storage Project	Thorhild to approximately 5 km northeast of Fort Saskatchewan	Shell Canada Ltd.	Carbon Capture and Storage Project	ERCB approval granted on July 10, 2012	The proposed development entails: construction of facilities for the capture of 1.2 megatonnes of CO_2 per year at the existing Shell Scotford Upgrader at 12-32-55-21 W4M; an 80 km pipeline to transport dense-phase CO_2 from the Scotford Upgrader to the sequestration site located north of the County of Thorhild at 15-29-60-21 W4M; and three to eight CO_2 injection wells connected to the main pipeline by laterals, each of which would be less than 15 km long.	$1.35 billion	Construction from late 2012 to 2015	Aquatics/ Wetland RSA	ERCB Decision: http://www.ercb.ca/decisions/2012/2012-ABERCB-008.pdf Shell website: http://www.shell.ca/en/aboutshell/our-business-tpkg/business-in-canada/upstream/oil-sands/quest.html
10	Western Reach Pipeline System	Gordondale to Fort Saskatchewan	Plains Midstream Canada ULC	Gas Pipelines	Pre-application (in early planning stages)	A proposed dual 570 km pipeline system originating in the Gordondale area to meet the transportation and processing demands of producers drilling in the Deep Basin.	$900 million	In-service by late 2015	Aquatics/ Wetland RSA	Plains Midstream Canada ULC website: http://www.plainsmidstream.com/content/open-season-proposed-new-western-reach-ngl-pipeline-system
11	Woodland Pipeline Extension Project	Fort McMurray to Sherwood Park	Enbridge Pipelines (Woodlands) Inc.	Oil Pipeline	ERCB approval granted on August 30, 2012	Construction and operation of two pump stations and a pipeline that would transport diluted bitumen from Enbridge Pipelines (Athabasca) Inc.'s existing Cheecham Terminal, located 7-8-84-6 W4M at Fort McMurray, Alberta to Enbridge Pipelines Inc.'s existing Edmonton Terminal, located at 5-4-53-23 W4M at Sherwood Park, Alberta.	$ unknown	Construction start in 2013, with operation scheduled for 2015	Air Quality RSA Aquatics/ Wetland RSA Acoustic RSA Wildlife RSA	ERCB Decision: http://www.ercb.ca/decisions/2012/2012-ABERCB-009.pdf Enbridge website: http://www.enbridge.com/WoodlandPipelineExtensionProject/ProjectOverview.aspx
Proposed Transmission Line Developments										
12	Eastern Alberta Transmission Line Project	Northeast Edmonton area to Brooks area	ATCO Electric Ltd.	Overhead Transmission Line	AUB approval granted on November15, 2012	A new transmission line between the Gibbons-Redwater area northeast of Edmonton and the Brooks area southeast of Calgary. The new line will be built and operated as a 500 kilovolt (kV) high voltage direct current line and run approximately 500 km in length.	$1.65 billion	Currently under construction, in-service by late 2014	Aquatics/ Wetland RSA	AUC website: http://www.auc.ab.ca/items-of-interest/eastern-alberta-transmission-line/Pages/default.aspx ATCO Electric Ltd. website: http://hvdc.atcoelectric.com/
13	Heartland Transmission Project	Edmonton Area	EPCOR Distribution and Transmission and AltaLink Management Ltd.	Overhead Transmission Line	AUB approval granted on November 1, 2011	Involves the construction of an overhead double circuit 500 kV transmission line, which will connect to the Heartland Substation (northwest of Fort Saskatchewan) to the Ellerslie Substation.	$582 million	Currently under construction, in-service by fall 2013	Air Quality RSA Aquatics/ Wetland RSA Acoustic RSA Soil LSA Vegetation RSA Wildlife RSA	AUC website: http://www.auc.ab.ca/items-of-interest/heartland-transmission-project/Pages/default.aspx Heartland Transmission Project website: http://www.heartlandtransmission.ca/update/index.asp
14	Western Alberta Transmission Line Project	Genesee area to Langdon area	AltaLink Management Ltd.	Overhead Transmission Line	AUB approval granted on December 6, 2012	A new transmission line between the Genesee area west of Edmonton to Langdon area east of Calgary. The new line will be built and operated as a 500 kV high voltage direct current line.	$ unknown	Currently under construction, in-service by spring 2015	Aquatics/ Wetland RSA	AUC website: http://www.auc.ab.ca/items-of-interest/western-alberta-transmission-line/Pages/default.aspx AltaLink Management Ltd. website: http://www.altalink.ca/projects/centralabtransmission/watl/watl-project.cfm

TABLE 8A.1-1 Cont'd

Mapping Number	Title	Location	Proponent	Type	Application Status	Description	Capital Cost	Construction Schedule	Element LSA or RSA	Sources
Additional Proposed Developments										
15	Parkland Airport (Phase 1)	Approximately 15 km east of Spruce Grove	Parkland Airport Development Corp.	Airport	Proposed	The proposed Parkland Airport will consist of two phases. Phase 1 will consist of an east–west runway with basic aviation services, hangars and offices. The potential Phase 2 (2015+) development would consist of a north–south runway to enhance the airport's operation in all wind conditions.	$35 million	Construction of Phase 1 from 2013 to 2014 and Phase 2 in 2015 or later	Air Quality RSA Aquatics/ Wetland RSA Acoustic RSA Soil LSA Vegetation RSA Wildlife RSA	Alberta Inventory of Major Projects: https://www.albertacanada.com/business/statistics/inventory-of-major-projects.aspx Parkland Airport Development Corp website: http://www.parklandairport.com/
16	Robb Trend Project	Approximately 40 km southeast of Hinton	Coal Valley Resources Inc.	Coal Mine	Under review (Environmental Impact Assessment [EIA] submitted to ERCB in April 2012)	The proposed Robb Trend Project is a proposed extension to the existing mining and coal processing activities at Coal Valley Mine, approximately 40 km southeast of Hinton. The development is located adjacent to existing mining operations, and will yield approximately 88.75 million clean metric tonnes available for sale. This additional tonnage would provide Coal Valley Resources Inc. with the necessary resources to operate at projected rates of production until 2038.	$ unknown	Construction and operation will occur in stages, with construction of Stages 1A and 1B from late 2013 to 2017 and initial operations anticipated to commence in late 2014	Aquatics/ Wetland RSA Grizzly Bear RSA	Alberta Environment and Sustainable Resource Development website: http://environment.alberta.ca/02313.html
17	Vista Coal Mine Project	Approximately 10 km east of Hinton	Coalspur Mines Ltd.	Coal Mine	Under review (EIA submitted to ERCB in May 2012)	The proposed mine will develop 5 million clean tonnes per year of moderately low-rank bituminous, suited for thermal electric generation. The proposed mine is approximately 10 km east of Hinton town boundary and extends southeast for approximately 12 km to the McLeod River valley. The proposed Vista Coal Mine Project will involve: • a surface coal mine including pits, external waste rock dumps, a full range of surface coal mining and support equipment and infrastructure; • associated infrastructure including raw and clean coal conveyors, crushers and sizers, a coal processing plant and drying facilities, fresh water storage pond, fines settling pond and clean-coal load-out facility. The load-out facility loads coal into rail cars on a siding that will be constructed, owned and operated by CN Rail; • access corridors, haul roads, utilities and environmental management systems for a 20-year mining area. Projected labour requirements include approximately 700 person-years of construction and approximately 510 full time positions during operation.	$ unknown	Construction will occur in stages, expected to start in 2014 and initial operations anticipated to commence in 2015	Air Quality RSA Aquatics/ Wetland RSA Acoustic RSA Vegetation RSA Wildlife RSA Grizzly Bear RSA	Alberta Environment and Sustainable Resource Development website: http://environment.alberta.ca/02313.html Coalspur Mines Ltd. website: http://www.coalspur.com/
HARGREAVES TO DARFIELD SEGMENT										
Proposed Hydroelectric Developments										
1	Castle Creek Hydropower Project	Approximately 30 km south of McBride	Castle Mountain Hydro Ltd.	Run-of-River Hydroelectric Project	Investigative use permit issued by BC MFLNRO on October 8, 2012	Proposed 8 MW hydropower project on Benjamin Creek located in the McBride area.	$20 million	In-service by November 2016	Aquatics/ Wetland RSA Wildlife RSA	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf Northern Development Initiative Trust website: http://investnorthcentralbc.ca/major-projects-investment-opportunities/map-view/robson-valley/castle-mountain-run-of-river-projects BC MFLNRO Investigative Use Application and Reasons for Decision (file #7408639): http://www.arfd.gov.bc.ca/ApplicationPosting/viewpost.jsp?PostID=8003 BC MFLNRO Investigative Use Application: http://arfd.gov.bc.ca/ApplicationPosting/viewpost.jsp?PostID=19649 BC Hydro website: http://www.bchydro.com/energy-in-bc/acquiring_power/closed_offerings/clean_power_call/outcome.html

TABLE 8A.1-1 Cont'd

Mapping Number	Title	Location	Proponent	Type	Application Status	Description	Capital Cost	Construction Schedule	Element LSA or RSA	Sources
2	McIntosh Creek Hydroelectric Project	Approximately 12 km northwest of McBride	Snowshoe Power Ltd.	Run-of-River Hydroelectric Project	Investigative use permit issued by BC MFLNRO	Proposed 1.2 MW hydroelectric facility on McIntosh Creek, approximately 12 km northwest of McBride.	$ unknown	In-service by December 2013	Grizzly Bear RSA	Northern Development Initiative Trust website: http://investnorthcentralbc.ca/major-projects-investment-opportunities/map-view/mcbride-2/mcintosh-creek-project BC Hydro Interconnection Queue: http://transmission.bchydro.com/NR/rdonlyres/20779185-8EEC-4622-9B6A-0AF4DD50E642/0/TGIQueue2013Apr22.pdf Personal communication (information request) with FrontCounter BC (May 27, 2013)
3	Morkill River Hydroelectric Project	Approximately 22 km northeast of Crescent Spur	Robson Valley Power Corp.	Run-of-River Hydroelectric Project	Investigative use permit issued by BC MFLNRO on February 11, 2013	Proposed 5 to 10 MW hydroelectric project on the Morkill River, a tributary to the Fraser River. The project will require access roads (temporary and permanent), staging and spoil areas. The project will require an approximately 52 km long 69 kV transmission line.	$ unknown	Construction to commence by 2017	Grizzly Bear RSA	Robson Valley Power Corp Investigative Use Plan: http://www.arfd.gov.bc.ca/ApplicationPosting/getfile.jsp?PostID=11105&FileID=43595&action=view BC MFLNRO Investigative Use Reasons for Decision (file #7408964): http://arfd.gov.bc.ca/ApplicationPosting/getdecisionfile.jsp?DecisionID=30724&DecisionFileID=27460&action=view BC MFLNRO websites: http://arfd.gov.bc.ca/ApplicationPosting/viewpost.jsp?PostID=11105 http://arfd.gov.bc.ca/ApplicationPosting/viewpost.jsp?PostID=11106
4	Robson Valley (Holmes River) Hydroelectric Project	Approximately 10 km west of McBride	Holmes Hydro Inc.	Run-of-River Hydroelectric Project	License of Occupation granted by BC MFLNRO	Series of 10 run-of-river plants with a total of 76.5 MW located on tributaries in the Holmes watershed.	$ unknown	In-service by December 2013 (note – according to FrontCounter BC, construction has not commenced)	Aquatics/ Wetland RSA Grizzly Bear RSA	BC Hydro Generator Interconnection Queue shows as under review. Website: http://transmission.bchydro.com/NR/rdonlyres/20779185-8EEC-4622-9B6A-0AF4DD50E642/0/TGIQueue2013Apr22.pdf BC MFLNRO Transmission Line Application: http://arfd.gov.bc.ca/ApplicationPosting/viewpost.jsp?PostID=7991 Holmes Hydro Inc. President letter to Regional District of Fraser-Fort George: https://rdffg.civicweb.net/Documents/DocumentDisplay.aspx?ID=10495 Personal communication (information request) with FrontCounter BC (May 13, 2013 and May 31, 2013)
Additional Proposed Developments										
5	Harper Creek Copper-Gold-Silver Project	Approximately 10 km south of Vavenby	Yellowhead Mining Inc.	Copper-Gold-Silver Mine	Pre-application (final AIRs submitted on October 21, 2011)	A proposed open pit mine with a 28 year mine life based on throughput of 70,000 tonnes/ day. Additional infrastructure includes power lines, access roads, facilities and storage areas.	$759 million	Mine will be constructed over a period of 18 to 24 months, with production expected for late 2016	Aquatics/ Wetland RSA Wildlife RSA Grizzly Bear RSA	BC EAO website: http://a100.gov.bc.ca/appsdata/epic/html/deploy/epic_project_home_333.html Yellowhead Mining Inc. website: http://www.yellowheadmining.com/s/Home.asp
BLACK PINES TO HOPE SEGMENT, HOPE TO BURNABY SEGMENT AND BURNABY TO WESTRIDGE SEGMENT										
Proposed Pipeline Developments										
1	Kingsvale – Oliver Natural Gas Pipeline Reinforcement Project	Kingsvale to Oliver	FortisBC Energy Inc. (FortisBC)	Natural Gas Pipeline	Pre-application (FortisBC received BC EAO approval of final Application Information Requirements on December 5, 2012)	The proposed project consists of looping the existing FortisBC pipeline system between Kingsvale, BC and Oliver, BC over a length of approximately 161 km, as well as a 1 km pipeline extension near Yahk and the addition of compression facilities at Kingsvale, Trail and Yahk.	$ unknown	Clearing and construction from Q4 2015 to Q4 2016	Air Quality RSA Aquatics/ Wetland RSA Acoustic RSA Soil LSA Vegetation RSA Wildlife RSA Grizzly Bear RSA	BC EAO website: http://a100.gov.bc.ca/appsdata/epic/html/deploy/epic_document_375_35173.html

TABLE 8A.1-1 Cont'd

Mapping Number	Title	Location	Proponent	Type	Application Status	Description	Capital Cost	Construction Schedule	Element LSA or RSA	Sources
Proposed Transmission Line Developments										
2	Interior – Lower Mainland Transmission Project	Merritt to Coquitlam	British Columbia Transmission Corporation	Overhead Transmission Line	BC EAO Certificate issued	Construction of a new 500 kV transmission line, mostly along the existing right-of-way from the Nicola Substation near Merritt to the Meridian Substation in Coquitlam.	$725 million	Currently under construction with an in-service date of January 2015	Air Quality RSA Aquatics/ Wetland RSA Acoustic RSA Soil LSA Vegetation RSA Wildlife RSA Wildlife Grizzly Bear RSA	BC EAO: http://a100.gov.bc.ca/appsdata/epic/html/deploy/epic_project_home_290.html BC Hydro Website: http://www.bchydro.com/energy_in_bc/projects/ilm.html
3	Merritt Area Transmission Project	Merritt	BC Hydro	Overhead Transmission Line	BC EAO Certificate issued	Proposed 35 km 138 kV transmission line between the Merritt and Highland substations, mostly along existing unused BC Hydro right-of-way.	$66 million	Construction start in early 2013 with operations by summer 2014	Air Quality RSA Aquatics/ Wetland RSA Acoustic RSA Soil LSA Vegetation RSA Wildlife RSA	BC Hydro: http://www.bchydro.com/energy_in_bc/projects/mat.html Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf
Hydroelectric Developments										
4	American Creek Hydroelectric Project	Approximately 5 km north of Hope	Highwater Power Corp.	Run-of-River Hydroelectric Project	Investigative use permit issued by BC MFLNRO on September 25, 2012	Proposed 11.6 MW hydroelectric project on American Creek, approximately 5 km north of Hope.	$ unknown	Undetermined	Aquatics/ Wetland RSA Wildlife RSA	BC MFLNRO Investigative Use Application and Reasons for Decision (file #2408339): http://www.arfd.gov.bc.ca/ApplicationPosting/viewpost.jsp?PostID=4085
5	Anderson River Hydroelectric Project	Approximately 10 km southeast of Boston Bar	Syntaris Power Corp.	Run-of-River Hydroelectric Project	Investigative use permit issued by BC MFLNRO on October 15, 2012	Proposed 13 MW run-of-river hydro project from Anderson, East Anderson and Uztlius intakes located approximately 10 km southeast of Boston Bar.	$90 million	Undetermined	Aquatics/ Wetland RSA Wildlife Grizzly Bear RSA	BC MFLNRO Investigative Use Application and Reasons for Decision (file #2409681): http://www.arfd.gov.bc.ca/ApplicationPosting/viewpost.jsp?PostID=8966
6	Big Silver Creek Hydroelectric Project	Approximately 55 km north-northwest of Agassiz	Innergex Renewable Energy Inc.	Run-of-River Hydroelectric Project	BC EAO Certificate Issued on August 17, 2012	The project collectively consists of three hydroelectric projects: a 23 MW hydroelectric project on Tretheway Creek, a 13 MW hydroelectric project on Shovel Creek; and a 36 MW hydroelectric project on Big Silver Creek. The area of development is approximately 55 km north-northwest of Agassiz.	$ unknown	In-service planned for December 2015 for Tretheway Creek and November 2016 for Shovel Creek and Big Silver Creek	Aquatics/ Wetland RSA	BC EAO Application File for Tretheway Creek: http://a100.gov.bc.ca/appsdata/epic/html/deploy/epic_project_home_325.html BC EAO Application File for Shovel Creek: http://a100.gov.bc.ca/appsdata/epic/html/deploy/epic_project_home_327.html BC EAO Application File for Big Silver Creek: http://a100.gov.bc.ca/appsdata/epic/html/deploy/epic_project_home_325.html
7	Borden Creek Hydroelectric Project	Approximately 18 km southeast of Chilliwack	Trigen Renewable Energy	Run-of-River Hydroelectric Project	Investigative use permit issued by BC MFLNRO on October 19, 2012	Proposed 4.1 MW hydroelectric project on Borden Creek, approximately 18 km southeast of Chilliwack.	$ unknown	Undetermined	Aquatics/ Wetland RSA Wildlife RSA Wildlife Grizzly Bear RSA	BC MFLNRO Investigative Use Application and Reasons for Decision (file #2409751): http://www.arfd.gov.bc.ca/ApplicationPosting/viewpost.jsp?PostID=9221
8	Bremner Creek Hydroelectric Project	Approximately 50 km north-northwest of Agassiz	Second Reality Effects Inc.	Run-of-River Hydroelectric Project	Investigative use permit issued by BC MFLNRO on August 31, 2012	Proposed hydroelectric project on Bremner Creek, approximately 50 km north-northwest of Agassiz. The number of MW generated by the project is unavailable.	$ unknown	Undetermined	Aquatics/ Wetland RSA	BC MFLNRO Investigative Use Application and Reasons for Decision (file #2409028): http://www.arfd.gov.bc.ca/ApplicationPosting/viewpost.jsp?PostID=5969
9	Cantelon-Yola Creeks Hydroelectric Project	Approximately 20 km south of Hope	Pamawed Resources Ltd.	Run-of-River Hydroelectric Project	Investigative use permit issued by BC MFLNRO on October 23, 2012	Proposed hydroelectric project on Cantelon and Yola creeks, approximately 20 km south of Hope. The number of MW generated by the project is unavailable.	$ unknown	Undetermined	Aquatics/ Wetland RSA Wildlife RSA Wildlife Grizzly Bear RSA	BC MFLNRO Investigative Use Application and Reasons for Decision (file #2409049): http://arfd.gov.bc.ca/ApplicationPosting/viewpost.jsp?PostID=5958
10	Airplane Creek Hydroelectric Project	Approximately 15 km east-southeast of Chilliwack	Chilliwack Power Corp.	Run-of-River Hydroelectric Project	Investigative use permit issued by BC MFLNRO on October 22, 2012	Proposed hydroelectric project on Airplane Creek, approximately 15 km east-southeast of Chilliwack. The number of MW generated by the project is unavailable.	$ unknown	Undetermined	Aquatics/ Wetland RSA Wildlife RSA Wildlife Grizzly Bear RSA	BC MFLNRO Investigative Use Application and Reasons for Decision (file #2409114): http://www.arfd.gov.bc.ca/ApplicationPosting/viewpost.jsp?PostID=6672

TABLE 8A.1-1 Cont'd

Mapping Number	Title	Location	Proponent	Type	Application Status	Description	Capital Cost	Construction Schedule	Element LSA or RSA	Sources
	Chipmunk Creek Hydroelectric Project	Approximately 10 km east of Chilliwack	Chilliwack Power Corp.	Run-of-River Hydroelectric Project	Investigative use permit issued by BC MFLNRO on November 23, 2012	Proposed hydroelectric project on Chipmunk Creek, approximately 10 km east of Chilliwack. The number of MW generated by the project is unavailable.	$ unknown	Undetermined	Aquatics/ Wetland RSA Wildlife RSA Wildlife Grizzly Bear RSA	BC MFLNRO Investigative Use Application and Reasons for Decision (file #2409115): http://www.arfd.gov.bc.ca/ApplicationPosting/viewpost.jsp?PostID=6671
11	Deneau Creek Hydroelectric Project	Approximately 10 km northeast of Hope	Trigen Renewable Energy	Run-of-River Hydroelectric Project	Investigative use permit issued by BC MFLNRO on October 29, 2012	Proposed 3 MW hydroelectric project on Deneau Creek, approximately 10 km northeast of Hope.	$ unknown	Undetermined	Air Quality RSA Aquatics/ Wetland RSA Acoustic RSA Soil LSA Vegetation RSA Wildlife RSA Wildlife Grizzly Bear RSA	BC MFLNRO Investigative Use Application and Reasons for Decision (File #2409645): http://www.arfd.gov.bc.ca/ApplicationPosting/viewpost.jsp?PostID=8907
12	Emory Creek Hydroelectric Project	Approximately 15 km north of Hope	Highwater Power Corp.	Run-of-River Hydroelectric Project	Investigative use permit issued by BC MFLNRO on September 25, 2012	Proposed 19 MW hydroelectric project on Emory Creek, approximately 15 km north of Hope.	$ unknown	Undetermined	Aquatics/ Wetland RSA Wildlife RSA	BC MFLNRO Investigative Use Application and Reasons for Decision (file #2408337): http://www.arfd.gov.bc.ca/ApplicationPosting/viewpost.jsp?PostID=4074
13	Fir Creek Hydroelectric Project	Approximately 55 km north of Agassiz	Innergex Renewable Energy Inc.	Run-of-River Hydroelectric Project	Investigative use permit issued by BC MFLNRO on October 1, 2012	Proposed 5.3 MW hydroelectric project on Fir Creek, approximately 55 km north of Agassiz.	$ unknown	Undetermined	Aquatics/ Wetland RSA	BC MFLNRO Investigative Use Application and Reasons for Decision (file #2409694): http://www.arfd.gov.bc.ca/ApplicationPosting/viewpost.jsp?PostID=9081
14	Florence Lake Pumped Storage Hydroelectric Project	Approximately 18 km north of Mission	Clean Balance Power Inc.	Pumped Storage Hydro Power Project	Investigative use permit issued by BC MFLNRO on October 19, 2012	Proposed 25 MW capacity pumped storage hydro power system located on Florence Lake, approximately 18 km north of Mission.	$ unknown	Undetermined	Aquatics/ Wetland RSA Wildlife RSA	BC MFLNRO Investigative Use Application and Reasons for Decision (file #2409767): http://www.arfd.gov.bc.ca/ApplicationPosting/viewpost.jsp?PostID=9277
15	Hoover Lake Pumped Storage Hydroelectric Project	Approximately 8 km northeast of Mission	Clean Balance Power Inc.	Pumped Storage Hydro Power Project	Investigative use permit issued by BC MFLNRO on October 18, 2012	Proposed 26 MW capacity pumped storage hydro power system located on Hoover Lake, approximately 8 km northeast of Mission.	$ unknown	Undetermined	Aquatics/ Wetland RSA Wildlife RSA	BC MFLNRO Investigative Use Application and Reasons for Decision (file #2409695): http://www.arfd.gov.bc.ca/ApplicationPosting/viewpost.jsp?PostID=9085
16	Hunter Creek Hydroelectric Project	Approximately 10 km southwest of Hope	Princeton Energy Inc.	Run-of-River Hydroelectric Project	Investigative use permit issued by BC MFLNRO on September 27, 2012	Proposed 2.64 MW hydroelectric project on Hunter Creek, approximately 10 km southwest of Hope.	$ unknown	Undetermined	Air Quality RSA Aquatics/ Wetland RSA Acoustic RSA Soil LSA Vegetation RSA Wildlife RSA Wildlife Grizzly Bear RSA	BC MFLNRO Investigative Use Application and Reasons for Decision (file #2408242): http://arfd.gov.bc.ca/ApplicationPosting/viewpost.jsp?PostID=3882
17	Isabel and Pitt Lake Pumped Storage Hydroelectric Project	Approximately 30 km north of Maple Ridge	6167047 Canada Ltd.	Pumped Storage Hydro Power Project	Investigative use permit issued by BC MFLNRO on October 22, 2012	Proposed 225 MW capacity pumped storage hydro power system on Isabel and Pitt lakes, approximately 30 km north of Maple Ridge.	$ unknown	Undetermined	Aquatics/ Wetland RSA	BC MFLNRO Investigative Use Application and Reasons for Decision (file #2409743): http://www.arfd.gov.bc.ca/ApplicationPosting/viewpost.jsp?PostID=9170
18	Kenyon Lake Pumped Storage Hydroelectric Project	Approximately 25 km north-northeast of Mission	Clean Balance Power Inc.	Pumped Storage Hydro Power Project	Investigative use permit issued by BC MFLNRO on November 27, 2012	Proposed 50 MW capacity pumped storage hydro power system on Kenyon Lake, approximately 25 km north-northeast of Mission.	$ unknown	Undetermined	Aquatics/ Wetland RSA Wildlife RSA	BC MFLNRO Investigative Use Application and Reasons for Decision (file #2409710): http://www.arfd.gov.bc.ca/ApplicationPosting/viewpost.jsp?PostID=9144
19	Kwoiek Creek Water Power Project	Approximately 22 km south of Lytton	Kwoiek Creek Resources and Innergex II Inc.	Run-of-River Hydroelectric Project	BC EAO Certificate issued	Proposed 50 MW, run-of-river project located on the lower reaches of Kwoiek Creek, a tributary to the Fraser River. The project will include an approximately 80 km long, 138 kV transmission line to the BC Hydro substation at Highland Valley.	$180 million	Currently under construction with completion scheduled for fall 2013	Aquatics/ Wetland RSA Wildlife Grizzly Bear RSA	BC EAO website: http://a100.gov.bc.ca/appsdata/epic/html/deploy/epic_project_home_125.html Kwoiek Creek Resources website: http://www.kwoiekcreekhydro.com/

TABLE 8A.1-1 Cont'd

Mapping Number	Title	Location	Proponent	Type	Application Status	Description	Capital Cost	Construction Schedule	Element LSA or RSA	Sources
20	Kookipi Creek Water Power Project	Approximately 15 km northwest of Boston Bar	Highwater Power Corporation	Run-of-River Hydroelectric Project	Investigative use permit issued by BC MFLNRO on July 23, 2012	Proposed 10 MW run-of-river hydro project on Kookipi Creek located approximately 15 km northwest of Boston Bar.	$20 million	Undetermined	Aquatics/ Wetland RSA	BC MFLNRO Investigative Use Application and Reasons for Decision: http://arfd.gov.bc.ca/ApplicationPosting/viewpost.jsp?PostID=28589 BC MFLNRO Transmission Line Investigative Use Application and Reasons for Decision: http://arfd.gov.bc.ca/ApplicationPosting/viewpost.jsp?PostID=8288
	Log Creek Water Power Project	Approximately 30 km northwest of Boston Bar	Highwater Power Corporation	Run-of-River Hydroelectric Project	Investigative use permit issued by BC MFLNRO on July 23, 2012	Proposed 10 MW run-of-river hydro project on Log Creek located approximately 30 km northwest of Boston Bar.	$20 million	Undetermined	Aquatics/ Wetland RSA Wildlife RSA	BC MFLNRO Investigative Use Application and Reasons for Decision: http://arfd.gov.bc.ca/ApplicationPosting/viewpost.jsp?PostID=28588 BC MFLNRO Transmission Line Investigative Use Application and Reasons for Decision: http://arfd.gov.bc.ca/ApplicationPosting/viewpost.jsp?PostID=8288
21	Lookout Mountain Pumped Storage Hydroelectric Project	Approximately 20 km north-northeast of Agassiz	Clean Balance Power Inc.	Pumped Storage Hydroelectric Project	Investigative use permit issued by BC MFLNRO on March 19, 2013	Proposed pumped storage hydroelectric project at unnamed lakes east of Harrison Lake, approximately 20 km north-northeast of Agassiz.	$ unknown	Undetermined	Aquatics/ Wetland RSA Wildlife RSA	BC MFLNRO Investigative Use Application and Reasons for Decision (file #2410808): http://www.arfd.gov.bc.ca/ApplicationPosting/viewpost.jsp?PostID=34686
22	Maselpanik Creek Hydroelectric Project	Approximately 40 km southeast of Hope	Pamawed Resources Ltd.	Run-of-River Hydroelectric Project	Investigative use permit issued by BC MFLNRO on October 9, 2012	Proposed hydroelectric project on Maselpanik Creek, approximately 40 km southeast of Hope. The number of MW generated by the project is unavailable.	$ unknown	Undetermined	Aquatics/ Wetland RSA Wildlife Grizzly Bear RSA	BC MFLNRO Investigative Use Application and Reasons for Decision (file #2409047): http://arfd.gov.bc.ca/ApplicationPosting/viewpost.jsp?PostID=5956
23	Nasakwatch Creek Hydroelectric Project	Approximately 30 km southeast of Chilliwack	Link Power Management Ltd.	Run-of-River Hydroelectric Project	Investigative use permit issued by BC MFLNRO on October 15, 2012	Proposed hydroelectric project on Nasakwatch Creek, approximately 30 km southeast of Chilliwack. The number of MW generated by the project is unavailable.	$ unknown	Undetermined	Aquatics/ Wetland RSA Wildlife Grizzly Bear RSA	BC MFLNRO Investigative Use Application and Reasons for Decision (file #2408594): http://www.arfd.gov.bc.ca/ApplicationPosting/viewpost.jsp?PostID=4184
24	Patterson Creek Nano Hydro Project	Approximately 7 km southeast of Agassiz	Lizabet Patheiger / Eric Redmond	Run-of-River Hydroelectric Project	Investigative use permit issued by BC MFLNRO on October 10, 2012	Proposed 0.4 MW hydroelectric project on Patterson Creek, approximately 7 km southeast of Agassiz.	$ unknown	Undetermined	Air Quality RSA Aquatics/ Wetland RSA Acoustic RSA Soil LSA Vegetation RSA Wildlife RSA Wildlife Grizzly Bear RSA	BC MFLNRO Investigative Use Application and Reasons for Decision (file #2409394): http://www.arfd.gov.bc.ca/ApplicationPosting/viewpost.jsp?PostID=7848
25	Peers Creek Hydroelectric Project	Approximately 10 km east of Hope	Princeton Energy Inc.	Run-of-River Hydroelectric Project	Investigative use permit issued by BC MFLNRO on October 15, 2012	Proposed 1.75 MW hydroelectric project on Peers Creek, approximately 10 km east of Hope.	$ unknown	Undetermined	Air Quality RSA Aquatics/ Wetland RSA Acoustic RSA Soil LSA Vegetation RSA Wildlife RSA Wildlife Grizzly Bear RSA	BC MFLNRO Investigative Use Application and Reasons for Decision (File #2408245): http://www.arfd.gov.bc.ca/ApplicationPosting/viewpost.jsp?PostID=4160
26	Pierce Creek Hydroelectric Project	Approximately 20 km southeast of Chilliwack	Larson Farms Inc.	Run-of-River Hydroelectric Project	Investigative use permit issued by BC MFLNRO on October 15, 2012	Proposed 0.76 MW hydroelectric project on Pierce Creek, approximately 20 km southeast of Chilliwack.	$ unknown	Undetermined	Aquatics/ Wetland RSA Wildlife RSA Wildlife Grizzly Bear RSA	BC MFLNRO Investigative Use Application and Reasons for Decision (file #2407992): http://www.arfd.gov.bc.ca/ApplicationPosting/viewpost.jsp?PostID=3884
27	Potter Creek Hydroelectric Project	Approximately 20 km southeast of Hope	Princeton Energy Inc.	Run-of-River Hydroelectric Project	Investigative use permit issued by BC MFLNRO on October 2, 2012	Proposed 1.75 MW hydroelectric project on Potter Creek, approximately 20 km southeast of Hope.	$ unknown	Undetermined	Wildlife RSA Wildlife Grizzly Bear RSA	BC MFLNRO Investigative Use Application and Reasons for Decision (file #2408243): http://arfd.gov.bc.ca/ApplicationPosting/viewpost.jsp?PostID=4163

TABLE 8A.1-1 Cont'd

Mapping Number	Title	Location	Proponent	Type	Application Status	Description	Capital Cost	Construction Schedule	Element LSA or RSA	Sources
28	Roaring Creek Hydroelectric Project	Approximately 40 km north-northeast of Mission	Alpine Power and Transmission Inc.	Run-of-River Hydroelectric Project	Investigative use permit issued by BC MFLNRO on October 23, 2012	Proposed 6.6 MW hydroelectric project on Roaring Creek, approximately 40 km north-northeast of Mission.	$ unknown	Undetermined	Aquatics/ Wetland RSA	BC MFLNRO Investigative Use Application and Reasons for Decision (file #2408255): http://www.arfd.gov.bc.ca/ApplicationPosting/viewpost.jsp?PostID=4130 BC MFLNRO Application Amendment: http://www.arfd.gov.bc.ca/ApplicationPosting/viewpost.jsp?PostID=8106
29	Sakwi Creek Hydroelectric Project	Approximately 40 km northeast of Mission	Sakwi Creek Power Corporation	Run-of-River Hydroelectric Project	Investigative use permit issued by BC MFLNRO on March 28, 2013	Proposed 5.5 MW hydroelectric project on Sakwi Creek, approximately 40 km northeast of Mission.	$ unknown	Undetermined	Aquatics/ Wetland RSA	BC MFLNRO Investigative Use Application and Reasons for Decision (file #2410820): http://www.arfd.gov.bc.ca/ApplicationPosting/viewpost.jsp?PostID=33305
30	Salsbury Creek Hydroelectric Project	Approximately 40 km north-northeast of Mission	Alpine Power and Transmission Inc.	Run-of-River Hydroelectric Project	Investigative use permit issued by BC MFLNRO on October 22, 2012	Proposed 7.8 MW hydroelectric project on Salsbury Creek, approximately 40 km north-northeast of Mission.	$ unknown	Undetermined	Aquatics/ Wetland RSA	BC MFLNRO Investigative Use Application and Reasons for Decision (file #2408256): http://www.arfd.gov.bc.ca/ApplicationPosting/viewpost.jsp?PostID=4140 BC MFLNRO Application Amendment: http://www.arfd.gov.bc.ca/ApplicationPosting/viewpost.jsp?PostID=8112
31	Sawmill Creek Hydroelectric Project	Approximately 25 km north of Hope	Jim Dent Construction Ltd.	Run-of-River Hydroelectric Project	Investigative use permit issued by BC MFLNRO on October 9, 2012	Proposed 7.5 MW run of river hydro project on Sawmill Creek located approximately 25 km north of Hope.	$ unknown	Undetermined	Aquatics/ Wetland RSA	BC MFLNRO Investigative Use Application and Reasons for Decision (file #2409806): http://www.arfd.gov.bc.ca/ApplicationPosting/viewpost.jsp?PostID=9474
32	Shovel Creek Hydroelectric Project	Approximately 55 km north-northwest of Agassiz	Innergex Renewable Energy Inc.	Run-of-River Hydroelectric Project	BC EAO Certificate Issued on August 17, 2012	The project collectively consists of three hydroelectric projects: a 23 MW hydroelectric project on Tretheway Creek, a 13 MW hydroelectric project on Shovel Creek; and a 36 MW hydroelectric project on Big Silver Creek. The area of development is approximately 55 km north-northwest of Agassiz.	$ unknown	In-service date planned for December 2015 for Tretheway Creek and November 2016 for Shovel Creek and Big Silver Creek	Aquatics/ Wetland RSA	BC EAO Application File for Tretheway Creek: http://a100.gov.bc.ca/appsdata/epic/html/deploy/epic_project_home_325.html BC EAO Application File for Shovel Creek: http://a100.gov.bc.ca/appsdata/epic/html/deploy/epic_project_home_327.html BC EAO Application File for Big Silver Creek: http://a100.gov.bc.ca/appsdata/epic/html/deploy/epic_project_home_325.html
33	Siwash Creek Hydroelectric Project	Approximately 15 km south of Lytton	Morehead Valley Hydro Inc.	Run-of-River Hydroelectric Project	Under review for tenure by BC MFLNRO	Proposed 2.2 MW run of river hydro project on Siwash Creek located approximately 15 km south of Lytton.	$ unknown	Undetermined	Aquatics/ Wetland RSA Wildlife Grizzly Bear RSA	BC MFLNRO Project Scope (file #3412485): http://arfd.gov.bc.ca/ApplicationPosting/viewpost.jsp?PostID=27246
34	Skwellepil Creek Hydroelectric Project	Approximately 40 km north-northeast of Mission	Alpine Power and Transmission Inc.	Run-of-River Hydroelectric Project	Investigative use permit issued by BC MFLNRO on October 23, 2012	Proposed 6.3 MW hydroelectric project on Skwellepil Creek, approximately 40 km north-northeast of Mission.	$ unknown	Undetermined	Aquatics/ Wetland RSA	BC MFLNRO Investigative Use Application and Reasons for Decision (file #2408254): http://www.arfd.gov.bc.ca/ApplicationPosting/viewpost.jsp?PostID=4127 BC MFLNRO Application Amendment: http://www.arfd.gov.bc.ca/ApplicationPosting/viewpost.jsp?PostID=8101
35	Slollicum Lake Pumped Storage Hydroelectric Project	Approximately 18 km west-northwest of Hope	Clean Balance Power Inc.	Pumped Storage Hydro Power Project	Investigative use permit issued by BC MFLNRO on November 1, 2012	Proposed 22.5 MW capacity pumped storage hydro power system located on Slollicum Lake, approximately 18 km west-northwest of Hope.	$ unknown	Undetermined	Aquatics/ Wetland RSA Wildlife RSA	BC MFLNRO Investigative Use Application and Reasons for Decision (file #2409765): http://www.arfd.gov.bc.ca/ApplicationPosting/viewpost.jsp?PostID=9270
36	Snowshoe Creek Hydroelectric Project	Approximately 60 km north of Agassiz	Innergex Renewable Energy Inc.	Run-of-River Hydroelectric Project	Investigative use permit issued by BC MFLNRO on September 25, 2012	Proposed 4.2 MW hydroelectric project on Snowshoe Creek, approximately 60 km north of Agassiz.	$ unknown	Undetermined	Aquatics/ Wetland RSA	BC MFLNRO Investigative Use Application and Reasons for Decision (file #2409689): http://www.arfd.gov.bc.ca/ApplicationPosting/viewpost.jsp?PostID=8998
37	Statlu Creek Hydroelectric Project	Approximately 30 km northeast of Mission	Innergex Renewable Energy Inc.	Run-of-River Hydroelectric Project	Investigative use permit issued by BC MFLNRO on October 10, 2012	Proposed 22.5 MW hydroelectric project on Statlu Creek, approximately 30 km northeast of Mission.	$ unknown	Undetermined	Aquatics/ Wetland RSA	BC MFLNRO Investigative Use Application and Reasons for Decision (file #2409277): http://www.arfd.gov.bc.ca/ApplicationPosting/viewpost.jsp?PostID=7323
38	Statlu Lake Hydroelectric Project	Approximately 40 km north-northeast of Mission	Alpine Power and Transmission Inc.	Run-of-River Hydroelectric Project	Investigative use permit issued by BC MFLNRO on October 22, 2012	Proposed 9.6 MW hydroelectric project on Statlu Lake, approximately 40 km north-northeast of Mission.	$ unknown	Undetermined	Aquatics/ Wetland RSA	BC MFLNRO Investigative Use Application and Reasons for Decision (file #2408253): http://www.arfd.gov.bc.ca/ApplicationPosting/viewpost.jsp?PostID=4131 BC MFLNRO Application Amendment: http://www.arfd.gov.bc.ca/ApplicationPosting/viewpost.jsp?PostID=8017
39	Tamihi Creek Hydroelectric Project	Approximately 15 km southeast of Chilliwack	KMC Energy Corp.	Run-of-River Hydroelectric Project	Investigative use permit issued by BC MFLNRO on February 18, 2013	Proposed 9.9 MW hydroelectric project on Tamihi Creek, approximately 15 km southeast of Chilliwack.	$20 million	Undetermined	Aquatics/ Wetland RSA Wildlife RSA Wildlife Grizzly Bear RSA	BC MFLNRO Investigative Use Application and Reasons for Decision (file #2408854): http://www.arfd.gov.bc.ca/ApplicationPosting/viewpost.jsp?PostID=5977

TABLE 8A.1-1 Cont'd

Mapping Number	Title	Location	Proponent	Type	Application Status	Description	Capital Cost	Construction Schedule	Element LSA or RSA	Sources
40	Thretheway Creek Hydroelectric Project	Approximately 55 km north-northwest of Agassiz	Innergex Renewable Energy Inc.	Run-of-River Hydroelectric Project	BC EAO Certificate Issued on August 17, 2012	The project collectively consists of three hydroelectric projects: a 23 MW hydroelectric project on Tretheway Creek, a 13 MW hydroelectric project on Shovel Creek; and a 36 MW hydroelectric project on Big Silver Creek. The area of development is approximately 55 km north-northwest of Agassiz.	$ unknown	In-service date planned for December 2015 for Tretheway Creek and November 2016 for Shovel Creek and Big Silver Creek	Aquatics/ Wetland RSA	BC EAO Application File for Tretheway Creek: http://a100.gov.bc.ca/appsdata/epic/html/deploy/epic_project_home_325.html BC EAO Application File for Shovel Creek: http://a100.gov.bc.ca/appsdata/epic/html/deploy/epic_project_home_327.html BC EAO Application File for Big Silver Creek: http://a100.gov.bc.ca/appsdata/epic/html/deploy/epic_project_home_325.html
41	Tributary to Nicolum Creek Hydroelectric Project	Approximately 5 km southeast of Hope	Princeton Energy Inc.	Run-of-River Hydroelectric Project	Investigative use permit issued by BC MFLNRO on October 16, 2012	Proposed 1.17 MW hydroelectric project on a tributary to Nicolum Creek, approximately 5 km southeast of Hope.	$ unknown	Undetermined	Air Quality RSA Aquatics/ Wetland RSA Acoustic RSA Wildlife RSA Wildlife Grizzly Bear RSA	BC MFLNRO Investigative Use Application and Reasons for Decision (file #2408247): http://arfd.gov.bc.ca/ApplicationPosting/viewpost.jsp?PostID=4161
42	Trio Creek Hydroelectric Project	Approximately 40 km north-northwest of Agassiz	Second Reality Effects Inc.	Run-of-River Hydroelectric Project	Investigative use permit issued by BC MFLNRO on October 31, 2012	Proposed hydroelectric project on Trio Creek, approximately 40 km north-northwest of Agassiz. The number of MW generated by the project is unavailable.	$ unknown	Undetermined	Aquatics/ Wetland RSA	BC MFLNRO Investigative Use Application and Reasons for Decision (file #2409027): http://www.arfd.gov.bc.ca/ApplicationPosting/viewpost.jsp?PostID=5992
43	Upper Pitt River Waterpower Project	Approximately 45 km north of Coquitlam	Run-of-River Power Inc.	Run-of-River Hydroelectric Project	Investigative use permits issued by BC MFLNRO on November 19, 2012 and March 5, 2013. Pre-application (draft Application Terms of Reference submitted to BC EAO on February 14, 2008)	The project collectively consists of eight hydroelectric projects generating a combined 180 MW on Buklin Creek, Steve Creek, Pinecone Creek, Homer Creek, East Corbold Creek, Corbold Creek, Boise Creek and Shale Creek. The area of development is approximately 45 km north of Coquitlam.	$ unknown	Undetermined	Aquatics/ Wetland RSA	BC MFLNRO Investigative Use Application and Reasons for Decision for Buklin Creek (file #2409042): http://www.arfd.gov.bc.ca/ApplicationPosting/viewpost.jsp?PostID=5950 BC MFLNRO Investigative Use Application and Reasons for Decision for Steve Creek (file #2409037): http://www.arfd.gov.bc.ca/ApplicationPosting/viewpost.jsp?PostID=10625 BC MFLNRO Investigative Use Application and Reasons for Decision for Pinecone Creek (file #2409040): http://www.arfd.gov.bc.ca/ApplicationPosting/viewpost.jsp?PostID=6022 BC MFLNRO Investigative Use Application and Reasons for Decision for Homer Creek (file #2409038): http://www.arfd.gov.bc.ca/ApplicationPosting/viewpost.jsp?PostID=5989 BC MFLNRO Investigative Use Application and Reasons for Decision for East Corbold Creek (file #2409036): http://www.arfd.gov.bc.ca/ApplicationPosting/viewpost.jsp?PostID=5994 BC MFLNRO Investigative Use Application and Reasons for Decision for Corbold Creek (file #2409043): http://www.arfd.gov.bc.ca/ApplicationPosting/viewpost.jsp?PostID=5991 BC MFLNRO Investigative Use Application and Reasons for Decision for Boise Creek (file #2409041): http://www.arfd.gov.bc.ca/ApplicationPosting/viewpost.jsp?PostID=5993 BC MFLNRO Investigative Use Application and Reasons for Decision for Shale Creek (file #2409039): http://www.arfd.gov.bc.ca/ApplicationPosting/viewpost.jsp?PostID=5954 BC EAO Website: http://a100.gov.bc.ca/appsdata/epic/html/deploy/epic_project_home_291.html
44	Winslow Creek Hydroelectric Project	Approximately 40 km north-northeast of Mission	Alpine Power and Transmission Inc.	Run-of-River Hydroelectric Project	Investigative use permit issued by BC MFLNRO on October 23, 2012	Proposed 5.4 MW hydroelectric project on Winslow Creek, approximately 40 km north-northeast of Mission.	$ unknown	Undetermined	Aquatics/ Wetland RSA	BC MFLNRO Investigative Use Application and Reasons for Decision (file #2408257): http://www.arfd.gov.bc.ca/ApplicationPosting/viewpost.jsp?PostID=4128 BC MFLNRO Application Amendment: http://www.arfd.gov.bc.ca/ApplicationPosting/viewpost.jsp?PostID=8671

