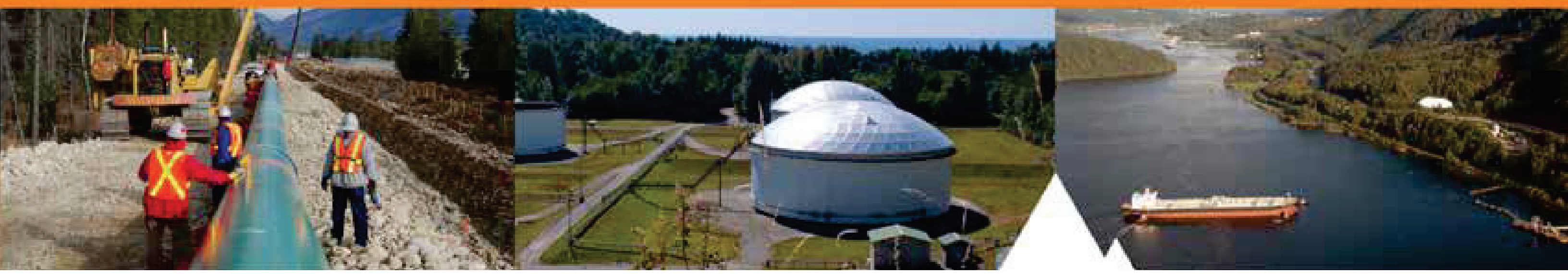
TRANSMOUNTAIN

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 8a Marine Transportation

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 | |
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## This volume contains:

| Volume 8A | |
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# ABBREVIATIONS AND ACRONYMS

This table lists the abbreviations and acronyms used in this volume of the application.

| Term | Meaning |
|---|---|
| ∑ BTEX | Sum of individual BTEX compounds |
| AANDC | Aboriginal Affairs and Northern Development Canada |
| AB | Alberta |
| AIS | Automated Information System |
| ANS | Alaska North Slope |
| AOOS | Alaska Ocean Observing System |
| A-S | age standardized |
| ASL | ambient sound levels |
| AWB | Access Western Blend |
| bbl | barrels |
| BC | British Columbia |
| BC CDC | British Columbia Conservation Data Centre |
| BC CSN | British Columbia Cetacean Sightings Network |
| BC MCA | British Columbia Marine Conservation Analysis |
| BC MFLNRO | British Columbia Ministry of Forests, Lands and Natural Resource Operations |
| BC MOE | British Columbia Ministry of Environment |
| BC OGC | British Columbia Oil and Gas Commission |
| BCCP | British Columbia Coastal Pilots |
| BCCPA | British Columbia Coast Pilots Association |
| BCIT | British Columbia Institute of Technology |
| BIEAP | Burrard Inlet Environmental Action Program |
| BSD | blue sac disease |
| BTEX | benzene, toluene, ethyl benzene, and xylene |
| CAAQS | Canadian Ambient Air Quality Standards |
| CACs | criteria air contaminants |
| CAPP | Canadian Association of Petroleum Producers |
| CCG | Canadian Coast Guard |
| CCME | Canadian Council of Ministers of the Environment |
| CEA | Canadian Environmental Assessment (both *Act* and Agency) |
| CEPA | *Canadian Environmental Protection Act* |
| CF | Conservation Framework |
| $CH_4$ | methane |
| CHS | Canadian Hydrographic Service |
| CLWB | Cold Lake Winter Blend |
| CMAQ | Community Multi-scale Air Quality Model |
| CN | Canadian National |
| CO | carbon monoxide |
| $CO_2$ | carbon dioxide |
| $CO_{2e}$ | Carbon Dioxide Equivalents |
| COPC | chemicals of potential concern |
| COSBC | Chamber of Shipping of British Columbia |
| COSEWIC | Committee on the Status of Endangered Wildlife in Canada |
| CPCN | Certificate of Public Convenience and Necessity |
| CRD | Capital Regional District |
| CSAS | Canadian Science Advisory Secretariat |
| cSt | centistokes |