TABLE 8A.1-1 Cont'd

Mapping Number	Title	Location	Proponent	Type	Application Status	Description	Capital Cost	Construction Schedule	Element LSA or RSA	Sources
45	Wray Creek Hydroelectric Project	Approximately 15 km southeast of Hope	Princeton Energy Inc.	Run-of-River Hydroelectric Project	Investigative use permit issued by BC MFLNRO on October 15, 2012	Proposed 2.29 MW hydroelectric project on Wray Creek, approximately 15 km southeast of Hope.	$ unknown	Undetermined	Aquatics/ Wetland RSA Wildlife RSA Wildlife Grizzly Bear RSA	BC MFLNRO Investigative Use Application and Reasons for Decision (#2408246): http://arfd.gov.bc.ca/ApplicationPosting/viewpost.jsp?PostID=4162
Additional Proposed Developments										
46	Ajax Project	Kamloops (partially within southwest city limits and located on the existing Trans Mountain pipeline right-of-way)	KGHM Ajax Mining Inc.	Open Pit Copper-Gold Mine	Pre-application (Ajax submitted draft Application Information Requirements to BC EAO on January 11, 2012)	KGHM Ajax Mining Inc. proposes to develop a new copper and gold mine with a production capacity of 21.9 million tonnes of ore per year. The mine's life expectancy is 23 years. Project application review will be conducted collaboratively between BC EAO and CEA Agency.	$795 million	Commencement in 2014, with production beginning by 2016 (original forecast was 2015)	Air Quality RSA Aquatics/ Wetland RSA Acoustic RSA Soil LSA Vegetation RSA Wildlife RSA	BC EAO website: http://a100.gov.bc.ca/appsdata/epic/html/deploy/epic_project_home_362.html KGHM Ajax Mining Inc. website: http://ajaxmine.ca/index.php
47	Gateway Program - Port Mann Bridge/Highway 1 Improvements – Golden Ears Connector	Surrey	BC MTI	Upgrade to existing roadway	Approved	Upgrade to existing Daly Road between 104th Avenue /176th Street and Golden Ears Way/96 Avenue intersections.	Part of $3.3 billion project	Under construction/February 2009 to late 2013	Air Quality RSA Aquatics/ Wetland RSA Acoustic RSA Soil LSA Vegetation RSA Wildlife RSA	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf Port Mann Bridge/Hwy 1 Improvements website: http://www.pmh1project.com/in-your-community/surrey/Pages/Project-Designs.aspx

TABLE 8A.1-2

REASONABLY FORESEEABLE PIPELINE DEVELOPMENTS WITHIN THE TRANS MOUNTAIN EXPANSION PROJECT RSA AND LSA OF VARIOUS ELEMENTS

Primary Applicant	Legal Location			Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment RSA	Vegetation RSA	Wildlife	
									RSA	RSA (Grizzly)
ACCESS PIPELINE INC.	01-09-056-21 W4M	TO	05-04-056-21 W4M		√					
ACCESS PIPELINE INC.	05-04-056-21 W4M	TO	01-09-056-21 W4M		√					
ACCESS PIPELINE INC.	15-32-059-19 W4M	TO	05-18-056-21 W4M		√					
ALBERTA OIL SANDS PIPELINE LTD.	08-20-053-23 W4M	TO	02-20-053-20 W4M		√	√	√		√	
ALBERTA OIL SANDS PIPELINE LTD.	08-20-053-23 W4M	TO	02-20-053-23 W4M		√	√	√		√	
ALBERTA OIL SANDS PIPELINE LTD.	16-20-053-23 W4M	TO	09-20-053-23 W4M		√	√	√		√	
ALBERTA PRODUCTS PIPE LINE LTD	01-19-052-23 W4M	TO	01-19-052-23 W4M		√	√	√		√	
ALBERTA PRODUCTS PIPE LINE LTD	03-14-050-25 W4M	TO	14-11-050-25 W4M		√				√	
ALBERTA PRODUCTS PIPE LINE LTD	04-25-051-24 W4M	TO	13-24-051-24 W4M		√	√	√		√	
ALBERTA PRODUCTS PIPE LINE LTD	11-29-052-23 W4M	TO	06-29-052-23 W4M		√	√	√		√	
ALEXANDER ENERGY LTD.	09-12-056-27 W4M	TO	11-07-056-26 W4M		√					
ALEXANDER ENERGY LTD.	10-07-056-26 W4M	TO	10-07-056-26 W4M		√					
ALEXANDER ENERGY LTD.	12-12-056-27 W4M	TO	14-12-056-27 W4M		√					
ALEXANDER ENERGY LTD.	14-12-056-27 W4M	TO	09-12-056-27 W4M		√					
ALEXANDER ENERGY LTD.	15-12-056-27 W4M	TO	09-12-056-27 W4M		√					
ALTAGAS UTILITIES INC.	14-23-056-25 W4M	TO	01-02-056-25 W4M		√					
ANTERRA ENERGY INC.	09-18-045-05 W5M	TO	01-18-045-05 W5M		√					
APACHE CANADA LTD.	01-29-057-20 W5M	TO	11-20-057-20 W5M		√					
APACHE CANADA LTD.	11-11-057-20 W5M	TO	10-13-057-20 W5M		√					
APACHE CANADA LTD.	13-02-057-20 W5M	TO	11-11-057-20 W5M		√					
ARC RESOURCES LTD.	01-14-056-21 W4M	TO	04-13-056-21 W4M		√					
ARC RESOURCES LTD.	03-03-049-07 W5M	TO	12-34-048-07 W5M		√					
ARC RESOURCES LTD.	03-03-049-07 W5M	TO	13-34-048-07 W5M		√					
ARC RESOURCES LTD.	03-03-049-07 W5M	TO	14-34-048-07 W5M		√					
ARC RESOURCES LTD.	04-23-049-08 W5M	TO	11-23-049-08 W5M		√					
ARC RESOURCES LTD.	05-09-048-07 W5M	TO	12-09-048-07 W5M		√					
ARC RESOURCES LTD.	05-20-056-20 W4M	TO	11-19-056-20 W4M		√					
ARC RESOURCES LTD.	06-03-049-08 W5M	TO	14-03-049-08 W5M		√					
ARC RESOURCES LTD.	08-09-049-05 W5M	TO	15-09-049-05 W5M		√					
ARC RESOURCES LTD.	08-22-048-06 W5M	TO	16-22-048-06 W5M		√					
ARC RESOURCES LTD.	10-19-056-20 W4M	TO	11-19-056-20 W4M		√					
ARC RESOURCES LTD.	12-34-048-07 W5M	TO	03-03-049-07 W5M		√					
ARC RESOURCES LTD.	13-04-049-07 W5M	TO	13-04-049-07 W5M		√					
ARC RESOURCES LTD.	13-26-048-05 W5M	TO	16-03-049-05 W5M		√					

TABLE 8A.1-2 Cont'd

Primary Applicant	Legal Location			Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment RSA	Vegetation RSA	Wildlife RSA	Wildlife RSA (Grizzly)
ARC RESOURCES LTD.	14-22-048-06 W5M	TO	16-22-048-06 W5M		√					
ARC RESOURCES LTD.	14-22-048-06 W5M	TO	16-22-048-06 W5M		√					
ARC RESOURCES LTD.	14-28-048-06 W5M	TO	14-29-048-06 W5M		√					
ARC RESOURCES LTD.	15-09-049-05 W5M	TO	11-31-049-05 W5M		√					
ARC RESOURCES LTD.	16-03-049-05 W5M	TO	16-10-049-05 W5M		√					
ARC RESOURCES LTD.	16-10-049-05 W5M	TO	15-09-049-05 W5M		√					
ARC RESOURCES LTD.	16-18-049-07 W5M	TO	12-17-049-07 W5M		√					
ARC RESOURCES LTD.	16-18-056-21 W4M	TO	05-18-056-21 W4M		√					
ARC RESOURCES LTD.	16-22-048-06 W5M	TO	16-27-048-06 W5M		√					
ARC RESOURCES LTD.	UNAVAILABLE	TO	UNAVAILABLE		√					
ARTEK EXPLORATION LTD.	01-34-048-26 W4M	TO	04-35-048-26 W4M		√					
ARTEK EXPLORATION LTD.	04-35-048-26 W4M	TO	01-34-048-26 W4M		√					
ARTEK EXPLORATION LTD.	05-25-048-26 W4M	TO	11-26-048-26 W4M		√					
ARTEK EXPLORATION LTD.	06-25-048-26 W4M	TO	05-25-048-26 W4M		√					
ARTISAN ENERGY CORPORATION	08-33-053-10 W5M	TO	08-33-053-10 W5M		√	√	√		√	
ARTISAN ENERGY CORPORATION	08-33-053-10 W5M	TO	10-29-053-10 W5M		√	√	√	√	√	
ATCO GAS AND PIPELINES LTD. (SOUTH)	01-07-049-27 W5M	TO	16-06-049-27 W5M						√	√
ATCO GAS AND PIPELINES LTD. (SOUTH)	01-07-060-05 W5M	TO	13-05-060-05 W5M		√					
ATCO GAS AND PIPELINES LTD. (SOUTH)	01-20-051-24 W4M	TO	01-20-051-24 W4M		√	√	√		√	
ATCO GAS AND PIPELINES LTD. (SOUTH)	01-20-051-24 W4M	TO	09-17-051-24 W4M		√	√	√		√	
ACCESS PIPELINE INC.	01-09-056-21 W4M	TO	05-04-056-21 W4M		√					
ATCO GAS AND PIPELINES LTD. (SOUTH)	01-26-054-01 W5M	TO	16-23-054-01 W5M		√				√	
ATCO GAS AND PIPELINES LTD. (SOUTH)	03-08-053-25 W4M	TO	03-08-053-25 W4M		√				√	
ATCO GAS AND PIPELINES LTD. (SOUTH)	04-33-054-22 W4M	TO	04-33-054-22 W4M		√					
ATCO GAS AND PIPELINES LTD. (SOUTH)	05-02-048-08 W5M	TO	05-02-048-08 W5M		√					
ATCO GAS AND PIPELINES LTD. (SOUTH)	08-17-051-24 W4M	TO	01-17-051-24 W4M		√	√	√		√	
ATCO GAS AND PIPELINES LTD. (SOUTH)	08-30-052-21 W4M	TO	01-30-052-21 W4M		√					
ATCO GAS AND PIPELINES LTD. (SOUTH)	08-33-052-26 W4M	TO	01-33-052-26 W4M		√	√	√	√	√	
ATCO GAS AND PIPELINES LTD. (SOUTH)	09-36-054-03 W5M	TO	15-36-054-03 W5M		√					
ATCO GAS AND PIPELINES LTD. (SOUTH)	10-33-054-22 W4M	TO	07-33-054-22 W4M		√					

TABLE 8A.1-2 Cont'd

Primary Applicant	Legal Location			Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment RSA	Vegetation RSA	Wildlife	
									RSA	RSA (Grizzly)
ATCO GAS AND PIPELINES LTD. (SOUTH)	12-01-054-24 W4M	TO	16-02-054-24 W4M		√	√			√	
ATCO GAS AND PIPELINES LTD. (SOUTH)	12-01-056-05 W5M	TO	12-01-056-05 W5M		√					
BACCALIEU ENERGY INC.	14-36-045-07 W5M	TO	15-36-045-07 W5M		√					
BAYTEX ENERGY LTD.	05-21-057-22 W4M	TO	05-21-057-22 W4M		√					
BAYTEX ENERGY LTD.	07-30-056-21 W4M	TO	10-30-056-21 W4M		√					
BAYTEX ENERGY LTD.	10-08-057-22 W4M	TO	13-09-057-22 W4M		√					
BAYTEX ENERGY LTD.	10-17-057-22 W4M	TO	02-20-057-22 W4M		√					
BAYTEX ENERGY LTD.	15-04-057-22 W4M	TO	15-09-057-22 W4M		√					
BAYTEX ENERGY LTD.	15-09-057-22 W4M	TO	01-16-057-22 W4M		√					
BAYTEX ENERGY LTD.	16-04-057-22 W4M	TO	15-04-057-22 W4M		√					
BELLATRIX EXPLORATION LTD.	03-26-047-07 W5M	TO	15-24-047-07 W5M		√					
BELLATRIX EXPLORATION LTD.	10-09-045-08 W5M	TO	10-05-046-06 W5M		√					
BELLATRIX EXPLORATION LTD.	13-23-047-07 W5M	TO	03-26-047-07 W5M		√					
BONAVISTA ENERGY CORPORATION	01-05-042-06 W5M	TO	11-04-042-06 W5M		√					
BONAVISTA ENERGY CORPORATION	03-04-053-15 W5M	TO	03-04-053-15 W5M		√				√	
BONAVISTA ENERGY CORPORATION	03-04-053-15 W5M	TO	06-04-053-15 W5M		√				√	
BONAVISTA ENERGY CORPORATION	03-25-054-16 W5M	TO	02-25-054-16 W5M		√				√	
BONAVISTA ENERGY CORPORATION	03-26-050-17 W5M	TO	10-23-050-17 W5M		√					
BONAVISTA ENERGY CORPORATION	12-04-042-06 W5M	TO	01-05-042-06 W5M		√					
BONAVISTA ENERGY CORPORATION	13-35-052-15 W5M	TO	16-34-052-15 W5M		√				√	
BONTERRA ENERGY CORP.	01-14-048-04 W5M	TO	06-13-048-04 W5M		√					
BONTERRA ENERGY CORP.	01-14-049-04 W5M	TO	16-11-049-04 W5M		√					
BONTERRA ENERGY CORP.	01-15-048-07 W5M	TO	01-15-048-07 W5M		√					
BONTERRA ENERGY CORP.	01-24-049-05 W5M	TO	08-19-049-04 W5M		√					
BONTERRA ENERGY CORP.	02-35-048-04 W5M	TO	07-35-048-04 W5M		√					
BONTERRA ENERGY CORP.	04-04-049-04 W5M	TO	16-32-048-04 W5M		√					
BONTERRA ENERGY CORP.	04-25-046-09 W5M	TO	16-26-046-09 W5M		√					
BONTERRA ENERGY CORP.	04-28-048-04 W5M	TO	06-28-048-04 W5M		√					
BONTERRA ENERGY CORP.	06-03-049-04 W5M	TO	04-03-049-04 W5M		√					
BONTERRA ENERGY CORP.	06-10-049-04 W5M	TO	06-03-049-04 W5M		√					
BONTERRA ENERGY CORP.	07-22-049-04 W5M	TO	13-15-049-04 W5M		√					
BONTERRA ENERGY CORP.	07-25-046-08 W5M	TO	14-25-046-08 W5M		√					
BONTERRA ENERGY CORP.	07-28-046-09 W5M	TO	08-28-046-09 W5M		√					
BONTERRA ENERGY CORP.	07-32-048-04 W5M	TO	07-32-048-04 W5M		√					
BONTERRA ENERGY CORP.	08-02-049-04 W5M	TO	06-01-049-04 W5M		√					
BONTERRA ENERGY CORP.	08-14-049-04 W5M	TO	16-11-049-04 W5M		√					
BONTERRA ENERGY CORP.	08-21-046-09 W5M	TO	16-21-046-09 W5M		√					
BONTERRA ENERGY CORP.	08-28-046-09 W5M	TO	16-28-046-09 W5M		√					
BONTERRA ENERGY CORP.	09-07-047-08 W5M	TO	08-07-047-08 W5M		√					

TABLE 8A.1-2 Cont'd

Primary Applicant	Legal Location			Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment RSA	Vegetation RSA	Wildlife	
									RSA	RSA (Grizzly)
BONTERRA ENERGY CORP.	11-03-048-05 W5M	TO	16-33-047-05 W5M		√					
BONTERRA ENERGY CORP.	11-07-047-08 W5M	TO	03-06-047-08 W5M		√					
BONTERRA ENERGY CORP.	11-22-048-04 W5M	TO	12-22-048-04 W5M		√					
BONTERRA ENERGY CORP.	12-17-048-04 W5M	TO	16-17-048-04 W5M		√					
BONTERRA ENERGY CORP.	12-22-048-04 W5M	TO	11-22-048-04 W5M		√					
BONTERRA ENERGY CORP.	13-05-051-04 W5M	TO	01-07-051-04 W5M		√					
BONTERRA ENERGY CORP.	13-08-048-04 W5M	TO	12-17-048-04 W5M		√					
BONTERRA ENERGY CORP.	13-13-047-07 W5M	TO	15-13-047-07 W5M		√					
BONTERRA ENERGY CORP.	13-13-049-04 W5M	TO	16-11-049-04 W5M		√					
BONTERRA ENERGY CORP.	13-18-048-03 W5M	TO	06-13-048-04 W5M		√					
BONTERRA ENERGY CORP.	15-08-049-04 W5M	TO	05-08-049-04 W5M		√					
BONTERRA ENERGY CORP.	15-08-049-04 W5M	TO	07-08-049-04 W5M		√					
BONTERRA ENERGY CORP.	15-13-047-07 W5M	TO	10-13-047-07 W5M		√					
BONTERRA ENERGY CORP.	15-18-048-03 W5M	TO	13-18-048-03 W5M		√					
BONTERRA ENERGY CORP.	16-10-048-04 W5M	TO	01-15-048-04 W5M		√					
BONTERRA ENERGY CORP.	16-11-049-04 W5M	TO	13-01-049-04 W5M		√					
BONTERRA ENERGY CORP.	16-18-048-03 W5M	TO	15-18-048-03 W5M		√					
BONTERRA ENERGY CORP.	16-21-046-09 W5M	TO	07-28-046-09 W5M		√					
BONTERRA ENERGY CORP.	16-28-046-09 W5M	TO	08-28-046-09 W5M		√					
BONTERRA ENERGY CORP.	16-32-048-04 W5M	TO	04-04-049-04 W5M		√					
BONTERRA ENERGY CORP.	UNAVAILABLE	TO	UNAVAILABLE		√					
CANADIAN NATURAL RESOURCES LIMITED	01-04-054-23 W5M	TO	16-33-053-23 W5M		√				√	
CANADIAN NATURAL RESOURCES LIMITED	03-06-054-22 W5M	TO	12-01-054-23 W5M		√				√	
CANADIAN NATURAL RESOURCES LIMITED	03-30-052-19 W5M	TO	02-30-052-19 W5M		√	√	√		√	
CANADIAN NATURAL RESOURCES LIMITED	04-16-054-20 W5M	TO	04-20-054-20 W5M		√				√	
CANADIAN NATURAL RESOURCES LIMITED	04-22-053-23 W5M	TO	13-27-053-23 W5M		√				√	
CANADIAN NATURAL RESOURCES LIMITED	13-27-053-23 W5M	TO	12-01-054-23 W5M		√				√	
CANADIAN NATURAL RESOURCES LIMITED	14-15-053-21 W5M	TO	16-04-053-21 W5M		√	√	√		√	
CANADIAN NATURAL RESOURCES LIMITED	16-33-053-23 W5M	TO	07-33-053-23 W5M		√				√	
CANADIAN NATURAL RESOURCES LIMITED	UNAVAILABLE	TO	UNAVAILABLE		√	√	√		√	
CANEXUS CORPORATION	UNAVAILABLE	TO	UNAVAILABLE		√					
CELTIC EXPLORATION ULC	01-26-058-01 W6M	TO	05-25-058-01 W6M							√
CELTIC EXPLORATION ULC	04-14-057-27 W5M	TO	04-11-057-27 W5M							√

TABLE 8A.1-2 Cont'd

Primary Applicant	Legal Location			Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment RSA	Vegetation RSA	Wildlife RSA	Wildlife RSA (Grizzly)
CELTIC EXPLORATION ULC	05-25-058-01 W6M	TO	01-26-058-01 W6M							√
CELTIC EXPLORATION ULC	11-03-060-01 W6M	TO	02-10-060-01 W6M							√
CHEVRON CANADA LIMITED	06-15-056-18 W5M	TO	03-34-055-18 W5M		√					
CHEVRON CANADA LIMITED	06-32-055-18 W5M	TO	13-28-055-18 W5M		√					
COLD CREEK RESOURCES LTD.	09-04-060-27 W5M	TO	13-03-060-27 W5M							√
CONOCOPHILLIPS CANADA OPERATIONS LTD.	05-22-060-26 W5M	TO	01-27-060-26 W5M							√
CONOCOPHILLIPS CANADA OPERATIONS LTD.	06-24-059-01 W6M	TO	15-25-059-01 W6M							√
CONOCOPHILLIPS CANADA OPERATIONS LTD.	12-02-047-10 W5M	TO	06-02-047-10 W5M		√					
CONOCOPHILLIPS CANADA OPERATIONS LTD.	12-12-054-15 W5M	TO	01-03-054-15 W5M		√	√	√		√	
CONOCOPHILLIPS CANADA OPERATIONS LTD.	16-28-049-15 W5M	TO	08-33-049-15 W5M		√					
CONOCOPHILLIPS CANADA OPERATIONS LTD.	UNAVAILABLE	TO	UNAVAILABLE		√					
CONOCOPHILLIPS CANADA RESOURCES CORP.	01-12-049-17 W5M	TO	15-01-049-17 W5M		√					
CONOCOPHILLIPS CANADA RESOURCES CORP.	01-23-062-06 W6M	TO	07-23-062-06 W6M							√
CONOCOPHILLIPS CANADA RESOURCES CORP.	13-11-045-07 W5M	TO	08-22-045-07 W5M		√					
CONOCOPHILLIPS CANADA RESOURCES CORP.	14-15-062-06 W6M	TO	16-15-062-06 W6M							√
CONOCOPHILLIPS CANADA RESOURCES CORP.	16-28-049-16 W5M	TO	15-27-049-16 W5M		√					
CROCOTTA ENERGY INC.	01-19-054-17 W5M	TO	03-19-054-17 W5M		√				√	
CROCOTTA ENERGY INC.	03-01-055-18 W5M	TO	08-35-054-18 W5M		√				√	
CROCOTTA ENERGY INC.	03-19-054-17 W5M	TO	13-19-054-17 W5M		√				√	
CROCOTTA ENERGY INC.	07-35-054-18 W5M	TO	01-35-054-18 W5M		√				√	
CROCOTTA ENERGY INC.	08-02-054-18 W5M	TO	15-12-054-18 W5M		√				√	
CROCOTTA ENERGY INC.	13-08-054-17 W5M	TO	10-18-054-17 W5M		√				√	
CROCOTTA ENERGY INC.	13-17-054-17 W5M	TO	02-19-054-17 W5M		√				√	
CROCOTTA ENERGY INC.	13-18-054-17 W5M	TO	03-19-054-17 W5M		√				√	
CROCOTTA ENERGY INC.	14-22-054-18 W5M	TO	03-22-054-18 W5M		√				√	
CROCOTTA ENERGY INC.	15-21-054-18 W5M	TO	14-22-054-18 W5M		√				√	
CROCOTTA ENERGY INC.	16-15-054-18 W5M	TO	13-14-054-18 W5M		√				√	
CROCOTTA ENERGY INC.	16-22-054-18 W5M	TO	05-23-054-18 W5M		√				√	
CROCOTTA ENERGY INC.	16-26-054-18 W5M	TO	01-35-054-18 W5M		√				√	
CROCOTTA ENERGY INC.	16-29-053-18 W5M	TO	09-29-053-18 W5M		√	√	√		√	
CROCOTTA ENERGY INC.	16-29-053-18 W5M	TO	16-29-053-18 W5M		√	√	√		√	
CROCOTTA ENERGY INC.	UNAVAILABLE	TO	UNAVAILABLE		√				√	

TABLE 8A.1-2 Cont'd

Primary Applicant	Legal Location			Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment RSA	Vegetation RSA	Wildlife	
									RSA	RSA (Grizzly)
DEVON CANADA CORPORATION	02-07-060-05 W6M	TO	07-07-060-05 W6M							√
DEVON CANADA CORPORATION	03-22-056-27 W5M	TO	14-15-056-27 W5M							√
DEVON CANADA CORPORATION	04-03-065-09 W6M	TO	03-03-065-09 W6M							√
DEVON CANADA CORPORATION	04-23-056-27 W5M	TO	09-22-056-27 W5M							√
DEVON CANADA CORPORATION	07-07-060-05 W6M	TO	03-07-060-05 W6M							√
DEVON CANADA CORPORATION	11-07-060-05 W6M	TO	07-07-060-05 W6M							√
DEVON CANADA CORPORATION	16-14-061-08 W6M	TO	16-14-061-08 W6M							√
DIRECT ENERGY MARKETING LIMITED	15-31-053-13 W5M	TO	06-31-053-13 W5M	√	√	√	√	√	√	
DIRECT ENERGY MARKETING LIMITED	16-36-053-14 W5M	TO	10-36-053-14 W5M		√	√	√	√	√	
ENBRIDGE PIPELINES (WOODLAND) INC.	UNAVAILABLE	TO	UNAVAILABLE		√	√	√	√	√	
ENCANA CORPORATION	01-14-047-03 W5M	TO	04-13-047-03 W5M		√					
ENCANA CORPORATION	07-27-062-07 W6M	TO	06-27-062-07 W6M							√
ENCANA CORPORATION	13-05-062-06 W6M	TO	13-05-062-06 W6M							√
ENCANA CORPORATION	14-22-047-03 W5M	TO	13-22-047-03 W5M		√					
ENCANA CORPORATION	15-19-061-06 W6M	TO	15-32-061-06 W6M							√
ENCANA CORPORATION	16-26-047-03 W5M	TO	16-26-047-03 W5M		√					
ENCANA CORPORATION	16-31-062-07 W6M	TO	06-27-062-07 W6M							√
ENCANA CORPORATION	UNAVAILABLE	TO	UNAVAILABLE							√
ENERPLUS CORPORATION	01-18-050-19 W5M	TO	14-08-050-19 W5M		√					
ENERPLUS CORPORATION	02-31-049-21 W4M	TO	02-31-049-21 W4M		√					
ENERPLUS CORPORATION	02-31-049-21 W4M	TO	07-31-049-21 W4M		√					
ENERPLUS CORPORATION	04-25-046-07 W5M	TO	08-26-046-07 W5M		√					
ENERPLUS CORPORATION	04-31-049-21 W4M	TO	04-31-049-21 W4M		√					
ENERPLUS CORPORATION	04-31-049-21 W4M	TO	12-31-049-21 W4M		√					
ENERPLUS CORPORATION	07-31-049-21 W4M	TO	08-31-049-21 W4M		√					
ENERPLUS CORPORATION	07-31-049-21 W4M	TO	10-31-049-21 W4M		√					
ENERPLUS CORPORATION	08-32-046-07 W5M	TO	14-28-046-07 W5M		√					
ENERPLUS CORPORATION	10-30-049-21 W4M	TO	02-31-049-21 W4M		√					
ENERPLUS CORPORATION	10-36-049-22 W4M	TO	10-36-049-22 W4M		√					
ENERPLUS CORPORATION	12-29-049-21 W4M	TO	13-29-049-21 W4M		√					
ENERPLUS CORPORATION	16-29-046-07 W5M	TO	02-32-046-07 W5M		√					
ENERPLUS CORPORATION	16-33-046-07 W5M	TO	05-05-047-06 W5M		√					
EOG RESOURCES CANADA INC.	12-15-049-08 W5M	TO	09-16-049-08 W5M		√					
EXORO ENERGY INC.	08-27-049-07 W5M	TO	08-28-049-07 W5M		√					
EXORO ENERGY INC.	08-28-049-07 W5M	TO	13-26-049-07 W5M		√					
HARVEST OPERATIONS CORP.	01-31-054-16 W5M	TO	10-32-054-16 W5M		√				√	
HARVEST OPERATIONS CORP.	02-01-044-08 W5M	TO	09-25-043-08 W5M		√					
HARVEST OPERATIONS CORP.	08-33-061-06 W6M	TO	02-34-061-06 W6M							√
HARVEST OPERATIONS CORP.	15-17-043-07 W5M	TO	14-16-043-07 W5M		√					
HUSKY OIL OPERATIONS LIMITED	01-29-049-18 W5M	TO	12-20-049-18 W5M		√					

TABLE 8A.1-2 Cont'd

Primary Applicant	Legal Location			Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment RSA	Vegetation RSA	Wildlife	
									RSA	RSA (Grizzly)
HUSKY OIL OPERATIONS LIMITED	01-34-055-20 W4M	TO	16-34-055-20 W4M		√					
HUSKY OIL OPERATIONS LIMITED	02-22-051-19 W5M	TO	02-22-051-19 W5M		√				√	
HUSKY OIL OPERATIONS LIMITED	03-06-049-18 W5M	TO	16-02-049-20 W5M		√					
HUSKY OIL OPERATIONS LIMITED	03-20-049-18 W5M	TO	12-20-049-18 W5M		√					
HUSKY OIL OPERATIONS LIMITED	03-20-050-18 W5M	TO	06-20-050-18 W5M		√					
HUSKY OIL OPERATIONS LIMITED	03-23-049-19 W5M	TO	01-23-049-19 W5M		√					
HUSKY OIL OPERATIONS LIMITED	04-13-050-19 W5M	TO	04-18-050-18 W5M		√					
HUSKY OIL OPERATIONS LIMITED	05-14-050-19 W5M	TO	04-13-050-19 W5M		√					
HUSKY OIL OPERATIONS LIMITED	08-15-049-18 W5M	TO	04-22-049-18 W5M		√					
HUSKY OIL OPERATIONS LIMITED	08-17-050-18 W5M	TO	08-17-050-18 W5M		√					
HUSKY OIL OPERATIONS LIMITED	08-26-055-20 W4M	TO	08-26-055-20 W4M		√					
HUSKY OIL OPERATIONS LIMITED	08-26-055-20 W4M	TO	16-27-055-20 W4M		√					
HUSKY OIL OPERATIONS LIMITED	11-29-049-18 W5M	TO	12-20-049-18 W5M		√					
HUSKY OIL OPERATIONS LIMITED	12-19-055-19 W4M	TO	14-24-055-20 W4M		√					
HUSKY OIL OPERATIONS LIMITED	12-20-049-18 W5M	TO	03-06-049-18 W5M		√					
HUSKY OIL OPERATIONS LIMITED	13-01-049-20 W5M	TO	14-01-049-20 W5M		√					
HUSKY OIL OPERATIONS LIMITED	13-04-050-18 W5M	TO	06-09-050-18 W5M		√					
HUSKY OIL OPERATIONS LIMITED	13-22-049-18 W5M	TO	16-21-049-18 W5M		√					
HUSKY OIL OPERATIONS LIMITED	14-24-055-20 W4M	TO	14-24-055-20 W4M		√					
HUSKY OIL OPERATIONS LIMITED	14-24-055-20 W4M	TO	16-23-055-20 W4M		√					
HUSKY OIL OPERATIONS LIMITED	15-05-049-18 W5M	TO	03-08-049-18 W5M		√					
HUSKY OIL OPERATIONS LIMITED	15-27-049-18 W5M	TO	16-21-049-18 W5M		√					
HUSKY OIL OPERATIONS LIMITED	15-35-048-20 W5M	TO	14-01-049-20 W5M		√					
HUSKY OIL OPERATIONS LIMITED	16-12-049-20 W5M	TO	14-01-049-20 W5M		√					
HUSKY OIL OPERATIONS LIMITED	16-23-055-20 W4M	TO	08-26-055-20 W4M		√					
HUSKY OIL OPERATIONS LIMITED	16-23-055-20 W4M	TO	16-23-055-20 W4M		√					
HUSKY OIL OPERATIONS LIMITED	16-27-055-20 W4M	TO	01-34-055-20 W4M		√					
HUSKY OIL OPERATIONS LIMITED	16-27-055-20 W4M	TO	08-26-055-20 W4M		√					
HUSKY OIL OPERATIONS LIMITED	16-27-055-20 W4M	TO	16-27-055-20 W4M		√					
HUSKY OIL OPERATIONS LIMITED	16-28-050-19 W5M	TO	03-32-050-19 W5M		√					
HUSKY OIL OPERATIONS LIMITED	16-30-050-19 W5M	TO	03-32-050-19 W5M		√					
HUSKY OIL OPERATIONS LIMITED	UNAVAILABLE	TO	UNAVAILABLE		√					
HYPERION EXPLORATION CORP.	03-11-056-14 W5M	TO	10-02-056-14 W5M		√					
HYPERION EXPLORATION CORP.	03-30-055-13 W5M	TO	13-30-055-13 W5M		√					
INSIGNIA ENERGY LTD.	16-20-048-05 W5M	TO	06-29-048-05 W5M		√					
JOURNEY ENERGY INC.	04-06-049-04 W5M	TO	12-31-048-04 W5M		√					
JOURNEY ENERGY INC.	04-06-049-04 W5M	TO	13-06-049-04 W5M		√					
JOURNEY ENERGY INC.	04-31-048-04 W5M	TO	08-36-048-05 W5M		√					
JOURNEY ENERGY INC.	08-36-048-05 W5M	TO	04-31-048-04 W5M		√					
JOURNEY ENERGY INC.	09-25-048-05 W5M	TO	09-25-048-05 W5M		√					
JOURNEY ENERGY INC.	12-31-048-04 W5M	TO	04-06-049-04 W5M		√					

TABLE 8A.1-2 Cont'd

Primary Applicant	Legal Location			Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment RSA	Vegetation RSA	Wildlife RSA	Wildlife RSA (Grizzly)
JOURNEY ENERGY INC.	12-31-048-04 W5M	TO	13-31-048-04 W5M		√					
JOURNEY ENERGY INC.	13-06-049-04 W5M	TO	04-06-049-04 W5M		√					
JOURNEY ENERGY INC.	13-31-048-04 W5M	TO	12-31-048-04 W5M		√					
JOURNEY ENERGY INC.	UNAVAILABLE	TO	UNAVAILABLE		√					
KEYERA ENERGY LTD.	16-25-055-22 W4M	TO	04-18-055-21 W4M		√					
KINGSMERE RESOURCES LTD.	01-09-048-05 W5M	TO	10-09-048-05 W5M		√					
KINGSMERE RESOURCES LTD.	15-03-047-03 W5M	TO	16-03-047-03 W5M		√					
KINGSMERE RESOURCES LTD.	16-03-047-03 W5M	TO	16-03-047-03 W5M		√					
KM CANADA TERMINALS ULC	06-05-053-23 W4M	TO	04-05-053-23 W4M	√	√	√	√	√	√	
LONG RUN EXPLORATION LTD.	01-36-055-21 W4M	TO	02-36-055-21 W4M		√					
LONG RUN EXPLORATION LTD.	02-24-055-21 W4M	TO	07-24-055-21 W4M		√					
LONG RUN EXPLORATION LTD.	02-27-054-05 W5M	TO	07-27-054-05 W5M		√				√	
LONG RUN EXPLORATION LTD.	03-08-056-20 W4M	TO	06-08-056-20 W4M		√					
LONG RUN EXPLORATION LTD.	07-34-056-21 W4M	TO	08-34-056-21 W4M		√					
LONG RUN EXPLORATION LTD.	13-19-055-04 W5M	TO	11-30-055-04 W5M		√					
LONGVIEW OIL CORP.	16-32-046-03 W5M	TO	03-04-047-03 W5M		√					
MADALENA VENTURES INC.	02-12-055-09 W5M	TO	10-01-055-09 W5M		√				√	
MADALENA VENTURES INC.	04-05-056-07 W5M	TO	04-05-056-07 W5M		√					
MADALENA VENTURES INC.	04-05-056-07 W5M	TO	15-32-055-07 W5M		√					
MADALENA VENTURES INC.	04-26-056-12 W5M	TO	14-23-056-12 W5M		√					
MADALENA VENTURES INC.	08-05-056-07 W5M	TO	15-32-055-07 W5M		√					
MADALENA VENTURES INC.	16-31-055-07 W5M	TO	04-05-056-07 W5M		√					
MADALENA VENTURES INC.	UNAVAILABLE	TO	UNAVAILABLE		√					
MALAK ENERGY INC.	03-14-050-26 W4M	TO	07-14-050-26 W4M		√					
MANCAL ENERGY INC.	UNAVAILABLE	TO	UNAVAILABLE		√					
MANITOK ENERGY INC.	02-29-042-15 W5M	TO	06-29-042-15 W5M							√
MANITOK ENERGY INC.	02-29-042-15 W5M	TO	14-18-042-15 W5M							√
MANITOK ENERGY INC.	06-29-042-15 W5M	TO	02-29-042-15 W5M							√
MANITOK ENERGY INC.	09-01-042-15 W5M	TO	15-01-042-15 W5M							√
MANITOK ENERGY INC.	09-11-042-15 W5M	TO	15-01-042-15 W5M							√
MANITOK ENERGY INC.	15-01-042-15 W5M	TO	05-01-042-15 W5M							√
MANITOK ENERGY INC.	15-01-042-15 W5M	TO	09-11-042-15 W5M							√
MOSAIC ENERGY LTD.	09-22-057-22 W4M	TO	07-21-057-22 W4M		√					
MOSAIC ENERGY LTD.	13-25-061-07 W6M	TO	12-25-061-07 W6M							√
NEP CANADA ULC	03-20-050-26 W4M	TO	03-20-050-26 W4M		√					
NEP CANADA ULC	03-30-050-26 W4M	TO	03-30-050-26 W4M		√					
NEP CANADA ULC	03-35-050-26 W4M	TO	14-26-050-26 W4M		√				√	
NEP CANADA ULC	05-15-050-26 W4M	TO	05-15-050-26 W4M		√					
NEP CANADA ULC	07-05-051-26 W4M	TO	06-04-051-26 W4M		√				√	
NEP CANADA ULC	10-34-049-26 W4M	TO	11-34-049-26 W4M		√					
NEP CANADA ULC	11-20-050-26 W4M	TO	11-20-050-26 W4M		√					

TABLE 8A.1-2 Cont'd

Primary Applicant	Legal Location			Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment RSA	Vegetation RSA	Wildlife	
									RSA	RSA (Grizzly)
NEP CANADA ULC	11-21-050-26 W4M	TO	08-21-050-26 W4M		√					
NEP CANADA ULC	13-35-049-26 W4M	TO	11-35-049-26 W4M		√					
NEP CANADA ULC	14-20-050-26 W4M	TO	14-20-050-26 W4M		√					
NEW STAR ENERGY LTD.	01-07-051-04 W5M	TO	10-04-051-04 W5M		√					
NEW STAR ENERGY LTD.	01-28-050-04 W5M	TO	01-28-050-04 W5M		√					
NEW STAR ENERGY LTD.	01-28-050-04 W5M	TO	13-22-050-04 W5M		√					
NEW STAR ENERGY LTD.	04-05-051-04 W5M	TO	13-32-050-04 W5M		√					
NEW STAR ENERGY LTD.	09-31-050-04 W5M	TO	12-32-050-04 W5M		√					
NEW STAR ENERGY LTD.	10-04-051-04 W5M	TO	01-07-051-04 W5M		√					
NEW STAR ENERGY LTD.	10-28-050-04 W5M	TO	10-28-050-04 W5M		√					
NEW STAR ENERGY LTD.	13-22-050-04 W5M	TO	01-28-050-04 W5M		√					
NEW STAR ENERGY LTD.	14-08-051-04 W5M	TO	16-08-051-04 W5M		√					
NEW STAR ENERGY LTD.	15-08-051-04 W5M	TO	16-08-051-04 W5M		√					
NEW STAR ENERGY LTD.	16-06-051-04 W5M	TO	13-05-051-04 W5M		√					
NEW STAR ENERGY LTD.	16-08-051-04 W5M	TO	08-07-051-04 W5M		√					
NEW STAR ENERGY LTD.	16-08-051-04 W5M	TO	12-09-051-04 W5M		√					
NEWALTA CORPORATION	UNAVAILABLE	TO	UNAVAILABLE		√	√	√		√	
NORTH WEST UPGRADING INC.	07-18-056-21 W4M	TO	15-08-056-21 W4M		√					
NORTH WEST UPGRADING INC.	15-08-056-21 W4M	TO	07-18-056-21 W4M		√					
NORTH WEST UPGRADING INC.	15-08-056-21 W4M	TO	10-11-056-21 W4M		√					
NORTH WEST UPGRADING INC.	UNAVAILABLE	TO	UNAVAILABLE		√					
PANTERRA RESOURCE CORP.	08-12-053-13 W5M	TO	12-12-053-13 W5M		√				√	
PANTERRA RESOURCE CORP.	16-01-053-13 W5M	TO	08-12-053-13 W5M		√				√	
PARAMOUNT RESOURCES LTD.	14-29-059-03 W6M	TO	13-29-059-03 W6M							√
PEMBINA GAS SERVICES LTD.	10-28-061-09 W6M	TO	15-28-061-09 W6M							√
Pembina Pipeline Corp	UNAVAILABLE	TO	UNAVAILABLE		√	√	√		√	
PEMBINA PIPELINE CORPORATION	02-05-053-23 W4M	TO	03-05-053-23 W4M	√	√	√	√	√	√	
PEMBINA PIPELINE CORPORATION	04-14-044-05 W5M	TO	10-24-044-07 W5M		√					
PEMBINA PIPELINE CORPORATION	04-32-053-23 W4M	TO	04-32-053-23 W4M		√	√			√	
PEMBINA PIPELINE CORPORATION	07-13-048-04 W5M	TO	08-13-048-04 W5M		√					
PEMBINA PIPELINE CORPORATION	10-24-044-07 W5M	TO	10-24-044-07 W5M		√					
PEMBINA PIPELINE CORPORATION	13-21-046-09 W5M	TO	16-20-046-09 W5M		√					
PEMBINA PIPELINE CORPORATION	13-32-053-23 W4M	TO	12-32-053-23 W4M		√	√			√	
PEMBINA PIPELINE CORPORATION	14-07-043-06 W5M	TO	13-27-042-08 W5M		√					
PEMBINA PIPELINE CORPORATION	14-08-051-24 W5M	TO	03-17-051-24 W4M		√	√	√		√	
PEMBINA PIPELINE CORPORATION	15-35-048-04 W5M	TO	08-13-048-04 W5M		√					
PEMBINA PIPELINE CORPORATION	16-20-046-09 W5M	TO	01-28-047-09 W5M		√					
PEMBINA PIPELINE CORPORATION	UNAVAILABLE	TO	UNAVAILABLE		√					
PENN WEST PETROLEUM LTD.	01-08-050-07 W5M	TO	06-07-050-07 W5M		√					
PENN WEST PETROLEUM LTD.	01-20-045-06 W5M	TO	01-21-045-06 W5M		√					
PENN WEST PETROLEUM LTD.	01-21-045-06 W5M	TO	04-26-045-06 W5M		√					

TABLE 8A.1-2 Cont'd

Primary Applicant	Legal Location			Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment RSA	Vegetation RSA	Wildlife	
									RSA	RSA (Grizzly)
PENN WEST PETROLEUM LTD.	02-30-046-03 W5M	TO	08-19-046-03 W5M		√					
PENN WEST PETROLEUM LTD.	04-10-052-08 W5M	TO	06-10-052-08 W5M						√	
PENN WEST PETROLEUM LTD.	05-10-045-06 W5M	TO	16-09-045-06 W5M		√					
PENN WEST PETROLEUM LTD.	06-07-050-07 W5M	TO	01-08-050-07 W5M		√					
PENN WEST PETROLEUM LTD.	07-35-055-04 W5M	TO	15-35-055-14 W5M		√					
PENN WEST PETROLEUM LTD.	12-01-048-08 W5M	TO	08-02-048-08 W5M		√					
PENN WEST PETROLEUM LTD.	14-14-052-26 W4M	TO	14-14-052-26 W4M		√	√	√		√	
PENN WEST PETROLEUM LTD.	14-17-045-06 W5M	TO	01-20-045-06 W5M		√					
PENN WEST PETROLEUM LTD.	16-09-045-06 W5M	TO	01-21-045-06 W5M		√					
PENN WEST PETROLEUM LTD.	16-16-047-10 W5M	TO	15-16-047-10 W5M		√					
PENN WEST PETROLEUM LTD.	16-16-047-10 W5M	TO	16-16-047-10 W5M		√					
PENN WEST PETROLEUM LTD.	UNAVAILABLE	TO	UNAVAILABLE		√	√	√		√	
PERPETUAL ENERGY OPERATING CORP.	04-20-051-18 W5M	TO	01-34-051-18 W5M		√					
PERPETUAL ENERGY OPERATING CORP.	05-27-051-16 W5M	TO	07-33-051-16 W5M		√					
PERPETUAL ENERGY OPERATING CORP.	09-07-051-18 W5M	TO	04-20-051-18 W5M		√					
PERPETUAL ENERGY OPERATING CORP.	16-31-050-18 W5M	TO	11-08-051-18 W5M		√					
PERPETUAL ENERGY OPERATING CORP.	UNAVAILABLE	TO	UNAVAILABLE		√					
PETROBAKKEN ENERGY LTD.	16-09-047-05 W5M	TO	16-09-047-05 W5M		√					
PETRUS RESOURCES LTD.	11-15-044-17 W5M	TO	03-22-044-17 W5M							√
PEYTO EXPLORATION & DEVELOPMENT CORP.	01-05-053-20 W5M	TO	04-04-053-20 W5M	√	√	√	√	√	√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	01-07-051-19 W5M	TO	01-06-051-19 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	01-13-055-22 W5M	TO	05-18-055-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	01-17-051-19 W5M	TO	03-18-051-19 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	01-27-054-20 W5M	TO	04-27-054-20 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	01-29-054-22 W5M	TO	08-29-054-22 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	02-18-056-21 W5M	TO	02-18-056-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	02-21-054-22 W5M	TO	15-16-054-22 W5M		√				√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	03-03-052-19 W5M	TO	02-26-052-19 W5M		√	√	√		√	

TABLE 8A.1-2 Cont'd

Primary Applicant	Legal Location			Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment RSA	Vegetation RSA	Wildlife	
									RSA	RSA (Grizzly)
PEYTO EXPLORATION & DEVELOPMENT CORP.	03-11-056-21 W5M	TO	09-10-056-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	03-26-052-19 W5M	TO	11-10-053-19 W5M	√	√	√	√	√	√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	04-01-054-20 W5M	TO	15-36-053-20 W5M		√				√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	04-04-053-20 W5M	TO	16-05-053-20 W5M	√	√	√	√	√	√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	04-10-053-20 W5M	TO	14-04-053-20 W5M		√	√	√		√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	04-17-054-21 W5M	TO	02-18-054-21 W5M		√				√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	04-17-054-22 W5M	TO	14-08-054-22 W5M		√				√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	04-18-056-21 W5M	TO	03-18-056-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	04-19-054-21 W5M	TO	08-24-054-22 W5M		√				√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	04-27-054-20 W5M	TO	04-27-054-20 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	04-28-055-21 W5M	TO	14-21-055-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	04-29-054-22 W5M	TO	08-29-054-22 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	04-30-052-19 W5M	TO	14-24-052-20 W5M		√	√	√		√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	05-32-053-21 W5M	TO	13-32-053-21 W5M		√				√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	06-02-051-20 W5M	TO	07-18-051-19 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	07-18-051-19 W5M	TO	14-34-051-19 W5M		√				√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	07-20-053-20 W5M	TO	08-29-053-20 W5M		√				√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	07-24-055-23 W5M	TO	03-21-055-23 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	08-05-054-19 W5M	TO	12-31-053-19 W5M		√				√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	08-05-054-19 W5M	TO	16-02-054-19 W5M		√				√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	08-29-053-20 W5M	TO	12-27-053-20 W5M		√				√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	08-29-054-22 W5M	TO	05-28-054-22 W5M		√					

TABLE 8A.1-2 Cont'd

Primary Applicant	Legal Location			Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment RSA	Vegetation RSA	Wildlife	
									RSA	RSA (Grizzly)
PEYTO EXPLORATION & DEVELOPMENT CORP.	08-31-055-21 W5M	TO	08-31-055-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	09-13-058-04 W6M	TO	01-19-058-03 W6M							√
PEYTO EXPLORATION & DEVELOPMENT CORP.	11-08-058-03 W6M	TO	05-09-058-03 W6M							√
PEYTO EXPLORATION & DEVELOPMENT CORP.	11-10-053-19 W5M	TO	08-05-054-19 W5M		√	√	√		√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	11-23-057-03 W6M	TO	04-36-057-03 W6M							√
PEYTO EXPLORATION & DEVELOPMENT CORP.	12-27-053-20 W5M	TO	09-34-053-20 W5M		√				√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	12-31-053-19 W5M	TO	08-05-054-19 W5M		√				√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	12-32-055-21 W5M	TO	08-31-055-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	13-01-054-20 W5M	TO	15-36-053-20 W5M		√				√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	13-17-054-22 W5M	TO	04-17-054-22 W5M		√				√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	13-20-053-21 W5M	TO	13-30-053-21 W5M		√				√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	13-21-052-18 W5M	TO	13-21-052-18 W5M		√				√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	13-23-052-20 W5M	TO	01-27-052-20 W5M		√	√	√		√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	13-24-052-20 W5M	TO	04-25-052-20 W5M		√	√	√		√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	13-28-054-22 W5M	TO	16-29-054-22 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	13-29-054-22 W5M	TO	04-32-054-22 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	13-30-053-21 W5M	TO	13-32-053-21 W5M		√				√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	13-32-053-21 W5M	TO	13-32-053-21 W5M		√				√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	13-32-053-21 W5M	TO	15-32-053-21 W5M		√				√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	14-04-053-20 W5M	TO	16-05-053-20 W5M		√	√	√	√	√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	14-05-054-21 W5M	TO	10-05-054-21 W5M		√				√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	14-17-055-21 W5M	TO	10-17-055-21 W5M		√					

TABLE 8A.1-2 Cont'd

Primary Applicant	Legal Location			Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment RSA	Vegetation RSA	Wildlife	
									RSA	RSA (Grizzly)
PEYTO EXPLORATION & DEVELOPMENT CORP.	14-19-054-22 W5M	TO	15-19-054-22 W5M		√				√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	14-35-054-21 W5M	TO	16-27-054-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	15-13-053-19 W5M	TO	10-15-053-19 W5M	√	√	√	√	√	√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	15-19-054-22 W5M	TO	04-29-054-22 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	15-30-054-21 W5M	TO	02-08-055-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	15-32-053-21 W5M	TO	10-05-054-21 W5M		√				√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	15-33-055-21 W5M	TO	10-33-055-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	15-36-053-20 W5M	TO	12-31-053-19 W5M		√				√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	16-05-053-20 W5M	TO	07-20-053-20 W5M		√	√	√	√	√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	16-05-055-21 W5M	TO	01-08-055-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	16-07-054-22 W5M	TO	13-08-054-22 W5M		√				√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	16-08-055-21 W5M	TO	10-08-055-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	16-08-056-21 W5M	TO	13-10-056-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	16-09-053-20 W5M	TO	12-09-053-20 W5M		√	√	√		√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	16-17-056-21 W5M	TO	05-16-056-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	16-18-054-21 W5M	TO	08-24-054-22 W5M		√				√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	16-18-055-21 W5M	TO	13-17-055-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	16-29-054-22 W5M	TO	16-29-054-22 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	16-31-055-21 W5M	TO	12-32-055-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	16-32-053-21 W5M	TO	15-32-053-21 W5M		√				√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	16-32-055-19 W5M	TO	06-05-056-19 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	16-33-055-21 W5M	TO	15-33-055-21 W5M		√					

TABLE 8A.1-2 Cont'd

Primary Applicant	Legal Location			Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment RSA	Vegetation RSA	Wildlife	
									RSA	RSA (Grizzly)
PEYTO EXPLORATION & DEVELOPMENT CORP.	UNAVAILABLE	TO	UNAVAILABLE		√					
PIPELINE MANAGEMENT INC.	UNAVAILABLE	TO	UNAVAILABLE		√	√	√	√	√	
POTTS PETROLEUM INC.	14-13-055-21 W4M	TO	02-14-055-21 W4M		√					
QUESTFIRE ENERGY CORP.	10-27-048-02 W5M	TO	15-22-048-02 W5M		√					
RAVENWOOD ENERGY CORP.	02-06-049-01 W5M	TO	03-06-049-01 W5M		√					
RAVENWOOD ENERGY CORP.	14-25-048-02 W5M	TO	14-25-048-02 W5M		√					
RAVENWOOD ENERGY CORP.	UNAVAILABLE	TO	UNAVAILABLE		√					
RIMFIRE ENERGY INC.	05-21-056-11 W5M	TO	05-21-056-11 W5M		√					
SANTONIA ENERGY INC.	03-16-044-15 W5M	TO	16-16-044-15 W5M							√
SECURE ENERGY SERVICES INC.	03-05-049-06 W5M	TO	10-05-049-06 W5M		√					
SHELL CANADA LIMITED	02-07-055-23 W5M	TO	11-09-055-23 W5M		√					
SHELL CANADA LIMITED	04-17-054-22 W5M	TO	11-19-054-22 W5M		√				√	
SHELL CANADA LIMITED	14-19-056-20 W5M	TO	07-24-056-21 W5M		√					
SHELL CANADA LIMITED	15-08-053-22 W5M	TO	05-09-053-22 W5M		√	√	√		√	
SHELL CANADA LIMITED	15-36-053-24 W5M	TO	09-36-053-24 W5M		√				√	
SHELL CANADA LIMITED	UNAVAILABLE	TO	UNAVAILABLE		√					
SINOPEC DAYLIGHT ENERGY LTD.	01-14-047-04 W5M	TO	08-14-047-04 W5M		√					
SINOPEC DAYLIGHT ENERGY LTD.	01-14-047-04 W5M	TO	10-11-047-04 W5M		√					
SINOPEC DAYLIGHT ENERGY LTD.	02-04-050-05 W5M	TO	08-04-050-06 W5M		√					
SINOPEC DAYLIGHT ENERGY LTD.	02-04-050-06 W5M	TO	08-04-050-06 W5M		√					
SINOPEC DAYLIGHT ENERGY LTD.	04-26-054-23 W5M	TO	09-23-054-23 W5M		√					
SINOPEC DAYLIGHT ENERGY LTD.	05-07-048-03 W5M	TO	08-07-048-03 W5M		√					
SINOPEC DAYLIGHT ENERGY LTD.	06-08-048-03 W5M	TO	06-16-048-03 W5M		√					
SINOPEC DAYLIGHT ENERGY LTD.	06-15-048-03 W5M	TO	06-16-048-03 W5M		√					
SINOPEC DAYLIGHT ENERGY LTD.	06-16-048-03 W5M	TO	06-15-048-03 W5M		√					
SINOPEC DAYLIGHT ENERGY LTD.	08-32-046-09 W5M	TO	06-32-046-09 W5M		√					
SINOPEC DAYLIGHT ENERGY LTD.	09-09-048-05 W5M	TO	01-09-048-05 W5M		√					
SINOPEC DAYLIGHT ENERGY LTD.	10-11-047-04 W5M	TO	01-14-047-04 W5M		√					
SINOPEC DAYLIGHT ENERGY LTD.	12-03-050-06 W5M	TO	12-03-050-06 W5M		√					
SINOPEC DAYLIGHT ENERGY LTD.	12-06-048-03 W5M	TO	05-07-048-03 W5M		√					
SINOPEC DAYLIGHT ENERGY LTD.	12-14-047-04 W5M	TO	10-14-047-04 W5M		√					
SINOPEC DAYLIGHT ENERGY LTD.	13-07-048-03 W5M	TO	05-07-048-03 W5M		√					
SINOPEC DAYLIGHT ENERGY LTD.	13-23-047-05 W5M	TO	02-03-048-05 W5M		√					
SINOPEC DAYLIGHT ENERGY LTD.	14-28-047-05 W5M	TO	02-03-048-05 W5M		√					
SINOPEC DAYLIGHT ENERGY LTD.	UNAVAILABLE	TO	UNAVAILABLE		√	√	√		√	
SPUR RESOURCES LTD.	UNAVAILABLE	TO	UNAVAILABLE		√					
SUNCOR ENERGY INC.	01-13-045-06 W5M	TO	16-12-045-06 W5M		√					
SUNCOR ENERGY INC.	02-13-045-06 W5M	TO	02-13-045-06 W5M		√					
SUNCOR ENERGY INC.	05-01-045-06 W5M	TO	08-11-045-06 W5M		√					
SUNCOR ENERGY INC.	13-05-045-05 W5M	TO	04-03-045-05 W5M		√					

TABLE 8A.1-2 Cont'd

Primary Applicant	Legal Location			Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment RSA	Vegetation RSA	Wildlife	
									RSA	RSA (Grizzly)
SUNCOR ENERGY INC.	16-12-045-06 W5M	TO	13-05-045-05 W5M		√					
TALISMAN ENERGY INC.	02-09-057-21 W5M	TO	06-09-057-21 W5M		√					
TALISMAN ENERGY INC.	07-14-064-14 W6M	TO	13-09-064-13 W6M							√
TALISMAN ENERGY INC.	08-18-056-20 W5M	TO	13-13-056-21 W5M		√					
TALISMAN ENERGY INC.	11-32-056-24 W5M	TO	11-32-056-24 W5M							√
TALISMAN ENERGY INC.	12-22-056-24 W5M	TO	10-22-056-24 W5M							√
TAQA NORTH LTD.	01-20-046-09 W5M	TO	04-21-046-09 W5M		√					
TAQA NORTH LTD.	01-24-053-20 W5M	TO	12-13-053-20 W5M		√	√	√		√	
TAQA NORTH LTD.	01-29-046-09 W5M	TO	13-21-046-09 W5M		√					
TAQA NORTH LTD.	02-30-046-09 W5M	TO	06-29-046-09 W5M		√					
TAQA NORTH LTD.	04-01-047-10 W5M	TO	06-07-047-09 W5M		√					
TAQA NORTH LTD.	04-08-047-09 W5M	TO	16-20-046-09 W5M		√					
TAQA NORTH LTD.	04-21-046-09 W5M	TO	12-21-046-09 W5M		√					
TAQA NORTH LTD.	04-31-046-09 W5M	TO	14-29-046-09 W5M		√					
TAQA NORTH LTD.	05-16-046-09 W5M	TO	04-21-046-09 W5M		√					
TAQA NORTH LTD.	05-16-046-09 W5M	TO	05-16-046-09 W5M		√					
TAQA NORTH LTD.	05-29-046-09 W5M	TO	05-29-046-09 W5M		√					
TAQA NORTH LTD.	06-29-046-09 W5M	TO	01-29-046-09 W5M		√					
TAQA NORTH LTD.	09-20-046-09 W5M	TO	12-21-046-09 W5M		√					
TAQA NORTH LTD.	12-16-046-09 W5M	TO	05-16-046-09 W5M		√					
TAQA NORTH LTD.	12-21-046-09 W5M	TO	16-20-046-09 W5M		√					
TAQA NORTH LTD.	14-29-046-09 W5M	TO	06-29-046-09 W5M		√					
TAQA NORTH LTD.	16-20-046-09 W5M	TO	06-29-046-09 W5M		√					
TORC OIL & GAS LTD.	01-33-054-16 W5M	TO	07-34-054-16 W5M		√				√	
TORC OIL & GAS LTD.	02-34-054-16 W5M	TO	07-34-054-16 W5M		√				√	
TORC OIL & GAS LTD.	03-25-054-18 W5M	TO	02-25-054-18 W5M		√				√	
TORC OIL & GAS LTD.	05-15-052-13 W5M	TO	14-10-052-13 W5M		√				√	
TORC OIL & GAS LTD.	06-25-054-16 W5M	TO	13-24-054-16 W5M		√				√	
TORC OIL & GAS LTD.	08-35-054-16 W5M	TO	04-25-054-16 W5M		√				√	
TORC OIL & GAS LTD.	14-10-052-13 W5M	TO	05-15-052-13 W5M		√				√	
TORC OIL & GAS LTD.	15-12-054-18 W5M	TO	16-14-054-18 W5M		√				√	
TORC OIL & GAS LTD.	16-12-054-18 W5M	TO	01-13-054-18 W5M		√				√	
TORC OIL & GAS LTD.	UNAVAILABLE	TO	UNAVAILABLE		√				√	
TOURMALINE OIL CORP.	01-03-054-25 W5M	TO	01-28-053-26 W5M		√					√
TOURMALINE OIL CORP.	01-13-058-02 W6M	TO	05-13-058-01 W6M							√
TOURMALINE OIL CORP.	01-27-057-01 W6M	TO	07-06-058-27 W5M							√
TOURMALINE OIL CORP.	02-02-057-27 W5M	TO	02-02-057-27 W5M							√
TOURMALINE OIL CORP.	02-05-050-20 W5M	TO	11-05-050-20 W5M		√					
TOURMALINE OIL CORP.	02-17-056-02 W6M	TO	16-18-056-02 W6M							√
TOURMALINE OIL CORP.	02-21-057-27 W5M	TO	10-16-057-27 W5M							√
TOURMALINE OIL CORP.	03-32-051-18 W5M	TO	12-21-051-18 W5M		√				√	

TABLE 8A.1-2 Cont'd

Primary Applicant	Legal Location			Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment RSA	Vegetation RSA	Wildlife RSA	Wildlife RSA (Grizzly)
TOURMALINE OIL CORP.	04-02-050-20 W5M	TO	03-35-049-20 W5M		√					
TOURMALINE OIL CORP.	04-11-062-06 W6M	TO	13-02-062-06 W6M							√
TOURMALINE OIL CORP.	05-10-051-20 W5M	TO	15-09-051-20 W5M		√					
TOURMALINE OIL CORP.	05-13-058-01 W6M	TO	07-06-058-27 W5M							√
TOURMALINE OIL CORP.	06-08-054-01 W6M	TO	03-07-054-01 W6M							√
TOURMALINE OIL CORP.	06-23-057-01 W6M	TO	02-26-057-01 W6M							√
TOURMALINE OIL CORP.	07-21-049-20 W5M	TO	09-22-049-20 W5M		√					
TOURMALINE OIL CORP.	08-13-062-06 W6M	TO	09-13-062-06 W6M							√
TOURMALINE OIL CORP.	08-17-048-20 W5M	TO	14-09-048-20 W5M		√					
TOURMALINE OIL CORP.	09-13-062-06 W6M	TO	08-13-062-06 W6M							√
TOURMALINE OIL CORP.	10-17-049-20 W5M	TO	11-09-049-20 W5M		√					
TOURMALINE OIL CORP.	10-34-057-27 W5M	TO	04-35-057-27 W5M							√
TOURMALINE OIL CORP.	11-21-050-22 W5M	TO	13-34-050-22 W5M		√					√
TOURMALINE OIL CORP.	13-01-058-01 W6M	TO	01-13-058-01 W6M							√
TOURMALINE OIL CORP.	13-11-058-27 W5M	TO	04-14-058-27 W5M							√
TOURMALINE OIL CORP.	13-26-054-02 W6M	TO	08-27-054-02 W6M							√
TOURMALINE OIL CORP.	13-35-046-18 W5M	TO	06-21-047-17 W5M		√					
TOURMALINE OIL CORP.	14-09-048-20 W5M	TO	08-17-048-20 W5M		√					
TOURMALINE OIL CORP.	14-15-049-21 W5M	TO	03-22-049-21 W5M		√					
TOURMALINE OIL CORP.	14-21-057-27 W5M	TO	13-10-057-27 W5M							√
TOURMALINE OIL CORP.	15-16-051-23 W5M	TO	10-20-051-23 W5M		√				√	√
TOURMALINE OIL CORP.	16-24-050-22 W5M	TO	09-19-050-21 W5M		√					
TRL GAS CO-OP LTD.	01-05-057-09 W5M	TO	04-01-057-10 W5M		√					
TRL GAS CO-OP LTD.	05-29-054-07 W5M	TO	08-30-054-07 W5M		√				√	
TRL GAS CO-OP LTD.	08-17-057-13 W5M	TO	08-17-057-13 W5M		√					
TRL GAS CO-OP LTD.	09-20-057-13 W5M	TO	09-20-057-13 W5M		√					
TRL GAS CO-OP LTD.	09-29-057-13 W5M	TO	09-29-057-13 W5M		√					
VELVET ENERGY LTD.	01-08-051-14 W5M	TO	02-08-051-14 W5M		√					
VELVET ENERGY LTD.	01-08-051-14 W5M	TO	08-09-051-14 W5M		√					
VELVET ENERGY LTD.	01-09-053-14 W5M	TO	06-09-053-14 W5M		√	√	√		√	
VELVET ENERGY LTD.	05-20-055-16 W5M	TO	03-20-055-16 W5M		√					
VELVET ENERGY LTD.	08-30-055-16 W5M	TO	05-20-055-16 W5M		√					
VELVET ENERGY LTD.	10-11-054-15 W5M	TO	10-11-054-15 W5M		√				√	
VELVET ENERGY LTD.	15-32-052-14 W5M	TO	01-05-053-14 W5M		√				√	
VERMILION ENERGY INC.	10-03-050-15 W5M	TO	04-22-050-15 W5M		√					
VESTA ENERGY LTD.	10-35-048-27 W4M	TO	13-35-048-27 W4M		√					
VESTA ENERGY LTD.	13-35-048-27 W4M	TO	08-27-048-27 W4M		√					
WHITECAP RESOURCES INC.	01-28-047-05 W5M	TO	04-22-047-05 W5M		√					
WHITECAP RESOURCES INC.	03-04-045-05 W5M	TO	11-04-045-05 W5M		√					
WHITECAP RESOURCES INC.	04-19-048-04 W5M	TO	12-19-048-04 W5M		√					
WHITECAP RESOURCES INC.	04-22-047-05 W5M	TO	04-22-047-05 W5M		√					

TABLE 8A.1-2 Cont'd

Primary Applicant	Legal Location			Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment RSA	Vegetation RSA	Wildlife RSA	Wildlife RSA (Grizzly)
WHITECAP RESOURCES INC.	04-28-048-05 W5M	TO	01-29-048-05 W5M		√					
WHITECAP RESOURCES INC.	05-03-048-03 W5M	TO	05-03-048-03 W5M		√					
WHITECAP RESOURCES INC.	05-03-048-03 W5M	TO	12-03-048-03 W5M		√					
WHITECAP RESOURCES INC.	10-21-048-05 W5M	TO	10-21-048-05 W5M		√					
WHITECAP RESOURCES INC.	12-03-048-03 W5M	TO	05-03-048-03 W5M		√					
WHITECAP RESOURCES INC.	12-22-048-05 W5M	TO	12-22-048-05 W5M		√					
WHITECAP RESOURCES INC.	13-19-049-04 W5M	TO	09-19-049-04 W5M		√					
WHITECAP RESOURCES INC.	13-21-047-05 W5M	TO	01-28-047-05 W5M		√					
WHITECAP RESOURCES INC.	14-20-049-04 W5M	TO	11-20-049-04 W5M		√					
WHITECAP RESOURCES INC.	14-21-049-04 W5M	TO	14-21-049-04 W5M		√					
WHITECAP RESOURCES INC.	15-21-049-04 W5M	TO	15-21-049-04 W5M		√					
WHITECAP RESOURCES INC.	16-19-049-04 W5M	TO	09-19-049-04 W5M		√					
WILD ROSE ENERGY LTD.	06-25-045-10 W5M	TO	13-20-047-11 W5M		√					
WRANGLER WEST ENERGY CORP.	05-08-060-03 W5M	TO	13-08-060-03 W5M		√					
WRANGLER WEST ENERGY CORP.	11-02-055-27 W4M	TO	07-02-055-27 W4M		√					
TOTAL				7	502	49	46	14	130	60

Sources: ERCB 2013a, IHS Inc. 2013a

TABLE 8A.1-3

REASONABLY FORESEEABLE OIL AND GAS FACILITY DEVELOPMENTS WITHIN THE TRANS MOUNTAIN EXPANSION PROJECT RSA AND LSA OF VARIOUS ELEMENTS

Primary Applicant	Development Type	Legal Location	Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment RSA	Vegetation RSA	Wildlife	
								RSA	RSA (Grizzly)
155725 CANADA LTD.	Battery	UNKNOWN		√					
ADVANTAGE OIL & GAS LTD.	Battery	08-15-053-10 W5M		√	√	√		√	
ADVANTAGE OIL & GAS LTD.	Battery	03-26-051-27 W4M		√				√	
ADVANTAGE OIL & GAS LTD.	Battery	09-22-051-27 W4M		√				√	
ADVANTAGE OIL & GAS LTD.	Battery	11-15-042-06 W5M		√					
ADVANTAGE OIL & GAS LTD.	Satellite	07-20-042-06 W5M		√					
ADVANTAGE OIL & GAS LTD.	Satellite	13-23-051-27 W4M		√				√	
ADVANTAGE OIL & GAS LTD.	Satellite	14-30-052-25 W4M		√	√	√		√	
ADVANTAGE WELL SERVICING LTD.	Battery	UNKNOWN		√				√	
ALEXANDER ENERGY LTD.	Battery	UNKNOWN		√					
ALEXANDER ENERGY LTD.	Battery	UNKNOWN		√					
ALEXANDER ENERGY LTD.	Battery	09-33-055-26 W4M		√					
ALEXANDER ENERGY LTD.	Battery	11-27-055-26 W4M		√					
ALEXANDER ENERGY LTD.	Gas Processing Plant	03-07-056-26 W4M		√					
ALEXANDER ENERGY LTD.	Satellite	09-12-056-27 W4M		√					
ALEXANDER ENERGY LTD.	Satellite	11-07-056-26 W4M		√					
ALSTON ENERGY INC.	Battery	04-17-058-03 W5M		√					
ANDERSON ENERGY LTD.	Battery	08-21-052-14 W5M		√				√	
ANDERSON ENERGY LTD.	Battery	02-11-055-02 W5M		√					
ANDERSON ENERGY LTD.	Battery	04-28-059-06 W5M		√					
ANDERSON ENERGY LTD.	Battery	06-32-059-06 W5M		√					
ANDERSON ENERGY LTD.	Battery	08-02-055-02 W5M		√					
ANDERSON ENERGY LTD.	Battery	10-16-059-06 W5M		√					
ANDERSON ENERGY LTD.	Battery	13-17-052-19 W4M		√					
ANTELOPE LAND SERVICES LTD.	Battery	UNKNOWN		√					
ANTERRA ENERGY INC.	Battery	11-35-047-04 W5M		√					
ANTERRA ENERGY INC.	Satellite	02-26-047-04 W5M		√					

TABLE 8A.1-3 Cont'd

Primary Applicant	Development Type	Legal Location	Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment RSA	Vegetation RSA	Wildlife	
								RSA	RSA (Grizzly)
ANTERRA ENERGY INC.	Satellite	12-36-047-04 W5M		√					
APACHE CANADA LTD.	Battery	13-26-043-07 W5M		√					
APACHE CANADA LTD.	Battery	11-25-056-22 W5M		√					
APACHE CANADA LTD.	Battery	01-17-056-21 W5M		√					
APACHE CANADA LTD.	Battery	15-17-056-21 W5M		√					
APACHE CANADA LTD.	Battery	04-11-056-22 W5M		√					
APACHE CANADA LTD.	Battery	05-10-055-26 W4M		√					
APACHE CANADA LTD.	Battery	09-09-045-16 W5M							√
APACHE CANADA LTD.	Battery	10-05-056-22 W5M		√					
APACHE CANADA LTD.	Battery	10-34-057-20 W5M		√					
APACHE CANADA LTD.	Battery	11-08-056-22 W5M		√					
APACHE CANADA LTD.	Battery	11-14-057-20 W5M		√					
APACHE CANADA LTD.	Battery	13-02-057-20 W5M		√					
APACHE CANADA LTD.	Battery	15-12-049-26 W4M		√					
APACHE CANADA LTD.	Battery	15-30-056-21 W5M		√					
APACHE CANADA LTD.	Satellite	08-27-048-26 W4M		√					
ARC RESOURCES LTD.	Injection Plant	01-22-056-21 W4M		√					
ARC RESOURCES LTD.	Injection Plant	02-35-056-21 W4M		√					
ARC RESOURCES LTD.	Injection Plant	03-25-056-21 W4M		√					
ARC RESOURCES LTD.	Injection Plant	03-27-056-21 W4M		√					
ARC RESOURCES LTD.	Injection Plant	05-24-056-21 W4M		√					
ARC RESOURCES LTD.	Injection Plant	05-26-056-21 W4M		√					
ARC RESOURCES LTD.	Injection Plant	05-31-056-20 W4M		√					
ARC RESOURCES LTD.	Injection Plant	05-35-056-21 W4M		√					
ARC RESOURCES LTD.	Injection Plant	05-36-056-21 W4M		√					
ARC RESOURCES LTD.	Injection Plant	06-13-056-21 W4M		√					
ARC RESOURCES LTD.	Injection Plant	06-19-056-20 W4M		√					
ARC RESOURCES LTD.	Injection Plant	07-23-056-21 W4M		√					
ARC RESOURCES LTD.	Injection Plant	09-16-056-21 W4M		√					
ARC RESOURCES LTD.	Injection Plant	14-27-056-21 W4M		√					
ARC RESOURCES LTD.	Injection Plant	15-23-056-21 W4M		√					
ARC RESOURCES LTD.	Injection Plant	15-31-049-06 W5M		√					
ARC RESOURCES LTD.	Satellite	01-08-049-07 W5M		√					
ARC RESOURCES LTD.	Satellite	01-22-048-07 W5M		√					
ARC RESOURCES LTD.	Satellite	02-13-048-08 W5M		√					
ARC RESOURCES LTD.	Satellite	02-19-048-07 W5M		√					
ARC RESOURCES LTD.	Satellite	02-25-049-08 W5M		√					
ARC RESOURCES LTD.	Satellite	02-30-048-07 W5M		√					
ARC RESOURCES LTD.	Satellite	03-03-048-07 W5M		√					
ARC RESOURCES LTD.	Satellite	03-03-049-07 W5M		√					

TABLE 8A.1-3 Cont'd

Primary Applicant	Development Type	Legal Location	Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment RSA	Vegetation RSA	Wildlife RSA	Wildlife RSA (Grizzly)
ARC RESOURCES LTD.	Satellite	03-22-049-07 W5M		√					
ARC RESOURCES LTD.	Satellite	03-29-049-07 W5M		√					
ARC RESOURCES LTD.	Satellite	03-30-047-07 W5M		√					
ARC RESOURCES LTD.	Satellite	03-31-048-07 W5M		√					
ARC RESOURCES LTD.	Satellite	03-35-048-08 W5M		√					
ARC RESOURCES LTD.	Satellite	03-35-056-21 W4M		√					
ARC RESOURCES LTD.	Satellite	04-02-048-07 W5M		√					
ARC RESOURCES LTD.	Satellite	04-08-048-07 W5M		√					
ARC RESOURCES LTD.	Satellite	04-08-048-08 W5M		√					
ARC RESOURCES LTD.	Satellite	04-13-049-07 W5M		√					
ARC RESOURCES LTD.	Satellite	04-14-049-06 W5M		√					
ARC RESOURCES LTD.	Satellite	04-14-049-07 W5M		√					
ARC RESOURCES LTD.	Satellite	04-21-048-08 W5M		√					
ARC RESOURCES LTD.	Satellite	04-31-047-07 W5M		√					
ARC RESOURCES LTD.	Satellite	04-31-056-20 W4M		√					
ARC RESOURCES LTD.	Satellite	04-34-047-07 W5M		√					
ARC RESOURCES LTD.	Satellite	05-03-047-09 W5M		√					
ARC RESOURCES LTD.	Satellite	05-07-049-07 W5M		√					
ARC RESOURCES LTD.	Satellite	05-10-049-07 W5M		√					
ARC RESOURCES LTD.	Satellite	05-22-048-07 W5M		√					
ARC RESOURCES LTD.	Satellite	05-26-056-21 W4M		√					
ARC RESOURCES LTD.	Satellite	06-03-049-08 W5M		√					
ARC RESOURCES LTD.	Satellite	06-04-050-06 W5M		√					
ARC RESOURCES LTD.	Satellite	06-05-049-06 W5M		√					
ARC RESOURCES LTD.	Satellite	06-05-050-06 W5M		√					
ARC RESOURCES LTD.	Satellite	06-07-049-04 W5M		√					
ARC RESOURCES LTD.	Satellite	06-11-049-05 W5M		√					
ARC RESOURCES LTD.	Satellite	06-14-056-21 W4M		√					
ARC RESOURCES LTD.	Satellite	06-15-049-05 W5M		√					
ARC RESOURCES LTD.	Satellite	06-16-049-05 W5M		√					
ARC RESOURCES LTD.	Satellite	06-20-049-06 W5M		√					
ARC RESOURCES LTD.	Satellite	06-25-049-06 W5M		√					
ARC RESOURCES LTD.	Satellite	06-31-048-06 W5M		√					
ARC RESOURCES LTD.	Satellite	06-35-049-06 W5M		√					
ARC RESOURCES LTD.	Satellite	07-04-048-07 W5M		√					
ARC RESOURCES LTD.	Satellite	07-09-047-08 W5M		√					
ARC RESOURCES LTD.	Satellite	07-12-049-06 W5M		√					
ARC RESOURCES LTD.	Satellite	07-13-056-21 W4M		√					
ARC RESOURCES LTD.	Satellite	07-23-049-06 W5M		√					
ARC RESOURCES LTD.	Satellite	07-24-056-21 W4M		√					

TABLE 8A.1-3 Cont'd

Primary Applicant	Development Type	Legal Location	Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment RSA	Vegetation RSA	Wildlife RSA	Wildlife RSA (Grizzly)
ARC RESOURCES LTD.	Satellite	07-25-056-21 W4M		√					
ARC RESOURCES LTD.	Satellite	07-30-048-06 W5M		√					
ARC RESOURCES LTD.	Satellite	07-30-056-20 W4M		√					
ARC RESOURCES LTD.	Satellite	07-36-056-21 W4M		√					
ARC RESOURCES LTD.	Satellite	08-01-049-08 W5M		√					
ARC RESOURCES LTD.	Satellite	08-05-047-09 W5M		√					
ARC RESOURCES LTD.	Satellite	08-05-049-06 W5M		√					
ARC RESOURCES LTD.	Satellite	08-07-049-04 W5M		√					
ARC RESOURCES LTD.	Satellite	08-10-049-05 W5M		√					
ARC RESOURCES LTD.	Satellite	08-13-049-06 W5M		√					
ARC RESOURCES LTD.	Satellite	08-17-049-05 W5M		√					
ARC RESOURCES LTD.	Satellite	08-17-049-06 W5M		√					
ARC RESOURCES LTD.	Satellite	08-20-049-05 W5M		√					
ARC RESOURCES LTD.	Satellite	08-22-048-06 W5M		√					
ARC RESOURCES LTD.	Satellite	08-27-048-05 W5M		√					
ARC RESOURCES LTD.	Satellite	08-34-048-05 W5M		√					
ARC RESOURCES LTD.	Satellite	08-35-047-07 W5M		√					
ARC RESOURCES LTD.	Satellite	09-07-049-07 W5M		√					
ARC RESOURCES LTD.	Satellite	09-16-048-08 W5M		√					
ARC RESOURCES LTD.	Satellite	09-16-056-21 W4M		√					
ARC RESOURCES LTD.	Satellite	09-22-049-06 W5M		√					
ARC RESOURCES LTD.	Satellite	09-24-049-06 W5M		√					
ARC RESOURCES LTD.	Satellite	09-28-049-06 W5M		√					
ARC RESOURCES LTD.	Satellite	09-34-048-05 W5M		√					
ARC RESOURCES LTD.	Satellite	10-05-048-07 W5M		√					
ARC RESOURCES LTD.	Satellite	10-07-047-09 W5M		√					
ARC RESOURCES LTD.	Satellite	10-26-049-07 W5M		√					
ARC RESOURCES LTD.	Satellite	10-27-048-08 W5M		√					
ARC RESOURCES LTD.	Satellite	10-27-049-07 W5M		√					
ARC RESOURCES LTD.	Satellite	10-28-047-07 W5M		√					
ARC RESOURCES LTD.	Satellite	10-28-048-07 W5M		√					
ARC RESOURCES LTD.	Satellite	10-29-048-06 W5M		√					
ARC RESOURCES LTD.	Satellite	11-11-049-08 W5M		√					
ARC RESOURCES LTD.	Satellite	11-19-056-20 W4M		√					
ARC RESOURCES LTD.	Satellite	11-23-049-08 W5M		√					
ARC RESOURCES LTD.	Satellite	11-23-056-21 W4M		√					
ARC RESOURCES LTD.	Satellite	11-33-048-07 W5M		√					
ARC RESOURCES LTD.	Satellite	11-35-056-21 W4M		√					
ARC RESOURCES LTD.	Satellite	11-36-048-07 W5M		√					
ARC RESOURCES LTD.	Satellite	12-01-049-07 W5M		√					

TABLE 8A.1-3 Cont'd

Primary Applicant	Development Type	Legal Location	Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment RSA	Vegetation RSA	Wildlife	
								RSA	RSA (Grizzly)
ARC RESOURCES LTD.	Satellite	12-09-048-07 W5M		√					
ARC RESOURCES LTD.	Satellite	12-14-049-06 W5M		√					
ARC RESOURCES LTD.	Satellite	12-19-048-06 W5M		√					
ARC RESOURCES LTD.	Satellite	12-25-048-07 W5M		√					
ARC RESOURCES LTD.	Satellite	12-27-048-06 W5M		√					
ARC RESOURCES LTD.	Satellite	12-32-048-06 W5M		√					
ARC RESOURCES LTD.	Satellite	13-13-049-06 W5M		√					
ARC RESOURCES LTD.	Satellite	13-13-049-08 W5M		√					
ARC RESOURCES LTD.	Satellite	13-16-049-07 W5M		√					
ARC RESOURCES LTD.	Satellite	13-27-049-07 W5M		√					
ARC RESOURCES LTD.	Satellite	13-36-056-21 W4M		√					
ARC RESOURCES LTD.	Satellite	14-04-049-05 W5M		√					
ARC RESOURCES LTD.	Satellite	14-07-049-04 W5M		√					
ARC RESOURCES LTD.	Satellite	14-17-049-05 W5M		√					
ARC RESOURCES LTD.	Satellite	14-18-049-05 W5M		√					
ARC RESOURCES LTD.	Satellite	14-18-049-06 W5M		√					
ARC RESOURCES LTD.	Satellite	14-27-047-07 W5M		√					
ARC RESOURCES LTD.	Satellite	14-28-048-06 W5M		√					
ARC RESOURCES LTD.	Satellite	14-29-049-06 W5M		√					
ARC RESOURCES LTD.	Satellite	14-30-049-06 W5M		√					
ARC RESOURCES LTD.	Satellite	15-09-049-05 W5M		√					
ARC RESOURCES LTD.	Satellite	15-34-048-08 W5M		√					
ARC RESOURCES LTD.	Satellite	15-36-056-21 W4M		√					
ARC RESOURCES LTD.	Satellite	16-03-049-05 W5M		√					
ARC RESOURCES LTD.	Satellite	16-07-049-05 W5M		√					
ARC RESOURCES LTD.	Satellite	16-08-048-07 W5M		√					
ARC RESOURCES LTD.	Satellite	16-08-049-05 W5M		√					
ARC RESOURCES LTD.	Satellite	16-10-049-05 W5M		√					
ARC RESOURCES LTD.	Satellite	16-20-049-06 W5M		√					
ARC RESOURCES LTD.	Satellite	16-21-049-06 W5M		√					
ARC RESOURCES LTD.	Satellite	16-22-048-06 W5M		√					
ARC RESOURCES LTD.	Satellite	16-23-049-06 W5M		√					
ARC RESOURCES LTD.	Satellite	16-28-048-06 W5M		√					
ARC RESOURCES LTD.	Satellite	16-32-049-06 W5M		√					
ARTEK EXPLORATION LTD.	Satellite	02-27-048-26 W4M		√					
BARRICK ENERGY INC.	Battery	14-03-053-17 W5M		√	√	√		√	
BAYTEX ENERGY LTD.	Battery	10-24-058-12 W5M		√					
BAYTEX ENERGY LTD.	Battery	10-30-056-21 W4M		√					
BAYTEX ENERGY LTD.	Satellite	02-10-056-24 W4M		√					
BAYTEX ENERGY LTD.	Satellite	02-19-057-22 W4M		√					

TABLE 8A.1-3 Cont'd

Primary Applicant	Development Type	Legal Location	Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment RSA	Vegetation RSA	Wildlife	
								RSA	RSA (Grizzly)
BAYTEX ENERGY LTD.	Satellite	02-20-057-22 W4M		√					
BAYTEX ENERGY LTD.	Satellite	02-21-057-22 W4M		√					
BAYTEX ENERGY LTD.	Satellite	05-21-057-22 W4M		√					
BAYTEX ENERGY LTD.	Satellite	05-28-056-24 W4M		√					
BAYTEX ENERGY LTD.	Satellite	06-10-056-24 W4M		√					
BAYTEX ENERGY LTD.	Satellite	06-22-048-08 W5M		√					
BAYTEX ENERGY LTD.	Satellite	07-10-056-24 W4M		√					
BAYTEX ENERGY LTD.	Satellite	07-31-056-24 W4M		√					
BAYTEX ENERGY LTD.	Satellite	13-09-057-22 W4M		√					
BAYTEX ENERGY LTD.	Satellite	14-03-056-24 W4M		√					
BAYTEX ENERGY LTD.	Satellite	14-24-056-24 W4M		√					
BAYTEX ENERGY LTD.	Satellite	15-04-057-22 W4M		√					
BAYTEX ENERGY LTD.	Satellite	15-09-057-22 W4M		√					
BAYTEX ENERGY LTD.	Satellite	16-21-056-24 W4M		√					
BEATTON ENERGY INC.	Battery	06-33-048-16 W5M		√					
BELLATRIX EXPLORATION LTD.	Battery	04-14-044-07 W5M		√					
BELLATRIX EXPLORATION LTD.	Battery	01-06-044-07 W5M		√					
BELLATRIX EXPLORATION LTD.	Battery	15-36-044-07 W5M		√					
BELLATRIX EXPLORATION LTD.	Battery	16-29-047-03 W5M		√					
BELLATRIX EXPLORATION LTD.	Battery	16-33-048-08 W5M		√					
BELLATRIX EXPLORATION LTD.	Satellite	08-35-046-04 W5M		√					
BELLATRIX EXPLORATION LTD.	Satellite	10-28-048-08 W5M		√					
BELLATRIX EXPLORATION LTD.	Satellite	16-28-048-08 W5M		√					
BENJAKA EXPLORATION INC.	Battery	11-27-052-16 W5M		√				√	
BONAVISTA ENERGY CORPORATION	Battery	09-09-059-05 W5M		√					
BONAVISTA ENERGY CORPORATION	Battery	01-03-054-16 W5M		√	√	√		√	
BONAVISTA ENERGY CORPORATION	Battery	01-10-054-16 W5M		√				√	
BONAVISTA ENERGY CORPORATION	Battery	01-33-053-16 W5M		√	√	√		√	

TABLE 8A.1-3 Cont'd

Primary Applicant	Development Type	Legal Location	Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment RSA	Vegetation RSA	Wildlife RSA	Wildlife RSA (Grizzly)
BONAVISTA ENERGY CORPORATION	Battery	02-25-055-20 W5M		√					
BONAVISTA ENERGY CORPORATION	Battery	02-34-055-20 W5M		√					
BONAVISTA ENERGY CORPORATION	Battery	03-19-055-06 W5M		√					
BONAVISTA ENERGY CORPORATION	Battery	04-02-054-15 W5M		√	√	√		√	
BONAVISTA ENERGY CORPORATION	Battery	04-11-054-16 W5M		√				√	
BONAVISTA ENERGY CORPORATION	Battery	04-13-047-03 W5M		√					
BONAVISTA ENERGY CORPORATION	Battery	06-04-053-15 W5M		√				√	
BONAVISTA ENERGY CORPORATION	Battery	06-13-044-08 W5M		√					
BONAVISTA ENERGY CORPORATION	Battery	07-23-043-07 W5M		√					
BONAVISTA ENERGY CORPORATION	Battery	09-32-055-19 W5M		√					
BONAVISTA ENERGY CORPORATION	Battery	09-36-055-20 W5M		√					
BONAVISTA ENERGY CORPORATION	Battery	10-03-053-15 W5M		√				√	
BONAVISTA ENERGY CORPORATION	Battery	10-13-053-15 W5M		√	√	√		√	
BONAVISTA ENERGY CORPORATION	Battery	13-25-053-15 W5M		√	√	√		√	
BONAVISTA ENERGY CORPORATION	Battery	13-26-053-15 W5M		√	√	√		√	
BONAVISTA ENERGY CORPORATION	Battery	13-36-055-19 W5M		√					
BONAVISTA ENERGY CORPORATION	Battery	14-12-053-15 W5M		√	√	√		√	
BONAVISTA ENERGY CORPORATION	Battery	14-34-055-19 W5M		√					
BONAVISTA ENERGY CORPORATION	Battery	15-04-053-15 W5M		√				√	
BONAVISTA ENERGY CORPORATION	Battery	15-17-055-19 W5M		√					
BONAVISTA ENERGY CORPORATION	Battery	15-28-055-19 W5M		√					
BONAVISTA ENERGY CORPORATION	Battery	16-01-054-15 W5M		√	√	√		√	

TABLE 8A.1-3 Cont'd

Primary Applicant	Development Type	Legal Location	Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment RSA	Vegetation RSA	Wildlife RSA	Wildlife RSA (Grizzly)
BONAVISTA ENERGY CORPORATION	Battery	16-07-056-19 W5M		√					
BONAVISTA ENERGY CORPORATION	Battery	16-25-053-15 W5M		√	√	√		√	
BONAVISTA ENERGY CORPORATION	Battery	16-25-055-20 W5M		√					
BONAVISTA ENERGY CORPORATION	Satellite	05-22-048-04 W5M		√					
BONAVISTA ENERGY CORPORATION	Satellite	06-22-048-04 W5M		√					
BONAVISTA ENERGY CORPORATION	Satellite	08-06-042-06 W5M		√					
BONAVISTA ENERGY CORPORATION	Satellite	11-17-042-06 W5M		√					
BONTERRA ENERGY CORP.	Battery	16-34-046-09 W5M		√					
BONTERRA ENERGY CORP.	Battery	03-01-050-05 W5M		√					
BONTERRA ENERGY CORP.	Battery	05-20-048-04 W5M		√					
BONTERRA ENERGY CORP.	Battery	08-13-049-04 W5M		√					
BONTERRA ENERGY CORP.	Gas Gathering System	04-25-047-03 W5M		√					
BONTERRA ENERGY CORP.	Satellite	01-15-048-04 W5M		√					
BONTERRA ENERGY CORP.	Satellite	01-24-049-05 W5M		√					
BONTERRA ENERGY CORP.	Satellite	02-09-049-04 W5M		√					
BONTERRA ENERGY CORP.	Satellite	02-13-047-09 W5M		√					
BONTERRA ENERGY CORP.	Satellite	02-24-047-07 W5M		√					
BONTERRA ENERGY CORP.	Satellite	02-33-046-09 W5M		√					
BONTERRA ENERGY CORP.	Satellite	02-34-046-09 W5M		√					
BONTERRA ENERGY CORP.	Satellite	03-12-047-07 W5M		√					
BONTERRA ENERGY CORP.	Satellite	03-19-046-07 W5M		√					
BONTERRA ENERGY CORP.	Satellite	04-03-049-04 W5M		√					

TABLE 8A.1-3 Cont'd

Primary Applicant	Development Type	Legal Location	Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment RSA	Vegetation RSA	Wildlife	
								RSA	RSA (Grizzly)
BONTERRA ENERGY CORP.	Satellite	04-04-049-04 W5M		√					
BONTERRA ENERGY CORP.	Satellite	04-28-048-04 W5M		√					
BONTERRA ENERGY CORP.	Satellite	04-31-046-07 W5M		√					
BONTERRA ENERGY CORP.	Satellite	05-08-049-04 W5M		√					
BONTERRA ENERGY CORP.	Satellite	05-19-047-08 W5M		√					
BONTERRA ENERGY CORP.	Satellite	05-20-048-04 W5M		√					
BONTERRA ENERGY CORP.	Satellite	05-23-048-05 W5M		√					
BONTERRA ENERGY CORP.	Satellite	06-01-047-09 W5M		√					
BONTERRA ENERGY CORP.	Satellite	06-01-049-04 W5M		√					
BONTERRA ENERGY CORP.	Satellite	06-03-048-06 W5M		√					
BONTERRA ENERGY CORP.	Satellite	06-03-049-04 W5M		√					
BONTERRA ENERGY CORP.	Satellite	06-06-048-06 W5M		√					
BONTERRA ENERGY CORP.	Satellite	06-10-049-04 W5M		√					
BONTERRA ENERGY CORP.	Satellite	06-11-056-20 W4M		√					
BONTERRA ENERGY CORP.	Satellite	06-14-048-07 W5M		√					
BONTERRA ENERGY CORP.	Satellite	06-15-049-04 W5M		√					
BONTERRA ENERGY CORP.	Satellite	06-18-048-03 W5M		√					
BONTERRA ENERGY CORP.	Satellite	06-18-048-05 W5M		√					
BONTERRA ENERGY CORP.	Satellite	06-19-048-03 W5M		√					
BONTERRA ENERGY CORP.	Satellite	06-23-048-04 W5M		√					
BONTERRA ENERGY CORP.	Satellite	06-28-046-09 W5M		√					
BONTERRA ENERGY CORP.	Satellite	06-28-048-04 W5M		√					