| Term | Meaning |
|---|---|
| CVTS | Cooperative Vessel Traffic Service |
| CWS | Canadian Wildlife Service |
| dB | decibel |
| dBA | A-Weighted decibels |
| DFO | Fisheries and Oceans Canada |
| DHI | Danish Hydraulic Institute |
| DNV | Det Norske Veritas |
| DPS | distinct population segment |
| dv | deciview |
| DWT | dead weight tonnage |
| EBA | EBA Engineering Consultants Ltd. operating as EBA, A Tetra Tech Company |
| EC | Environment Canada |
| ECA | emissions control area |
| ECRC | Eastern Canada Response Corporation |
| EEDI | Energy Efficiency Design Index |
| EEMP | Environmental Emergency Management Program |
| ENGO | Environmental Non-Governmental Organization |
| ERA | ecological risk assessment |
| ESA | Environmental and Socio-Economic Assessment |
| EVOS | Exxon Valdez Oil Spill |
| EVOSTC | Exxon Valdez Oil Spill Trustee Council |
| FEARO | Federal Environmental Assessment Review Office |
| FHA | Fraser Health Authority |
| FOSET | Fishers Oil Spill Emergency Team |
| FSC | food, social, and ceremonial |
| FVRD | Fraser Valley Regional District |
| GHG | greenhouse gas |
| $H_2S$ | hydrogen sulphide |
| HCB | hydrocarbonoclastic bacteria |
| HHRA | Human Health Risk Assessment |
| HSDA | Health Service Delivery Areas |
| IBA | Important Bird Area |
| ICS | Incident Command System |
| IMO | International Maritime Organization |
| Intrinsik | Intrinsik Environmental Sciences Inc |
| IOPC | International Oil Pollution Compensation |
| IRA | Increased Response Area |
| ISO | International Organization for Standardization |
| ITOPF | International Tanker Owners Pollution Federation |
| JASCO | JASCO Applied Sciences Ltd. |
| KMC | Kinder Morgan Canada Inc. |
| KPI | key performance indicator |
| kt | kilotonnes |
| $L_{eq}$ | energy equivalent sound level |
| LFV | Lower Fraser Valley Photochemical Model Domain |
| LNG | liquefied natural gas |
| LOU | Letter of Understanding |
| LSA | Local Study Area |
| MAMU | Marbled murrelet |
| MARPOL | International Convention for the Prevention of Pollution from Ships |

| Term | Meaning |
|---|---|
| MBA | Mutual Benefit Agreement |
| MBCA | Migratory Birds Convention Act |
| MCRTU | marine commercial, recreational and tourism use |
| MCTS | Marine Communications and Traffic Services |
| MLA | *Marine Liability Act* |
| MMPA | *Marine Mammals Protection Act* |
| MNA | minimum number alive |
| MOU | memorandum of understanding |
| MPA | Marine Protected Area |
| MPMO | Major Projects Management Office |
| MPOI | Maximum Point of Impingement |
| MRA | Movement Restriction Area |
| MSRC | Marine Spill Response Corporation |
| MSZ | Moving Safety Zone |
| Mt | megatonne |
| MTSA | *Marine Transportation Security Act* |
| $N_2O$ | nitrous oxide |
| NAAQS | National Ambient Air Quality Standards |
| NEB | National Energy Board |
| *NEB Act* | *National Energy Board Act* |
| NGO | Non Governmental Organization |
| NM | nautical mile |
| NMFS | National Marine Fisheries Service |
| $NO_2$ | nitrogen dioxide |
| NOAA | National Oceanic and Atmospheric Administration |
| $NO_x$ | nitrogen oxides |
| NWA | National Wildlife Areas |
| OPEP | Oil Pollution Emergency Plan |
| OPPP | Oil Pollution Prevention Plan |
| OSA | oil-suspended particulate matter aggregate |
| OSRP | Oil Spill Response Plan |
| OSV | offshore supply vessel |
| $P_{50}$ | $50^{th}$ percentile |
| $P_{90}$ | $90^{th}$ percentile |
| PAH | polycyclic aromatic hydrocarbon |
| PHC | petroleum hydrocarbon |
| PM | particulate matter |
| PMV | Port Metro Vancouver |
| PPA | Pacific Pilotage Authority |
| ppb | parts per billion |
| PPE | personal protective equipment |
| ppt | parts per thousand |
| PPU | Portable Pilotage Unit |
| PSL | Permissible Sound Levels |
| PTS | Permanent Threshold Shifts |
| RCA | Rockfish Conservation Area |
| REET | Regional Environmental Emergency Team |
| RMS | Root Mean Square |
| RP | Responsible Party |
| RSA | Regional Study Area |