TABLE 8A.1-3 Cont'd

Primary Applicant	Development Type	Legal Location	Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment RSA	Vegetation RSA	Wildlife RSA	Wildlife RSA (Grizzly)
BONTERRA ENERGY CORP.	Satellite	06-31-048-03 W5M		√					
BONTERRA ENERGY CORP.	Satellite	06-32-048-04 W5M		√					
BONTERRA ENERGY CORP.	Satellite	06-34-048-04 W5M		√					
BONTERRA ENERGY CORP.	Satellite	07-08-049-04 W5M		√					
BONTERRA ENERGY CORP.	Satellite	07-18-046-07 W5M		√					
BONTERRA ENERGY CORP.	Satellite	07-25-046-08 W5M		√					
BONTERRA ENERGY CORP.	Satellite	07-36-047-09 W5M		√					
BONTERRA ENERGY CORP.	Satellite	08-02-049-04 W5M		√					
BONTERRA ENERGY CORP.	Satellite	08-04-049-04 W5M		√					
BONTERRA ENERGY CORP.	Satellite	08-07-047-08 W5M		√					
BONTERRA ENERGY CORP.	Satellite	08-11-047-09 W5M		√					
BONTERRA ENERGY CORP.	Satellite	08-11-048-06 W5M		√					
BONTERRA ENERGY CORP.	Satellite	08-11-049-04 W5M		√					
BONTERRA ENERGY CORP.	Satellite	08-13-048-04 W5M		√					
BONTERRA ENERGY CORP.	Satellite	08-14-049-04 W5M		√					
BONTERRA ENERGY CORP.	Satellite	08-15-048-04 W5M		√					
BONTERRA ENERGY CORP.	Satellite	08-16-049-04 W5M		√					
BONTERRA ENERGY CORP.	Satellite	08-17-049-04 W5M		√					
BONTERRA ENERGY CORP.	Satellite	08-19-049-04 W5M		√					
BONTERRA ENERGY CORP.	Satellite	08-22-048-04 W5M		√					
BONTERRA ENERGY CORP.	Satellite	08-24-047-07 W5M		√					
BONTERRA ENERGY CORP.	Satellite	08-26-048-04 W5M		√					

TABLE 8A.1-3 Cont'd

Primary Applicant	Development Type	Legal Location	Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment RSA	Vegetation RSA	Wildlife	
								RSA	RSA (Grizzly)
BONTERRA ENERGY CORP.	Satellite	08-28-046-09 W5M		√					
BONTERRA ENERGY CORP.	Satellite	08-33-048-04 W5M		√					
BONTERRA ENERGY CORP.	Satellite	08-36-048-04 W5M		√					
BONTERRA ENERGY CORP.	Satellite	09-30-048-04 W5M		√					
BONTERRA ENERGY CORP.	Satellite	09-36-047-07 W5M		√					
BONTERRA ENERGY CORP.	Satellite	10-25-048-04 W5M		√					
BONTERRA ENERGY CORP.	Satellite	10-25-048-07 W5M		√					
BONTERRA ENERGY CORP.	Satellite	10-32-047-06 W5M		√					
BONTERRA ENERGY CORP.	Satellite	11-07-047-08 W5M		√					
BONTERRA ENERGY CORP.	Satellite	11-27-048-04 W5M		√					
BONTERRA ENERGY CORP.	Satellite	12-05-047-08 W5M		√					
BONTERRA ENERGY CORP.	Satellite	12-22-048-04 W5M		√					
BONTERRA ENERGY CORP.	Satellite	13-02-048-07 W5M		√					
BONTERRA ENERGY CORP.	Satellite	13-07-047-06 W5M		√					
BONTERRA ENERGY CORP.	Satellite	13-13-049-04 W5M		√					
BONTERRA ENERGY CORP.	Satellite	13-15-049-04 W5M		√					
BONTERRA ENERGY CORP.	Satellite	13-18-048-03 W5M		√					
BONTERRA ENERGY CORP.	Satellite	13-22-048-05 W5M		√					
BONTERRA ENERGY CORP.	Satellite	14-05-048-05 W5M		√					
BONTERRA ENERGY CORP.	Satellite	14-06-047-09 W5M		√					
BONTERRA ENERGY CORP.	Satellite	14-09-048-06 W5M		√					
BONTERRA ENERGY CORP.	Satellite	14-10-049-04 W5M		√					

TABLE 8A.1-3 Cont'd

Primary Applicant	Development Type	Legal Location	Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment RSA	Vegetation RSA	Wildlife RSA	Wildlife RSA (Grizzly)
BONTERRA ENERGY CORP.	Satellite	14-12-048-06 W5M		√					
BONTERRA ENERGY CORP.	Satellite	14-13-048-04 W5M		√					
BONTERRA ENERGY CORP.	Satellite	14-14-048-04 W5M		√					
BONTERRA ENERGY CORP.	Satellite	14-16-048-04 W5M		√					
BONTERRA ENERGY CORP.	Satellite	14-18-047-08 W5M		√					
BONTERRA ENERGY CORP.	Satellite	14-18-048-03 W5M		√					
BONTERRA ENERGY CORP.	Satellite	14-20-049-04 W5M		√					
BONTERRA ENERGY CORP.	Satellite	14-21-048-04 W5M		√					
BONTERRA ENERGY CORP.	Satellite	14-29-048-04 W5M		√					
BONTERRA ENERGY CORP.	Satellite	14-34-046-08 W5M		√					
BONTERRA ENERGY CORP.	Satellite	14-35-048-04 W5M		√					
BONTERRA ENERGY CORP.	Satellite	15-22-047-08 W5M		√					
BONTERRA ENERGY CORP.	Satellite	15-26-048-04 W5M		√					
BONTERRA ENERGY CORP.	Satellite	16-02-049-04 W5M		√					
BONTERRA ENERGY CORP.	Satellite	16-02-056-20 W4M		√					
BONTERRA ENERGY CORP.	Satellite	16-06-048-06 W5M		√					
BONTERRA ENERGY CORP.	Satellite	16-09-049-04 W5M		√					
BONTERRA ENERGY CORP.	Satellite	16-10-048-04 W5M		√					
BONTERRA ENERGY CORP.	Satellite	16-10-048-06 W5M		√					
BONTERRA ENERGY CORP.	Satellite	16-11-049-04 W5M		√					
BONTERRA ENERGY CORP.	Satellite	16-16-048-04 W5M		√					
BONTERRA ENERGY CORP.	Satellite	16-16-048-05 W5M		√					

TABLE 8A.1-3 Cont'd

Primary Applicant	Development Type	Legal Location	Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment RSA	Vegetation RSA	Wildlife	
								RSA	RSA (Grizzly)
BONTERRA ENERGY CORP.	Satellite	16-17-048-04 W5M		√					
BONTERRA ENERGY CORP.	Satellite	16-21-048-04 W5M		√					
BONTERRA ENERGY CORP.	Satellite	16-23-048-04 W5M		√					
BONTERRA ENERGY CORP.	Satellite	16-24-048-04 W5M		√					
BONTERRA ENERGY CORP.	Satellite	16-26-047-03 W5M		√					
BONTERRA ENERGY CORP.	Satellite	16-28-047-05 W5M		√					
BONTERRA ENERGY CORP.	Satellite	16-33-047-05 W5M		√					
BONTERRA ENERGY CORP.	Satellite	16-35-047-06 W5M		√					
BONTERRA ENERGY CORP.	Satellite	16-36-048-04 W5M		√					
BUMPER DEVELOPMENT CORPORATION LTD.	Satellite	08-13-045-07 W5M		√					
BUMPER DEVELOPMENT CORPORATION LTD.	Satellite	14-03-046-07 W5M		√					
CANADIAN NATURAL RESOURCES LIMITED	Battery	01-05-056-21 W5M		√					
CANADIAN NATURAL RESOURCES LIMITED	Battery	01-14-055-22 W5M		√					
CANADIAN NATURAL RESOURCES LIMITED	Battery	01-25-054-21 W5M		√					
CANADIAN NATURAL RESOURCES LIMITED	Battery	01-31-051-19 W5M		√				√	
CANADIAN NATURAL RESOURCES LIMITED	Battery	01-36-051-20 W5M		√				√	
CANADIAN NATURAL RESOURCES LIMITED	Battery	02-08-052-19 W5M		√				√	
CANADIAN NATURAL RESOURCES LIMITED	Battery	02-12-052-20 W5M		√				√	
CANADIAN NATURAL RESOURCES LIMITED	Battery	02-18-052-19 W5M		√				√	
CANADIAN NATURAL RESOURCES LIMITED	Battery	02-19-058-02 W6M							√
CANADIAN NATURAL RESOURCES LIMITED	Battery	02-21-059-08 W5M		√					
CANADIAN NATURAL RESOURCES LIMITED	Battery	02-29-056-24 W5M							√

TABLE 8A.1-3 Cont'd

Primary Applicant	Development Type	Legal Location	Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment RSA	Vegetation RSA	Wildlife RSA	Wildlife RSA (Grizzly)
CANADIAN NATURAL RESOURCES LIMITED	Battery	02-34-053-19 W5M		√				√	
CANADIAN NATURAL RESOURCES LIMITED	Battery	03-01-055-18 W4M		√					
CANADIAN NATURAL RESOURCES LIMITED	Battery	03-10-052-19 W5M		√				√	
CANADIAN NATURAL RESOURCES LIMITED	Battery	03-14-052-20 W5M		√				√	
CANADIAN NATURAL RESOURCES LIMITED	Battery	03-19-055-19 W5M		√					
CANADIAN NATURAL RESOURCES LIMITED	Battery	03-29-051-23 W5M		√				√	√
CANADIAN NATURAL RESOURCES LIMITED	Battery	04-27-052-20 W5M		√	√	√		√	
CANADIAN NATURAL RESOURCES LIMITED	Battery	04-28-052-20 W5M		√	√	√		√	
CANADIAN NATURAL RESOURCES LIMITED	Battery	05-01-052-20 W5M		√				√	
CANADIAN NATURAL RESOURCES LIMITED	Battery	06-13-052-21 W5M		√				√	
CANADIAN NATURAL RESOURCES LIMITED	Battery	06-15-055-18 W4M		√					
CANADIAN NATURAL RESOURCES LIMITED	Battery	06-22-053-20 W5M		√	√	√		√	
CANADIAN NATURAL RESOURCES LIMITED	Battery	07-08-052-19 W5M		√				√	
CANADIAN NATURAL RESOURCES LIMITED	Battery	07-23-052-20 W5M		√	√	√		√	
CANADIAN NATURAL RESOURCES LIMITED	Battery	07-27-052-20 W5M		√	√	√		√	
CANADIAN NATURAL RESOURCES LIMITED	Battery	08-20-058-02 W6M							√
CANADIAN NATURAL RESOURCES LIMITED	Battery	08-32-051-19 W5M		√				√	
CANADIAN NATURAL RESOURCES LIMITED	Battery	08-34-045-20 W5M							√
CANADIAN NATURAL RESOURCES LIMITED	Battery	08-35-052-25 W5M		√				√	√
CANADIAN NATURAL RESOURCES LIMITED	Battery	09-16-056-26 W5M							√
CANADIAN NATURAL RESOURCES LIMITED	Battery	09-24-058-03 W6M							√
CANADIAN NATURAL RESOURCES LIMITED	Battery	09-29-058-03 W5M		√					

TABLE 8A.1-3 Cont'd

Primary Applicant	Development Type	Legal Location	Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment RSA	Vegetation RSA	Wildlife RSA	Wildlife RSA (Grizzly)
CANADIAN NATURAL RESOURCES LIMITED	Battery	10-02-055-01 W5M		√					
CANADIAN NATURAL RESOURCES LIMITED	Battery	10-05-052-19 W5M		√				√	
CANADIAN NATURAL RESOURCES LIMITED	Battery	10-06-052-19 W5M		√				√	
CANADIAN NATURAL RESOURCES LIMITED	Battery	10-10-054-10 W5M		√				√	
CANADIAN NATURAL RESOURCES LIMITED	Battery	10-16-053-19 W5M		√	√	√		√	
CANADIAN NATURAL RESOURCES LIMITED	Battery	10-29-054-24 W5M		√					
CANADIAN NATURAL RESOURCES LIMITED	Battery	10-30-051-03 W5M		√					
CANADIAN NATURAL RESOURCES LIMITED	Battery	11-07-052-19 W5M		√				√	
CANADIAN NATURAL RESOURCES LIMITED	Battery	12-01-054-23 W5M		√				√	
CANADIAN NATURAL RESOURCES LIMITED	Battery	12-04-052-19 W5M		√				√	
CANADIAN NATURAL RESOURCES LIMITED	Battery	12-07-056-20 W5M		√					
CANADIAN NATURAL RESOURCES LIMITED	Battery	12-15-055-18 W4M		√					
CANADIAN NATURAL RESOURCES LIMITED	Battery	12-25-058-03 W6M							√
CANADIAN NATURAL RESOURCES LIMITED	Battery	12-28-053-23 W5M		√				√	
CANADIAN NATURAL RESOURCES LIMITED	Battery	12-30-052-19 W5M		√	√	√		√	
CANADIAN NATURAL RESOURCES LIMITED	Battery	13-01-056-18 W5M		√					
CANADIAN NATURAL RESOURCES LIMITED	Battery	13-17-058-02 W6M							√
CANADIAN NATURAL RESOURCES LIMITED	Battery	13-34-049-18 W5M		√					
CANADIAN NATURAL RESOURCES LIMITED	Battery	14-06-055-22 W5M		√					
CANADIAN NATURAL RESOURCES LIMITED	Battery	14-22-053-20 W5M		√				√	
CANADIAN NATURAL RESOURCES LIMITED	Battery	14-22-058-04 W6M							√
CANADIAN NATURAL RESOURCES LIMITED	Battery	14-30-051-19 W5M		√				√	

TABLE 8A.1-3 Cont'd

Primary Applicant	Development Type	Legal Location	Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment RSA	Vegetation RSA	Wildlife	
								RSA	RSA (Grizzly)
CANADIAN NATURAL RESOURCES LIMITED	Battery	14-31-052-20 W5M		√	√	√	√	√	
CANADIAN NATURAL RESOURCES LIMITED	Battery	15-09-058-04 W6M							√
CANADIAN NATURAL RESOURCES LIMITED	Battery	15-12-053-20 W5M		√	√	√		√	
CANADIAN NATURAL RESOURCES LIMITED	Battery	15-23-058-03 W6M							√
CANADIAN NATURAL RESOURCES LIMITED	Battery	16-06-052-19 W5M		√				√	
CANADIAN NATURAL RESOURCES LIMITED	Battery	16-06-055-21 W5M		√					
CANADIAN NATURAL RESOURCES LIMITED	Battery	16-08-053-20 W5M		√	√	√		√	
CANADIAN NATURAL RESOURCES LIMITED	Battery	16-22-055-25 W5M							√
CANADIAN NATURAL RESOURCES LIMITED	Battery	16-34-053-16 W5M		√	√	√		√	
CANADIAN NATURAL RESOURCES LIMITED	Satellite	01-07-059-08 W5M		√					
CANADIAN NATURAL RESOURCES LIMITED	Satellite	07-23-050-22 W4M		√					
CANCEN OIL PROCESSORS CORP.	Central Treating Plants	02-31-052-23 W4M		√	√	√		√	
CELTIC EXPLORATION ULC	Battery	01-13-060-09 W6M							√
CELTIC EXPLORATION ULC	Battery	05-17-058-27 W5M							√
CELTIC EXPLORATION ULC	Battery	12-24-061-10 W6M							√
CELTIC EXPLORATION ULC	Battery	12-36-059-08 W6M							√
CEQUEL ENERGY INC.	Battery	04-09-051-02 W5M		√					
CEQUENCE ENERGY LTD.	Battery	12-06-058-11 W5M		√					
CHINOOK ENERGY INC.	Battery	01-17-054-20 W4M		√					
CHINOOK ENERGY LTD.	Battery	06-09-057-08 W5M		√					
CHINOOK ENERGY LTD.	Battery	06-34-056-08 W5M		√					
CHINOOK ENERGY LTD.	Satellite	06-24-042-07 W5M		√					
CHINOOK ENERGY LTD.	Satellite	14-04-049-01 W5M		√					
CHINOOK ENERGY LTD.	Satellite	16-33-048-01 W5M		√					
COMPTON PETROLEUM CORPORATION	Battery	10-01-055-14 W5M		√				√	
COMPTON PETROLEUM CORPORATION	Battery	01-35-053-14 W5M		√	√	√	√	√	
COMPTON PETROLEUM CORPORATION	Battery	06-16-054-15 W5M		√				√	

TABLE 8A.1-3 Cont'd

Primary Applicant	Development Type	Legal Location	Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment RSA	Vegetation RSA	Wildlife RSA	Wildlife RSA (Grizzly)
COMPTON PETROLEUM CORPORATION	Battery	11-29-053-14 W5M		√	√	√		√	
COMPTON PETROLEUM CORPORATION	Battery	12-07-054-14 W5M		√				√	
COMPTON PETROLEUM CORPORATION	Battery	12-27-054-13 W5M		√				√	
COMPTON PETROLEUM CORPORATION	Battery	13-11-054-13 W5M		√	√	√		√	
COMPTON PETROLEUM CORPORATION	Battery	14-12-054-14 W5M		√	√	√		√	
COMPTON PETROLEUM CORPORATION	Battery	14-24-054-14 W5M		√				√	
COMPTON PETROLEUM CORPORATION	Battery	16-09-054-14 W5M		√				√	
CONOCOPHILLIPS CANADA OPERATIONS LTD.	Battery	02-27-049-14 W5M		√					
CONOCOPHILLIPS CANADA OPERATIONS LTD.	Battery	03-15-052-15 W5M		√				√	
CONOCOPHILLIPS CANADA OPERATIONS LTD.	Battery	03-34-064-09 W6M							√
CONOCOPHILLIPS CANADA OPERATIONS LTD.	Battery	05-04-065-09 W6M							√
CONOCOPHILLIPS CANADA OPERATIONS LTD.	Battery	05-10-046-09 W5M		√					
CONOCOPHILLIPS CANADA OPERATIONS LTD.	Battery	08-11-051-15 W5M		√					
CONOCOPHILLIPS CANADA OPERATIONS LTD.	Battery	08-22-063-08 W6M							√
CONOCOPHILLIPS CANADA OPERATIONS LTD.	Battery	08-29-063-11 W6M							√
CONOCOPHILLIPS CANADA OPERATIONS LTD.	Battery	12-02-047-10 W5M		√					
CONOCOPHILLIPS CANADA OPERATIONS LTD.	Battery	13-15-049-14 W5M		√					
CONOCOPHILLIPS CANADA OPERATIONS LTD.	Battery	14-26-045-09 W5M		√					
CONOCOPHILLIPS CANADA OPERATIONS LTD.	Battery	14-31-052-14 W5M		√				√	
CONOCOPHILLIPS CANADA OPERATIONS LTD.	Battery	15-33-049-14 W5M		√					
CONOCOPHILLIPS CANADA OPERATIONS LTD.	Battery	16-07-047-06 W5M		√					
CONOCOPHILLIPS CANADA RESOURCES CORP.	Battery	01-31-059-12 W5M		√					

TABLE 8A.1-3 Cont'd

Primary Applicant	Development Type	Legal Location	Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment RSA	Vegetation RSA	Wildlife	
								RSA	RSA (Grizzly)
CONOCOPHILLIPS CANADA RESOURCES CORP.	Battery	UNKNONWN		√					
CONOCOPHILLIPS CANADA RESOURCES CORP.	Battery	UNKNOWN		√					
CONOCOPHILLIPS CANADA RESOURCES CORP.	Battery	01-12-046-08 W5M		√					
CONOCOPHILLIPS CANADA RESOURCES CORP.	Battery	01-13-046-09 W5M		√					
CONOCOPHILLIPS CANADA RESOURCES CORP.	Battery	01-21-052-14 W5M		√				√	
CONOCOPHILLIPS CANADA RESOURCES CORP.	Battery	01-28-044-07 W5M		√					
CONOCOPHILLIPS CANADA RESOURCES CORP.	Battery	01-34-044-06 W5M		√					
CONOCOPHILLIPS CANADA RESOURCES CORP.	Battery	02-26-046-09 W5M		√					
CONOCOPHILLIPS CANADA RESOURCES CORP.	Battery	03-33-056-20 W5M		√					
CONOCOPHILLIPS CANADA RESOURCES CORP.	Battery	04-29-046-08 W5M		√					
CONOCOPHILLIPS CANADA RESOURCES CORP.	Battery	04-30-058-11 W5M		√					
CONOCOPHILLIPS CANADA RESOURCES CORP.	Battery	05-14-051-15 W5M		√					
CONOCOPHILLIPS CANADA RESOURCES CORP.	Battery	06-04-046-09 W5M		√					
CONOCOPHILLIPS CANADA RESOURCES CORP.	Battery	06-08-046-08 W5M		√					
CONOCOPHILLIPS CANADA RESOURCES CORP.	Battery	06-11-045-08 W5M		√					
CONOCOPHILLIPS CANADA RESOURCES CORP.	Battery	06-29-059-08 W6M							√
CONOCOPHILLIPS CANADA RESOURCES CORP.	Battery	07-02-059-12 W5M		√					
CONOCOPHILLIPS CANADA RESOURCES CORP.	Battery	07-05-057-20 W5M		√					
CONOCOPHILLIPS CANADA RESOURCES CORP.	Battery	07-13-047-07 W5M		√					
CONOCOPHILLIPS CANADA RESOURCES CORP.	Battery	07-20-051-15 W5M		√					
CONOCOPHILLIPS CANADA RESOURCES CORP.	Battery	07-33-050-15 W5M		√					
CONOCOPHILLIPS CANADA RESOURCES CORP.	Battery	08-29-063-11 W6M							√

TABLE 8A.1-3 Cont'd

Primary Applicant	Development Type	Legal Location	Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment RSA	Vegetation RSA	Wildlife	
								RSA	RSA (Grizzly)
CONOCOPHILLIPS CANADA RESOURCES CORP.	Battery	09-07-052-16 W4M		√					
CONOCOPHILLIPS CANADA RESOURCES CORP.	Battery	09-14-046-09 W5M		√					
CONOCOPHILLIPS CANADA RESOURCES CORP.	Battery	10-01-059-13 W5M		√					
CONOCOPHILLIPS CANADA RESOURCES CORP.	Battery	10-18-048-22 W5M		√					√
CONOCOPHILLIPS CANADA RESOURCES CORP.	Battery	10-18-056-10 W5M		√					
CONOCOPHILLIPS CANADA RESOURCES CORP.	Battery	10-19-050-14 W5M		√					
CONOCOPHILLIPS CANADA RESOURCES CORP.	Battery	10-21-055-12 W5M		√					
CONOCOPHILLIPS CANADA RESOURCES CORP.	Battery	10-23-046-09 W5M		√					
CONOCOPHILLIPS CANADA RESOURCES CORP.	Battery	10-24-046-08 W5M		√					
CONOCOPHILLIPS CANADA RESOURCES CORP.	Battery	11-24-046-09 W5M		√					
CONOCOPHILLIPS CANADA RESOURCES CORP.	Battery	11-25-049-16 W5M		√					
CONOCOPHILLIPS CANADA RESOURCES CORP.	Battery	11-25-058-12 W5M		√					
CONOCOPHILLIPS CANADA RESOURCES CORP.	Battery	11-28-056-20 W5M		√					
CONOCOPHILLIPS CANADA RESOURCES CORP.	Battery	11-35-058-12 W5M		√					
CONOCOPHILLIPS CANADA RESOURCES CORP.	Battery	12-11-052-15 W5M		√				√	
CONOCOPHILLIPS CANADA RESOURCES CORP.	Battery	12-13-046-09 W5M		√					
CONOCOPHILLIPS CANADA RESOURCES CORP.	Battery	12-16-051-15 W5M		√					
CONOCOPHILLIPS CANADA RESOURCES CORP.	Battery	13-10-046-08 W5M		√					
CONOCOPHILLIPS CANADA RESOURCES CORP.	Battery	13-11-046-08 W5M		√					
CONOCOPHILLIPS CANADA RESOURCES CORP.	Battery	14-02-046-08 W5M		√					
CONOCOPHILLIPS CANADA RESOURCES CORP.	Battery	14-11-063-08 W6M							√
CONOCOPHILLIPS CANADA RESOURCES CORP.	Battery	14-15-046-08 W5M		√					

TABLE 8A.1-3 Cont'd

Primary Applicant	Development Type	Legal Location	Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment RSA	Vegetation RSA	Wildlife	
								RSA	RSA (Grizzly)
CONOCOPHILLIPS CANADA RESOURCES CORP.	Battery	14-18-046-08 W5M		√					
CONOCOPHILLIPS CANADA RESOURCES CORP.	Battery	15-03-054-15 W5M		√	√	√		√	
CONOCOPHILLIPS CANADA RESOURCES CORP.	Battery	16-05-053-01 W5M	√	√	√	√	√	√	
CONOCOPHILLIPS CANADA RESOURCES CORP.	Battery	16-15-046-09 W5M		√					
CONOCOPHILLIPS CANADA RESOURCES CORP.	Battery	16-25-063-08 W6M							√
CONOCOPHILLIPS CANADA RESOURCES CORP.	Battery	16-28-050-16 W5M		√					
CONOCOPHILLIPS CANADA RESOURCES CORP.	Battery	16-34-045-09 W5M		√					
CONOCOPHILLIPS CANADA RESOURCES CORP.	Satellite	01-10-055-13 W5M		√				√	
CONOCOPHILLIPS CANADA RESOURCES CORP.	Satellite	02-02-055-13 W5M		√				√	
CONOCOPHILLIPS CANADA RESOURCES CORP.	Satellite	06-25-054-13 W5M		√				√	
CONOCOPHILLIPS CANADA RESOURCES CORP.	Satellite	14-18-054-12 W5M		√				√	
CONOCOPHILLIPS CANADA RESOURCES CORP.	Satellite	14-25-048-02 W5M		√					
CONOCOPHILLIPS CANADA RESOURCES CORP.	Satellite	16-24-048-02 W5M		√					
CREW ENERGY INC.	Battery	01-04-052-15 W5M		√					
CREW ENERGY INC.	Battery	03-34-051-15 W5M		√					
CREW ENERGY INC.	Battery	04-15-056-18 W5M		√					
CREW ENERGY INC.	Battery	07-27-051-15 W5M		√					
CREW ENERGY INC.	Battery	12-17-060-26 W5M							√
CREW ENERGY INC.	Battery	13-27-051-15 W5M		√					
CREW ENERGY INC.	Battery	14-10-052-15 W5M		√				√	
CREW ENERGY INC.	Battery	14-34-052-16 W5M		√				√	
CROCOTTA ENERGY INC.	Battery	09-18-054-18 W5M		√				√	
CROCOTTA ENERGY INC.	Battery	01-13-054-19 W5M		√				√	
CROCOTTA ENERGY INC.	Battery	04-17-054-18 W5M		√				√	
CROCOTTA ENERGY INC.	Battery	07-24-045-17 W5M							√
CROCOTTA ENERGY INC.	Battery	13-15-054-18 W5M		√				√	
CROCOTTA ENERGY INC.	Gas Processing Plant	06-16-054-18 W5M		√				√	
CROCOTTA ENERGY INC.	Satellite	01-19-054-17 W5M		√				√	
CROCOTTA ENERGY INC.	Satellite	07-11-053-18 W5M		√	√	√		√	

TABLE 8A.1-3 Cont'd

Primary Applicant	Development Type	Legal Location	Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment RSA	Vegetation RSA	Wildlife	
								RSA	RSA (Grizzly)
CROCOTTA ENERGY INC.	Satellite	08-02-054-19 W5M		√				√	
CROCOTTA ENERGY INC.	Satellite	13-18-054-17 W5M		√				√	
CROCOTTA ENERGY INC.	Satellite	16-26-054-18 W5M		√				√	
DESMARAIS ENERGY CORPORATION	Battery	09-36-058-05 W5M		√					
DESMARAIS ENERGY CORPORATION	Battery	15-26-058-05 W5M		√					
DEVON CANADA	Battery	14-03-057-26 W5M							√
DEVON CANADA	Gas Gathering System	07-02-059-26 W5M							√
DEVON CANADA CORPORATION	Battery	02-24-062-11 W6M							√
DEVON CANADA CORPORATION	Battery	02-25-052-15 W5M		√				√	
DEVON CANADA CORPORATION	Battery	03-34-057-06 W6M							√
DEVON CANADA CORPORATION	Battery	05-26-055-22 W5M		√					
DEVON CANADA CORPORATION	Battery	07-06-058-06 W6M							√
DEVON CANADA CORPORATION	Battery	08-03-065-09 W6M							√
DEVON CANADA CORPORATION	Battery	08-14-043-18 W5M							√
DEVON CANADA CORPORATION	Battery	11-31-060-09 W6M							√
DIRECT ENERGY MARKETING LIMITED	Battery	02-05-048-26 W4M		√					
DIRECT ENERGY MARKETING LIMITED	Battery	03-20-051-14 W5M		√					
DIRECT ENERGY MARKETING LIMITED	Battery	14-18-051-14 W5M		√					
DIRECT ENERGY MARKETING LIMITED	Battery	16-21-056-21 W4M		√					
DIRECT ENERGY MARKETING LIMITED	Battery	16-36-050-15 W5M		√					
DOW CHEMICAL CANADA ULC	Battery	12-11-055-22 W4M		√					
ECLIPSE RESOURCES LTD.	Satellite	16-33-049-05 W5M		√					
ENCANA CORPORATION	Battery	01-36-052-14 W5M		√				√	
ENCANA CORPORATION	Battery	13-36-050-15 W5M		√				√	
ENCANA CORPORATION	Battery	01-14-047-03 W5M		√					
ENCANA CORPORATION	Battery	02-08-062-06 W6M							√
ENCANA CORPORATION	Battery	05-10-059-26 W5M							√

TABLE 8A.1-3 Cont'd

Primary Applicant	Development Type	Legal Location	Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment RSA	Vegetation RSA	Wildlife RSA	Wildlife RSA (Grizzly)
ENCANA CORPORATION	Battery	09-07-062-06 W6M							√
ENCANA CORPORATION	Battery	11-15-059-26 W5M							√
ENCANA CORPORATION	Battery	11-18-059-02 W6M							√
ENCANA CORPORATION	Battery	11-23-048-01 W5M		√					
ENCANA CORPORATION	Battery	14-22-047-03 W5M		√					
ENCANA CORPORATION	Gas Gathering System	01-35-060-05 W6M							√
ENCANA CORPORATION	Satellite	09-18-053-13 W5M		√	√	√		√	
ENCANA CORPORATION	Satellite	16-26-047-03 W5M		√					
ENERPLUS CORPORATION	Battery	07-28-046-07 W5M		√					
ENERPLUS CORPORATION	Battery	06-24-053-20 W5M		√				√	
ENERPLUS CORPORATION	Injection Plant	08-32-046-07 W5M		√					
ENERPLUS CORPORATION	Satellite	02-21-055-05 W5M		√					
ENERPLUS CORPORATION	Satellite	02-24-050-22 W4M		√					
ENERPLUS CORPORATION	Satellite	04-18-047-07 W5M		√					
ENERPLUS CORPORATION	Satellite	04-25-046-07 W5M		√					
ENERPLUS CORPORATION	Satellite	06-09-047-07 W5M		√					
ENERPLUS CORPORATION	Satellite	06-11-047-07 W5M		√					
ENERPLUS CORPORATION	Satellite	06-15-046-07 W5M		√					
ENERPLUS CORPORATION	Satellite	06-19-055-05 W5M		√					
ENERPLUS CORPORATION	Satellite	06-24-046-07 W5M		√					
ENERPLUS CORPORATION	Satellite	08-19-046-07 W5M		√					
ENERPLUS CORPORATION	Satellite	08-21-046-07 W5M		√					
ENERPLUS CORPORATION	Satellite	08-25-055-06 W5M		√					
ENERPLUS CORPORATION	Satellite	08-27-046-07 W5M		√					
ENERPLUS CORPORATION	Satellite	08-30-046-07 W5M		√					
ENERPLUS CORPORATION	Satellite	10-14-047-07 W5M		√					
ENERPLUS CORPORATION	Satellite	10-16-047-07 W5M		√					
ENERPLUS CORPORATION	Satellite	10-36-049-22 W4M		√					
ENERPLUS CORPORATION	Satellite	11-27-054-05 W5M		√				√	
ENERPLUS CORPORATION	Satellite	11-31-049-21 W4M		√					
ENERPLUS CORPORATION	Satellite	12-07-050-21 W4M		√					
ENERPLUS CORPORATION	Satellite	13-31-049-21 W4M		√					
ENERPLUS CORPORATION	Satellite	14-31-049-21 W4M		√					
ENERPLUS CORPORATION	Satellite	15-12-050-22 W4M		√					
ENHANCE ENERGY INC.	Compressor Station	12-17-056-21 W4M		√					
ENHANCE ENERGY INC.	Pump Station	01-25-055-21 W4M		√					
EQUAL ENERGY LTD.	Battery	10-14-050-22 W5M		√					√
ESCALADE ENERGY INC.	Battery	10-20-053-02 W5M		√	√	√		√	
EXORO ENERGY INC.	Injection Plant	13-22-049-07 W5M		√					
GAMET RESOURCES LTD.	Satellite	08-23-050-04 W5M		√					

TABLE 8A.1-3 Cont'd

Primary Applicant	Development Type	Legal Location	Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment RSA	Vegetation RSA	Wildlife RSA	Wildlife RSA (Grizzly)
GIBSON ENERGY ULC	Central Treating Plants	09-06-053-23 W4M	√	√	√	√	√	√	
GIBSON ENERGY ULC	Injection Plant	10-18-057-05 W6M							√
GRAND RAPIDS PIPELINE PROJECT	Pump station and tank farm	12-15-055-21 W4M		√					
HANSEN DRILLING VENTURES LTD.	Battery	07-11-053-09 W5M		√	√	√		√	
HARVEST OPERATIONS CORP.	Battery	UNKNOWN		√					
HARVEST OPERATIONS CORP.	Battery	13-07-057-09 W5M		√					
HARVEST OPERATIONS CORP.	Battery	01-02-047-05 W5M		√					
HARVEST OPERATIONS CORP.	Battery	02-01-044-07 W5M		√					
HARVEST OPERATIONS CORP.	Battery	02-04-062-10 W6M							√
HARVEST OPERATIONS CORP.	Battery	02-15-055-21 W4M		√					
HARVEST OPERATIONS CORP.	Battery	02-17-041-17 W5M							√
HARVEST OPERATIONS CORP.	Battery	03-20-043-06 W5M		√					
HARVEST OPERATIONS CORP.	Battery	04-01-044-08 W5M		√					
HARVEST OPERATIONS CORP.	Battery	06-12-057-10 W5M		√					
HARVEST OPERATIONS CORP.	Battery	06-33-062-06 W6M							√
HARVEST OPERATIONS CORP.	Battery	07-30-043-06 W5M		√					
HARVEST OPERATIONS CORP.	Battery	08-33-061-06 W6M							√
HARVEST OPERATIONS CORP.	Battery	09-35-042-06 W5M		√					
HARVEST OPERATIONS CORP.	Battery	10-12-055-16 W5M		√					
HARVEST OPERATIONS CORP.	Battery	10-14-063-08 W6M							√
HARVEST OPERATIONS CORP.	Battery	10-15-044-07 W5M		√					
HARVEST OPERATIONS CORP.	Battery	10-18-043-06 W5M		√					
HARVEST OPERATIONS CORP.	Battery	10-36-063-08 W6M							√

TABLE 8A.1-3 Cont'd

Primary Applicant	Development Type	Legal Location	Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment RSA	Vegetation RSA	Wildlife	
								RSA	RSA (Grizzly)
HARVEST OPERATIONS CORP.	Battery	12-19-043-06 W5M		√					
HARVEST OPERATIONS CORP.	Battery	13-11-055-21 W4M		√					
HARVEST OPERATIONS CORP.	Battery	14-15-044-07 W5M		√					
HARVEST OPERATIONS CORP.	Battery	15-35-061-06 W6M							√
HARVEST OPERATIONS CORP.	Satellite	01-31-054-16 W5M		√				√	
HARVEST OPERATIONS CORP.	Satellite	02-15-055-21 W4M		√					
HARVEST OPERATIONS CORP.	Satellite	04-05-055-20 W4M		√					
HARVEST OPERATIONS CORP.	Satellite	04-14-055-21 W4M		√					
HARVEST OPERATIONS CORP.	Satellite	04-36-055-05 W5M		√					
HARVEST OPERATIONS CORP.	Satellite	05-36-055-05 W5M		√					
HARVEST OPERATIONS CORP.	Satellite	06-10-055-16 W5M		√					
HARVEST OPERATIONS CORP.	Satellite	07-06-056-04 W5M		√					
HARVEST OPERATIONS CORP.	Satellite	09-36-055-05 W5M		√					
HARVEST OPERATIONS CORP.	Satellite	10-32-054-16 W5M		√				√	
HARVEST OPERATIONS CORP.	Satellite	11-12-055-21 W4M		√					
HARVEST OPERATIONS CORP.	Satellite	12-15-055-21 W4M		√					
HARVEST OPERATIONS CORP.	Satellite	14-11-055-21 W4M		√					
HARVEST OPERATIONS CORP.	Satellite	14-31-055-04 W5M		√					
HARVEST OPERATIONS CORP.	Satellite	15-33-054-16 W5M		√				√	
HARVEST OPERATIONS CORP.	Satellite	16-26-055-05 W5M		√					
HORSESHOE BAY RESOURCES LIMITED	Battery	16-22-056-05 W5M		√					
HUNT OIL COMPANY OF CANADA, INC.	Battery	06-27-061-06 W6M							√

TABLE 8A.1-3 Cont'd

Primary Applicant	Development Type	Legal Location	Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment RSA	Vegetation RSA	Wildlife	
								RSA	RSA (Grizzly)
HUSKY OIL OPERATIONS LIMITED	Battery	UNKNOWN		√					
HUSKY OIL OPERATIONS LIMITED	Battery	07-02-043-16 W5M							√
HUSKY OIL OPERATIONS LIMITED	Battery	UNKNOWN		√					
HUSKY OIL OPERATIONS LIMITED	Battery	01-02-051-19 W5M		√					
HUSKY OIL OPERATIONS LIMITED	Battery	01-10-060-27 W5M							√
HUSKY OIL OPERATIONS LIMITED	Battery	01-23-050-19 W5M		√					
HUSKY OIL OPERATIONS LIMITED	Battery	01-34-055-20 W4M		√					
HUSKY OIL OPERATIONS LIMITED	Battery	02-02-043-16 W5M							√
HUSKY OIL OPERATIONS LIMITED	Battery	02-03-055-21 W5M		√					
HUSKY OIL OPERATIONS LIMITED	Battery	02-04-056-20 W4M		√					
HUSKY OIL OPERATIONS LIMITED	Battery	02-28-049-19 W5M		√					
HUSKY OIL OPERATIONS LIMITED	Battery	02-28-050-20 W5M		√					
HUSKY OIL OPERATIONS LIMITED	Battery	03-04-042-14 W5M							√
HUSKY OIL OPERATIONS LIMITED	Battery	03-08-049-18 W5M		√					
HUSKY OIL OPERATIONS LIMITED	Battery	03-12-051-19 W5M		√					
HUSKY OIL OPERATIONS LIMITED	Battery	03-16-051-19 W5M		√					
HUSKY OIL OPERATIONS LIMITED	Battery	03-18-049-18 W5M		√					
HUSKY OIL OPERATIONS LIMITED	Battery	04-09-049-18 W5M		√					
HUSKY OIL OPERATIONS LIMITED	Battery	04-11-051-19 W5M		√					
HUSKY OIL OPERATIONS LIMITED	Battery	04-13-050-19 W5M		√					
HUSKY OIL OPERATIONS LIMITED	Battery	04-18-050-18 W5M		√					
HUSKY OIL OPERATIONS LIMITED	Battery	04-33-053-20 W5M		√				√	

TABLE 8A.1-3 Cont'd

Primary Applicant	Development Type	Legal Location	Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment RSA	Vegetation RSA	Wildlife	
								RSA	RSA (Grizzly)
HUSKY OIL OPERATIONS LIMITED	Battery	05-03-055-21 W5M		√					
HUSKY OIL OPERATIONS LIMITED	Battery	05-05-050-06 W5M		√					
HUSKY OIL OPERATIONS LIMITED	Battery	05-08-050-19 W5M		√					
HUSKY OIL OPERATIONS LIMITED	Battery	05-32-049-19 W5M		√					
HUSKY OIL OPERATIONS LIMITED	Battery	05-32-053-20 W5M		√				√	
HUSKY OIL OPERATIONS LIMITED	Battery	05-36-042-16 W5M							√
HUSKY OIL OPERATIONS LIMITED	Battery	05-36-055-20 W4M		√					
HUSKY OIL OPERATIONS LIMITED	Battery	06-03-051-19 W5M		√					
HUSKY OIL OPERATIONS LIMITED	Battery	06-06-050-19 W5M		√					
HUSKY OIL OPERATIONS LIMITED	Battery	06-08-050-18 W5M		√					
HUSKY OIL OPERATIONS LIMITED	Battery	06-15-051-19 W5M		√					
HUSKY OIL OPERATIONS LIMITED	Battery	06-19-049-18 W5M		√					
HUSKY OIL OPERATIONS LIMITED	Battery	06-23-050-19 W5M		√					
HUSKY OIL OPERATIONS LIMITED	Battery	06-25-049-19 W5M		√					
HUSKY OIL OPERATIONS LIMITED	Battery	06-33-049-19 W5M		√					
HUSKY OIL OPERATIONS LIMITED	Battery	06-33-054-21 W5M		√					
HUSKY OIL OPERATIONS LIMITED	Battery	07-03-050-19 W5M		√					
HUSKY OIL OPERATIONS LIMITED	Battery	07-03-051-19 W5M		√					
HUSKY OIL OPERATIONS LIMITED	Battery	07-16-050-18 W5M		√					
HUSKY OIL OPERATIONS LIMITED	Battery	07-18-043-17 W5M							√
HUSKY OIL OPERATIONS LIMITED	Battery	07-18-050-18 W5M		√					
HUSKY OIL OPERATIONS LIMITED	Battery	07-20-053-20 W5M		√	√	√		√	

TABLE 8A.1-3 Cont'd

Primary Applicant	Development Type	Legal Location	Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment RSA	Vegetation RSA	Wildlife	
								RSA	RSA (Grizzly)
HUSKY OIL OPERATIONS LIMITED	Battery	07-20-056-20 W4M		√					
HUSKY OIL OPERATIONS LIMITED	Battery	07-27-041-16 W5M							√
HUSKY OIL OPERATIONS LIMITED	Battery	07-28-053-21 W5M		√				√	
HUSKY OIL OPERATIONS LIMITED	Battery	07-32-048-18 W5M		√					
HUSKY OIL OPERATIONS LIMITED	Battery	07-35-053-21 W5M		√				√	
HUSKY OIL OPERATIONS LIMITED	Battery	08-03-043-16 W5M							√
HUSKY OIL OPERATIONS LIMITED	Battery	08-06-051-18 W5M		√					
HUSKY OIL OPERATIONS LIMITED	Battery	08-11-054-21 W5M		√				√	
HUSKY OIL OPERATIONS LIMITED	Battery	08-16-056-20 W4M		√					
HUSKY OIL OPERATIONS LIMITED	Battery	08-18-055-19 W4M		√					
HUSKY OIL OPERATIONS LIMITED	Battery	08-29-053-20 W5M		√				√	
HUSKY OIL OPERATIONS LIMITED	Battery	08-30-053-20 W5M		√				√	
HUSKY OIL OPERATIONS LIMITED	Battery	09-05-043-17 W5M							√
HUSKY OIL OPERATIONS LIMITED	Battery	09-19-055-19 W4M		√					
HUSKY OIL OPERATIONS LIMITED	Battery	09-19-056-20 W4M		√					
HUSKY OIL OPERATIONS LIMITED	Battery	09-25-050-20 W5M		√					
HUSKY OIL OPERATIONS LIMITED	Battery	09-30-055-19 W4M		√					
HUSKY OIL OPERATIONS LIMITED	Battery	09-33-055-20 W4M		√					
HUSKY OIL OPERATIONS LIMITED	Battery	10-09-051-19 W5M		√					
HUSKY OIL OPERATIONS LIMITED	Battery	10-12-050-20 W5M		√					
HUSKY OIL OPERATIONS LIMITED	Battery	10-12-051-19 W5M		√					
HUSKY OIL OPERATIONS LIMITED	Battery	10-13-051-19 W5M		√					

TABLE 8A.1-3 Cont'd

Primary Applicant	Development Type	Legal Location	Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment RSA	Vegetation RSA	Wildlife RSA	Wildlife RSA (Grizzly)
HUSKY OIL OPERATIONS LIMITED	Battery	10-18-052-17 W5M		√				√	
HUSKY OIL OPERATIONS LIMITED	Battery	10-28-050-19 W5M		√					
HUSKY OIL OPERATIONS LIMITED	Battery	11-02-051-19 W5M		√					
HUSKY OIL OPERATIONS LIMITED	Battery	11-09-056-20 W4M		√					
HUSKY OIL OPERATIONS LIMITED	Battery	11-10-051-19 W5M		√					
HUSKY OIL OPERATIONS LIMITED	Battery	11-13-051-19 W5M		√					
HUSKY OIL OPERATIONS LIMITED	Battery	11-18-050-18 W5M		√					
HUSKY OIL OPERATIONS LIMITED	Battery	11-22-053-21 W5M		√				√	
HUSKY OIL OPERATIONS LIMITED	Battery	11-33-053-20 W5M		√				√	
HUSKY OIL OPERATIONS LIMITED	Battery	11-33-054-21 W5M		√					
HUSKY OIL OPERATIONS LIMITED	Battery	12-10-043-16 W5M							√
HUSKY OIL OPERATIONS LIMITED	Battery	12-19-050-18 W5M		√					
HUSKY OIL OPERATIONS LIMITED	Battery	12-19-055-19 W4M		√					
HUSKY OIL OPERATIONS LIMITED	Battery	12-27-051-19 W5M		√				√	
HUSKY OIL OPERATIONS LIMITED	Battery	12-28-054-21 W5M		√					
HUSKY OIL OPERATIONS LIMITED	Battery	12-35-050-19 W5M		√					
HUSKY OIL OPERATIONS LIMITED	Battery	13-01-060-10 W6M							√
HUSKY OIL OPERATIONS LIMITED	Battery	13-08-057-02 W6M							√
HUSKY OIL OPERATIONS LIMITED	Battery	13-10-050-19 W5M		√					
HUSKY OIL OPERATIONS LIMITED	Battery	13-21-054-21 W5M		√					
HUSKY OIL OPERATIONS LIMITED	Battery	13-25-055-20 W4M		√					
HUSKY OIL OPERATIONS LIMITED	Battery	13-27-050-20 W5M		√					

TABLE 8A.1-3 Cont'd

Primary Applicant	Development Type	Legal Location	Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment RSA	Vegetation RSA	Wildlife	
								RSA	RSA (Grizzly)
HUSKY OIL OPERATIONS LIMITED	Battery	14-01-049-20 W5M		√					
HUSKY OIL OPERATIONS LIMITED	Battery	14-07-051-18 W5M		√					
HUSKY OIL OPERATIONS LIMITED	Battery	14-16-051-19 W5M		√				√	
HUSKY OIL OPERATIONS LIMITED	Battery	14-21-050-19 W5M		√					
HUSKY OIL OPERATIONS LIMITED	Battery	14-33-042-17 W5M							√
HUSKY OIL OPERATIONS LIMITED	Battery	15-01-054-21 W5M		√				√	
HUSKY OIL OPERATIONS LIMITED	Battery	15-12-050-20 W5M		√					
HUSKY OIL OPERATIONS LIMITED	Battery	15-17-050-19 W5M		√					
HUSKY OIL OPERATIONS LIMITED	Battery	15-19-055-19 W4M		√					
HUSKY OIL OPERATIONS LIMITED	Battery	15-24-053-21 W5M		√				√	
HUSKY OIL OPERATIONS LIMITED	Battery	15-27-050-19 W5M		√					
HUSKY OIL OPERATIONS LIMITED	Battery	15-28-055-19 W4M		√					
HUSKY OIL OPERATIONS LIMITED	Battery	15-30-049-18 W5M		√					
HUSKY OIL OPERATIONS LIMITED	Battery	15-31-050-19 W5M		√					
HUSKY OIL OPERATIONS LIMITED	Battery	16-03-051-19 W5M		√					
HUSKY OIL OPERATIONS LIMITED	Battery	16-17-049-18 W5M		√					
HUSKY OIL OPERATIONS LIMITED	Battery	16-20-049-19 W5M		√					
HUSKY OIL OPERATIONS LIMITED	Battery	16-20-053-20 W5M		√				√	
HUSKY OIL OPERATIONS LIMITED	Battery	16-22-049-19 W5M		√					
HUSKY OIL OPERATIONS LIMITED	Battery	16-27-055-20 W4M		√					
HUSKY OIL OPERATIONS LIMITED	Battery	16-29-049-19 W5M		√					
HUSKY OIL OPERATIONS LIMITED	Battery	16-33-050-19 W5M		√					

TABLE 8A.1-3 Cont'd

Primary Applicant	Development Type	Legal Location	Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment RSA	Vegetation RSA	Wildlife RSA	Wildlife RSA (Grizzly)
HUSKY OIL OPERATIONS LIMITED	Gas Gathering System	10-17-050-18 W5M		√					
HUSKY OIL OPERATIONS LIMITED	Injection Plant	08-30-055-19 W4M		√					
HUSKY OIL OPERATIONS LIMITED	Satellite	01-30-047-06 W5M		√					
HUSKY OIL OPERATIONS LIMITED	Satellite	02-20-047-07 W5M		√					
HUSKY OIL OPERATIONS LIMITED	Satellite	04-16-056-20 W4M		√					
HUSKY OIL OPERATIONS LIMITED	Satellite	05-15-056-20 W4M		√					
HUSKY OIL OPERATIONS LIMITED	Satellite	06-36-055-20 W4M		√					
HUSKY OIL OPERATIONS LIMITED	Satellite	07-16-056-20 W4M		√					
HUSKY OIL OPERATIONS LIMITED	Satellite	08-16-056-20 W4M		√					
HUSKY OIL OPERATIONS LIMITED	Satellite	08-26-055-20 W4M		√					
HUSKY OIL OPERATIONS LIMITED	Satellite	09-08-056-20 W4M		√					
HUSKY OIL OPERATIONS LIMITED	Satellite	10-16-056-20 W4M		√					
HUSKY OIL OPERATIONS LIMITED	Satellite	13-19-055-20 W4M		√					
HUSKY OIL OPERATIONS LIMITED	Satellite	14-20-047-06 W5M		√					
HUSKY OIL OPERATIONS LIMITED	Satellite	14-29-047-07 W5M		√					
IMPERIAL OIL RESOURCES LIMITED	Battery	01-04-045-18 W5M							√
IMPERIAL OIL RESOURCES LIMITED	Battery	08-08-045-18 W5M							√
IMPERIAL OIL RESOURCES LIMITED	Battery	10-01-046-20 W5M							√
IMPERIAL OIL RESOURCES LIMITED	Battery	13-34-045-20 W5M							√
IMPERIAL OIL RESOURCES LIMITED	Battery	16-11-046-20 W5M							√
IMPERIAL OIL RESOURCES LIMITED	Injection Plant	07-23-050-28 W4M		√					
IMPERIAL OIL RESOURCES LIMITED	Injection Plant	08-01-053-24 W4M		√	√	√		√	

TABLE 8A.1-3 Cont'd

Primary Applicant	Development Type	Legal Location	Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment RSA	Vegetation RSA	Wildlife RSA	Wildlife RSA (Grizzly)
IMPERIAL OIL RESOURCES LIMITED	Injection Plant	09-01-053-24 W4M		√	√	√		√	
IMPERIAL OIL RESOURCES LIMITED	Satellite	01-03-050-26 W4M		√					
IMPERIAL OIL RESOURCES LIMITED	Satellite	01-22-050-26 W4M		√				√	
IMPERIAL OIL RESOURCES LIMITED	Satellite	01-34-050-26 W4M		√				√	
IMPERIAL OIL RESOURCES LIMITED	Satellite	02-05-051-26 W4M		√				√	
IMPERIAL OIL RESOURCES LIMITED	Satellite	03-17-050-26 W4M		√					
IMPERIAL OIL RESOURCES LIMITED	Satellite	04-03-051-26 W4M		√				√	
IMPERIAL OIL RESOURCES LIMITED	Satellite	04-32-050-26 W4M		√					
IMPERIAL OIL RESOURCES LIMITED	Satellite	06-04-051-26 W4M		√				√	
IMPERIAL OIL RESOURCES LIMITED	Satellite	06-09-050-26 W4M		√					
IMPERIAL OIL RESOURCES LIMITED	Satellite	06-15-051-26 W4M		√				√	
IMPERIAL OIL RESOURCES LIMITED	Satellite	06-19-050-26 W4M		√					
IMPERIAL OIL RESOURCES LIMITED	Satellite	06-27-050-26 W4M		√				√	
IMPERIAL OIL RESOURCES LIMITED	Satellite	07-19-050-26 W4M		√					
IMPERIAL OIL RESOURCES LIMITED	Satellite	07-36-049-26 W4M		√					
IMPERIAL OIL RESOURCES LIMITED	Satellite	09-03-051-26 W4M		√				√	
IMPERIAL OIL RESOURCES LIMITED	Satellite	10-03-050-26 W4M		√					
IMPERIAL OIL RESOURCES LIMITED	Satellite	10-04-050-26 W4M		√					
IMPERIAL OIL RESOURCES LIMITED	Satellite	10-26-050-26 W4M		√				√	
IMPERIAL OIL RESOURCES LIMITED	Satellite	11-06-050-26 W4M		√					
IMPERIAL OIL RESOURCES LIMITED	Satellite	11-18-050-26 W4M		√					
IMPERIAL OIL RESOURCES LIMITED	Satellite	11-21-050-26 W4M		√					

TABLE 8A.1-3 Cont'd

Primary Applicant	Development Type	Legal Location	Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment RSA	Vegetation RSA	Wildlife	
								RSA	RSA (Grizzly)
IMPERIAL OIL RESOURCES LIMITED	Satellite	11-29-050-26 W4M		√					
IMPERIAL OIL RESOURCES LIMITED	Satellite	11-33-049-26 W4M		√					
IMPERIAL OIL RESOURCES LIMITED	Satellite	15-25-049-26 W4M		√					
IMPERIAL OIL RESOURCES LIMITED	Satellite	15-31-050-26 W4M		√					
IMPERIAL OIL RESOURCES LIMITED	Satellite	16-19-050-26 W4M		√					
IMPERIAL OIL RESOURCES LIMITED	Satellite	16-34-049-26 W4M		√					
IMPERIAL OIL RESOURCES LIMITED	Satellite	16-36-050-26 W4M		√				√	
ISH ENERGY LTD.	Battery	09-07-056-16 W5M		√					
JAYHAWK RESOURCES LTD.	Battery	03-14-044-07 W5M		√					
JAYHAWK RESOURCES LTD.	Battery	04-17-044-07 W5M		√					
JAYHAWK RESOURCES LTD.	Battery	05-13-044-07 W5M		√					
JAYHAWK RESOURCES LTD.	Battery	06-17-044-06 W5M		√					
JAYHAWK RESOURCES LTD.	Battery	06-18-044-06 W5M		√					
JAYHAWK RESOURCES LTD.	Battery	06-22-044-07 W5M		√					
JAYHAWK RESOURCES LTD.	Battery	06-23-044-07 W5M		√					
JAYHAWK RESOURCES LTD.	Battery	10-07-044-06 W5M		√					
JAYHAWK RESOURCES LTD.	Battery	11-10-044-07 W5M		√					
JAYHAWK RESOURCES LTD.	Battery	11-16-044-07 W5M		√					
JAYHAWK RESOURCES LTD.	Battery	15-24-044-07 W5M		√					
JOURNEY ENERGY INC.	Battery	03-12-059-02 W5M		√					
JOURNEY ENERGY INC.	Battery	11-19-058-02 W5M		√					
JOURNEY ENERGY INC.	Battery	13-22-060-03 W5M		√					
JOURNEY ENERGY INC.	Satellite	04-06-049-04 W5M		√					
JOURNEY ENERGY INC.	Satellite	04-31-048-04 W5M		√					
JOURNEY ENERGY INC.	Satellite	06-06-049-04 W5M		√					

TABLE 8A.1-3 Cont'd

Primary Applicant	Development Type	Legal Location	Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment RSA	Vegetation RSA	Wildlife RSA	Wildlife RSA (Grizzly)
JOURNEY ENERGY INC.	Satellite	09-25-048-05 W5M		√					
JOURNEY ENERGY INC.	Satellite	11-07-059-02 W5M		√					
JOURNEY ENERGY INC.	Satellite	14-29-059-02 W5M		√					
JOURNEY ENERGY INC.	Satellite	14-30-048-04 W5M		√					
JOURNEY ENERGY INC.	Satellite	14-31-048-04 W5M		√					
JOURNEY ENERGY INC.	Satellite	15-26-059-03 W5M		√					
KEEPER RESOURCES INC.	Battery	06-01-055-12 W5M		√				√	
KEYERA ENERGY LTD.	Battery	06-20-045-05 W5M		√					
KEYERA ENERGY LTD.	Battery	10-08-045-05 W5M		√					
KEYERA ENERGY LTD.	Battery	10-18-045-05 W5M		√					
KEYERA ENERGY LTD.	Battery	14-21-046-06 W5M		√					
KEYERA ENERGY LTD.	Battery	15-09-046-06 W5M		√					
KINGSMERE RESOURCES LTD.	Battery	13-15-048-27 W4M		√					
KNOWLEDGE ENERGY INC.	Battery	04-31-043-06 W5M		√					
LEDDY EXPLORATION LIMITED	Satellite	02-30-052-25 W4M	√	√	√	√	√	√	
LONG RUN EXPLORATION LTD.	Battery	03-25-055-21 W4M		√					
LONG RUN EXPLORATION LTD.	Battery	04-25-055-21 W4M		√					
LONG RUN EXPLORATION LTD.	Satellite	02-31-055-20 W4M		√					
LONG RUN EXPLORATION LTD.	Satellite	02-36-055-21 W4M		√					
LONG RUN EXPLORATION LTD.	Satellite	03-27-056-21 W4M		√					
LONG RUN EXPLORATION LTD.	Satellite	04-25-055-05 W5M		√					
LONG RUN EXPLORATION LTD.	Satellite	05-21-057-22 W4M		√					
LONG RUN EXPLORATION LTD.	Satellite	06-08-056-20 W4M		√					
LONG RUN EXPLORATION LTD.	Satellite	06-25-055-05 W5M		√					
LONG RUN EXPLORATION LTD.	Satellite	06-34-056-21 W4M		√					
LONG RUN EXPLORATION LTD.	Satellite	07-07-056-20 W4M		√					
LONG RUN EXPLORATION LTD.	Satellite	07-22-056-21 W4M		√					
LONG RUN EXPLORATION LTD.	Satellite	07-24-055-21 W4M		√					

TABLE 8A.1-3 Cont'd

Primary Applicant	Development Type	Legal Location	Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment RSA	Vegetation RSA	Wildlife RSA	Wildlife RSA (Grizzly)
LONG RUN EXPLORATION LTD.	Satellite	07-25-055-21 W4M		√					
LONG RUN EXPLORATION LTD.	Satellite	07-31-055-20 W4M		√					
LONG RUN EXPLORATION LTD.	Satellite	07-34-056-21 W4M		√					
LONG RUN EXPLORATION LTD.	Satellite	08-16-057-22 W4M		√					
LONG RUN EXPLORATION LTD.	Satellite	08-23-055-21 W4M		√					
LONG RUN EXPLORATION LTD.	Satellite	08-34-056-06 W5M		√					
LONG RUN EXPLORATION LTD.	Satellite	09-26-055-21 W4M		√					
LONG RUN EXPLORATION LTD.	Satellite	09-36-055-21 W4M		√					
LONG RUN EXPLORATION LTD.	Satellite	10-15-056-21 W4M		√					
LONG RUN EXPLORATION LTD.	Satellite	10-31-055-20 W4M		√					
LONG RUN EXPLORATION LTD.	Satellite	10-36-055-21 W4M		√					
LONG RUN EXPLORATION LTD.	Satellite	13-21-057-22 W4M		√					
LONG RUN EXPLORATION LTD.	Satellite	15-13-055-21 W4M		√					
LONG RUN EXPLORATION LTD.	Satellite	15-21-057-22 W4M		√					
LONG RUN EXPLORATION LTD.	Satellite	15-23-055-21 W4M		√					
LONG RUN EXPLORATION LTD.	Satellite	15-36-055-21 W4M		√					
LONG RUN EXPLORATION LTD.	Satellite	16-23-055-21 W4M		√					
LONGVIEW OIL CORP.	Battery	UNKNOWN		√					
LONGVIEW OIL CORP.	Battery	01-04-047-03 W5M		√					
LONGVIEW OIL CORP.	Battery	01-05-047-08 W5M		√					
LONGVIEW OIL CORP.	Satellite	03-12-053-10 W5M		√	√	√		√	
LONGVIEW OIL CORP.	Satellite	15-33-046-08 W5M		√					
LONGVIEW OIL CORP.	Satellite	16-11-053-10 W5M		√	√	√		√	
MADALENA VENTURES INC.	Battery	UNKNOWN		√					

TABLE 8A.1-3 Cont'd

Primary Applicant	Development Type	Legal Location	Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment RSA	Vegetation RSA	Wildlife	
								RSA	RSA (Grizzly)
MADALENA VENTURES INC.	Battery	04-05-056-07 W5M		√					
MADALENA VENTURES INC.	Battery	04-10-058-10 W5M		√					
MADALENA VENTURES INC.	Battery	04-29-058-09 W5M		√					
MADALENA VENTURES INC.	Battery	06-04-058-08 W5M		√					
MADALENA VENTURES INC.	Battery	06-10-058-08 W5M		√					
MADALENA VENTURES INC.	Battery	08-05-056-07 W5M		√					
MADALENA VENTURES INC.	Battery	08-05-058-09 W5M		√					
MADALENA VENTURES INC.	Battery	09-23-056-10 W5M		√					
MADALENA VENTURES INC.	Battery	10-01-057-10 W5M		√					
MANCAL ENERGY INC.	Battery	12-12-055-19 W5M		√					
MANCAL ENERGY INC.	Satellite	09-02-057-22 W4M		√					
MANCAL ENERGY INC.	Satellite	14-29-056-21 W4M		√					
MANCAL ENERGY INC.	Satellite	15-30-056-21 W4M		√					
MANITOK ENERGY INC.	Battery	06-29-042-15 W5M							√
MANITOK ENERGY INC.	Battery	08-06-055-22 W5M		√					
MANITOK ENERGY INC.	Battery	16-30-050-23 W5M		√				√	√
MARQUEE ENERGY LTD.	Battery	UNKNOWN		√					
MARQUEE ENERGY LTD.	Battery	12-28-047-07 W5M		√					
MARQUEE ENERGY LTD.	Satellite	07-36-045-09 W5M		√					
MARQUEE ENERGY LTD.	Satellite	09-07-052-12 W5M		√				√	
MARQUEE ENERGY LTD.	Satellite	10-08-052-12 W5M		√				√	
MOSAIC ENERGY LTD.	Battery	05-34-054-17 W5M		√				√	
MOSAIC ENERGY LTD.	Battery	07-24-052-15 W5M		√				√	
MOSAIC ENERGY LTD.	Battery	10-19-052-14 W5M		√				√	
MURPHY OIL COMPANY LTD.	Satellite	11-17-055-18 W5M		√					
NAL RESOURCES LIMITED	Battery	02-06-054-18 W5M		√				√	
NAL RESOURCES LIMITED	Satellite	03-21-056-19 W5M		√					
NAL RESOURCES LIMITED	Satellite	07-04-055-18 W5M		√					
NEO EXPLORATION INC.	Battery	05-22-048-26 W4M		√					
NEO EXPLORATION INC.	Battery	09-04-048-26 W4M		√					
NEO EXPLORATION INC.	Battery	10-34-048-26 W4M		√					
NEO EXPLORATION INC.	Battery	13-19-048-25 W4M		√					

TABLE 8A.1-3 Cont'd

Primary Applicant	Development Type	Legal Location	Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment RSA	Vegetation RSA	Wildlife	
								RSA	RSA (Grizzly)
NEP CANADA ULC	Battery	05-36-050-26 W4M		√				√	
NEP CANADA ULC	Battery	11-33-049-26 W4M		√					
NEP CANADA ULC	Battery	15-03-051-26 W4M		√				√	
NEP CANADA ULC	Satellite	01-16-050-26 W4M		√					
NEP CANADA ULC	Satellite	01-35-050-26 W4M		√				√	
NEP CANADA ULC	Satellite	03-14-050-26 W4M		√					
NEP CANADA ULC	Satellite	05-13-053-18 W4M		√					
NEP CANADA ULC	Satellite	06-29-049-25 W4M		√					
NEP CANADA ULC	Satellite	06-33-050-26 W4M		√				√	
NEP CANADA ULC	Satellite	07-15-050-26 W4M		√					
NEP CANADA ULC	Satellite	07-16-051-26 W4M		√				√	
NEP CANADA ULC	Satellite	07-21-051-26 W4M		√				√	
NEP CANADA ULC	Satellite	07-24-053-18 W4M		√					
NEP CANADA ULC	Satellite	08-21-050-26 W4M		√					
NEP CANADA ULC	Satellite	09-14-053-18 W4M		√					
NEP CANADA ULC	Satellite	09-16-050-26 W4M		√					
NEP CANADA ULC	Satellite	09-16-051-26 W4M		√				√	
NEP CANADA ULC	Satellite	10-08-050-26 W4M		√					
NEP CANADA ULC	Satellite	10-09-051-26 W4M		√				√	
NEP CANADA ULC	Satellite	10-32-049-26 W4M		√					
NEP CANADA ULC	Satellite	11-02-050-26 W4M		√					
NEP CANADA ULC	Satellite	11-04-051-26 W4M		√				√	
NEP CANADA ULC	Satellite	11-18-049-25 W4M		√					
NEP CANADA ULC	Satellite	11-24-053-18 W4M		√					
NEP CANADA ULC	Satellite	11-34-049-26 W4M		√					
NEP CANADA ULC	Satellite	11-35-049-26 W4M		√					
NEP CANADA ULC	Satellite	13-13-053-18 W4M		√					
NEP CANADA ULC	Satellite	14-13-053-18 W4M		√					
NEP CANADA ULC	Satellite	14-30-049-25 W4M		√					
NEW NORTH RESOURCES LTD.	Battery	02-12-047-09 W5M		√					
NEW STAR ENERGY LTD.	Battery	11-06-051-03 W5M		√					
NEW STAR ENERGY LTD.	Battery	12-32-050-04 W5M		√					
NEW STAR ENERGY LTD.	Battery	15-34-050-04 W5M		√					
NEW STAR ENERGY LTD.	Battery	15-36-050-04 W5M		√					
NEW STAR ENERGY LTD.	Injection Plant	14-17-051-03 W5M		√					
NEW STAR ENERGY LTD.	Satellite	01-28-050-04 W5M		√					
NEW STAR ENERGY LTD.	Satellite	02-24-050-05 W5M		√					
NEW STAR ENERGY LTD.	Satellite	04-04-051-04 W5M		√					
NEW STAR ENERGY LTD.	Satellite	04-22-051-04 W5M		√					

TABLE 8A.1-3 Cont'd

Primary Applicant	Development Type	Legal Location	Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment RSA	Vegetation RSA	Wildlife RSA	Wildlife RSA (Grizzly)
NEW STAR ENERGY LTD.	Satellite	05-21-051-04 W5M		√					
NEW STAR ENERGY LTD.	Satellite	06-32-050-04 W5M		√					
NEW STAR ENERGY LTD.	Satellite	08-14-051-04 W5M		√					
NEW STAR ENERGY LTD.	Satellite	08-30-050-04 W5M		√					
NEW STAR ENERGY LTD.	Satellite	08-36-050-05 W5M		√					
NEW STAR ENERGY LTD.	Satellite	10-09-051-04 W5M		√					
NEW STAR ENERGY LTD.	Satellite	10-30-050-04 W5M		√					
NEW STAR ENERGY LTD.	Satellite	11-16-051-04 W5M		√					
NEW STAR ENERGY LTD.	Satellite	12-04-051-04 W5M		√					
NEW STAR ENERGY LTD.	Satellite	12-10-051-04 W5M		√					
NEW STAR ENERGY LTD.	Satellite	13-22-050-04 W5M		√					
NEW STAR ENERGY LTD.	Satellite	14-18-051-03 W5M		√					
NEW STAR ENERGY LTD.	Satellite	14-20-050-04 W5M		√					
NEW STAR ENERGY LTD.	Satellite	14-29-050-04 W5M		√					
NEW STAR ENERGY LTD.	Satellite	14-31-050-04 W5M		√					
NEW STAR ENERGY LTD.	Satellite	16-05-051-04 W5M		√					
NEW STAR ENERGY LTD.	Satellite	16-08-050-04 W5M		√					
NEW STAR ENERGY LTD.	Satellite	16-08-051-04 W5M		√					
NEW STAR ENERGY LTD.	Satellite	16-13-051-04 W5M		√					
NEW STAR ENERGY LTD.	Satellite	16-25-050-05 W5M		√					
NEWALTA CORPORATION	Injection Plant	05-07-043-06 W5M		√					
NORDEGG RESOURCES INC.	Battery	08-16-052-11 W5M						√	
NORDEGG RESOURCES INC.	Battery	14-16-052-11 W5M						√	
NORTHWESTERN UTILITIES LIMITED	Meter Station	11-08-052-24 W4M		√	√	√		√	
NUVISTA ENERGY LTD.	Battery	06-06-053-10 W5M		√				√	
NUVISTA ENERGY LTD.	Battery	13-34-047-02 W5M		√					
NUVISTA ENERGY LTD.	Battery	11-15-050-15 W5M		√					
OMERS ENERGY INC.	Battery	01-24-055-04 W6M							√
OMERS ENERGY INC.	Battery	05-17-055-03 W6M							√
OMERS ENERGY INC.	Battery	06-20-055-18 W4M		√					
OMERS ENERGY INC.	Satellite	16-07-042-06 W5M		√					
ONE EARTH OIL & GAS INC.	Satellite	15-33-054-25 W4M		√					
PANTERRA RESOURCE CORP.	Battery	07-36-052-06 W5M		√				√	
PARAMOUNT RESOURCES LTD.	Battery	11-04-055-19 W5M		√					
PARAMOUNT RESOURCES LTD.	Battery	06-16-045-05 W5M		√					

TABLE 8A.1-3 Cont'd

Primary Applicant	Development Type	Legal Location	Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment RSA	Vegetation RSA	Wildlife RSA	Wildlife RSA (Grizzly)
PEMBINA NGL CORPORATION	Gas Processing Plant	02-12-056-22 W4M		√					
PEMBINA PIPELINE CORPORATION	Pump Station	09-06-046-03 W5M		√					
PEMBINA PIPELINE CORPORATION	Pump Station	13-19-055-24 W4M		√					
PENGROWTH ENERGY CORPORATION	Battery	UNKNOWN		√				√	
PENGROWTH ENERGY CORPORATION	Battery	UNKNOWN		√	√	√	√	√	
PENGROWTH ENERGY CORPORATION	Battery	UNKNOWN		√					
PENGROWTH ENERGY CORPORATION	Battery	03-22-057-20 W5M		√					
PENGROWTH ENERGY CORPORATION	Battery	06-15-056-15 W5M		√					
PENGROWTH ENERGY CORPORATION	Battery	12-10-045-16 W5M							√
PENGROWTH ENERGY CORPORATION	Battery	14-08-050-14 W5M		√					
PENGROWTH ENERGY CORPORATION	Injection Plant	05-15-055-11 W5M		√					
PENN WEST PETROLEUM LTD.	Battery	UNKNOWN		√	√	√		√	
PENN WEST PETROLEUM LTD.	Battery	08-27-048-04 W5M		√					
PENN WEST PETROLEUM LTD.	Battery	12-17-046-06 W5M		√					
PENN WEST PETROLEUM LTD.	Battery	14-34-045-05 W5M		√					
PENN WEST PETROLEUM LTD.	Battery	UNKNOWN		√	√	√		√	
PENN WEST PETROLEUM LTD.	Battery	UNKNOWN		√	√	√		√	
PENN WEST PETROLEUM LTD.	Battery	UNKNOWN							√
PENN WEST PETROLEUM LTD.	Battery	13-22-054-25 W4M		√					
PENN WEST PETROLEUM LTD.	Battery	14-01-049-06 W5M		√					
PENN WEST PETROLEUM LTD.	Battery	04-02-046-06 W5M		√					
PENN WEST PETROLEUM LTD.	Battery	04-20-052-26 W4M		√	√	√		√	

TABLE 8A.1-3 Cont'd

Primary Applicant	Development Type	Legal Location	Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment RSA	Vegetation RSA	Wildlife RSA	Wildlife RSA (Grizzly)
PENN WEST PETROLEUM LTD.	Battery	04-28-057-09 W5M		√					
PENN WEST PETROLEUM LTD.	Battery	04-31-052-26 W4M	√	√	√	√	√	√	
PENN WEST PETROLEUM LTD.	Battery	06-02-053-26 W4M		√	√	√		√	
PENN WEST PETROLEUM LTD.	Battery	06-08-050-23 W4M		√					
PENN WEST PETROLEUM LTD.	Battery	06-23-057-10 W5M		√					
PENN WEST PETROLEUM LTD.	Battery	06-24-048-04 W5M		√					
PENN WEST PETROLEUM LTD.	Battery	06-24-050-04 W5M		√					
PENN WEST PETROLEUM LTD.	Battery	06-36-045-06 W5M		√					
PENN WEST PETROLEUM LTD.	Battery	07-17-052-26 W4M		√	√	√		√	
PENN WEST PETROLEUM LTD.	Battery	07-18-052-26 W4M		√	√	√		√	
PENN WEST PETROLEUM LTD.	Battery	07-30-049-23 W4M		√					
PENN WEST PETROLEUM LTD.	Battery	08-06-057-09 W5M		√					
PENN WEST PETROLEUM LTD.	Battery	08-07-052-26 W4M		√				√	
PENN WEST PETROLEUM LTD.	Battery	08-18-050-23 W4M		√				√	
PENN WEST PETROLEUM LTD.	Battery	08-22-052-26 W4M		√	√	√		√	
PENN WEST PETROLEUM LTD.	Battery	09-31-055-25 W4M		√					
PENN WEST PETROLEUM LTD.	Battery	09-35-057-10 W5M		√					
PENN WEST PETROLEUM LTD.	Battery	09-36-057-10 W5M		√					
PENN WEST PETROLEUM LTD.	Battery	10-08-050-03 W5M		√					
PENN WEST PETROLEUM LTD.	Battery	10-12-052-27 W4M		√				√	
PENN WEST PETROLEUM LTD.	Battery	10-22-058-09 W5M		√					
PENN WEST PETROLEUM LTD.	Battery	10-25-057-10 W5M		√					

TABLE 8A.1-3 Cont'd

Primary Applicant	Development Type	Legal Location	Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment RSA	Vegetation RSA	Wildlife RSA	Wildlife RSA (Grizzly)
PENN WEST PETROLEUM LTD.	Battery	10-27-058-09 W5M		√					
PENN WEST PETROLEUM LTD.	Battery	10-30-050-07 W5M		√					
PENN WEST PETROLEUM LTD.	Battery	10-33-051-26 W4M		√				√	
PENN WEST PETROLEUM LTD.	Battery	11-06-052-26 W4M		√				√	
PENN WEST PETROLEUM LTD.	Battery	11-13-057-10 W5M		√					
PENN WEST PETROLEUM LTD.	Battery	12-08-050-03 W5M		√					
PENN WEST PETROLEUM LTD.	Battery	12-21-047-09 W5M		√					
PENN WEST PETROLEUM LTD.	Battery	12-31-057-09 W5M		√					
PENN WEST PETROLEUM LTD.	Battery	13-18-051-26 W4M		√				√	
PENN WEST PETROLEUM LTD.	Battery	14-19-057-09 W5M		√					
PENN WEST PETROLEUM LTD.	Battery	14-21-045-06 W5M		√					
PENN WEST PETROLEUM LTD.	Battery	14-27-048-25 W4M		√					
PENN WEST PETROLEUM LTD.	Battery	15-16-052-27 W4M		√	√	√		√	
PENN WEST PETROLEUM LTD.	Battery	15-30-057-09 W5M		√					
PENN WEST PETROLEUM LTD.	Battery	16-21-058-09 W5M		√					
PENN WEST PETROLEUM LTD.	Battery	16-27-058-09 W5M		√					
PENN WEST PETROLEUM LTD.	Battery	16-32-051-26 W4M		√				√	
PENN WEST PETROLEUM LTD.	Injection Plant	14-06-043-06 W5M		√					
PENN WEST PETROLEUM LTD.	Injection Plant	16-28-042-06 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	01-08-050-07 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	01-17-047-10 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	01-22-049-27 W4M		√					

TABLE 8A.1-3 Cont'd

Primary Applicant	Development Type	Legal Location	Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment RSA	Vegetation RSA	Wildlife RSA	Wildlife RSA (Grizzly)
PENN WEST PETROLEUM LTD.	Satellite	01-24-045-06 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	01-24-052-12 W5M						√	
PENN WEST PETROLEUM LTD.	Satellite	02-01-048-08 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	02-05-048-07 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	02-06-048-07 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	02-08-045-05 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	02-10-047-08 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	02-13-047-04 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	02-16-047-03 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	02-24-050-06 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	02-25-052-26 W4M	√	√	√	√	√	√	
PENN WEST PETROLEUM LTD.	Satellite	02-26-052-26 W4M	√	√	√	√	√	√	
PENN WEST PETROLEUM LTD.	Satellite	03-02-053-26 W4M		√	√	√		√	
PENN WEST PETROLEUM LTD.	Satellite	03-07-045-06 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	03-14-047-10 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	03-24-056-05 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	03-35-052-26 W4M		√	√	√		√	
PENN WEST PETROLEUM LTD.	Satellite	04-04-048-07 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	04-05-048-07 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	04-06-048-07 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	04-07-050-07 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	04-08-050-07 W5M		√					

TABLE 8A.1-3 Cont'd

Primary Applicant	Development Type	Legal Location	Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment RSA	Vegetation RSA	Wildlife RSA	Wildlife RSA (Grizzly)
PENN WEST PETROLEUM LTD.	Satellite	04-11-047-08 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	04-13-050-07 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	04-13-051-27 W4M		√				√	
PENN WEST PETROLEUM LTD.	Satellite	04-13-052-12 W5M						√	
PENN WEST PETROLEUM LTD.	Satellite	04-16-046-06 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	04-16-049-06 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	04-17-050-07 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	04-18-045-05 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	04-20-046-03 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	04-21-047-09 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	04-25-047-09 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	04-26-045-06 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	04-26-052-26 W4M	√	√	√	√	√	√	
PENN WEST PETROLEUM LTD.	Satellite	04-36-047-09 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	05-12-042-07 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	05-14-052-26 W4M		√	√	√		√	
PENN WEST PETROLEUM LTD.	Satellite	05-27-052-08 W5M		√				√	
PENN WEST PETROLEUM LTD.	Satellite	05-36-052-27 W4M	√	√	√	√	√	√	
PENN WEST PETROLEUM LTD.	Satellite	06-02-053-26 W4M		√	√	√		√	
PENN WEST PETROLEUM LTD.	Satellite	06-05-050-07 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	06-06-046-06 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	06-06-050-06 W5M		√					

TABLE 8A.1-3 Cont'd

Primary Applicant	Development Type	Legal Location	Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment RSA	Vegetation RSA	Wildlife RSA	Wildlife RSA (Grizzly)
PENN WEST PETROLEUM LTD.	Satellite	06-07-046-03 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	06-07-050-07 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	06-09-047-03 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	06-13-042-07 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	06-13-056-05 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	06-15-047-09 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	06-15-050-07 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	06-18-048-06 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	06-18-050-07 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	06-21-052-12 W5M		√				√	
PENN WEST PETROLEUM LTD.	Satellite	06-21-056-23 W4M		√					
PENN WEST PETROLEUM LTD.	Satellite	06-23-045-07 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	06-23-052-26 W4M		√	√	√		√	
PENN WEST PETROLEUM LTD.	Satellite	06-25-051-27 W4M		√				√	
PENN WEST PETROLEUM LTD.	Satellite	06-28-045-06 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	06-29-049-03 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	06-30-045-06 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	06-30-056-04 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	06-31-045-06 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	06-34-049-07 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	06-35-042-07 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	06-36-045-07 W5M		√					

TABLE 8A.1-3 Cont'd

Primary Applicant	Development Type	Legal Location	Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment RSA	Vegetation RSA	Wildlife	
								RSA	RSA (Grizzly)
PENN WEST PETROLEUM LTD.	Satellite	07-05-043-06 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	07-29-046-03 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	07-30-048-05 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	07-34-045-06 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	08-01-050-04 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	08-02-046-04 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	08-03-047-08 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	08-04-047-06 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	08-05-047-06 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	08-07-049-06 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	08-09-050-07 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	08-10-047-08 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	08-10-053-26 W4M		√	√	√		√	
PENN WEST PETROLEUM LTD.	Satellite	08-11-046-04 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	08-11-050-08 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	08-15-052-12 W5M		√				√	
PENN WEST PETROLEUM LTD.	Satellite	08-17-050-07 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	08-19-047-08 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	08-19-056-04 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	08-27-047-09 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	08-28-047-08 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	08-29-045-06 W5M		√					

TABLE 8A.1-3 Cont'd

Primary Applicant	Development Type	Legal Location	Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment RSA	Vegetation RSA	Wildlife	
								RSA	RSA (Grizzly)
PENN WEST PETROLEUM LTD.	Satellite	08-29-047-08 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	08-30-047-08 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	08-36-042-07 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	09-04-052-26 W4M		√				√	
PENN WEST PETROLEUM LTD.	Satellite	09-22-052-26 W4M		√	√	√	√	√	
PENN WEST PETROLEUM LTD.	Satellite	09-33-049-07 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	09-34-052-26 W4M		√	√	√		√	
PENN WEST PETROLEUM LTD.	Satellite	10-01-046-07 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	10-03-053-26 W4M		√	√	√		√	
PENN WEST PETROLEUM LTD.	Satellite	10-06-050-07 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	10-11-044-08 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	10-18-050-07 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	10-26-047-09 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	10-27-047-09 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	10-27-052-26 W4M	√	√	√	√	√	√	
PENN WEST PETROLEUM LTD.	Satellite	10-28-049-03 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	10-29-049-03 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	10-31-047-07 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	10-32-046-06 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	10-33-047-07 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	10-33-049-07 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	11-01-050-07 W5M		√					

TABLE 8A.1-3 Cont'd

Primary Applicant	Development Type	Legal Location	Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment RSA	Vegetation RSA	Wildlife RSA	Wildlife RSA (Grizzly)
PENN WEST PETROLEUM LTD.	Satellite	11-06-052-26 W4M		√				√	
PENN WEST PETROLEUM LTD.	Satellite	11-09-047-06 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	11-10-047-09 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	11-11-053-26 W4M		√				√	
PENN WEST PETROLEUM LTD.	Satellite	11-13-050-08 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	11-26-052-26 W4M	√	√	√	√	√	√	
PENN WEST PETROLEUM LTD.	Satellite	11-29-049-03 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	11-32-049-03 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	11-35-052-26 W4M		√	√	√		√	
PENN WEST PETROLEUM LTD.	Satellite	12-02-047-08 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	12-03-052-26 W4M		√				√	
PENN WEST PETROLEUM LTD.	Satellite	12-07-047-03 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	12-11-047-08 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	12-12-052-09 W5M		√				√	
PENN WEST PETROLEUM LTD.	Satellite	12-15-047-10 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	12-18-056-04 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	12-23-047-09 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	12-25-047-09 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	12-26-045-06 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	12-28-047-07 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	12-31-046-08 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	12-35-051-27 W4M		√				√	

TABLE 8A.1-3 Cont'd

Primary Applicant	Development Type	Legal Location	Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment RSA	Vegetation RSA	Wildlife RSA	Wildlife RSA (Grizzly)
PENN WEST PETROLEUM LTD.	Satellite	13-03-050-07 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	13-04-043-06 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	13-13-056-05 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	13-17-045-06 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	13-23-052-26 W4M		√	√	√	√	√	
PENN WEST PETROLEUM LTD.	Satellite	13-36-055-04 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	14-01-050-08 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	14-05-049-06 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	14-07-043-06 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	14-18-042-06 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	14-20-045-06 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	14-24-045-07 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	15-01-043-07 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	15-05-043-06 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	15-09-046-06 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	15-16-047-08 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	15-21-045-06 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	15-31-047-08 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	15-32-042-06 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	15-35-045-07 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	16-04-047-03 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	16-09-045-06 W5M		√					

TABLE 8A.1-3 Cont'd

Primary Applicant	Development Type	Legal Location	Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment RSA	Vegetation RSA	Wildlife	
								RSA	RSA (Grizzly)
PENN WEST PETROLEUM LTD.	Satellite	16-09-047-09 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	16-12-042-07 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	16-13-042-07 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	16-25-045-07 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	16-27-045-06 W5M		√					
PENN WEST PETROLEUM LTD.	Satellite	16-36-045-04 W5M		√					
PERPETUAL ENERGY INC.	Battery	12-27-051-14 W5M		√					
PERPETUAL ENERGY OPERATING CORP.	Battery	01-36-052-15 W5M		√				√	
PERPETUAL ENERGY OPERATING CORP.	Battery	04-14-052-17 W4M		√					
PERPETUAL ENERGY OPERATING CORP.	Battery	06-22-049-18 W4M		√					
PERPETUAL ENERGY OPERATING CORP.	Battery	08-02-052-16 W5M		√				√	
PERPETUAL ENERGY OPERATING CORP.	Battery	09-18-052-15 W5M		√				√	
PERPETUAL ENERGY OPERATING CORP.	Battery	10-04-052-15 W5M		√					
PERPETUAL ENERGY OPERATING CORP.	Battery	10-26-051-15 W5M		√					
PERPETUAL ENERGY OPERATING CORP.	Battery	13-04-052-15 W5M		√				√	
PERPETUAL ENERGY OPERATING CORP.	Battery	13-33-051-15 W5M		√					
PERPETUAL ENERGY OPERATING CORP.	Battery	16-11-049-18 W4M		√					
PERPETUAL ENERGY OPERATING CORP.	Battery	16-27-051-15 W5M		√					
PERPETUAL ENERGY OPERATING CORP.	Battery	16-32-051-15 W5M		√					
PERSTA RESOURCES INC.	Battery	12-21-047-19 W5M							√
PETROBAKKEN ENERGY LTD.	Battery	06-31-057-09 W5M		√					
PETROBAKKEN ENERGY LTD.	Battery	13-10-047-05 W5M		√					
PETROBAKKEN ENERGY LTD.	Battery	15-08-056-11 W5M		√					

TABLE 8A.1-3 Cont'd

Primary Applicant	Development Type	Legal Location	Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment RSA	Vegetation RSA	Wildlife	
								RSA	RSA (Grizzly)
PETROBAKKEN ENERGY LTD.	Satellite	05-11-046-05 W5M		√					
PETROBAKKEN ENERGY LTD.	Satellite	08-09-046-05 W5M		√					
PETROBAKKEN ENERGY LTD.	Satellite	14-04-046-05 W5M		√					
PETROBAKKEN ENERGY LTD.	Satellite	16-18-047-05 W5M		√					
PETROGLOBE INC.	Battery	11-19-053-15 W5M		√	√	√	√	√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	01-05-056-20 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	01-06-051-19 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	01-07-051-19 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	01-07-055-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	01-10-054-22 W5M		√				√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	01-20-054-22 W5M		√				√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	01-28-055-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	01-28-063-10 W6M							√
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	01-29-054-22 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	01-32-055-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	01-33-053-20 W5M		√				√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	02-02-055-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	02-03-054-20 W5M		√				√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	02-03-056-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	02-04-055-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	02-04-056-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	02-06-055-21 W5M		√					

TABLE 8A.1-3 Cont'd

Primary Applicant	Development Type	Legal Location	Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment RSA	Vegetation RSA	Wildlife RSA	Wildlife RSA (Grizzly)
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	02-10-056-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	02-11-056-20 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	02-12-055-22 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	02-16-055-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	02-22-055-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	02-34-055-20 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	03-04-054-21 W5M		√				√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	03-04-055-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	03-16-053-21 W5M		√	√	√		√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	03-23-054-22 W5M		√				√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	03-23-055-20 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	03-23-055-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	03-27-054-22 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	03-28-054-22 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	03-33-054-20 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	04-05-055-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	04-11-054-20 W5M		√				√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	04-12-055-22 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	04-14-055-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	04-15-056-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	04-17-054-21 W5M		√				√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	04-17-054-22 W5M		√				√	

TABLE 8A.1-3 Cont'd

Primary Applicant	Development Type	Legal Location	Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment RSA	Vegetation RSA	Wildlife RSA	Wildlife RSA (Grizzly)
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	04-22-055-20 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	04-26-053-20 W5M		√				√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	04-27-053-21 W5M		√				√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	04-27-054-20 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	04-28-055-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	04-29-054-22 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	04-35-053-20 W5M		√				√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	04-36-054-22 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	05-05-055-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	05-08-055-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	05-13-055-22 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	05-18-054-21 W5M		√				√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	05-21-055-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	05-25-053-22 W5M		√				√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	05-25-054-22 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	05-30-054-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	05-32-055-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	05-34-055-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	05-35-055-20 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	06-05-055-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	06-05-056-19 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	06-15-055-20 W5M		√					

TABLE 8A.1-3 Cont'd

Primary Applicant	Development Type	Legal Location	Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment RSA	Vegetation RSA	Wildlife RSA	Wildlife RSA (Grizzly)
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	06-20-055-20 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	06-20-055-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	06-21-063-10 W6M							√
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	06-22-054-20 W5M		√				√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	06-22-055-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	06-25-053-20 W5M		√				√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	06-28-055-20 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	07-04-059-03 W6M							√
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	07-07-056-17 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	07-08-055-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	07-13-055-22 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	07-21-055-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	07-22-054-22 W5M		√				√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	07-27-053-20 W5M		√				√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	07-28-054-20 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	07-30-054-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	08-03-054-22 W5M		√				√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	08-03-056-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	08-09-056-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	08-14-055-22 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	08-15-054-22 W5M		√				√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	08-16-055-20 W5M		√					

TABLE 8A.1-3 Cont'd

Primary Applicant	Development Type	Legal Location	Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment RSA	Vegetation RSA	Wildlife	
								RSA	RSA (Grizzly)
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	08-16-059-03 W6M							√
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	08-21-055-20 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	08-26-055-22 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	08-28-054-22 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	08-28-055-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	08-31-055-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	08-33-055-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	08-34-055-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	09-05-056-20 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	09-06-055-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	09-10-054-22 W5M		√				√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	09-12-055-22 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	09-16-056-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	09-18-054-21 W5M		√				√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	09-20-055-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	09-22-054-22 W5M		√				√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	09-25-054-22 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	09-26-054-22 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	09-27-055-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	09-30-054-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	09-34-053-20 W5M		√				√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	09-34-055-20 W5M		√					

TABLE 8A.1-3 Cont'd

Primary Applicant	Development Type	Legal Location	Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment RSA	Vegetation RSA	Wildlife RSA	Wildlife RSA (Grizzly)
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	10-08-055-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	10-12-054-22 W5M		√				√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	10-13-055-22 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	10-15-054-22 W5M		√				√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	10-16-059-03 W6M							√
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	10-23-055-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	10-23-063-10 W6M							√
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	10-29-054-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	10-31-055-19 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	10-33-055-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	10-34-055-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	11-01-056-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	11-13-056-20 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	11-18-054-21 W5M		√				√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	11-21-053-21 W5M		√				√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	11-21-055-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	11-25-053-21 W5M		√				√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	11-27-053-20 W5M		√				√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	11-27-054-22 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	11-27-055-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	12-05-054-21 W5M		√				√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	12-13-055-21 W5M		√					

TABLE 8A.1-3 Cont'd

Primary Applicant	Development Type	Legal Location	Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment RSA	Vegetation RSA	Wildlife	
								RSA	RSA (Grizzly)
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	12-14-055-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	12-15-055-20 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	12-23-055-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	12-25-053-20 W5M		√				√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	12-25-054-22 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	12-30-054-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	13-01-054-20 W5M		√				√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	13-05-055-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	13-20-053-21 W5M		√				√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	13-20-055-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	13-23-052-20 W5M		√	√	√		√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	13-26-054-22 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	13-27-054-22 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	13-28-054-22 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	13-29-054-22 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	13-32-054-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	13-33-055-20 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	14-04-055-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	14-05-054-21 W5M		√				√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	14-16-055-20 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	14-17-055-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	14-17-057-02 W6M							√