| Term | Meaning |
|---|---|
| RWDI | Rowan Williams Davies and Irwin Inc |
| SARA | *Species at Risk Act* |
| SCAT | Shoreline clean-up and assessment techniques |
| SDR | Special Drawing Right |
| SEAPRO | Southeast Alaska Petroleum Response Organization |
| SEL | Sound Exposure Level |
| SMIT | SMIT Harbour Towage Inc |
| SMS | Safety Management Systems |
| $SO_2$ | sulphur dioxide |
| SOLAS | Safety of Life at Sea |
| SOPEP | Shipboard Oil Pollution Emergency Plan |
| SOPF | Ship-source Oil Pollution Fund |
| $SO_x$ | sulphur oxides |
| SPL | Sound Pressure Level |
| Stantec | Stantec Consulting Ltd |
| STCW | Standards of Training, Certification and Watchkeeping for Seafarers |
| TBT | tributyl tin |
| TC | Transport Canada |
| TERA | TERA Environmental Consultants |
| TERMPOL | Technical Review Process of Marine Terminal Systems and Transshipment Sites |
| TEZ | Tanker Exclusion Zone |
| the Panel | the Federal Tanker Safety Expert Panel |
| the Project | Trans Mountain Expansion Project |
| TMEP | Trans Mountain Expansion Project |
| TMPL system | Trans Mountain pipeline system |
| TMRU | traditional marine resource use |
| TPH | total petroleum hydrocarbons |
| Trans Mountain | Trans Mountain Pipeline ULC |
| TSB | Transportation Safety Board |
| TSP | total suspended particulate |
| TSS | Traffic Separation Scheme |
| TTS | Temporary Threshold Shifts |
| US | United States |
| USCG | United States Coast Guard |
| VCHA | Vancouver Coastal Health Authority |
| VECs | valued ecosystem component |
| VIHA | Vancouver Island Health Authority |
| Vista Strategy | Vista Strategy Corp |
| VLCC | very large crude carrier |
| VOCs | volatile organic compound |
| VSCs | valued social component |
| VTS | Vessel Traffic Services |
| WCMRC | Western Canada Marine Response Corporation |
| WDFW | Washington State Department of Fish and Wildlife |
| WMA | Wildlife Management Area |
| YVR | Vancouver International Airport |
| ZOI | zone of influence |