TABLE 8A.1-3 Cont'd

Primary Applicant	Development Type	Legal Location	Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment RSA	Vegetation RSA	Wildlife	
								RSA	RSA (Grizzly)
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	14-21-055-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	14-28-055-20 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	14-31-054-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	14-31-055-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	14-35-054-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	14-35-055-20 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	15-03-056-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	15-05-053-20 W5M		√	√	√		√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	15-14-054-22 W5M		√				√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	15-15-055-20 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	15-17-055-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	15-18-055-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	15-21-055-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	15-22-055-20 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	15-28-054-22 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	15-30-054-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	15-33-055-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	15-35-059-04 W6M							√
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	16-05-055-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	16-06-055-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	16-08-055-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	16-08-056-21 W5M		√					

TABLE 8A.1-3 Cont'd

Primary Applicant	Development Type	Legal Location	Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment RSA	Vegetation RSA	Wildlife RSA	Wildlife RSA (Grizzly)
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	16-09-053-20 W5M		√	√	√		√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	16-15-055-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	16-18-055-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	16-20-055-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	16-21-055-20 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	16-25-053-21 W5M		√				√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	16-27-053-21 W5M		√				√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	16-27-055-22 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	16-29-054-22 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	16-31-053-21 W5M		√				√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	16-32-053-21 W5M		√				√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	Battery	16-34-053-20 W5M		√				√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	Gas Processing Plant	06-18-054-21 W5M		√				√	
PINE CLIFF ENERGY LTD.	Battery	01-16-051-14 W5M		√					
PINE CLIFF ENERGY LTD.	Battery	01-21-051-14 W5M		√					
PINE CLIFF ENERGY LTD.	Battery	03-21-051-14 W5M		√					
PINE CLIFF ENERGY LTD.	Battery	08-09-051-14 W5M		√					
PINE CLIFF ENERGY LTD.	Battery	12-21-051-14 W5M		√					
PINE CLIFF ENERGY LTD.	Battery	16-23-052-14 W5M		√				√	
PROGRESS ENERGY CANADA LTD.	Battery	01-02-061-09 W6M							√
PROGRESS ENERGY CANADA LTD.	Battery	10-03-060-06 W6M							√
RAVENWOOD ENERGY CORP.	Battery	06-34-045-04 W5M		√					
RAVENWOOD ENERGY CORP.	Battery	10-03-046-04 W5M		√					
RAVENWOOD ENERGY CORP.	Battery	14-07-048-01 W5M		√					

TABLE 8A.1-3 Cont'd

Primary Applicant	Development Type	Legal Location	Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment RSA	Vegetation RSA	Wildlife RSA	Wildlife RSA (Grizzly)
RAVENWOOD ENERGY CORP.	Satellite	06-04-049-01 W5M		√					
REDWATER ENERGY CORP.	Battery	01-33-054-21 W4M		√					
RESPONSE ENERGY CORPORATION	Satellite	06-32-055-25 W4M		√					
RESPONSE ENERGY CORPORATION	Satellite	15-07-051-25 W4M		√				√	
RIFE RESOURCES LTD.	Battery	02-13-050-24 W4M		√				√	
RIFE RESOURCES LTD.	Battery	10-33-049-23 W4M		√					
RMP ENERGY INC.	Battery	04-35-054-20 W5M		√					
RMP ENERGY INC.	Battery	10-35-054-20 W5M		√					
SANTONIA ENERGY INC.	Battery	03-17-045-15 W5M							√
SECURE ENERGY SERVICES INC.	Central Treating Plants	08-01-055-18 W5M		√				√	
SECURE ENERGY SERVICES INC.	Central Treating Plants	11-21-055-20 W5M		√					
SECURE ENERGY SERVICES INC.	Central Treating Plants	16-26-052-23 W5M		√	√	√	√	√	
SECURE ENERGY SERVICES INC.	Injection Plant	06-09-057-22 W5M		√					
SECURE ENERGY SERVICES INC.	Injection Plant	08-01-055-18 W5M		√				√	
SHELL CANADA ENERGY	Battery	04-13-056-21 W5M		√					
SHELL CANADA LIMITED	Battery	14-35-053-22 W5M		√				√	
SHELL CANADA LIMITED	Battery	01-01-057-21 W5M		√					
SHELL CANADA LIMITED	Battery	01-11-054-23 W5M		√				√	
SHELL CANADA LIMITED	Battery	01-14-054-23 W5M		√				√	
SHELL CANADA LIMITED	Battery	01-34-053-22 W5M		√				√	
SHELL CANADA LIMITED	Battery	02-07-055-23 W5M		√					
SHELL CANADA LIMITED	Battery	02-12-054-22 W5M		√				√	
SHELL CANADA LIMITED	Battery	02-22-055-24 W5M		√					
SHELL CANADA LIMITED	Battery	03-07-054-21 W5M		√				√	
SHELL CANADA LIMITED	Battery	03-07-054-23 W5M		√				√	
SHELL CANADA LIMITED	Battery	03-32-053-21 W5M		√				√	
SHELL CANADA LIMITED	Battery	04-14-057-21 W5M		√					
SHELL CANADA LIMITED	Battery	06-01-054-22 W5M		√				√	
SHELL CANADA LIMITED	Battery	06-19-055-17 W5M		√					
SHELL CANADA LIMITED	Battery	06-23-053-22 W5M		√				√	
SHELL CANADA LIMITED	Battery	06-23-056-25 W5M							√
SHELL CANADA LIMITED	Battery	07-25-054-24 W5M		√					
SHELL CANADA LIMITED	Battery	08-02-054-22 W5M		√				√	

TABLE 8A.1-3 Cont'd

Primary Applicant	Development Type	Legal Location	Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment RSA	Vegetation RSA	Wildlife	
								RSA	RSA (Grizzly)
SHELL CANADA LIMITED	Battery	08-07-056-24 W5M							√
SHELL CANADA LIMITED	Battery	08-13-054-19 W5M		√				√	
SHELL CANADA LIMITED	Battery	09-23-056-21 W5M		√					
SHELL CANADA LIMITED	Battery	11-11-054-22 W5M		√				√	
SHELL CANADA LIMITED	Battery	11-24-054-22 W5M		√					
SHELL CANADA LIMITED	Battery	11-24-056-25 W5M							√
SHELL CANADA LIMITED	Battery	12-07-057-20 W5M		√					
SHELL CANADA LIMITED	Battery	12-08-054-21 W5M		√				√	
SHELL CANADA LIMITED	Battery	13-06-051-23 W5M		√				√	√
SHELL CANADA LIMITED	Battery	13-14-057-21 W5M		√					
SHELL CANADA LIMITED	Battery	13-17-056-25 W5M							√
SHELL CANADA LIMITED	Battery	13-28-054-23 W5M		√					
SHELL CANADA LIMITED	Battery	14-02-054-22 W5M		√				√	
SHELL CANADA LIMITED	Battery	14-19-056-20 W5M		√					
SHELL CANADA LIMITED	Battery	14-35-053-22 W5M		√				√	
SHELL CANADA LIMITED	Battery	15-35-053-22 W5M		√				√	
SHELL CANADA LIMITED	Battery	15-36-053-24 W5M		√				√	
SHELL CANADA LIMITED	Battery	16-11-054-22 W5M		√				√	
SHELL CANADA LIMITED	Battery	16-15-056-25 W5M							√
SIGNALTA RESOURCES LIMITED	Battery	UNKNOWN		√					
SIGNALTA RESOURCES LIMITED	Battery	09-15-055-25 W4M		√					
SINOPEC DAYLIGHT ENERGY LTD.	Battery	13-23-052-21 W5M		√	√	√		√	
SINOPEC DAYLIGHT ENERGY LTD.	Battery	08-26-054-22 W4M		√					
SINOPEC DAYLIGHT ENERGY LTD.	Battery	UNKNOWN		√	√	√		√	
SINOPEC DAYLIGHT ENERGY LTD.	Battery	16-11-050-06 W5M		√					
SINOPEC DAYLIGHT ENERGY LTD.	Battery	01-16-052-21 W5M		√				√	
SINOPEC DAYLIGHT ENERGY LTD.	Battery	01-27-050-06 W5M		√					
SINOPEC DAYLIGHT ENERGY LTD.	Battery	03-28-050-06 W5M		√					
SINOPEC DAYLIGHT ENERGY LTD.	Battery	03-34-053-10 W5M		√	√	√		√	
SINOPEC DAYLIGHT ENERGY LTD.	Battery	04-31-056-16 W5M		√					

TABLE 8A.1-3 Cont'd

Primary Applicant	Development Type	Legal Location	Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment RSA	Vegetation RSA	Wildlife RSA	Wildlife RSA (Grizzly)
SINOPEC DAYLIGHT ENERGY LTD.	Battery	06-05-054-18 W4M		√					
SINOPEC DAYLIGHT ENERGY LTD.	Battery	06-20-056-16 W5M		√					
SINOPEC DAYLIGHT ENERGY LTD.	Battery	07-17-056-23 W4M		√					
SINOPEC DAYLIGHT ENERGY LTD.	Battery	07-17-057-17 W5M		√					
SINOPEC DAYLIGHT ENERGY LTD.	Battery	08-24-053-20 W5M		√	√	√		√	
SINOPEC DAYLIGHT ENERGY LTD.	Battery	10-17-056-16 W5M		√					
SINOPEC DAYLIGHT ENERGY LTD.	Battery	11-21-055-17 W5M		√					
SINOPEC DAYLIGHT ENERGY LTD.	Battery	11-28-058-12 W5M		√					
SINOPEC DAYLIGHT ENERGY LTD.	Battery	12-01-058-07 W5M		√					
SINOPEC DAYLIGHT ENERGY LTD.	Battery	12-09-052-21 W5M		√				√	
SINOPEC DAYLIGHT ENERGY LTD.	Battery	12-10-049-06 W5M		√					
SINOPEC DAYLIGHT ENERGY LTD.	Battery	13-01-056-20 W5M		√					
SINOPEC DAYLIGHT ENERGY LTD.	Battery	14-04-055-18 W4M		√					
SINOPEC DAYLIGHT ENERGY LTD.	Battery	14-14-056-25 W4M		√					
SINOPEC DAYLIGHT ENERGY LTD.	Battery	14-32-056-09 W5M		√					
SINOPEC DAYLIGHT ENERGY LTD.	Battery	15-19-055-19 W5M		√					
SINOPEC DAYLIGHT ENERGY LTD.	Battery	15-30-056-16 W5M		√					
SINOPEC DAYLIGHT ENERGY LTD.	Injection Plant	03-20-048-03 W5M		√					
SINOPEC DAYLIGHT ENERGY LTD.	Injection Plant	10-15-050-04 W5M		√					
SINOPEC DAYLIGHT ENERGY LTD.	Satellite	01-06-048-03 W5M		√					
SINOPEC DAYLIGHT ENERGY LTD.	Satellite	01-09-048-05 W5M		√					
SINOPEC DAYLIGHT ENERGY LTD.	Satellite	01-10-050-06 W5M		√					

TABLE 8A.1-3 Cont'd

Primary Applicant	Development Type	Legal Location	Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment RSA	Vegetation RSA	Wildlife RSA	Wildlife RSA (Grizzly)
SINOPEC DAYLIGHT ENERGY LTD.	Satellite	01-34-047-03 W5M		√					
SINOPEC DAYLIGHT ENERGY LTD.	Satellite	02-08-048-02 W5M		√					
SINOPEC DAYLIGHT ENERGY LTD.	Satellite	02-21-047-03 W5M		√					
SINOPEC DAYLIGHT ENERGY LTD.	Satellite	02-26-048-03 W5M		√					
SINOPEC DAYLIGHT ENERGY LTD.	Satellite	03-26-048-08 W5M		√					
SINOPEC DAYLIGHT ENERGY LTD.	Satellite	03-33-048-08 W5M		√					
SINOPEC DAYLIGHT ENERGY LTD.	Satellite	04-07-048-02 W5M		√					
SINOPEC DAYLIGHT ENERGY LTD.	Satellite	04-11-050-06 W5M		√					
SINOPEC DAYLIGHT ENERGY LTD.	Satellite	04-14-050-06 W5M		√					
SINOPEC DAYLIGHT ENERGY LTD.	Satellite	04-17-048-02 W5M		√					
SINOPEC DAYLIGHT ENERGY LTD.	Satellite	04-27-050-06 W5M		√					
SINOPEC DAYLIGHT ENERGY LTD.	Satellite	05-07-048-03 W5M		√					
SINOPEC DAYLIGHT ENERGY LTD.	Satellite	05-27-054-18 W4M		√					
SINOPEC DAYLIGHT ENERGY LTD.	Satellite	05-35-053-10 W5M		√	√	√		√	
SINOPEC DAYLIGHT ENERGY LTD.	Satellite	06-04-048-02 W5M		√					
SINOPEC DAYLIGHT ENERGY LTD.	Satellite	06-05-048-02 W5M		√					
SINOPEC DAYLIGHT ENERGY LTD.	Satellite	06-06-048-03 W5M		√					
SINOPEC DAYLIGHT ENERGY LTD.	Satellite	06-08-048-03 W5M		√					
SINOPEC DAYLIGHT ENERGY LTD.	Satellite	06-11-047-03 W5M		√					
SINOPEC DAYLIGHT ENERGY LTD.	Satellite	08-03-048-03 W5M		√					
SINOPEC DAYLIGHT ENERGY LTD.	Satellite	08-07-048-03 W5M		√					
SINOPEC DAYLIGHT ENERGY LTD.	Satellite	08-10-048-03 W5M		√					

TABLE 8A.1-3 Cont'd

Primary Applicant	Development Type	Legal Location	Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment RSA	Vegetation RSA	Wildlife	
								RSA	RSA (Grizzly)
SINOPEC DAYLIGHT ENERGY LTD.	Satellite	08-23-048-03 W5M		√					
SINOPEC DAYLIGHT ENERGY LTD.	Satellite	10-03-047-04 W5M		√					
SINOPEC DAYLIGHT ENERGY LTD.	Satellite	10-14-047-04 W5M		√					
SINOPEC DAYLIGHT ENERGY LTD.	Satellite	10-15-047-04 W5M		√					
SINOPEC DAYLIGHT ENERGY LTD.	Satellite	11-03-050-06 W5M		√					
SINOPEC DAYLIGHT ENERGY LTD.	Satellite	11-04-049-03 W5M		√					
SINOPEC DAYLIGHT ENERGY LTD.	Satellite	11-13-054-26 W4M		√					
SINOPEC DAYLIGHT ENERGY LTD.	Satellite	11-21-047-03 W5M		√					
SINOPEC DAYLIGHT ENERGY LTD.	Satellite	11-25-053-26 W4M		√				√	
SINOPEC DAYLIGHT ENERGY LTD.	Satellite	12-06-048-03 W5M		√					
SINOPEC DAYLIGHT ENERGY LTD.	Satellite	12-27-054-18 W4M		√					
SINOPEC DAYLIGHT ENERGY LTD.	Satellite	12-30-047-03 W5M		√					
SINOPEC DAYLIGHT ENERGY LTD.	Satellite	13-23-047-05 W5M		√					
SINOPEC DAYLIGHT ENERGY LTD.	Satellite	13-33-047-03 W5M		√					
SINOPEC DAYLIGHT ENERGY LTD.	Satellite	14-01-048-04 W5M		√					
SINOPEC DAYLIGHT ENERGY LTD.	Satellite	14-02-048-04 W5M		√					
SINOPEC DAYLIGHT ENERGY LTD.	Satellite	14-28-047-05 W5M		√					
SINOPEC DAYLIGHT ENERGY LTD.	Satellite	14-32-047-02 W5M		√					
SINOPEC DAYLIGHT ENERGY LTD.	Satellite	14-33-050-05 W5M		√					
SINOPEC DAYLIGHT ENERGY LTD.	Satellite	15-35-047-02 W5M		√					
SINOPEC DAYLIGHT ENERGY LTD.	Satellite	16-12-048-03 W5M		√					
SINOPEC DAYLIGHT ENERGY LTD.	Satellite	16-33-047-02 W5M		√					

TABLE 8A.1-3 Cont'd

Primary Applicant	Development Type	Legal Location	Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment RSA	Vegetation RSA	Wildlife RSA	Wildlife RSA (Grizzly)
SINOPEC DAYLIGHT ENERGY LTD.	Satellite	16-35-047-02 W5M		√					
SINO-WESTERN PETROLEUM, INC.	Battery	11-20-049-25 W4M		√					
SOLARA EXPLORATION LTD.	Battery	02-09-045-05 W5M		√					
SOLARA EXPLORATION LTD.	Battery	04-09-045-05 W5M		√					
SONDE RESOURCES CORP.	Battery	07-19-055-25 W4M		√					
SUNCOR ENERGY INC.	Battery	01-07-044-18 W5M							√
SUNCOR ENERGY INC.	Battery	02-01-042-15 W5M							√
SUNCOR ENERGY INC.	Battery	02-21-041-14 W5M							√
SUNCOR ENERGY INC.	Battery	02-28-044-19 W5M							√
SUNCOR ENERGY INC.	Battery	02-30-044-17 W5M							√
SUNCOR ENERGY INC.	Battery	02-33-041-14 W5M							√
SUNCOR ENERGY INC.	Battery	03-08-043-16 W5M							√
SUNCOR ENERGY INC.	Battery	03-09-042-15 W5M							√
SUNCOR ENERGY INC.	Battery	03-16-049-21 W5M		√					
SUNCOR ENERGY INC.	Battery	04-08-045-18 W5M							√
SUNCOR ENERGY INC.	Battery	05-01-045-18 W5M							√
SUNCOR ENERGY INC.	Battery	05-35-045-19 W5M							√
SUNCOR ENERGY INC.	Battery	06-05-044-06 W5M		√					
SUNCOR ENERGY INC.	Battery	06-13-045-19 W5M							√
SUNCOR ENERGY INC.	Battery	06-23-042-15 W5M							√
SUNCOR ENERGY INC.	Battery	07-17-044-17 W5M							√
SUNCOR ENERGY INC.	Battery	07-33-041-14 W5M							√
SUNCOR ENERGY INC.	Battery	08-19-042-15 W5M							√
SUNCOR ENERGY INC.	Battery	09-07-044-18 W5M							√
SUNCOR ENERGY INC.	Battery	09-14-042-16 W5M							√
SUNCOR ENERGY INC.	Battery	09-16-044-17 W5M							√
SUNCOR ENERGY INC.	Battery	09-21-041-14 W5M							√
SUNCOR ENERGY INC.	Battery	09-35-047-20 W5M							√
SUNCOR ENERGY INC.	Battery	10-03-041-14 W5M							√
SUNCOR ENERGY INC.	Battery	10-21-045-19 W5M							√
SUNCOR ENERGY INC.	Battery	11-29-043-06 W5M		√					
SUNCOR ENERGY INC.	Battery	11-29-046-20 W5M							√
SUNCOR ENERGY INC.	Battery	12-23-043-17 W5M							√
SUNCOR ENERGY INC.	Battery	13-16-044-17 W5M							√
SUNCOR ENERGY INC.	Battery	13-17-042-17 W5M							√
SUNCOR ENERGY INC.	Battery	13-22-044-19 W5M							√

TABLE 8A.1-3 Cont'd

Primary Applicant	Development Type	Legal Location	Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment RSA	Vegetation RSA	Wildlife RSA	Wildlife RSA (Grizzly)
SUNCOR ENERGY INC.	Battery	13-23-048-21 W5M		√					
SUNCOR ENERGY INC.	Battery	14-23-041-15 W5M							√
SUNCOR ENERGY INC.	Battery	15-15-049-22 W5M		√					√
SUNCOR ENERGY INC.	Battery	16-18-043-16 W5M							√
SUNCOR ENERGY INC.	Satellite	02-13-045-06 W5M		√					
SUNCOR ENERGY INC.	Satellite	05-01-045-06 W5M		√					
SUNCOR ENERGY INC.	Satellite	08-11-045-06 W5M		√					
SUNCOR ENERGY RESOURCES PARTNERSHIP	Battery	UNKNOWN		√					√
SUNCOR ENERGY RESOURCES PARTNERSHIP	Battery	06-02-043-07 W5M		√					
SUNCOR ENERGY RESOURCES PARTNERSHIP	Battery	06-29-044-17 W5M							√
SUNCOR ENERGY RESOURCES PARTNERSHIP	Battery	14-06-049-18 W5M		√					
SUPERMAN RESOURCES INC.	Satellite	07-21-042-06 W5M		√					
SURE ENERGY INC.	Battery	01-09-056-20 W4M		√					
SURE ENERGY INC.	Battery	02-04-056-20 W4M		√					
SURE ENERGY INC.	Battery	03-09-056-20 W4M		√					
TALISMAN ENERGY INC.	Battery	06-20-054-21 W5M		√					
TALISMAN ENERGY INC.	Battery	13-24-053-18 W4M		√					
TALISMAN ENERGY INC.	Battery	01-07-056-21 W5M		√					
TALISMAN ENERGY INC.	Battery	02-27-052-21 W5M		√	√	√		√	
TALISMAN ENERGY INC.	Battery	02-32-052-21 W5M		√	√	√		√	
TALISMAN ENERGY INC.	Battery	03-08-044-17 W5M							√
TALISMAN ENERGY INC.	Battery	03-19-053-21 W5M		√				√	
TALISMAN ENERGY INC.	Battery	03-33-052-21 W5M		√	√	√		√	
TALISMAN ENERGY INC.	Battery	04-02-053-22 W5M	√	√	√	√	√	√	
TALISMAN ENERGY INC.	Battery	04-25-052-21 W5M		√	√	√		√	
TALISMAN ENERGY INC.	Battery	04-26-053-21 W5M		√				√	
TALISMAN ENERGY INC.	Battery	04-28-053-21 W5M		√				√	
TALISMAN ENERGY INC.	Battery	04-34-051-20 W5M		√				√	
TALISMAN ENERGY INC.	Battery	05-28-052-15 W5M		√				√	
TALISMAN ENERGY INC.	Battery	06-04-051-15 W5M		√					
TALISMAN ENERGY INC.	Battery	06-15-057-20 W5M		√					
TALISMAN ENERGY INC.	Battery	07-35-052-22 W5M	√	√	√	√	√	√	
TALISMAN ENERGY INC.	Battery	09-14-054-21 W5M		√				√	

TABLE 8A.1-3 Cont'd

Primary Applicant	Development Type	Legal Location	Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment RSA	Vegetation RSA	Wildlife RSA	Wildlife RSA (Grizzly)
TALISMAN ENERGY INC.	Battery	10-05-046-19 W5M							√
TALISMAN ENERGY INC.	Battery	10-11-051-15 W5M		√					
TALISMAN ENERGY INC.	Battery	10-11-053-18 W5M		√	√	√		√	
TALISMAN ENERGY INC.	Battery	11-14-054-20 W5M		√				√	
TALISMAN ENERGY INC.	Battery	11-23-052-21 W5M		√	√	√		√	
TALISMAN ENERGY INC.	Battery	11-26-052-21 W5M		√	√	√		√	
TALISMAN ENERGY INC.	Battery	11-32-056-24 W5M							√
TALISMAN ENERGY INC.	Battery	11-34-052-21 W5M		√	√	√	√	√	
TALISMAN ENERGY INC.	Battery	12-22-056-24 W5M							√
TALISMAN ENERGY INC.	Battery	13-29-053-20 W5M		√				√	
TALISMAN ENERGY INC.	Battery	13-32-052-17 W5M		√				√	
TALISMAN ENERGY INC.	Battery	14-35-052-22 W5M	√	√	√	√	√	√	
TALISMAN ENERGY INC.	Battery	16-14-065-13 W6M							√
TAMARACK VALLEY ENERGY LTD.	Battery	01-04-047-06 W5M		√					
TANDEM ENERGY CORPORATION	Battery	03-22-042-06 W5M		√					
TAQA NORTH LTD.	Battery	14-01-048-02 W5M		√					
TAQA NORTH LTD.	Battery	06-24-054-12 W5M		√				√	
TAQA NORTH LTD.	Battery	16-19-057-14 W5M		√					
TAQA NORTH LTD.	Battery	11-05-063-07 W6M							√
TAQA NORTH LTD.	Battery	08-29-046-09 W5M		√					
TAQA NORTH LTD.	Battery	01-09-049-06 W5M		√					
TAQA NORTH LTD.	Battery	01-20-046-09 W5M		√					
TAQA NORTH LTD.	Battery	01-30-058-09 W5M		√					
TAQA NORTH LTD.	Battery	02-17-063-08 W6M							√
TAQA NORTH LTD.	Battery	03-16-047-09 W5M		√					
TAQA NORTH LTD.	Battery	03-35-047-09 W5M		√					
TAQA NORTH LTD.	Battery	04-01-047-10 W5M		√					
TAQA NORTH LTD.	Battery	04-05-053-05 W5M		√	√	√		√	
TAQA NORTH LTD.	Battery	04-18-062-07 W6M							√
TAQA NORTH LTD.	Battery	04-28-046-09 W5M		√					
TAQA NORTH LTD.	Battery	04-31-047-05 W5M		√					
TAQA NORTH LTD.	Battery	05-02-049-06 W5M		√					
TAQA NORTH LTD.	Battery	05-31-047-08 W5M		√					
TAQA NORTH LTD.	Battery	05-36-048-06 W5M		√					
TAQA NORTH LTD.	Battery	06-07-055-15 W5M		√				√	
TAQA NORTH LTD.	Battery	06-10-049-06 W5M		√					
TAQA NORTH LTD.	Battery	06-15-046-09 W5M		√					
TAQA NORTH LTD.	Battery	07-12-049-06 W5M		√					

TABLE 8A.1-3 Cont'd

Primary Applicant	Development Type	Legal Location	Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment RSA	Vegetation RSA	Wildlife	
								RSA	RSA (Grizzly)
TAQA NORTH LTD.	Battery	07-18-049-05 W5M		√					
TAQA NORTH LTD.	Battery	07-19-044-06 W5M		√					
TAQA NORTH LTD.	Battery	08-27-047-09 W5M		√					
TAQA NORTH LTD.	Battery	11-07-049-05 W5M		√					
TAQA NORTH LTD.	Battery	12-16-046-09 W5M		√					
TAQA NORTH LTD.	Battery	12-19-046-08 W5M		√					
TAQA NORTH LTD.	Battery	12-32-047-08 W5M		√					
TAQA NORTH LTD.	Battery	12-32-048-06 W5M		√					
TAQA NORTH LTD.	Battery	13-04-047-09 W5M		√					
TAQA NORTH LTD.	Battery	13-14-048-01 W5M		√					
TAQA NORTH LTD.	Battery	13-29-046-09 W5M		√					
TAQA NORTH LTD.	Battery	14-15-046-10 W5M		√					
TAQA NORTH LTD.	Battery	14-28-043-06 W5M		√					
TAQA NORTH LTD.	Battery	14-31-047-08 W5M		√					
TAQA NORTH LTD.	Battery	15-26-061-07 W6M							√
TAQA NORTH LTD.	Battery	16-17-058-09 W5M		√					
TAQA NORTH LTD.	Satellite	01-32-057-14 W5M		√					
TAQA NORTH LTD.	Satellite	05-13-063-08 W6M							√
TAQA NORTH LTD.	Satellite	05-16-046-09 W5M		√					
TAQA NORTH LTD.	Satellite	06-23-063-08 W6M							√
TAQA NORTH LTD.	Satellite	07-16-055-05 W5M		√					
TAQA NORTH LTD.	Satellite	07-22-063-08 W6M							√
TAQA NORTH LTD.	Satellite	08-12-063-08 W6M							√
TAQA NORTH LTD.	Satellite	08-13-063-08 W6M							√
TAQA NORTH LTD.	Satellite	09-15-063-08 W6M							√
TAQA NORTH LTD.	Satellite	11-05-051-25 W4M		√				√	
TAQA NORTH LTD.	Satellite	11-12-063-08 W6M							√
TAQA NORTH LTD.	Satellite	14-05-062-07 W6M							√
TAQA NORTH LTD.	Satellite	14-07-062-07 W6M							√
TAQA NORTH LTD.	Satellite	16-21-063-08 W6M							√
TIMBERROCK ENERGY CORP.	Battery	06-22-056-17 W5M		√					
TORC OIL & GAS LTD.	Battery	16-09-053-14 W5M		√	√	√		√	
TOURMALINE OIL CORP.	Battery	06-17-051-18 W5M		√					
TOURMALINE OIL CORP.	Battery	14-10-058-27 W5M							√
TOURMALINE OIL CORP.	Battery	07-04-053-24 W5M		√				√	√
TOURMALINE OIL CORP.	Battery	01-12-058-02 W6M							√
TOURMALINE OIL CORP.	Battery	01-18-056-24 W5M							√
TOURMALINE OIL CORP.	Battery	01-28-061-06 W6M							√
TOURMALINE OIL CORP.	Battery	03-17-055-24 W5M		√					

TABLE 8A.1-3 Cont'd

Primary Applicant	Development Type	Legal Location	Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment RSA	Vegetation RSA	Wildlife	
								RSA	RSA (Grizzly)
TOURMALINE OIL CORP.	Battery	04-02-050-20 W5M		√					
TOURMALINE OIL CORP.	Battery	04-11-062-06 W6M							√
TOURMALINE OIL CORP.	Battery	04-36-055-23 W5M		√					
TOURMALINE OIL CORP.	Battery	05-29-051-25 W5M		√				√	√
TOURMALINE OIL CORP.	Battery	07-21-049-20 W5M		√					
TOURMALINE OIL CORP.	Battery	07-34-051-26 W5M						√	√
TOURMALINE OIL CORP.	Battery	07-36-051-26 W5M						√	√
TOURMALINE OIL CORP.	Battery	08-10-057-27 W5M							√
TOURMALINE OIL CORP.	Battery	09-13-062-06 W6M							√
TOURMALINE OIL CORP.	Battery	09-15-049-20 W5M		√					
TOURMALINE OIL CORP.	Battery	09-31-050-20 W5M		√					
TOURMALINE OIL CORP.	Battery	10-15-050-21 W5M		√					
TOURMALINE OIL CORP.	Battery	12-02-058-27 W5M							√
TOURMALINE OIL CORP.	Battery	12-28-061-06 W6M							√
TOURMALINE OIL CORP.	Battery	12-36-055-23 W5M		√					
TOURMALINE OIL CORP.	Battery	13-09-055-24 W5M		√					
TOURMALINE OIL CORP.	Battery	13-13-053-01 W6M							√
TOURMALINE OIL CORP.	Battery	13-15-062-06 W6M							√
TOURMALINE OIL CORP.	Battery	13-16-055-22 W5M		√					
TOURMALINE OIL CORP.	Battery	14-22-050-21 W5M		√					
TOURMALINE OIL CORP.	Battery	15-10-062-06 W6M							√
TOURMALINE OIL CORP.	Battery	15-20-053-27 W5M							√
TOURMALINE OIL CORP.	Battery	15-26-051-26 W5M						√	√
TOURMALINE OIL CORP.	Battery	16-15-051-26 W5M		√				√	√
TRANSCANADA PIPELINES LIMITED	Battery	UNKNOWN		√				√	
TRANSCANADA PIPELINES LIMITED	Battery	10-20-054-19 W5M		√				√	
TRANSCANADA PIPELINES LIMITED	Gas Processing Plant	07-19-054-19 W5M		√				√	
TRIAXON ENERGY INC.	Battery	03-08-050-27 W4M		√					
TRIDENT EXPLORATION (ALBERTA) CORP.	Battery	14-33-060-05 W5M		√					
TRIDENT EXPLORATION (ALBERTA) CORP.	Battery	01-19-058-06 W5M		√					
TRIMOX ENERGY INC.	Battery	14-23-056-12 W5M		√					
TRIMOX ENERGY INC.	Battery	05-27-056-12 W5M		√					
TRIMOX ENERGY INC.	Battery	12-14-056-12 W5M		√					
TRIMOX ENERGY INC.	Battery	16-22-056-12 W5M		√					
TWOCO PETROLEUMS LTD.	Battery	13-16-050-18 W4M		√					
VELVET ENERGY LTD.	Battery	01-05-053-14 W5M		√				√	

TABLE 8A.1-3 Cont'd

Primary Applicant	Development Type	Legal Location	Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment RSA	Vegetation RSA	Wildlife	
								RSA	RSA (Grizzly)
VELVET ENERGY LTD.	Battery	01-08-051-14 W5M		√					
VELVET ENERGY LTD.	Battery	02-16-056-17 W5M		√					
VELVET ENERGY LTD.	Battery	02-25-053-16 W5M	√	√	√	√	√	√	
VELVET ENERGY LTD.	Battery	03-09-054-15 W5M		√	√	√		√	
VELVET ENERGY LTD.	Battery	04-14-056-19 W5M		√					
VELVET ENERGY LTD.	Battery	06-17-054-15 W5M		√				√	
VELVET ENERGY LTD.	Battery	10-15-056-19 W5M		√					
VELVET ENERGY LTD.	Battery	13-05-055-17 W5M		√				√	
VELVET ENERGY LTD.	Battery	13-24-054-17 W5M		√				√	
VELVET ENERGY LTD.	Battery	13-34-052-14 W5M		√				√	
VELVET ENERGY LTD.	Battery	16-23-054-16 W5M		√				√	
VERMILION ENERGY INC.	Battery	04-28-052-11 W5M						√	
VERMILION ENERGY INC.	Battery	11-08-047-08 W5M		√					
VERMILION ENERGY INC.	Battery	14-16-047-08 W5M		√					
VERMILION RESOURCES LTD.	Battery	10-21-049-15 W5M		√					
VERMILION RESOURCES LTD.	Battery	12-02-050-14 W5M		√					
VESTA ENERGY LTD.	Battery	11-34-048-27 W4M		√					
WALDRON ENERGY CORPORATION	Battery	02-21-058-03 W5M		√					
WALDRON ENERGY CORPORATION	Battery	05-28-058-03 W5M		√					
WALDRON ENERGY CORPORATION	Battery	15-36-058-04 W5M		√					
WHITECAP RESOURCES INC.	Battery	05-16-048-05 W5M		√					
WHITECAP RESOURCES INC.	Battery	05-21-048-05 W5M		√					
WHITECAP RESOURCES INC.	Battery	08-14-048-05 W5M		√					
WHITECAP RESOURCES INC.	Battery	09-04-049-06 W5M		√					
WHITECAP RESOURCES INC.	Satellite	01-09-048-03 W5M		√					
WHITECAP RESOURCES INC.	Satellite	04-22-047-05 W5M		√					
WHITECAP RESOURCES INC.	Satellite	05-34-047-03 W5M		√					
WHITECAP RESOURCES INC.	Satellite	10-20-048-05 W5M		√					

TABLE 8A.1-3 Cont'd

Primary Applicant	Development Type	Legal Location	Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment RSA	Vegetation RSA	Wildlife	
								RSA	RSA (Grizzly)
WHITECAP RESOURCES INC.	Satellite	10-21-048-05 W5M		√					
WHITECAP RESOURCES INC.	Satellite	12-03-048-03 W5M		√					
WHITECAP RESOURCES INC.	Satellite	12-35-047-03 W5M		√					
WHITECAP RESOURCES INC.	Satellite	13-19-049-04 W5M		√					
WHITECAP RESOURCES INC.	Satellite	13-21-047-05 W5M		√					
WHITECAP RESOURCES INC.	Satellite	13-34-047-03 W5M		√					
WHITECAP RESOURCES INC.	Satellite	16-19-049-04 W5M		√					
WRANGLER WEST ENERGY CORP.	Battery	11-02-055-27 W4M		√					
WRANGLER WEST ENERGY CORP.	Satellite	08-03-055-27 W4M		√					
WRANGLER WEST ENERGY CORP.	Satellite	12-02-055-27 W4M		√					
WRANGLER WEST ENERGY CORP.	Satellite	14-02-055-27 W4M		√					
ZARGON OIL & GAS LTD.	Satellite	06-09-052-11 W5M						√	
ZARGON OIL & GAS LTD.	Satellite	06-28-051-04 W5M		√				√	
TOTAL			14	1,617	96	96	21	333	167

Sources: ERCB 2013a, IHS Inc. 2013b

TABLE 8A.1-4

REASONABLY FORESEEABLE OIL AND GAS WELL DEVELOPMENTS WITHIN THE TRANS MOUNTAIN EXPANSION PROJECT RSA AND LSA OF VARIOUS ELEMENTS

Primary Applicant	Legal Location	Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment LSA	Vegetation RSA	Wildlife RSA	Wildlife RSA (Grizzly)
APACHE CANADA LTD.	01-29-057-20 W5M		√					
APACHE CANADA LTD.	04-32-064-09 W6M							√
APACHE CANADA LTD.	05-25-048-26 W4M		√					
ARC RESOURCES LTD.	02-35-047-07 W5M		√					
ARC RESOURCES LTD.	03-25-049-07 W5M		√					
ARC RESOURCES LTD.	04-20-048-06 W5M		√					
ARC RESOURCES LTD.	08-07-047-08 W5M		√					
ARC RESOURCES LTD.	08-17-047-08 W5M		√					
ARC RESOURCES LTD.	08-18-047-08 W5M		√					
ARC RESOURCES LTD.	11-23-056-21 W4M		√					
ARC RESOURCES LTD.	12-04-048-08 W5M		√					
ARC RESOURCES LTD.	13-05-049-05 W5M		√					
ARC RESOURCES LTD.	16-35-048-05 W5M		√					
ARC RESOURCES LTD.	16-35-049-07 W5M		√					
ARSENAL ENERGY INC.	10-27-058-05 W5M		√					
AVATAR ENERGY LTD.	07-06-052-20 W4M		√					
BACCALIEU ENERGY INC.	14-36-045-07 W5M		√					
BACCALIEU ENERGY INC.	15-10-047-05 W5M		√					
BACCALIEU ENERGY INC.	15-36-045-07 W5M		√					
BAYTEX ENERGY LTD.	02-19-057-22 W4M		√					
BAYTEX ENERGY LTD.	10-08-057-22 W4M		√					
BAYTEX ENERGY LTD.	10-17-057-22 W4M		√					
BAYTEX ENERGY LTD.	16-04-057-22 W4M		√					
BELLATRIX EXPLORATION LTD.	01-26-049-07 W5M		√					
BELLATRIX EXPLORATION LTD.	03-18-044-07 W5M		√					
BELLATRIX EXPLORATION LTD.	03-26-047-07 W5M		√					
BELLATRIX EXPLORATION LTD.	04-25-056-24 W4M		√					
BELLATRIX EXPLORATION LTD.	06-28-048-08 W5M		√					
BELLATRIX EXPLORATION LTD.	13-23-047-07 W5M		√					
BONAVISTA ENERGY CORPORATION	04-32-055-19 W5M		√					
BONAVISTA ENERGY CORPORATION	13-35-052-15 W5M		√				√	
BONAVISTA ENERGY CORPORATION	14-18-056-19 W5M		√					
BONAVISTA ENERGY CORPORATION	16-07-056-19 W5M		√					
BONAVISTA ENERGY CORPORATION	16-24-055-20 W5M		√					

TABLE 8A.1-4 Cont'd

Primary Applicant	Legal Location	Soil	Aquatics/Wetland	Air Quality	Acoustic Environment	Vegetation	Wildlife	
		LSA	RSA	RSA	LSA	RSA	RSA	RSA (Grizzly)
BONTERRA ENERGY CORP.	01-32-048-04 W5M		√					
BONTERRA ENERGY CORP.	03-22-050-07 W5M		√					
BONTERRA ENERGY CORP.	04-22-050-07 W5M		√					
BONTERRA ENERGY CORP.	13-13-047-07 W5M		√					
BONTERRA ENERGY CORP.	15-13-047-07 W5M		√					
BONTERRA ENERGY CORP.	16-12-048-06 W5M		√					
CANADIAN NATURAL RESOURCES LIMITED	08-05-053-21 W5M		√	√	√	√	√	
CANADIAN NATURAL RESOURCES LIMITED	10-05-053-23 W5M		√	√	√		√	√
CANADIAN NATURAL RESOURCES LIMITED	10-08-052-23 W5M		√	√	√		√	√
CANYON OIL & GAS CORPORATION	08-05-050-05 W5M		√					
CELTIC EXPLORATION ULC	04-14-057-27 W5M							√
CELTIC EXPLORATION ULC	06-19-057-26 W5M							√
CEQUENCE ENERGY LTD.	14-10-057-11 W5M		√					
CHEVRON CANADA LIMITED	12-12-057-22 W5M		√					
COALSPUR MINES (OPERATIONS) LTD.	04-30-051-23 W5M		√				√	√
COALSPUR MINES (OPERATIONS) LTD.	09-30-051-23 W5M		√				√	√
COALSPUR MINES (OPERATIONS) LTD.	10-20-051-23 W5M		√				√	√
COALSPUR MINES (OPERATIONS) LTD.	12-19-051-23 W5M		√				√	√
COMPTON PETROLEUM CORPORATION	04-27-053-14 W5M	√	√	√	√	√	√	
APACHE CANADA LTD.	01-29-057-20 W5M		√					
COMPTON PETROLEUM CORPORATION	13-11-054-13 W5M		√	√	√		√	
CONOCOPHILLIPS CANADA OPERATIONS LTD.	03-13-057-27 W5M							√
CONOCOPHILLIPS CANADA OPERATIONS LTD.	03-25-059-01 W6M							√
CONOCOPHILLIPS CANADA OPERATIONS LTD.	05-12-059-02 W6M							√
CONOCOPHILLIPS CANADA OPERATIONS LTD.	07-08-057-20 W5M		√					
CONOCOPHILLIPS CANADA OPERATIONS LTD.	16-28-049-15 W5M		√					
CREW ENERGY INC.	06-32-051-16 W5M		√					
CROCOTTA ENERGY INC.	01-11-055-18 W5M		√					
CROCOTTA ENERGY INC.	01-19-054-17 W5M		√				√	
CROCOTTA ENERGY INC.	05-15-054-18 W5M		√				√	
CROCOTTA ENERGY INC.	05-17-054-18 W5M		√				√	
CROCOTTA ENERGY INC.	13-18-054-17 W5M		√				√	
CROCOTTA ENERGY INC.	5-29-53-18 W5M		√	√	√		√	
DESMARAIS ENERGY CORPORATION	05-14-058-04 W5M		√					
DEVON CANADA CORPORATION	01-23-059-27 W5M							√
DEVON NEC CORPORATION	01-25-064-10 W6M							√
DEVON NEC CORPORATION	04-16-056-04 W6M							√
DIRECT ENERGY MARKETING LIMITED	14-18-051-14 W5M		√					
ECLIPSE RESOURCES LTD.	16-28-049-05 W5M		√					
ENCANA CORPORATION	01-14-047-03 W5M		√					
ENCANA CORPORATION	01-24-061-06 W6M							√

TABLE 8A.1-4 Cont'd

Primary Applicant	Legal Location	Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment LSA	Vegetation RSA	Wildlife RSA	Wildlife RSA (Grizzly)
ENCANA CORPORATION	05-19-061-05 W6M							√
ENCANA CORPORATION	05-26-059-02 W6M							√
ENCANA CORPORATION	06-21-063-08 W6M							√
ENCANA CORPORATION	08-10-059-02 W6M							√
ENCANA CORPORATION	09-03-060-02 W6M							√
ENCANA CORPORATION	10-12-044-07 W5M		√					
ENCANA CORPORATION	12-01-060-02 W6M							√
ENCANA CORPORATION	12-09-062-06 W6M							√
ENCANA CORPORATION	14-31-061-06 W6M							√
ENCANA CORPORATION	16-21-056-21 W5M		√					
ENERPLUS CORPORATION	01-18-050-19 W5M		√					
ENERPLUS CORPORATION	13-07-045-05 W5M		√					
ENERPLUS CORPORATION	13-26-045-09 W5M		√					
ENQUEST ENVIRONMENTAL SERVICES CORP.	07-28-058-10 W5M		√					
EPSILON ENERGY LTD.	07-28-047-03 W5M		√					
FAWN MEADOWS DEVELOPMENT INC.	15-04-053-02 W5M		√	√	√	√	√	
FORT HILLS ENERGY CORPORATION	07-14-056-22 W4M		√					
FORT HILLS ENERGY CORPORATION	09-11-056-22 W4M		√					
FORT HILLS ENERGY CORPORATION	14-12-056-22 W4M		√					
GRIZZLY RESOURCES LTD.	07-05-050-06 W5M		√					
HARVEST OPERATIONS CORP.	01-27-062-06 W6M							√
HARVEST OPERATIONS CORP.	10-12-055-09 W5M		√					
HARVEST OPERATIONS CORP.	12-09-057-17 W5M		√					
HARVEST OPERATIONS CORP.	12-26-061-06 W6M							√
HITIC ENERGY LTD.	04-04-049-03 W5M		√					
HUSKY OIL OPERATIONS LIMITED	01-10-056-07 W5M		√					
HUSKY OIL OPERATIONS LIMITED	01-13-056-07 W5M		√					
HUSKY OIL OPERATIONS LIMITED	01-24-051-20 W5M		√				√	
HUSKY OIL OPERATIONS LIMITED	02-20-056-20 W4M		√					
HUSKY OIL OPERATIONS LIMITED	03-02-049-18 W5M		√					
HUSKY OIL OPERATIONS LIMITED	03-07-049-18 W5M		√					
HUSKY OIL OPERATIONS LIMITED	03-17-049-17 W5M		√					
HUSKY OIL OPERATIONS LIMITED	03-26-048-18 W5M		√					
HUSKY OIL OPERATIONS LIMITED	05-14-050-19 W5M		√					
HUSKY OIL OPERATIONS LIMITED	06-29-049-18 W5M		√					
HUSKY OIL OPERATIONS LIMITED	07-28-053-21 W5M		√				√	
HUSKY OIL OPERATIONS LIMITED	08-03-055-20 W4M		√					
HUSKY OIL OPERATIONS LIMITED	08-04-056-20 W4M		√					
HUSKY OIL OPERATIONS LIMITED	08-20-056-20 W4M		√					
HUSKY OIL OPERATIONS LIMITED	11-13-054-08 W5M		√				√	
HUSKY OIL OPERATIONS LIMITED	11-29-049-18 W5M		√					

TABLE 8A.1-4 Cont'd

Primary Applicant	Legal Location	Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment LSA	Vegetation RSA	Wildlife RSA	Wildlife RSA (Grizzly)
HUSKY OIL OPERATIONS LIMITED	12-03-056-07 W5M		√					
HUSKY OIL OPERATIONS LIMITED	12-04-051-19 W5M		√					
HUSKY OIL OPERATIONS LIMITED	12-10-056-07 W5M		√					
HUSKY OIL OPERATIONS LIMITED	13-04-050-18 W5M		√					
HUSKY OIL OPERATIONS LIMITED	13-08-050-18 W5M		√					
HUSKY OIL OPERATIONS LIMITED	13-15-049-18 W5M		√					
HUSKY OIL OPERATIONS LIMITED	16-03-049-18 W5M		√					
HUSKY OIL OPERATIONS LIMITED	16-14-050-20 W5M		√					
HUSKY OIL OPERATIONS LIMITED	16-19-055-19 W4M		√					
HYPERION EXPLORATION CORP.	04-06-054-12 W5M		√	√	√		√	
HYPERION EXPLORATION CORP.	05-31-046-04 W5M		√					
IBERDROLA CANADA ENERGY SERVICES LTD.	10-18-055-14 W5M		√					
IMPERIAL OIL RESOURCES LIMITED	01-19-060-26 W5M							√
JAYCOR RESOURCES INC.	12-18-049-25 W4M		√					
JAYCOR RESOURCES INC.	13-18-049-25 W4M		√					
JOURNEY ENERGY INC.	06-36-048-05 W5M		√					
JOURNEY ENERGY INC.	13-31-048-04 W5M		√					
JOURNEY ENERGY INC.	13-6-49-4 W5M		√					
LONE PINE RESOURCES CANADA LTD.	10-04-064-13 W6M							√
LONG RUN EXPLORATION LTD.	02-24-055-21 W4M		√					
LONG RUN EXPLORATION LTD.	03-08-056-20 W4M		√					
LONG RUN EXPLORATION LTD.	05-08-056-20 W4M		√					
LONG RUN EXPLORATION LTD.	08-30-055-07 W5M		√					
LONG RUN EXPLORATION LTD.	08-32-055-20 W4M		√					
LONG RUN EXPLORATION LTD.	10-23-055-21 W4M		√					
LONG RUN EXPLORATION LTD.	10-34-056-21 W4M		√					
LONG RUN EXPLORATION LTD.	12-08-056-20 W4M		√					
LONG RUN EXPLORATION LTD.	13-13-055-21 W4M		√					
LONG RUN EXPLORATION LTD.	14-08-056-20 W4M		√					
LONG RUN EXPLORATION LTD.	14-22-056-21 W4M		√					
LONG RUN EXPLORATION LTD.	15-23-055-21 W4M		√					
LONGVIEW OIL CORP.	01-14-053-10 W5M		√	√	√		√	
LONGVIEW OIL CORP.	02-26-053-10 W5M		√	√	√	√	√	
LONGVIEW OIL CORP.	16-32-046-03 W5M		√					
LONGVIEW OIL CORP.	16-33-046-03 W5M		√					
MADALENA VENTURES	08-05-056-07 W5M		√					
MADALENA VENTURES	15-16-058-09 W5M		√					
MANCAL ENERGY INC.	09-18-056-20 W4M		√					
MANITOK ENERGY INC.	02-29-042-15 W5M							√
MANITOK ENERGY INC.	03-29-042-15 W5M							√
MANITOK ENERGY INC.	04-34-052-26 W5M							√

TABLE 8A.1-4 Cont'd

Primary Applicant	Legal Location	Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment LSA	Vegetation RSA	Wildlife	
							RSA	RSA (Grizzly)
MANITOK ENERGY INC.	06-21-042-15 W5M							√
MANITOK ENERGY INC.	14-25-042-16 W5M							√
MANITOK ENERGY INC.	15-01-042-15 W5M							√
MISTAHIYA RESOURCES LTD.	13-30-056-20 W4M		√					
MKE CANADA LTD.	16-05-047-10 W5M		√					
MOSAIC ENERGY LTD.	05-19-057-22 W4M		√					
MOSAIC ENERGY LTD.	06-31-052-11 W5M		√				√	
NAL RESOURCES LIMITED	14-28-054-17 W5M		√				√	
NEP CANADA ULC	01-17-050-26 W4M		√					
NEP CANADA ULC	01-22-050-26 W4M		√				√	
NEP CANADA ULC	04-09-049-25 W4M		√					
NEP CANADA ULC	04-20-050-26 W4M		√					
NEP CANADA ULC	05-15-050-26 W4M		√					
NEP CANADA ULC	06-22-050-26 W4M		√				√	
NEP CANADA ULC	06-36-050-26 W4M		√				√	
NEP CANADA ULC	07-02-050-26 W4M		√					
NEP CANADA ULC	07-05-051-26 W4M		√				√	
NEP CANADA ULC	07-15-050-26 W4M		√					
NEP CANADA ULC	09-21-051-26 W4M		√				√	
NEP CANADA ULC	12-04-051-26 W4M		√				√	
NEP CANADA ULC	12-09-050-26 W4M		√					
NEP CANADA ULC	12-16-050-26 W4M		√					
NEP CANADA ULC	13-09-050-26 W4M		√					
NEP CANADA ULC	14-15-050-26 W4M		√					
NEP CANADA ULC	14-25-050-26 W4M		√				√	
NEP CANADA ULC	15-16-051-26 W4M		√				√	
NEP CANADA ULC	16-21-051-26 W4M		√				√	
NEP CANADA ULC	16-22-050-26 W4M		√				√	
NEW STAR ENERGY LTD.	05-09-051-04 W5M		√					
NEW STAR ENERGY LTD.	08-16-051-04 W5M		√					
NEWALTA CORPORATION	06-31-058-09 W5M		√					
OMERS ENERGY INC.	09-31-053-01 W6M							√
OMERS ENERGY INC.	16-17-053-01 W6M							√
PANTERRA RESOURCE CORP.	04-07-053-12 W5M		√				√	
PANTERRA RESOURCE CORP.	16-36-052-06 W5M		√	√	√		√	
PEMBINA NGL CORPORATION	02-12-056-22 W4M		√					
PEMBINA NGL CORPORATION	13-01-056-22 W4M		√					
PENGROWTH ENERGY CORPORATION	01-07-056-19 W5M		√					
PENGROWTH ENERGY CORPORATION	11-06-056-19 W5M		√					
PENN WEST PETROLEUM LTD.	02-07-045-06 W5M		√					
PENN WEST PETROLEUM LTD.	04-15-047-03 W5M		√					

TABLE 8A.1-4 Cont'd

Primary Applicant	Legal Location	Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment LSA	Vegetation RSA	Wildlife RSA	Wildlife RSA (Grizzly)
PENN WEST PETROLEUM LTD.	04-17-045-06 W5M		√					
PENN WEST PETROLEUM LTD.	16-16-047-10 W5M		√					
PERPETUAL ENERGY OPERATING CORP.	04-20-051-18 W5M		√					
PERPETUAL ENERGY OPERATING CORP.	13-10-052-15 W5M		√				√	
PERPETUAL ENERGY OPERATING CORP.	13-11-052-16 W5M		√				√	
PERPETUAL ENERGY OPERATING CORP.	16-16-051-18 W5M		√					
PERSTA RESOURCES INC.	04-01-048-20 W5M		√					
PERSTA RESOURCES INC.	04-23-048-20 W5M		√					
PETROGLOBE INC.	12-20-053-15 W5M		√	√	√	√	√	
PETRUS RESOURCES LTD.	11-12-045-18 W5M							√
PEYTO EXPLORATION & DEVELOPMENT CORP.	01-05-053-20 W5M	√	√	√	√	√	√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	01-29-054-22 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	02-17-054-22 W5M		√				√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	02-18-056-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	04-03-055-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	04-05-055-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	04-18-056-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	04-27-054-20 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	04-29-054-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	04-29-054-22 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	04-32-055-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	05-04-054-21 W5M		√				√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	05-32-053-21 W5M		√				√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	07-15-054-21 W5M		√				√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	07-20-054-21 W5M		√				√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	09-27-055-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	09-30-054-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	11-23-057-03 W6M							√
PEYTO EXPLORATION & DEVELOPMENT CORP.	12-12-054-20 W5M		√				√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	13-03-055-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	13-04-054-21 W5M		√				√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	13-13-052-19 W5M		√				√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	13-17-054-22 W5M		√				√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	13-23-052-20 W5M		√	√	√		√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	13-24-052-20 W5M		√	√	√		√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	13-27-054-22 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	13-29-054-21 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	16-07-054-22 W5M		√				√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	16-29-054-22 W5M		√					
PEYTO EXPLORATION & DEVELOPMENT CORP.	16-32-053-21 W5M		√				√	
PEYTO EXPLORATION & DEVELOPMENT CORP.	16-34-053-20 W5M		√				√	

TABLE 8A.1-4 Cont'd

Primary Applicant	Legal Location	Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment LSA	Vegetation RSA	Wildlife RSA	Wildlife RSA (Grizzly)
PINE CLIFF ENERGY LTD.	03-21-051-14 W5M		√					
PINE CLIFF ENERGY LTD.	08-08-051-14 W5M		√					
PINE CLIFF ENERGY LTD.	08-09-051-14 W5M		√					
PINE CLIFF ENERGY LTD.	15-16-051-14 W5M		√					
POTTS PETROLEUM INC.	03-12-045-17 W5M							√
PREDATOR OIL LTD.	14-34-054-05 W5M		√				√	
PRIMROSE DRILLING VENTURES LTD.	06-26-053-09 W5M		√	√	√		√	
PRIMROSE DRILLING VENTURES LTD.	14-23-053-09 W5M	√	√	√	√	√	√	
QUESTERRE ENERGY CORPORATION	04-18-062-05 W6M							√
RAVENWOOD ENERGY CORP.	02-03-049-01 W5M		√					
RAVENWOOD ENERGY CORP.	15-34-048-01 W5M		√					
SANTONIA ENERGY INC.	16-16-044-15 W5M							√
SANTONIA ENERGY INC.	16-30-043-15 W5M							√
SHELL CANADA LIMITED	01-31-065-13 W6M							√
SHELL CANADA LIMITED	01-33-053-22 W5M		√				√	
SHELL CANADA LIMITED	03-12-054-22 W5M		√				√	
SHELL CANADA LIMITED	10-09-054-21 W5M		√				√	
SHELL CANADA LIMITED	11-07-054-21 W5M		√				√	
SHELL CANADA LIMITED	13-30-054-22 W5M		√					
SHELL CANADA LIMITED	14-19-056-20 W5M		√					
SHELL CANADA LIMITED	16-11-054-23 W5M		√				√	
SINOPEC DAYLIGHT ENERGY LTD.	01-29-048-05 W5M		√					
SINOPEC DAYLIGHT ENERGY LTD.	04-26-054-23 W5M		√					
SINOPEC DAYLIGHT ENERGY LTD.	08-01-057-17 W5M		√					
SINOPEC DAYLIGHT ENERGY LTD.	12-14-047-04 W5M		√					
SINOPEC DAYLIGHT ENERGY LTD.	12-31-047-03 W5M		√					
SINOPEC DAYLIGHT ENERGY LTD.	13-31-047-03 W5M		√					
SPYGLASS RESOURCES CORP.	01-04-049-05 W5M		√					
SPYGLASS RESOURCES CORP.	16-35-045-08 W5M		√					
SUNDANCE ENERGY CORPORATION	16-11-056-27 W4M		√					
SURE ENERGY INC.	02-04-056-20 W4M		√					
TALISMAN ENERGY INC.	01-05-057-24 W5M							√
TALISMAN ENERGY INC.	01-17-051-17 W5M		√					
TALISMAN ENERGY INC.	01-21-051-17 W5M		√					
TALISMAN ENERGY INC.	04-04-052-22 W5M		√				√	√
TALISMAN ENERGY INC.	08-17-052-22 W5M		√				√	
TALISMAN ENERGY INC.	09-32-056-24 W5M							√
TALISMAN ENERGY INC.	12-06-052-20 W5M		√				√	
TALISMAN ENERGY INC.	12-22-056-24 W5M							√
TALISMAN ENERGY INC.	13-06-052-20 W5M		√				√	
TALISMAN ENERGY INC.	13-21-052-20 W5M		√	√	√		√	

TABLE 8A.1-4 Cont'd

Primary Applicant	Legal Location	Soil LSA	Aquatics/Wetland RSA	Air Quality RSA	Acoustic Environment LSA	Vegetation RSA	Wildlife RSA	Wildlife RSA (Grizzly)
TALISMAN ENERGY INC.	14-35-053-21 W5M		√				√	
TALISMAN ENERGY INC.	16-22-051-18 W5M		√					
TALLGRASS ENERGY CORP.	13-15-054-13 W5M		√				√	
TAMARACK ACQUISITION CORP.	03-27-055-20 W4M		√					
TAMARACK ACQUISITION CORP.	05-19-055-19 W4M		√					
TAMARACK ACQUISITION CORP.	06-26-055-20 W4M		√					
TAMARACK ACQUISITION CORP.	07-23-055-20 W4M		√					
TAMARACK VALLEY ENERGY LTD.	06-22-046-06 W5M		√					
TAMARACK VALLEY ENERGY LTD.	11-13-045-16 W5M							√
TAQA NORTH LTD.	05-22-052-10 W5M						√	
TORC OIL & GAS LTD.	01-06-054-15 W5M		√	√	√		√	
TORC OIL & GAS LTD.	03-26-054-16 W5M		√				√	
TORC OIL & GAS LTD.	04-33-052-14 W5M		√				√	
TORC OIL & GAS LTD.	06-04-056-17 W5M		√					
TORC OIL & GAS LTD.	08-34-057-14 W5M		√					
TOURMALINE OIL CORP.	01-17-059-01 W6M							√
TOURMALINE OIL CORP.	01-29-055-22 W5M		√					
TOURMALINE OIL CORP.	01-29-061-06 W6M							√
TOURMALINE OIL CORP.	03-15-062-06 W6M							√
TOURMALINE OIL CORP.	03-22-054-25 W5M		√					
TOURMALINE OIL CORP.	04-08-051-21 W5M		√					
TOURMALINE OIL CORP.	04-11-062-06 W6M							√
TOURMALINE OIL CORP.	04-12-058-04 W6M							√
TOURMALINE OIL CORP.	07-27-049-19 W5M		√					
TOURMALINE OIL CORP.	09-15-049-20 W5M		√					
TOURMALINE OIL CORP.	11-12-050-21 W5M		√					
TOURMALINE OIL CORP.	13-01-052-23 W5M		√				√	√
TOURMALINE OIL CORP.	13-05-059-01 W6M							√
TOURMALINE OIL CORP.	13-20-047-19 W5M							√
TOURMALINE OIL CORP.	13-31-050-21 W5M		√					
TOURMALINE OIL CORP.	16-16-047-19 W5M							√
TOURNAMENT EXPLORATION LTD.	09-12-049-08 W5M		√					
TWIN BUTTE ENERGY LTD.	04-07-056-07 W5M		√					
VELVET ENERGY LTD.	03-10-054-15 W5M		√	√	√		√	
VELVET ENERGY LTD.	03-31-054-17 W5M		√				√	
VELVET ENERGY LTD.	08-30-055-16 W5M		√					
VERMILION ENERGY INC.	05-32-047-06 W5M		√					
VERMILION ENERGY INC.	13-21-046-09 W5M		√					
VERMILION ENERGY INC.	14-03-052-09 W5M						√	
WHITECAP RESOURCES INC.	14-21-049-04 W5M		√					
TOTAL		3	268	20	20	7	77	57

Sources: ERCB 2013a, IHS Inc. 2013d

TABLE 8A.1-5

REASONABLY FORESEEABLE DEVELOPMENTS IN ALBERTA (UNMAPPED)

Project	Location/Proponent	Description	Status and/or Schedule	Sources
PUBLIC, TOURISM, ARTS AND OUTDOOR RECREATION DEVELOPMENTS				
Calder, Capilano and Stanley Milner Libraries ($38.5 million)	Edmonton/City of Edmonton	Proposed development consists of construction of the new Calder Library and Capilano Library and the rehabilitation of the Milner Library.	Proposed/unknown.	Alberta Inventory of Major Projects: https://www.albertacanada.com/business/statistics/inventory-of-major-projects.aspx
Clareview Multi-Purpose Facility ($93 million)	Edmonton/City of Edmonton	Development of outdoor natural grass and artificial turf sports fields, park spaces and a multi-purpose recreation centre, as well as a high school completion centre and the Clareview Library.	Under construction/completion in 2014.	City of Edmonton Website: http://www.edmonton.ca/city_government/projects_redevelopment/clareview-district-park-development.aspx
Downtown Performing Arts Centre ($850 million)	Edmonton/Edmonton Academic and Cultural Foundation	Proposed development includes a performing arts centre including open air arts galleria, 1,600-seat theatre and three smaller spaces, underground parking garage and office tower.	Proposed/construction from 2014 to 2017.	Alberta Inventory of Major Projects: https://www.albertacanada.com/business/statistics/inventory-of-major-projects.aspx
Edmonton Area and Entertainment District Development Project ($604.5 million)	Edmonton/City of Edmonton and Edmonton Arena Corp.	The proposed project includes a new arena to house the Edmonton Oilers, Winter Garden, community rink, LRT connection and pedestrian corridor.	Proposed/construction start in early 2014, in-service by September 2016.	City of Edmonton Website: http://www.edmonton.ca/city_government/projects_redevelopment/downtown-arena.aspx
Edmonton Police Service Northwest Campus ($65 million)	Edmonton/City of Edmonton and Edmonton Police Service	Proposed Northwest Campus would include a police station, arrest processing unit and training facility.	Proposed/unknown.	Alberta Inventory of Major Projects: https://www.albertacanada.com/business/statistics/inventory-of-major-projects.aspx
Edmonton Valley Zoo Developments ($50 million)	Edmonton/City of Edmonton	Proposed development consists of several phases of development including a main public pathway to the new exhibit areas as they develop and an interactive play and education area.	Under construction/unknown.	City of Edmonton Website: http://www.edmonton.ca/city_government/projects_redevelopment/downtown-arena.aspx
Edson Health Care Centre ($186.4 million)	Edson/Alberta Health Services and Alberta Infrastructure	The proposed new Edson Health Care Centre will include: an emergency department; acute care; outpatient services; renal dialysis unit; surgical services; primary health care services; diagnostic imaging and laboratory services; physician clinic space; and continuing care.	Under construction/completion in 2015.	Alberta Inventory of Major Projects: https://www.albertacanada.com/business/statistics/inventory-of-major-projects.aspx Alberta Health Services website: http://www.albertahealthservices.ca/2342.asp
Emerald Hills Aquatic and Wellness Centre ($25.8 million)	Sherwood Park/Strathcona County	Proposed new aquatic and wellness centre.	Proposed/unknown.	Alberta Inventory of Major Projects: https://www.albertacanada.com/business/statistics/inventory-of-major-projects.aspx
Federal Building Parkade and Centennial Plaza ($110 million)	Edmonton/Alberta Infrastructure	Renewal of the Federal Building and construction of a new public plaza and parkade to increase public space at the Legislature grounds and provide year round recreational opportunities for visitors.	Under construction/completion in late 2013.	Alberta Inventory of Major Projects: https://www.albertacanada.com/business/statistics/inventory-of-major-projects.aspx Alberta Infrastructure Website: http://www.infrastructure.alberta.ca/5.htm

TABLE 8A.1-5 Cont'd

Project	Location/Proponent	Description	Status and/or Schedule	Sources
Fort Edmonton Park Expansion ($110 million)	Edmonton/Fort Edmonton Park Management Co.	Proposed expansion of Fort Edmonton Park.	Proposed/construction anticipated to take between 7 and 10 years.	Alberta Inventory of Major Projects: https://www.albertacanada.com/business/statistics/inventory-of-major-projects.aspx
Glenrose Long Term Care Facility ($51.4 million)	Edmonton/Alberta Infrastructure and Alberta Health and Wellness	Proposed development of a long-term care and transition and continuing care facility.	Proposed/unknown.	Alberta Inventory of Major Projects: https://www.albertacanada.com/business/statistics/inventory-of-major-projects.aspx
Hinton Training Centre Additions/Alterations ($39.1 million)	Hinton/Alberta Infrastructure and Alberta Environment and Sustainable Resource Development	Proposed additions and alterations to the Hinton Training Centre.	Proposed/unknown.	Alberta Inventory of Major Projects: https://www.albertacanada.com/business/statistics/inventory-of-major-projects.aspx
Meadows Recreation Centre and Library ($88.8 million)	Edmonton/City of Edmonton	New recreation centre and library.	Under construction/completion in 2014.	Alberta Inventory of Major Projects: https://www.albertacanada.com/business/statistics/inventory-of-major-projects.aspx
NAIT Centre for Applied Technologies ($200 million)	Edmonton/NAIT	New centre for applied technologies.	Proposed/construction start in 2013/2014 with several years to complete.	Alberta Inventory of Major Projects: https://www.albertacanada.com/business/statistics/inventory-of-major-projects.aspx NAIT Website: http://www.nait.ca/44779_90969.htm
NorQuest College North Learning Centre (Downtown Campus) Development ($170 million)	Edmonton/NorQuest College	The learning centre is planned as a 27,500 m2, five-storey building facing Capital Boulevard, flanked by 103 Avenue and 107 Street.	Proposed/unknown.	NorQuest College Website: http://www.norquest.ca/media-centre/news/2011/norquest-s-downtown-campus-development-project-and.aspx Alberta Inventory of Major Projects: https://www.albertacanada.com/business/statistics/inventory-of-major-projects.aspx
Royal Alberta Museum ($340 million)	Edmonton/Government of Alberta	A new provincial museum anticipated to be an iconic institution respected around the world.	Under construction/completion in 2016.	Alberta Infrastructure: http://www.infrastructure.alberta.ca/5.htm
Stollery Children's Hospital Renovations ($33.7 million)	Edmonton/Alberta Infrastructure	Development consists of a surgical suite redevelopment and IMRI renovations.	Under construction/completion in 2015.	Alberta Inventory of Major Projects: https://www.albertacanada.com/business/statistics/inventory-of-major-projects.aspx
Strathcona Hospital Phase 1 ($130 million)	Sherwood Park/Alberta Infrastructure	Construction of Strathcona Hospital Phase 1. Phase 2 cancelled in 2013 provincial budget.	Under construction/completion in 2014.	Alberta Inventory of Major Projects: https://www.albertacanada.com/business/statistics/inventory-of-major-projects.aspx
The Quarters Hotel ($45 million)	Edmonton/Shivam Developments	Proposed new hotel.	Proposed/completion in 2014.	Alberta Inventory of Major Projects: https://www.albertacanada.com/business/statistics/inventory-of-major-projects.aspx
Trestle Creek Golf Resort ($30 million)	East of Entwistle/Trestle Creek Golf Resort	Development consists of an RV resort, recreation centre, equine centre, sports park and 27 hole golf course.	Under construction/first 9 holes completed in 2012, second nine to be completed in 2014.	Alberta Inventory of Major Projects: https://www.albertacanada.com/business/statistics/inventory-of-major-projects.aspx
University of Alberta Dentistry/Pharmacy Building Repurposing ($170 million)	Edmonton/University of Alberta	Proposed dentistry/pharmacy building repurposing and refurbishment.	Proposed/unknown.	Alberta Inventory of Major Projects: https://www.albertacanada.com/business/statistics/inventory-of-major-projects.aspx

TABLE 8A.1-5 Cont'd

Project	Location/Proponent	Description	Status and/or Schedule	Sources
University of Alberta Student Physical Activity and Wellness Centre ($57 million)	Edmonton/University of Alberta	Development of a new student physical activities and wellness centre.	Under construction/construction from 2012 to 2014.	Alberta Inventory of Major Projects: https://www.albertacanada.com/business/statistics/inventory-of-major-projects.aspx
University of Alberta Student Residence Buildings A and B in East Campus ($27 million)	Edmonton/University of Alberta	Proposed development of student residence buildings in the East Campus Village.	Proposed/unknown.	Alberta Inventory of Major Projects: https://www.albertacanada.com/business/statistics/inventory-of-major-projects.aspx
University of Alberta St. Joseph's College Women's Residence ($28 million)	Edmonton/University of Alberta	Proposed development of a new women's residential building.	Proposed/construction from 2013 to 2015.	Alberta Inventory of Major Projects: https://www.albertacanada.com/business/statistics/inventory-of-major-projects.aspx
Visual Performing Arts Centre ($90 million)	Edmonton/Grant MacEwan University	Proposed new visual performing arts centre at the MacEwan University Downtown Campus.	Proposed/construction from 2013 to 2015.	Alberta Inventory of Major Projects: https://www.albertacanada.com/business/statistics/inventory-of-major-projects.aspx
TRANSPORTATION AND INFRASTRUCTURE				
Bethel Transit Terminal and Park and Ride ($23 million)	Sherwood Park/Strathcona County	The new development will be located at the current site of Strathcona Station and Park and Ride on Bethel Drive. The new transit terminal will be an integrated terminal and park and ride lot that will eventually anchor intermunicipal transit service between Strathcona County and Edmonton.	Under construction/completion in late 2013.	Alberta Inventory of Major Projects: https://www.albertacanada.com/business/statistics/inventory-of-major-projects.aspx Strathcona County Website: http://www.strathcona.ca/departments/Transit/Bethel-Terminal-Background.aspx
Campbell Road Transit Centre/Park and Ride ($30 million)	St. Albert/City of St. Albert	Proposed Campbell Road transit centre and park and ride.	Proposed/unknown.	Alberta Inventory of Major Projects: https://www.albertacanada.com/business/statistics/inventory-of-major-projects.aspx
Central Station LRT Rehabilitation and Jasper Avenue Streetscaping ($44 million)	Edmonton/City of Edmonton	Development includes repairs to the Central LRT Station and the development of a new streetscape along a section of Jasper Avenue between 100 and 102 Street.	Under construction/completion in December 2013.	Alberta Inventory of Major Projects: https://www.albertacanada.com/business/statistics/inventory-of-major-projects.aspx City of Edmonton Website: http://www.edmonton.ca/transportation/road_projects/central-lrt-station-jasper-avenue-streetscape.aspx
Highway 22 Bridge Construction and Highway Realignment ($51 million)	Drayton Valley/Alberta Transportation	Development entails bridge replacement over the North Saskatchewan River, highway realignment and grade revisions, access management and intersection relocation/improvements.	Under construction/completion in 2014.	Alberta Transportation Website: http://www.transportation.alberta.ca/projects/index.html
LRT Bridge Replacement of Cloverdale Pedestrian Bridge ($45 to $65 million)	Edmonton/City of Edmonton	A proposed LRT bridge to replace Cloverdale pedestrian bridge on Downtown – Millwoods Line.	Proposed/unknown.	Alberta Inventory of Major Projects: https://www.albertacanada.com/business/statistics/inventory-of-major-projects.aspx

TABLE 8A.1-5 Cont'd

Project	Location/Proponent	Description	Status and/or Schedule	Sources
North LRT to NAIT (Metro Line) ($755 million)	Edmonton/City of Edmonton	The North LRT to NAIT (Metro Line) is a 3.3 km extension from Churchill LRT Station in downtown Edmonton northwest to NAIT. It is the first segment of a planned LRT expansion to Edmonton city limits near St. Albert and is part of the Transportation Master Plan's vision to expand LRT service to all sectors of the City by 2040.	Under construction/completion in December 2013.	City of Edmonton Website: http://www.edmonton.ca/transportation/ets/lrt_projects/downtown-to-nait-lrt-study.aspx
Northeast Anthony Henday Project ($1.81 billion)	Edmonton/City of Edmonton	The Northeast Anthony Henday Project will include 18 km of reconstructed six and eight-lane divided freeway, 9 km of new six and eight-lane divided freeway, nine service interchanges, seven grade separations and twin river bridge structures. The 27 km northeast leg of the ring road will be free-flow (there will be no traffic lights on the freeway).	Under construction/construction from 2012 to 2016.	Alberta Inventory of Major Projects: https://www.albertacanada.com/business/statistics/inventory-of-major-projects.aspx Northeast Anthony Henday Project website: http://www.northeastanthonyhenday.com/index.php
Northeast Transit Garage ($ 130 million)	Edmonton/City of Edmonton	Replacement of the Westwood Transit Garage with the Northeast Transit Garage.	Proposed/unknown.	Alberta Inventory of Major Projects: https://www.albertacanada.com/business/statistics/inventory-of-major-projects.aspx
Southeast to West LRT (Valley Line) Project ($3.2 billion)	Edmonton/City of Edmonton	A proposed 27 km low-floor urban line that will run from Mill Woods to Lewis Farms, crossing through downtown Edmonton. The project is currently in the preliminary design phase.	City Council approval/construction could start in 2015 and take several years.	City of Edmonton Website: http://www.edmonton.ca/transportation/ets/lrt_projects/southeast-to-west-lrt-mill-woods-to-lewis-farms.aspx
Queen Elizabeth II (QE II) Highway and 41 Avenue SW Interchange ($205 million)	Edmonton/City of Edmonton	Proposed activities include construction on a grade-separated interchange in south Edmonton, at the junction of QE II Highway and 41 Avenue SW. This partial cloverleaf interchange will convert 41 Avenue SW into a continuous corridor with full access to and from QE II Highway. Further, a new bridge will be constructed over Blackmud Creek on the realigned section of 41 Avenue SW. The project will also include a road/rail grade separation of the Canadian Pacific Railway tracks east of QE II Highway.	Approved/construction from summer 2013 to 2015.	Alberta Inventory of Major Projects: https://www.albertacanada.com/business/statistics/inventory-of-major-projects.aspx City of Edmonton Website: http://www.edmonton.ca/transportation/road_projects/qe-2-hwy-41-avenue-interchange.aspx
UTILITY AND PUBLIC WORKS ACTIVITIES				
Urban Pipelines Replacements Project ($600 to $700 million)	Edmonton/ATCO Gas and Pipelines Ltd.	Proposed construction of new high-pressure natural gas pipeline network in the Transportation Utility Corridors of Edmonton and Calgary over a period of five years.	Proposed/unknown.	Alberta Inventory of Major Projects: https://www.albertacanada.com/business/statistics/inventory-of-major-projects.aspx ATCO Gas and Pipelines Ltd. Website: http://www.atcopipelines.com/upr/ AUC Website: http://www.auc.ab.ca/items-of-interest/urban-pipeline-replacement/Pages/default.aspx

TABLE 8A.1-5 Cont'd

Project	Location/Proponent	Description	Status and/or Schedule	Sources
OIL AND GAS EXPLORATION AND DEVELOPMENT				
Edmonton Terminal (South) Expansion Project	Edmonton/Enbridge Pipelines Inc.	Proposed construction and operation of several new tanks and associated facilities at the existing Enbridge Edmonton Terminal at NW 32-52-23 W4M, with transfer pipe via NE 32-52-23 W4M that integrates the new tanks into the existing terminal in SE 5-53-23 W4M.	NEB approval granted on July 25, 2013 (Order XO-E101-017-2013) and pre-clearing activities commenced in fall 2013 with operations to begin in the first half of 2015.	NEB Website: https://www.neb-one.gc.ca/ll-eng/livelink.exe?func=ll&objId=919196&objAction=browse&sort=-name
Edmonton Terminal Expansion Project	Edmonton/Trans Mountain Pipeline ULC.	Trans Mountain is currently in the process of constructing the Edmonton Terminal Expansion Project, which involves constructing 10 new tanks and associated facilities at the Edmonton Terminal. This project was approved by the NEB in March 2008 and is now being constructed under Amending Order AO-005-XO-T246-04-2008. In February 2013, Trans Mountain applied to the NEB to vary Amending Order AO-005-XO-T246-04-2008 to permit construction of four additional tanks at the Edmonton Terminal for a total of 14 tanks. The NEB issued an Amending Order AO-006-XO-T246-04-2008 on June 20, 2013 and the four additional tanks are expected to come into service by late 2014.	Under construction/all tanks in-service by late 2014.	NEB Website: https://www.neb-one.gc.ca/ll-eng/livelink.exe?func=ll&objId=474966&objAction=browse&sort=-name
Natural Gas to Liquid Fuel Plant ($8 billion)	Edmonton/Sasol Canada Holdings Ltd.	Proposed gas-to-liquid conversion facility. The development would create more than 500 new, permanent skilled jobs once in operation and employ over 5,000 other individuals during peak construction periods.	In planning stages/in-service by late 2015.	Alberta Inventory of Major Projects: http://www.albertacanada.com/business/statistics/inventory-of-major-projects.aspx Sasol Canada Holdings Ltd. Website: http://www.sasolcanada.com/our-canadian-business/canada-gtl-project/

TABLE 8A.1-6

REASONABLY FORESEEABLE DEVELOPMENTS IN BC (UNMAPPED)

Project	Location/Proponent	Description	Status and/or Schedule	Sources
PUBLIC, TOURISM, ARTS AND RECREATION DEVELOPMENT AND ACTIVITIES				
Acadia Road Primary and Intermediate School ($29 million)	Vancouver/School District 39	Replacement of existing University Hill Secondary school with new a 1,030 student capacity K-8 school.	Under construction/February 2012 to January 2014.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf
BC Children's and Women's Hospital Expansion ($682 million)	Vancouver/Provincial Health Services Authority	Redevelopment of the BC Children's and Women's Hospital to create a state of the art facility for pediatric care and research.	Under construction/spring 2011 to fall 2018.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf
Bike Lane Master Plan ($25 million)	Vancouver/City of Vancouver	Proposed investment in 55 km of new bike lanes for Vancouver's Cycling Master Plan.	Proposed/unknown.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf
Burke Mountain Secondary School ($64 million)	Coquitlam/School District 43	Proposed new school with a capacity for 1,200 students.	Proposed/November 2013 to August 2016.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf
Casino, Hotel and Convention Centre ($100 million)	Surrey/unknown	A proposed 200-room hotel and 800-seat convention centre with casino is planned for a 10 ha site at 8th Avenue and 168th Street.	Proposed/unknown.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf
Centennial Secondary School ($62 million)	Coquitlam	Proposed replacement of the 1,250 student school.	Proposed/February 2013 to April 2015.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf
Chilliwack Senior Secondary Replacement ($58 million)	Chilliwack	Replacement of the secondary school on the existing site for 1,200 student capacity and a Neighbourhood Learning Centre.	Construction started/January2011 to fall 2013.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf
Chip and Shannon Wilson School of Design - Kwantlen University College ($36 million)	Richmond/Kwantlen University College	Proposed 4,900m^2 facility for a technical apparel design program.	Proposed/fall 2013 to March 2016.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf
Dalai Lama Educational Centre ($60 million)	Vancouver/unknown	Proposed development for a 2,790 m^2 educational centre.	Proposed/unknown.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf
False Creek Elementary School ($20 million)	Vancouver/School District 93	A new Conseil Scolaire Francophone elementary school to be located in the False Creek neighbourhood.	Proposed/unknown.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf
Great Northern Way Campus Expansion ($134 million)	Burnaby	Expansion of the Great Northern Way Campus, including construction of a state-of-the-art Emily Carr visual, media and design art facility that would accommodate up to 1,800 students.	Construction started/June 2011 to July 2016.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf
Guildford Recreation Centre Complex Expansion ($41 million)	Surrey/City of Surrey	A new 52.5 m long swimming pool building will be added in a planned expansion of the Guildford Recreation Centre complex.	Proposed/2013 to 2014.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf
Hemlock Valley Mountain Ski Resort Expansion ($ unknown)	Agassiz	Proposed expansion to include additional lifts and ski runs as well as a new village centre, several 35 to 65 room hotels and up to 5,000 housing units.	Proposed/unknown.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf Company Website: www.hemlockvalleyresort.com

TABLE 8A.1-6 Cont'd

Project	Location/Proponent	Description	Status and/or Schedule	Sources
Heritage Mountain Middle School ($28 million)	Coquitlam	New 500 student capacity junior middle school.	Under construction/August 2012 to April 2014.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf
International Village Elementary School ($23 million)	Vancouver/School District 39	Proposed new elementary school located in the International Village neighbourhood.	Proposed/unknown.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf
John Oliver Secondary ($45 million)	Vancouver School District 39	Renovation and seismic upgrade of the school.	Proposed/June 2013 to September 2016.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf
John Robson Elementary School ($23 million)	New Westminster/School District 40	Replacement of elementary school with 380-student capacity on a new site.	Proposed/spring 2013 to September 2014.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf
Kitsilano Secondary School Replacement ($58 million)	Vancouver/School District 39	Proposed replacement of the school at 2550 W. 10th Ave with an 18,000 m^2, 3-storey facility.	Proposed/March 2013 to August 2015.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf
Lord Strathcona Community Elementary School ($30 million)	Vancouver/School District 39	Seismic upgrade to elementary school is in planning stages.	Proposed/August 2013 to December 2016.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf
Lions Gate Hospital Acute Mental Health Facility - Hope Centre ($62 million)	North Vancouver/Vancouver Coastal Health Authority and Lions Gate Hospital Foundation	Development of a 4 storey, 26-bed psychiatric services building.	Under construction/fall 2012 to summer 2014.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf
Mission Community Health Centre ($31 million)	Mission	Proposed 2,510 m^2 health complex located near Mission General Hospital will include primary care, public health, clinics and a senior`s campus of care.	Under construction/July 2012 to late 2013.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf
Moody Middle School Replacement ($23 million)	Coquitlam	Replacement of Moody Middle School with a capacity for 450 students.	Proposed/April 2013 to December 2014.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf
New Westminster Secondary School (82 million)	New Westminster/School District 40	Proposed new secondary school to replace the existing 1,800-student capacity school.	Proposed/July 2013 to September 2016.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf
Pacific National Exhibition (PNE) Expansion ($208 million)	Vancouver/City of Vancouver	Proposed redevelopment plan of the Hastings Park that would see Playland expanded ($36.5M) and pulled back from Hastings St. Improvements to auditoriums ($40.6M) and parking expansion ($32M).	Proposed/unknown.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf
Pitt River Middle School Replacement ($20 million)	Coquitlam	Replacement of the 450 capacity middle school.	Under construction/February 2012 to July 2013.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf
Royal Inland Hospital - Clinical Services Building, Parking and Site Infrastructure Upgrading ($80 million)	Kamloops/Interior Health Authority	Proposal to upgrade hospital site infrastructure and construct a multi-storey parkade and clinical building.	Proposed/late 2013 to unknown.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf

TABLE 8A.1-6 Cont'd

Project	Location/Proponent	Description	Status and/or Schedule	Sources
Simon Fraser University Student Union Building and Stadium (SFU) ($65 million)	Burnaby	Proposed 9,290 m^2 student union building and 2,500 seat outdoor stadium.	Proposed/spring 2013 to September 2017.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf SFU Website: http://buildsfu.sfss.ca/
South Surrey Recreational Amenities ($51 million)	Surrey/City of Surrey	Construction of a new 50 m swimming pool, a new fitness facility and an addition for community arts.	Proposed/2012 to 2015.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf
Surrey City Hall and Civic Facility ($97 million)	Surrey/City of Surrey	New city hall to be located in the Whalley area. A performing arts centre, office building, additional space for SFU and mixed use building will be included in the planned facility on 102 Avenue.	Under construction/summer 2012 to 2013.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf
Surrey Memorial Hospital Emergency Department and Critical Care Tower ($512 million)	Surrey/Surrey Memorial Hospital	Construction is underway on a new emergency department and critical care tower at the Surrey Memorial Hospital as well as renovation and expansion of existing space.	Under construction/March 2011 to summer 2014.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf
Thompson River University - Faculty of Law Building ($20 million)	Kamloops/Thompson Rivers University	Expansion to the Faculty of Law at Thompson Rivers University.	Under construction/fall 2012 to September 2013.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf
UBC Student Union Building ($120 million)	Vancouver/UBC	Proposed Student Union Building.	Proposed/complete by August 2014.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf
Quintet Mixed Use Development ($ 1 billion)	Richmond/Canada Sunrise Development Corp.	A 5 tower development including a community centre and a campus for Trinity Western University, located on Minoru Boulevard.	Under construction/summer 2011 to 2013.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf
Vancouver Art Gallery ($350 million)	Vancouver/Vancouver Art Gallery	Proposed relocation of the Vancouver Art Gallery.	Proposed/2013 to 2015.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf
Vancouver Aquarium Revitalization and Expansion Project ($100 million)	Vancouver/Vancouver Aquarium	The revitalization and expansion will include 8 projects approved in August 2010.	Under construction/fall 2011 to 2013.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf
Vancouver General Hospital - Joseph and Rosalie Segal Family Centre ($85 million)	Vancouver/Vancouver General Hospital	Planned replacement of the aging psychiatric facility at Vancouver General Hospital.	Proposed/2014 to 2017.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf
Whitecaps Stadium - Thunderbird Park ($33 million)	Vancouver/Vancouver Whitecaps FC	Proposed National Soccer Development Centre will be built at UBC Thunderbird Park.	Proposed/spring 2013 to 2015.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf
Willoughby Elementary School ($20 million)	Langley	Proposed new elementary school for the Willoughby neighbourhood.	Proposed/unknown.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf
Willoughby Middle School ($20 million)	Langley	Proposed new middle school for the Willoughby neighbourhood.	Proposed/unknown.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf

TABLE 8A.1-6 Cont'd

Project	Location/Proponent	Description	Status and/or Schedule	Sources
Yorkson Area Middle School ($23 million)	Langley	Middle School will accommodate 750 students from grades 6 to 8 and include a Neighbourhood Learning Centre.	Proposed/early 2013 to September 2014.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf
TRANSPORTATION AND INFRASTRUCTURE DEVELOPMENT				
Abbotsford Airport Expansion ($100 million)	Abbotsford/City of Abbotsford	Expansion for the Abbotsford airport that will include a 1,300 m^2 passenger terminal, runway upgrades. A hotel and tourist-related services are also part of the plan. The $30 million runway expansion portion of the project was completed in September 2011. Approximately 81 ha will be designated for future aerospace related developments.	Under construction/2010 to 2020.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf Abbotsford International Airport Backgrounder Report: http://www.abbotsford.ca/Assets/Abbotsford/News+Releases/2011-09-16+Abbotsford+Airport+Expansion+Backgrounder.pdf
Brooksbank Avenue Underpass/ Lynn Creek Rail Bridge ($46 million)	North Vancouver/Port Metro Vancouver	Modifications to Brooksbank Avenue underpass ($25M) for future port and terminal expansion have completed construction. The Lynn Creek Rail Bridge addition ($21M) is expected to complete in spring 2014.	Under construction/July 2010 to spring 2014.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf
Burrard Street Bridge Improvements ($63 million)	Vancouver/City of Vancouver	Proposed renovation of the Burrard Street Bridge.	Proposed/unknown.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf
Deltaport Terminal Road and Rail Improvement Project ($280 million)	Delta/PMV, Province of BC and TSI Terminal Systems Inc.	The project has four key elements: an overpass on the existing Roberts Bank causeway that will separate road and rail traffic; reconfiguration of rail track and additional container handling equipment within the existing Deltaport Terminal; additional rail track within the existing railway corridor and a portion of the Option Lands; and road improvements on Deltaport Way.	Under construction/late 2012 to late 2014.	PMV Website: http://portmetrovancouver.com/en/projects/ongoingprojects/DTRRIP/Environment.aspx
Gateway Program – North Fraser Perimeter Road ($72 million)	Coquitlam to Pitt Meadows/BC MTI	Route to improve trucking and vehicle route along an extended United Boulevard through Coquitlam along Highway 7 to the north end of the Golden Ears Bridge.	Proposed/unknown.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf
Gateway Program – North Fraser Perimeter Road, New Westminster Section ($60 million)	New Westminster/BC MTI	Route to provide improved trucking and vehicle route along the north end of the Queensborough Bridge along Front, Columbia and Brunette in New Westminster.	Proposed/unknown.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf
Gateway Program - Port Mann Bridge/Highway 1 Improvements ($3.3 billion)	Langley To Vancouver/BC MTI	Construction is underway on a new 10-lane bridge across the Fraser River between Coquitlam and Surrey, 37 km of highway widening from Vancouver to Langley, including 30 km of new high occupancy vehicle lanes, and the replacement of nine highway interchanges.	Under construction/February 2009 to late 2013.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf Port Mann Bridge/Hwy 1 Improvements Website: http://www.pmh1project.com/Pages/default.aspx

TABLE 8A.1-6 Cont'd

Project	Location/Proponent	Description	Status and/or Schedule	Sources
Gateway Program - South Fraser Perimeter Road ($1,264 million)	Surrey to Delta/BC MTI and Fraser Transportation Group Partnership	A 40 km long four-lane, 80 km/hr route along the south side of the Fraser River from Deltaport Way in southwest Delta to 176th Street (Highway 15) in Surrey, with connections to Highways 1, 15, 17, 91, 99, and TransLink.	Under construction/fall 2008 to December 2013.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf Fraser Transportation Group Partnership Website: http://www.sfprconstruction.ca/index.php
Highway 1 Truck Lane - 232 Street to 264 Street ($24 million)	Langley	An eastbound truck climbing lane will be added to Highway 1 between 232 Street and 264 Street and the 248th Street overpass will be replaced.	Proposed/2013 to spring 2014.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf
Highway 99 Interchange - 16th Avenue ($24 million)	Surrey/BC MTI	A new interchange on Highway 99 will replace the 16th Avenue overpass.	Proposed/2013 to 2014.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf
Hope to Kawkawa Lake Road Bridge Replacement ($6.6 million)	Hope/Jakes Construction Ltd.	Replacement of the Kawkawa Lake Road Bridge from a timber bridge to a two vehicular-lane concrete bridge with one dedicated pedestrian path and two 1.5 m shoulders. The project will also include an upgrade of approximately 200 m of Kawkawa Lake Road.	Under construction/complete by summer 2013.	Jakes Construction Website: http://www.jakesconstruction.ca/2013/02/15/suckers-creek-bridge-replacement-kawkawa-lake-road-improvements/ CEA Agency Website: http://www.acee-ceaa.gc.ca/052/details-eng.cfm?pid=51930 BC MTI News Release: http://www2.news.gov.bc.ca/news_releases_2005-2009/2009TRAN0016-000252.htm
Low Level Road Realignment ($100 million)	North Vancouver/TransLink	Realignment of Lower Level Road over 1.5 km to accommodate 2 new tracks and the North Shore Spirit Trail.	Proposed/unknown.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf
Mission Bridge Seismic Upgrade ($21 million)	Mission/BC MTI	Phased upgrade of the Mission Bridge.	Under construction/October 2010 to late 2013.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf
Neptune/Cargill Grade Separation ($48 million)	North Vancouver/PMV	Project to improve rail movements near Lower Level Road and 3rd Street East.	Proposed/unknown.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf
Old Port Mann Bridge Demolition ($50 million)	Coquitlam and Surrey/Transportation Investment Corporation	Demolition and removal of the superstructure, substructure, piers, and footings of the old Port Mann Bridge down to the Fraser River mudline.	Demolition started/completion by late 2014.	Port Metro Vancouver Website: http://portmetrovancouver.com/en/projects/OngoingProjects/Tenant-Led_Projects/PortMannDemo.aspx
Pemberton Ave Grade Separation ($43 million)	North Vancouver/District of North Vancouver	Proposed overpass over the CN Rail line replacing the Pemberton Avenue and Philip Avenue crossings.	Proposed/unknown.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf
Port of Vancouver - South Shore Corridor Project ($75 million)	Vancouver/Vancouver Fraser Port Authority	The project includes road improvements on port lands between Heatley Avenue and McGill Street in Vancouver.	Under construction/complete by 2013.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf
Powell Street Grade Separation ($48 million)	Vancouver/Port Metro Vancouver	Proposed grade separation located between the Clark Drive and Heatley Avenue entrances to the PMV terminals.	Proposed/complete by March 2014.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf

TABLE 8A.1-6 Cont'd

Project	Location/Proponent	Description	Status and/or Schedule	Sources
Roberts Bank Rail Corridor – Grade Separation and Improvements ($307 million)	Delta, Surrey and Langley/TransLink	Grade separation and rail improvements at nine sites in the Lower Mainland.	Under construction/spring 2011 to 2018.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf
Shortsea Shipping Route ($26 million)	Vancouver/Transport Canada	Proposed development of specialized multimodal facilities for a Shortsea shipping route will consist of seven projects.	Proposed/unknown.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf
Skytrain - Evergreen Line Rapid Transit Project ($1.4 billion)	Vancouver to Coquitlam/BC MTI and TransLink	A new rapid transit line that will connect Coquitlam to Vancouver via Port Moody and Burnaby.	Under construction/complete by summer 2016.	Major Project Inventory http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf BC EAO Website: http://a100.gov.bc.ca/appsdata/epic/html/deploy/epic_project_home_348.html Evergreen Line Website: http://www.evergreenline.gov.bc.ca/index.htm
Skytrain - Expo Line Upgrade Strategy ($3.1 billion)	Surrey and Vancouver Area/BC MTI and TransLink	Double the capacity of the existing Expo Line and add a proposed 6 km SkyTrain extension in Surrey to Fleetwood Area.	Under construction/2008 to 2020.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/September_2012.pdf TransLink Website: http://www.translink.ca/en/Plans-and-Projects/Rapid-Transit-Projects/Expo-Line-Upgrade-Strategy.aspx
Stewart Street Elevated Structure ($80 million)	Vancouver/Port Metro Vancouver	Proposed elevated structure to accommodate through traffic will be located east of Clark Drive near Vanterm.	Proposed/complete by March 2014.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf
Trans Canada Hwy Improvements - Hoffman's Bluff ($42 million)	Kamloops/BC MTI	Proposed improvements to re-align and widen 3.1 km of the Trans Canada Highway through Hoffman's Bluff to four lanes.	Proposed/2013 to fall 2015.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf
Trans Canada Hwy Improvements – Monte Creek to Pritchard ($49 million)	Kamloops/BC MTI	Widening to four lanes of Highway 1 between Monte Creek and Pritchard.	Proposed/October 2011 to fall 2014.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf
Trans Canada Hwy Improvements - Pritchard to Hoffman's Bluff ($20 million)	Kamloops/BC MTI	Proposed improvements to widen 3 km of the Trans Canada Hwy from Pritchard to Hoffman's Bluff to four lanes.	Proposed/spring 2013 to fall 2015.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf
Vancouver International Airport Upgrades ($1.74 billion)	Richmond/Vancouver Airport Authority	Upgrades include: 700 m of corridors, moving walkways and a high-speed baggage system for the international terminal ($408M); and upgrades to the domestic terminal ($488.7M). Airfield improvements ($286.4M) will include runway safety enhancements and upgrades to roads, bridges and dykes ($559.8M).	Proposed/completed by 2022.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf

TABLE 8A.1-6 Cont'd

Project	Location/Proponent	Description	Status and/or Schedule	Sources
Vancouver International Airport Expansion ($1.76 billion)	Richmond/Vancouver Airport Authority	Expansion Plan 2010 includes several phases, many of which are completed. New proposal for continued airport development in Expansion Plan 2027 includes an additional terminal (by 2015) and runway (by 2023) and 14 additional gates and options are being reviewed for an additional runway at the estimated capital cost of $1 billion (not included in capital cost shown).	Under construction/April 2000 to 2027.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf
Western Lower Level Route Extension to Marine Drive ($87 million)	North Vancouver/BC MTI	Project to extend Lower Level Route from Garden Avenue to Marine Drive to include a bridge over the Capilano River.	Proposed/unknown.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf
UTILITY, PUBLIC WORKS AND ALTERNATIVE ENERGY DEVELOPMENT				
Berkey Creek Hydroelectric Project ($ unknown)	Hope/Princeton Energy Inc.	Proposed 1.5 MW hydroelectric project on Berkey Creek, approximately 10 km southeast of Hope.	Proposed/unknown.	BC MFLNRO Investigative Use Application and Reasons for Decision: http://arfd.gov.bc.ca/ApplicationPosting/viewpost.jsp?PostID=3883
Big Bend Substation ($32 million)	South Burnaby/BC Hydro	The South Burnaby, Big Bend area requires a new greenfield, 100 MVA, 69/12 kV substation to meet local residential and commercial load growth.	Proposed/spring 2013 to spring 2015.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf BC Hydro Website: http://www.bchydro.com/energy-in-bc/projects/substation/bigbend.html
Biomass Heating Project ($27 million)	Vancouver/UBC	Proposed biomass project located at the University of British Columbia.	Proposed/unknown.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf
Burnaby - New Westminster Area Reinforcement ($31 million)	New Westminster/BC Hydro	A new 60 kV underground transmission circuit and upgrading the New Westminster Substation.	Under construction/spring 2012 to fall 2013.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf
Cache Creek Landfill Extension ($100 million)	Cache Creek/Belkorp Environmental Services	Proposed extension of the existing Cache Creek landfill to provide an additional 15 million tonnes of capacity.	Proposed/spring 2013 to 2017.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf
Capilano Substation Upgrade ($45 million)	North Vancouver/BC Hydro	Project will add a new building, 25 kV and 60 kV indoor switchgear and two 75 MVA 60/25 kV transformers to raise the capacity to 100 MVA at Capilano Substation.	Proposed/complete by fall 2016.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf
Capilano (Cleveland) Dam Powerplant ($90 million)	North Vancouver/Greater Vancouver Regional District	Proposed 14 MW plant built in the Capilano watershed would include turbines and generators to produce power for approximately 6,000 homes.	Proposed/complete by 2020.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf

TABLE 8A.1-6 Cont'd

Project	Location/Proponent	Description	Status and/or Schedule	Sources
Clemina Creek Hydroelectric Project ($27 million)	Valemount/TransAlta Corp.	11 MW hydroelectric run-of-river project located on the Clemina Creek south of Valemount.	Under Review (not confirmed)/start date unknown, in-service by July 2014.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf BC Hydro Generator Interconnection Queue shows as under review. Website: http://transmission.bchydro.com/NR/rdonlyres/20779185-8EEC-4622-9B6A-0AF4DD50E642/0/TGIQueue2013Apr22.pdf BC Ministry of JTST Regional Economic Investment Pilot website indicates still undeveloped. Website: http://www.jtst.gov.bc.ca/economic_pilots/barriere_mcbride_info.htm#projects
Coquitlam Area Reinforcement ($21 million)	Coquitlam/BC Hydro	Add a 150 MVA 230 25 kV transformer and a 100 MVA feeder section at Como Lake substation which serves the community of Coquitlam.	Under construction/spring 2012 to spring 2014.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf
Esme Creek Hydroelectric Project ($ unknown)	Hope/Innergex Renewable Energy Inc.	Proposed 9.3 MW hydroelectric project on Esme Creek, approximately 45 km northwest of Hope.	Proposed/unknown.	BC MFLNRO Investigative Use Application and Reasons for Decision: http://www.arfd.gov.bc.ca/ApplicationPosting/viewpost.jsp?PostID=9080
Eureka Creek Hydroelectric Project ($ unknown)	Hope/Princeton Energy Inc.	Proposed 1.35 MW hydroelectric project on Eureka Creek, approximately 3 km south of Hope.	Proposed/unknown.	BC MFLNRO Investigative Use Application and Reasons for Decision: http://arfd.gov.bc.ca/ApplicationPosting/viewpost.jsp?PostID=4169
Iona Island Wastewater Treatment Plant Upgrades ($1 billion)	Richmond/Greater Vancouver Regional District	Proposed upgrades to Iona Island wastewater treatment plant.	Proposed/unknown.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf
Kamloops Sewage Treatment Centre Upgrade ($43 million)	Kamloops/City of Kamloops	The upgrade will result in the improvement of effluent quality for discharge into the Thompson River. In addition, the upgrade will replace the aging infrastructure, improve energy efficiency and recover resources.	Under construction/April 2012 to February 2014 .	Canada Economic Action Plan Projects Map: http://actionplan.gc.ca/en/page/projects-map City of Kamloops News Release: http://www.kamloops.ca/news/2012/04-20-SewageTreatmentCentre.shtml Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf
Kidd 2 Substation Upgrade Project ($34 million)	Richmond/BC Hydro	Replace aging equipment and increase the capacity of the Kidd 2 Substation to meet the growing demand for electricity in the Richmond area.	Under construction/fall 2011 to fall 2013.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf BC Hydro Website: http://www.bchydro.com/energy-in-bc/projects/substation/kidd2.html

TABLE 8A.1-6 Cont'd

Project	Location/Proponent	Description	Status and/or Schedule	Sources
Lions Gate Sewage Treatment Plant ($400 million)	North Vancouver/City of North Vancouver	Proposed construction of a new secondary sewage treatment plant near Burrard Inlet on the former BC Rail passenger station at McKeen Avenue and West First Street to replace the existing Lions Gate Primary Treatment plant at the north end of the Lions Gate Bridge.	Proposed/complete by 2020.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf
Lynn Valley Substation Upgrade - Phase 1 ($21 million)	North Vancouver/BC Hydro	The project involves adding an indoor 25 kV feeder section and a 150 MVA 230/25 kV transformer to increase station capacity.	Proposed/early 2011 to fall 2013.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf
McBride Biomass Project ($140 million)	McBride/EcoTECH Energy Group	Project to include a combined heat and electricity generating station. Phase 1 will produce a total of 7 MW of power and will be followed by phase 2 planned for 24 MW. Phase 3 is in the planning stages. Rezoning and permitting are in place and establishment of temporary housing for workers is underway.	Proposed/spring 2013 to 2015.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf Northern Development Initiative Trust Website: http://investnorthcentralbc.ca/major-projects-investment-opportunities/map-view/mcbride-2/green-technology-industrial-park
Merritt Green Energy Project ($120 million)	Merritt/Western Bioenergy Inc.	Proposed 40 MW biomass energy project requiring provincial and BC Hydro approvals.	Proposed/complete by early 2014.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf BC Hydro Interconnection Queue: http://transmission.bchydro.com/NR/rdonlyres/20779185-8EEC-4622-9B6A-0AF4DD50E642/0/TGIQueue2013Apr22.pdf
Metro Vancouver Waste-to-Energy Incineration Facility ($500 million)	Vancouver/Metro Vancouver	Approval issued; however, proposed waste-to-energy incinerator is dependent on solid waste management plan.	Proposed/unknown.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf
Nicola 500 kV Station Reconfiguration ($15 million)	Merritt/BC Hydro	The project scope includes a 500 kV transmission line position rearrangement within the substation, bus conductor upgrade and transformer high-side breaker installation.	Under construction/spring 2012 to fall 2014.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf
Northwest Stave River Hydroelectric Project ($41 million)	Mission/Innergex Renewable Energy Inc.	Proposed 18 MW run-of-river hydroelectric project located 45 km northwest of Mission.	Under construction/fall 2011 to late 2013.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf
Organic Biofuel Facility ($68 million)	Surrey/City of Surrey	Organic biofuel facility located near the Port Kells Transfer Station. 80,000 metric tonnes/year of organic waste will be converted into compressed natural gas.	Proposed/start date unknown, completion in 2015.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf
Ruskin Dam Safety and Powerhouse Upgrade ($718 million)	Mission/BC Hydro	Seismic and other upgrades required to Ruskin Dam	Construction from 2012 to 2018.	BC Hydro Website: http://www.bchydro.com/energy-in-bc/projects/ruskin_dam_powerhouse_upgrade.html BCUC Decision: http://www.bcuc.com/Documents/Decisions/2012/DOC_30241_03-30-2012_C-5-12_BCH_Ruskin-Dam-Decision-WEB.pdf

TABLE 8A.1-6 Cont'd

Project	Location/Proponent	Description	Status and/or Schedule	Sources
Serpentine Creek Hydroelectric Project ($22 million)	Blue River/TransAlta Corp.	9.6 MW run-of-river hydro project on Serpentine Creek located near Blue River.	Under Review (not confirmed)/start date unknown, in-service by July 2014.	BC Hydro Generator Interconnection Queue shows as under review. Website: http://transmission.bchydro.com/NR/rdonlyres/20779185-8EEC-4622-9B6A-0AF4DD50E642/0/TGIQueue2013Apr22.pdf BC Ministry of JTST Regional Economic Investment Pilot website indicates still undeveloped. http://www.jtst.gov.bc.ca/economic_pilots/barriere_mcbride_info.htm#projects
Seymour Arm Series (Capacitor Station 5L71/5L72 Project) ($55 million)	Chase/BC Hydro	Construct a 500 kV series capacitor station adjacent to the existing transmission lines 5L71 and 5L72, which run between Mica Generating Station and the Nicola Substation near Merritt.	Under construction/fall 2011 to fall 2013.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf
Seymour-Capilano Filtration Project ($600 million)	North Vancouver/Metro Vancouver	Water filtration plant. Construction of pumping station completed in late 2008 and filtration plant in spring 2010. Commissioning of twin 7.1 km long tunnels is expected in 2014.	Construction from 2003 to 2014.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf
Silverdale Substation Project ($37 million)	Mission/BC Hydro	A new substation to serve the growing demand for electricity in the Mission area.	Under construction/early 2012 to fall 2014.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf BC Hydro Website: http://www.bchydro.com/energy-in-bc/projects/substation/silverdale.html
Surrey Area Substation Project ($67 million)	Lower Mainland/BC Hydro	Construction of facilities necessary to reinforce the transmission system in the Fraser Valley West Area.	Proposed/Complete fall 2014.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf
Surrey Waste-to-Energy Incineration Facility ($ unknown)	Surrey/City of Surrey	Proposed waste-to-energy plant to be located near Surrey town centre.	Proposed/complete by 2015.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf
Telus Data Centre ($100 million)	Kamloops/Telus Communications Corp.	Flagship data centre to accommodate 200 workers.	Under construction/fall 2012 to summer 2013.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf
Tributary to Wardle Creek Hydroelectric Project ($ unknown)	Hope/Princeton Energy Inc.	Proposed 0.61 MW hydroelectric project on a tributary to Wardle Creek, approximately 5 km southeast of Hope.	Proposed/unknown.	BC MFLNRO Investigative Use Application and Reasons for Decision: http://arfd.gov.bc.ca/ApplicationPosting/viewpost.jsp?PostID=4159
Vancouver City Central Transmission Project ($180 million)	Vancouver/BC Hydro	Build an enclosed 230/12 kV substation in the Mount Pleasant area of Vancouver and two new underground 230 kV transmission lines connecting the new substation to the existing transmission network to serve growing loads in the Mount Pleasant/False Creek area and maintain a reliable supply of electricity to other areas of Vancouver.	Under construction/November 2010 to early 2014.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf BC Hydro Website: http://www.bchydro.com/energy-in-bc/projects/vcct.html

TABLE 8A.1-6 Cont'd

Project	Location/Proponent	Description	Status and/or Schedule	Sources
MARINE AND INDUSTRIAL DEVELOPMENT				
Coal Handling Infrastructure Upgrade and Expansion ($120 million)	North Vancouver/Neptune Bulk Terminals Ltd.	Upgrade and expansion of metallurgical coal handling systems at a terminal to increase throughput and improve coal handling operations. The increased vessel traffic from the project is expected to be approximately one additional train per day and one additional vessel per week.	Under construction/January 2013 to November 2014.	Permit Application: http://portmetrovancouver.com/Libraries/PROJECTS_Project_Review/2012-06-01_Application_fr_Neptune_-_Neptune_-_Coal_Handling_Infrastructure_Improvements__Project_Allison__PP_2012-066.sflb.ashx Permit Approval: http://portmetrovancouver.com/Libraries/PROJECTS_Project_Review/2013-01-23_Project_Permit_-_Signed_with_Plans_and_Schedule_-_Neptune_Coal_Capacity_PP_2012-066.sflb.ashx
Fraser Surrey Docks Direct Transfer Coal Facility (unknown)	Surrey/Fraser Surrey Docks	Proposed development of a Direct Transfer Coal Facility at the southwest end of the existing terminal to handle up to four million metric tonnes of coal per year. The coal will be transferred by rail to the terminal and will be loaded onto barges at existing Berth 2. When loaded, tugs will take single barges down to the mouth of the Fraser River. Once barges pass Sand Heads, they will be towed in tandem to Texada Island. From there the coal will be stored before transfer to a deep sea vessel for overseas export.	Under review/construction from Q1 to Q4 2014.	Port Metro Vancouver Website: http://portmetrovancouver.com/en/projects/OngoingProjects/Tenant-Led_Projects/FraserSurreyDocks.aspx
Maple Ridge Industrial Park ($250 million)	Maple Ridge/Steve Pelton	Proposal for 81 ha of land on 203rd Street in Maple Ridge would include an industrial park, 2 ha of community garden, park space, trails and community amenities.	Under construction/construction started in fall 2012.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf
Richardson International Grain Storage Capacity ($105 million)	North Vancouver/Richardson International Ltd.	The proposal includes installation of approximately 494 open-ended steel wall piles and 315 timber piles, and construction of two 40,000 metric tonne concrete storage annexes.	Under construction/in-service by early 2015.	Port Metro Vancouver Website: http://www.portmetrovancouver.com/en/projects/OngoingProjects/Tenant-Led_Projects/RichardsonInternational.aspx
Roberts Bank Terminal 2 Expansion Project ($2 billion)	Delta/PMV	The Roberts Bank Terminal 2 Project is a proposed new multi-berth container terminal at Roberts Bank in Delta, B.C. that would provide 2.4 million TEUs (twenty-foot equivalent unit containers) of container capacity. The project is part of Port Metro Vancouver's Container Capacity Improvement Program, a long-term strategy to deliver projects to meet anticipated growth in demand for container capacity to 2030.	Pre-application/ construction from 2017/2018 to 2024.	Roberts Bank Project Website: http://www.robertsbankterminal2.com/
Seaspan Shipyard Modernization ($62 million)	North Vancouver (Burrard Inlet)/Seaspan ULC	Proposed works under PMV's permit review process include Construction of a 53.56 m long x 31.8 m wide concrete load-out pier and installation of approximately 102 steel piles.	Under construction/in-service by early 2015.	Port Metro Vancouver Website: http://portmetrovancouver.com/en/projects/OngoingProjects/Tenant-Led_Projects/Seaspan.aspx

TABLE 8A.1-6 Cont'd

Project	Location/Proponent	Description	Status and/or Schedule	Sources
South Richmond Terminal Project ($ unknown)	Richmond/Lehigh Hanson Materials Ltd.	Proposed development of an aggregate (sand and gravel) processing and distribution facility on leased property owned by Port Metro Vancouver in southeast Richmond. Components include a wash plant, aggregate material stockpiles, reclaimer, rail and truck loading facilities and two marine berths for loading and unloading barges. Several years of site preparation will be required to achieve the necessary ground settlement across the site prior to construction of the facility, which is expected to begin in 2018.	Under review/construction from 2014 to 2022.	Port Metro Vancouver Website: http://www.portmetrovancouver.com/en/projects/OngoingProjects/Tenant-Led_Projects/LehighHansonSouthRichmondTerminalProject.aspx
Vancouver Shipyard Improvements ($200 million)	North Vancouver (Burrard Inlet)/Seaspan ULC	Improvements to the Vancouver shipyard include a fabrication shop, assembly hall, workshops, offices and equipment required to build large vessels.	Under construction/November 2012 to October 2014.	Seaspan Marine Corp. Website: http://www.seaspan.com/shipyards/modernization.php
MINERAL RESOURCES				
Highland Valley Copper Modernization ($475 million)	Logan Lake/Teck Resources Ltd.	Modernization to extend the life of the mill and increase the mill capacity.	Under construction/summer 2012 to late 2013.	Major Project Inventory: http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf
PROPOSED PIPELINE DEVELOPMENTS				
Vancouver Airport Fuel Delivery Project ($100 million)	Richmond to Vancouver/Vancouver Airport Fuel Facilities Corp.	Proposed marine terminal expansion in Richmond along the South Arm of the Fraser, a fuel receiving and storage facility near the marine terminal and a new jet fuel delivery pipeline to YVR. Application currently under review by the BC EAO.	BC EAO application approval is pending/estimated 24 month construction period following approval.	Major Project Inventory http://www.jtst.gov.bc.ca/ministry/major_projects_inventory/pdfs/December_2012.pdf BC EAO Website: http://a100.gov.bc.ca/appsdata/epic/html/deploy/epic_project_home_346.html Fuel Delivery Project Website: http://www.vancouverairportfuel.ca/home

9.0 SUPPLEMENTAL STUDIES

9.1 Introduction

A comprehensive environmental field program was conducted in 2012 and 2013 in support of the ESA to address the following objectives:

- characterize the environmental setting of the Project (including physical and meteorological environment, soil and soil productivity, water quality and quantity, air emissions, GHG emissions, acoustic environment, fish and fish habitat, wetlands, vegetation, wildlife and wildlife habitat and species at risk);
- identify sensitive or unique features;
- support the selection and refinement of a proposed pipeline corridor;
- develop environmental mitigation measures to avoid or reduce potential effects; and
- assess the potential residual environmental effects (including the Project's contribution to residual cumulative effects) that might be caused by or otherwise affect the Project.

The environmental field program was designed to support the highest standards of environmental assessment in recognition of the large scale of the Project and the many ecosystems the Project crosses.

Co-operation was received from many Aboriginal communities, landowners and regulatory authorities, resulting in access to most lands and facilities along the proposed pipeline corridor for the environmental field crews. This allowed for the collection of field data which complemented desktop studies, literature reviews, information available from 60 years of operational experience, adjacent lands, and professional judgment.

Access was not available at some land parcels at the time of field study; however, potential effects and mitigation measures were developed based on existing literature and desktop studies and knowledge of adjacent lands as well as the professional judgment of the assessment team. Additional field studies will be completed in 2014 for lands where access was not available in order to confirm literature results and mitigation measures, including those found in the EPPs. Additional field studies may also be warranted if route refinement results in new lands being crossed.

All applicable permits that may be necessary will be identified prior to commencing supplemental field investigations. The EPPs (Volumes 6B, 6C and 6D), Environmental Alignment Sheets (Volume 6E) and Environmental Facility Drawings (Volumes 6C and 6D) will be updated and re-issued prior to construction with pertinent information on site-specific issues and mitigation measures arising from the supplemental (ongoing) studies. Current mitigation, management and contingency plans have been developed to address potential findings from the ongoing studies and have been based on existing literature as well as professional judgment based on continuity of adjoining land parcels for which comprehensive field studies have been completed. The proposed mitigation measures are anticipated to be sufficient to address potential adverse effects from the Project.

No supplemental studies relating to the following elements are anticipated:

- physical and meteorological environment;
- water quality and quantity;
- air emissions;
- GHG emissions;
- acoustic environment;

- marine sediment and water quality;
- marine fish and fish habitat;
- marine mammals; and
- marine birds.

Although no specific surveys for the species at risk element are anticipated, the field work and supplemental filings for fish and fish habitat, vegetation and wildlife and wildlife habitat will include information regarding species at risk for each of those elements.

The objectives of the supplemental filings are to confirm predictions and gather site-specific information for the implementation of mitigation measures and EPPs.

Soils, archaeology and terrestrial ecosystem mapping (TEM) field investigations will be completed in Finn Creek Provincial Park, North Thompson Provincial Park, Lac Du Bois Grasslands Protected Area, Coquihalla Summit Recreation Area and Bridal Veil Falls Provincial Park as the Research and Education Park Use Permit was issued by the BC Ministry of Environment on November 15, 2013. Application for this permit was submitted to BC Parks in December 2012 and further updated in June 2013. This permit allows for ground disturbance in the provincial parks. Other field surveys that did not warrant any ground disturbance have already been completed.

The additional data for soil and soil productivity, fish and fish habitat, wetlands, vegetation and wildlife and wildlife habitat will be collected in spring/summer 2014 to confirm predictions and proposed mitigation measures. Results of the supplemental studies, along with an update to the biophysical assessment (including results of updated TEM-based habitat models) will be submitted to the NEB in Q3 2014.

9.2 Soil and Soil Productivity

9.2.1 Location of Survey

Exact locations of additional test holes will be determined in Q1 2014 after field results from Q3 and Q4 2013 are processed.

9.2.2 Survey Methodology

All field surveys in 2014 will be consistent with those detailed in the Soils Technical Report in Volume 5C.

9.2.2.1 Qualifications of Personnel Designing and Conducting the Survey

The soils assessment methods for the Project, outlined in the Soils Technical Report (Volume 5C) were developed by Al Twardy (senior soils scientist at Mentiga) who has over 40 years of field and office experience. The soils survey for areas where land access was not available will be conducted by qualified soil scientists under the direction of Al Twardy, the owner and senior consultant at Mentiga.

9.2.2.2 Consultation with Applicable Government Agencies

Additional regulatory consultation is not anticipated because there will be no change to the baseline soil and soil productivity survey methods previously employed. If an alteration to the soil method approach is warranted, appropriate regulatory authorities will be consulted and details of any additional consultation will also be submitted to the NEB.

9.3 Fish and Fish Habitat

Field programs in 2012 and 2013 focused on the assessment of potential fish habitat traversed by the proposed pipeline corridor in both Alberta and BC, where private and Crown land access was permitted. Sites for pump stations and power lines were also assessed for potential fish habitat in BC. No pump stations or ancillary facilities encroached upon watercourses in Alberta, so assessments were completed in association with the proposed pipeline corridor of the Edmonton to Hinton Segment only. Access to proposed crossings occurring on private land or in Aboriginal traditional territory was not granted for minor areas along the Fish and Fish Habitat LSA, which precluded habitat assessments.

Watercourses with previously documented fish information and sufficient existing habitat related data were assigned a fish-bearing classification and sensitivity ranking. However, field investigations at these fish-bearing watercourses will be completed to collect detailed habitat information, photos and to document fish presence within the Fish and Fish Habitat LSA. In the absence of field data from 2012 and 2013, and any available historical information, watercourses have been assigned an interim classification until fish presence/absence and habitat potential can be confirmed. Interim classifications included the use of data collected adjacent to the proposed pipeline corridor, where access was available, the watercourse gradient or presence of other barriers downstream and the overall size of the potential watercourse. Where unsure, a default “fish-bearing status” was assigned.

At approximately 11 watercourses in BC, private land access, timing constraints and sampling restrictions in provincial parks limited multiple seasons of sampling. Watercourses with low fish habitat potential retained a nonfish-bearing designation when no fish were captured or observed through one season of sampling and the habitat value was considered to be low or nil. Watercourses were assigned a fish-bearing status when no fish were captured or observed, habitat was rated moderate or higher and there were no obvious barriers to fish migration. The potential for fish within these watercourses near the proposed pipeline corridor is likely low, but a second season of sampling will be conducted to confirm the absence of fish presence as per sampling requirements for BC in the specific cases mentioned.

If the potential watercourses not yet investigated are determined to be watercourses (*i.e.*, have defined bed and banks), the applicable Environmental Monitoring Sheet(s) from the technical report will be revised to reflect the updated information. The Environmental Alignment Sheets will be updated to include the new crossing details.

A re-examination of the Project’s federal notification and authorization requirements, as related to construction activities with the potential to affect fish and fish habitat, will also be needed. It is expected that a MOU between the NEB and DFO will be released prior to the end of 2013. Once this MOU (and relevant review process tools) is interpreted with the Project’s activities in context, appropriate notification and authorization requirements will be identified.

9.3.1 Location of Survey

A total of 47 of 836 potential crossings (including power line crossings) were not assessed during the 2012 and/or 2013 field program, while additional sampling will be conducted at 18 watercourses to confirm habitat potential and use for some of the indicator species over part or the entire Fish and Fish Habitat LSA, or to collect habitat data or photo documentation of the crossing site. Exact locations and timing of surveys will be determined in Q1 2014.

9.3.2 Survey Methodology

The methods for the fish and fish habitat surveys will be consistent with those detailed in the Fisheries (Alberta) Technical Report and Fisheries (British Columbia) Technical Report in Volume 5C.

9.3.2.1 Qualifications of Personnel Designing the Survey

The fisheries assessment methods for the Project, outlined in the Fisheries (Alberta) Technical Report and Fisheries (British Columbia) Technical Report (Volume 5C) were developed collectively by TERA’s Aquatics Discipline, GeoMarine and Triton, and will continue to be used.

9.3.2.2 Qualifications of Personnel Conducting the Survey

The 2014 fisheries surveys will be conducted by TERA and Triton staff in Alberta and BC, respectively. Where feasible, the same Field Crew Lead(s) and member(s) that conducted the 2012/2013 field program for the proposed pipeline corridor will conduct the 2014 fisheries surveys. In the event that the aforementioned field personnel are not available to conduct the survey, a suitable alternate(s) with similar qualifications will be supplied by TERA and/or Triton.

9.3.2.3 Consultation with Applicable Government Agencies

Baseline survey methods for the 2012 open water aquatic assessments were discussed with federal authorities (DFO) in September 2012 and 2013, and provincial regulatory authorities (*e.g.*, AESRD, BC MFLNRO) throughout spring/summer 2012 and 2013.

9.4 Wetlands

Detailed wetland information along the proposed pipeline corridor has been collected through overflights as well as field reconnaissance. The purpose of the 2014 ground-based wetland surveys will be to confirm baseline wetland information derived from literature reviews and professional knowledge for the various wetlands crossed by the proposed pipeline corridor and associated power lines. The results of the 2014 wetland surveys will confirm wetland information in Sections 7.0 and 8.0, as well as wetlands mitigation in the EPPs and the Environmental Alignment Sheets.

9.4.1 Location of Survey

Wetland surveys were conducted for the proposed pipeline corridor in 2012 and 2013. Additional wetland surveys will be conducted in spring/summer 2014 at locations where access was not granted during the 2012 and 2013 field seasons to confirm predictions and proposed mitigation measures.

9.4.2 Survey Methodology

Wetlands will be classified according to the Canadian Wetland Classification System (NWWG 1997) in Alberta and Mackenzie and Moran's Wetlands of British Columbia: A Guide to Identification (Mackenzie and Moran 2004) in BC. The methodology outlined in the Wetland Evaluation Technical Report (Volume 5C) will be used for any additional wetland surveys and will be conducted by qualified wetland specialists.

9.4.2.1 Qualifications of Personnel Designing and Conducting the Survey

The wetland field program has been designed and will be conducted by qualified wetland ecologists under the guidance of a senior wetland ecologist and Registered Professional Biologist that have over 15 years of experience designing and implementing wetland studies, and planning and designing mitigation for development projects.

In the event that the aforementioned field personnel are not available to conduct the survey, a suitable alternate(s) with similar qualifications will be supplied.

9.4.2.2 Consultation with Appropriate Regulatory Authorities

Consultation with federal and provincial regulatory authorities is ongoing. A summary of consultation with government and regulatory authorities that has occurred to date can be found in Section 2.0 of the Wetland Evaluation Technical Report (Volume 5C). Detailed information on consultation with additional stakeholders can also be found in the Wetland Evaluation Technical Report.

9.5 Vegetation

9.5.1 Vegetation and Rare Plants

Vegetation studies planned for 2014 will focus on acquiring additional data to support and confirm potential effects on vegetation.

The 2014 rare plant surveys will gather data for site-specific environmental protection planning for areas where access was not available during the 2013 field season. The data will be used to refine and augment the Rare Ecological Community and Rare Plant Population Management Plan provided in Volumes 6B and 6C.

The 2014 rare plant surveys will confirm mitigation measures for site-specific rare plants, lichens, and ecological communities as well as mitigation identified in the Vegetation Technical Report of Volume 5C, the EPPs of Volumes 6B and 6C, and on the Environmental Alignment Sheets of Volume 6E.

9.5.1.1 Location of Survey

Additional vegetation surveys will be conducted in 2014 at locations where access was not available during the 2013 field season to confirm predictions and proposed mitigation measures. The locations to be chosen for additional rare plant survey will be large areas or areas important from a vegetation perspective, where access was not granted or where Project details have been revised (*e.g.*, reroutes). They will be refined further prior to and during 2014 field work.

9.5.1.2 Survey Methodology

The rare plant survey methodology is based on the guidelines described in the ANPC *Guidelines for Rare Plant Surveys in Alberta* (ANPC 2012) and the BC CDC and E-Flora BC *Protocols for Rare Plant Surveys* (Penny and Klinkenberg 2012), and is provided in the Vegetation Technical Report of Volume 5C. Specific information collected will include plant and lichen species, incidental weed observations, UTM coordinates and species distributions.

Qualifications of Personnel Designing the Survey

Vegetation and rare plant survey methods were developed by qualified botanists with substantial experience and are based on the ANPC *Guidelines for Rare Plant Surveys in Alberta* (ANPC 2012) and the BC CDC and E-Flora BC *Protocols for Rare Plant Surveys* (Penny and Klinkenberg 2012), in conjunction with methodologies described in the *Occupancy Survey Guidelines for Prairie Plant Species at Risk* (Henderson 2009).

Qualifications of Personnel Conducting the Survey

Each Field Crew Lead conducting the vegetation or rare plant surveys will be a TERA vegetation specialist with substantial experience in performing vegetation surveys. Botanists have a specific knowledge base in vegetation. Each crew member has completed post-secondary education (*e.g.*, B.Sc., Environmental Science, Plant Science, etc.) and/or obtained a professional designation (*e.g.*, Biologist in Training [B.I.T.] or P. Biol with the Alberta Society of Professional Biologists, etc.).

Consultation with Appropriate Regulatory Authorities

In advance of the 2014 vegetation surveys, the BC CDC and ACIMS will be contacted for possible updated information regarding rare plant, lichen and ecological community occurrences.

9.5.2 Terrestrial Ecosystem Mapping

TEM field surveys were conducted in fall 2013 in order to confirm and support predictions and proposed mitigation measures. The 2013 field surveys included the Edson to Hinton Segment and areas in the Coquihalla and the Lower Mainland Region of BC where access was not previously available. The TEM plots were planned to achieve Survey Level Intensity 5. The fall 2013 field surveys are considered supplemental since results were not available in time to be incorporated into the application but will be included in the supplemental reporting to be submitted to the NEB in 2014.

9.5.2.1 Location of Survey

The exact locations of the completed fall 2013 TEM field surveys will be available in the supplemental report to be submitted to the NEB in 2014.

9.5.2.2 Survey Methodology

The survey methods will follow the methods described in the TEM Report in Appendix C of the Vegetation Technical Report of Volume 5C.

Qualifications of Personnel Designing the Survey and Mapping

TERA vegetation personnel have substantial experience designing and applying TEM mapping methodology. TEM mapping methodology for the Project was developed according to the *Standard for Terrestrial Ecosystem Mapping in British Columbia* (Resources Inventory Committee 1998) and was applied to both the Alberta and BC portions of the Project. As per standard TEM projects, the ecosystem mapping was based on a hierarchical ecosystem classification framework, which includes natural subregion units and ecosystem units in Alberta, and BGC subzone variant units and ecosystem units in BC. The TEM survey methodology is based on the methods outlined in the *Field Manual for Describing Terrestrial Ecosystems, 2nd Edition* (BC MOFR and BC MOE 2010).

Consultation with Appropriate Regulatory Authorities

Representatives from the Government of BC, including ecologists from the Thompson-Okanagan Region, Omineca and NE Region and the Coastal Region were contacted in 2012 and 2013 to introduce the Project and discuss TEM survey methodologies. A summary of the responses received during this consultation program is provided in the TEM Report (Appendix C) of the Vegetation Technical Report of Volume 5C. No additional consultation is planned in relation to supplemental surveys.

9.6 Wildlife and Wildlife Habitat

Additional wildlife surveys are planned in 2014 for areas where access was not available in 2012 and 2013 to confirm predicted effects and proposed mitigation measures.

9.6.1 Location of Survey

Field surveys will be conducted within the Wildlife LSA. The supplemental field survey list will be revised in Q1 2014 prior to commencement of surveys in areas where land access was limited and route refinements have been proposed.

9.6.2 Survey Methodology

The 2014 field surveys will follow the methods provided in the Wildlife Technical Report of Volume 5C.

Habitat models will follow the methods provided in the Wildlife Modelling and Species Accounts Report (Volume 5C) and TEM will be prepared following the methods provided in the Vegetation Technical Report (Volume 5C).

9.6.2.1 Qualifications of Personnel Designing the Survey

The field surveys were designed by a team of qualified and experienced professional biologists. The same survey procedures used in 2013 will be used in 2014. The Wildlife Technical Lead for the Project has over 15 years of experience designing and implementing wildlife studies, and planning and designing mitigation for development projects.

In the event that the aforementioned personnel are not available, a suitable alternate(s) with similar qualifications will be supplied.

9.6.2.2 Qualifications of Personnel Conducting the Survey

The 2014 field surveys will be conducted by a team of qualified professional biologists, including biologists with local expertise.

9.6.2.3 Consultation with Appropriate Regulatory Authorities

In advance of the 2014 wildlife surveys, updated information on wildlife occurrence records will be requested from the BC CDC and AESRD. Provincial and federal regulatory authorities will be consulted, when needed, to confirm the proposed survey locations and protocols.

9.7 Update to the Biophysical Assessment

An update to Volume 5A ESA – Biophysical will be provided to the NEB in Q3 2014. The update will contain the following information:

- an update to the biophysical settings (Sections 5.0 and 6.0), confirmation of effects assessment (Section 7.0) and cumulative effects assessment (Section 8.0) based on the collection of additional field information as well as the results of ongoing engagement and consultation that will confirm predictions; and
- an update to the biophysical setting (Sections 5.0 and 6.0), effects assessment (Section 7.0) and cumulative effects assessment (Section 8.0) based on confirmation of selected route, including any proposed reroutes that are located outside of the studied proposed pipeline corridor that will confirm predictions.

9.8 References

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10.0 FOLLOW-UP

Under the *CEA Act, 2012* and as described in the NEB *Filing Manual*, a follow-up program is defined as a program to verify the accuracy of the environmental assessment of a designated project, and to determine the effectiveness of any mitigation measures.

Based on Project knowledge and comprehensive field studies to date, the need for follow-up programs under the *CEA Act, 2012* have been identified for select wildlife species at risk. Trans Mountain plans to collect additional information in 2014 to inform and refine the mitigation strategies recommended in the Environmental Protection Plans.

11.0 CONCLUSION

This biophysical component of the Environmental and Socio-Economic Assessment (ESA) was completed in support of the proposed Trans Mountain Expansion Project (referred to as "TMEP" or "the Project"). The socio-economic component of the ESA is found in the companion Volume 5B.

Application is being made by Trans Mountain Pipeline ULC (Trans Mountain), a Canadian corporation with its head office located in Calgary, Alberta, pursuant to Section 52 of the *National Energy Board Act* (*NEB Act*) for the TMEP.

The proposed expansion will, in essence, comprise the following:

- Pipeline segments that complete a twinning (or "looping") of the pipeline in Alberta and BC with about 987 km of new buried pipeline.
- New and modified facilities, including pump stations and tanks.
- Three new berths at the Westridge Marine Terminal in Burnaby, BC, each capable of handling Aframax class vessels.

The Project will require a NEB CPCN pursuant to Section 52 of the *NEB Act*. In addition, according to the *Regulations Designating Physical Activities,* the Project is a designated project under the *Canadian Environmental Assessment Act, 2012* (*CEA Act, 2012*). The ESA considers the mandatory factors listed in Section 19(1) of the *CEA Act, 2012*, the factors listed in the NEB *Filing Manual* (NEB 2013a), and pertinent issues and concerns identified through consultation and engagement with Aboriginal communities, landowners, regulatory authorities, stakeholders and the general public.

In addition, the ESA addresses the NEB's *List of Issues* (July 29, 2013) for the Project (NEB 2013b) provided below. Issues 4 and 5 of this list specifically informed the ESA.

1. *The need for the proposed project.*
2. *The economic feasibility of the proposed project.*
3. *The potential commercial impacts of the proposed project.*
4. *The potential environmental and socio-economic effects of the proposed project, including any cumulative environmental effects that are likely to result from the project, including those required to be considered by the NEB's Filing Manual.*
5. *The potential environmental and socio-economic effects of marine shipping activities that would result from the proposed project, including the potential effects of accidents or malfunctions that may occur (addressed in Volume 8A).*
6. *The appropriateness of the general route and land requirements for the proposed project.*
7. *The suitability of the design of the proposed project.*
8. *The terms and conditions to be included in any approval the Board may issue.*
9. *Potential impacts of the project on Aboriginal interests.*
10. *Potential impacts of the project on landowners and land use.*
11. *Contingency planning for spills, accidents or malfunctions, during construction and operation of the project.*
12. *Safety and security during construction of the proposed project and operation of the project, including emergency response planning and third-party damage prevention.*

The Board does not intend to consider the environmental and socio-economic effects associated with upstream activities, the development of oil sands, or the downstream use of the oil transported by the pipeline.

The scope and methodology of the ESA is more fully described in Section 1.2 of this volume. In summary, the ESA includes a description of the following:

- the environmental and socio-economic setting;
- the predicted beneficial and adverse effects of the proposed Project on the socio-economic and biophysical environment over the life of the Project;
- the methods used for effects analysis, and the rationale for selecting the methods chosen;
- the proposed inspection, monitoring and mitigation measures; and
- the predicted significance of residual Project effects and residual cumulative effects.

The ESA was prepared by a team of highly qualified environmental professionals with element-specific expertise led by TERA Environmental Consultants (TERA). Team members included representatives from:

- BGC Engineering Inc. for geotechnical expertise;
- Mentiga Pedology Consultants Ltd. for soils expertise;
- Waterline Resources Inc. for groundwater expertise;
- Rowan Williams Davies and Irwin Inc. for air, GHG and noise expertise;
- GeoMarine Environmental Consultants Ltd. and Triton Environmental Consultants Ltd. for fisheries expertise;
- Stantec Consulting Ltd. for marine resources, marine birds and marine sediment and water quality expertise; and
- TERA for fisheries, surface water, wetland, vegetation and wildlife expertise.

Environmental elements potentially interacting with the Project include: physical and meteorological environment; soil and soil productivity; water quality and quantity; air emissions; GHG emissions; acoustic environment; fish and fish habitat; wetland loss or alteration; vegetation; wildlife and wildlife habitat; marine sediment and water quality; marine fish and fish habitat; marine mammals; marine birds; and species at risk. The description of the environmental setting (current state of the environment) within the Project area was compared against the Project description to assess potential environmental effects that might be caused by the Project. For this assessment, one or more indicators (often referred to as Valued Ecosystem Components) were selected to describe the present and predicted future condition of an element. One or more measurement endpoints (measurable parameters) were identified for each indicator to allow quantitative or qualitative measurement of potential Project effects.

The environmental issues identified through engagement with Aboriginal communities, and consultation with landowners, regulatory authorities, stakeholders and the general public, as well as through literature reviews, field studies and the professional experience of the assessment team, are consistent with other projects of this nature. Most of the associated potential effects on environmental indicators arising from construction of the Project can be readily mitigated by standard environmental mitigation measures common to pipeline projects in similar settings.

Most of the potential environmental residual effects that are of high probability of occurring during construction and operation of the Project are considered to be reversible in the short to long-term.

The environmental assessment concludes that the proposed pipeline and associated facilities (*e.g.*, pump stations, terminals, Westridge Marine Terminal) do not result in significant adverse residual environmental effects as defined in Section 7.1. Consequently, the identified residual effects of construction and operation of the Project on environmental indicators will be not significant for the pipeline and facilities component of the Project.

The Project may act cumulatively with existing activities and reasonably foreseeable developments in the vicinity of the Project including agriculture (*e.g.*, crop production and livestock grazing), forestry, recreational activities, transportation activities (*e.g.*, vehicle and rail traffic, road infrastructure and highway maintenance), utilities activities (*e.g.*, transmission lines and gas distribution lines), rural and urban residential and commercial development, and industrial, oil and gas, and mineral resources developments. Cumulative effects associated with the Project were evaluated conservatively using assumptions relevant to the element under consideration. Most of the Project's contribution to cumulative effects within the element-specific LSAs and RSAs that are likely to occur, are anticipated to be reversible in the short to long-term and are generally of low to medium magnitude. There are no situations that would result in a significant adverse cumulative environmental effect, as defined in Section 7.1 for the pipeline and facilities component of the Project.

The TMX Anchor Loop Project required construction through Jasper National Park in Alberta and Mount Robson Provincial Park in BC, both of which are part of the United Nations Environmental, Scientific and Cultural Organization Canadian Rocky Mountain Parks World Heritage Site. In recognition of this setting and through consultation with stakeholders and various regulatory authorities, Trans Mountain implemented a number of unique and innovative restoration measures at particularly sensitive areas, with the objective of restoring ecological integrity of these lands and watercourses. Following construction of the TMX Anchor Loop Project, Trans Mountain reported on the effectiveness of mitigation and restoration that was implemented during and following construction as outlined in the Environmental Protection Plan and Restoration Plan for the Project. Many of the successes identified during post-construction monitoring can be attributed to the implementation of those mitigation measures outlined in the plans. The mitigation measures were successful at achieving the desired end results and management objectives of Parks Canada (TERA 2013). The TMX Anchor Loop Project is viewed by many as a legacy project, and has achieved a level of success that has exceeded expectations in many areas. This project proved that an oil pipeline can be constructed, maintained and operated in a highly valued ecological and historical setting of international importance. Many of the approaches, plans and programs which were implemented on TMX Anchor Loop have been adapted and enhanced for the TMEP.

Project design and industry and regulatory standards anticipate and address most of the Project's potential effects on the environment. Routing of the proposed pipeline corridor to parallel existing linear disturbances for most of its length (89%) has reduced the potential effects associated with construction and operation of the Project. Mitigation measures have been developed to further reduce the potential adverse residual environmental effects. Implementation of the proposed mitigation measures will further reduce the adverse residual environmental effects associated with the construction and operation of the Project. Applicable proposed construction mitigation measures will form the basis of operation and maintenance procedures during the life of the Project.

11.1 References

11.1.1 Literature Cited

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National Energy Board. 2013b. List of Issues for the Trans Mountain Expansion Project. Website: http://www.neb-one.gc.ca/clf-nsi/rthnb/pplctnsbfrthnb/trnsmntnxpnsn/trnsmntnxpnsn-eng.html#s4. Accessed: August 2013.

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