# 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<br>Volume 3B Section 1.2.1 | -- |
| 2. | The principles and goals of consultation for the project. | Volume 3A Section 1.2.2<br>Volume 3B Section 1.2.2<br>Volume 5A Section 3.2.1<br>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<br>Volume 3B Section 1.3<br>Volume 5A Section 3.1.1, 3.2.2<br>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<br>Volume 3B Section 1.5 Table 1.5.1<br>Volume 5A Section 3.1.5, 3.2.4<br>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:<br>• Written statement by qualified professional engineer<br>• Description of the designs and measures required to safeguard the pipeline | Volume 4A Section 2.9 | -- |
| 8. | If directional drilling involved:<br>• Preliminary feasibility report<br>• 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:<br>• Welding specifications and procedures<br>• 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<br>• Sections 5.0 and 6.0<br>Volume 5B: ESA - Socio-Economic<br>• Sections 5.0 and 6.0<br>Volume 5C: ESA - Biophysical Technical Reports<br>Volume 5D: ESA - Socio-Economic Technical Reports | **Volume 8A: Marine Transportation**<br>• **Section 4.2**<br>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:<br>i. Table A-2 – Filing Requirements for Biophysical Elements; or<br>ii. Table A-3 – Filing Requirements for Socio-economic Elements. | Volume 5A: ESA - Biophysical<br>• Sections 5.0 and 6.0<br>Volume 5B: ESA - Socio-Economic<br>• Sections 5.0 and 6.0<br>Volume 5C: ESA - Biophysical Technical Reports<br>Volume 5D: ESA - Socio-Economic Technical Reports | **Volume 8A: Marine Transportation**<br>• **Section 4.2**<br>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:<br>• information and data collected;<br>• analysis completed;<br>• conclusions reached; and<br>• 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<br>• Sections 5.0 and 6.0<br>Volume 5B: ESA - Socio-Economic<br>• Sections 5.0 and 6.0<br>Volume 5C: ESA - Biophysical Technical Reports<br>Volume 5D: ESA - Socio-Economic Technical Reports | **Volume 8A: Marine Transportation**<br>• **Section 4.2**<br>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<br>• Sections 5.0 and 6.0<br>Volume 5B: ESA - Socio-Economic<br>• Sections 5.0 and 6.0<br>Volume 5C: ESA - Biophysical Technical Reports<br>Volume 5D: ESA - Socio-Economic Technical Reports | **Volume 8A: Marine Transportation**<br>• **Section 4.2**<br>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<br>• Sections 3.0, 5.0 and 6.0<br>Volume 5B: ESA - Socio-Economic<br>• Sections 3.0, 5.0 and 6.0<br>Volume 5C: ESA - Biophysical Technical Reports<br>Volume 5D: ESA - Socio-Economic Technical Reports | **Volume 8A: Marine Transportation**<br>• **Sections 3.0 and 4.2**<br>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<br>• Section 7.0<br>Volume 5B: ESA - Socio-Economic<br>• Section 7.0<br>Volume 7: Risk Assessment and Management of Pipeline and Facility Spills<br>• Sections 6.0, 7.0 and 8.0<br>• Technical Reports | **Volume 8A: Marine Transportation**<br>• **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<br>• Section 7.0<br>Volume 5B: ESA - Socio-Economic<br>• Section 7.0<br>Volume 5C: ESA - Biophysical Technical Reports<br>Volume 5D: ESA - Socio-Economic Technical Reports<br>Volume 7: Risk Assessment and Management of Pipeline and Facility Spills<br>• Sections 6.0, 7.0 and 8.0<br>• Technical Reports | **Volume 8A: Marine Transportation**<br>• **Sections 4.3, 5.6 and 5.7**<br>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<br>• Section 7.0<br>Volume 5B: ESA - Socio-Economic<br>• Section 7.0<br>Volume 5C: ESA - Biophysical Technical Reports<br>Volume 5D: ESA - Socio-Economic Technical Reports<br>Volume 6B: Pipeline Environmental Protection Plan (EPP)<br>Volume 6C: Facilities EPP<br>Volume 6D: Westridge Marine Terminal EPP<br>Volume 6E: Environmental Alignment Sheets<br>Volume 7: Risk Assessment and Management of Pipeline and Facility Spills<br>• Sections 2.0, 3.0, 4.0, 6.0, 7.0, and 8.0<br>• Technical Reports | **Volume 8A: Marine Transportation**<br>• **Sections 4.3, 5.1, 5.3, 5.6 and 5.7**<br>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<br>• Section 7.0<br>Volume 5B: ESA - Socio-Economic<br>• Section 7.0<br>Volume 6A: Environmental Compliance<br>Volume 6B: Pipeline EPP<br>Volume 6C: Facilities EPP<br>Volume 6D: Westridge Marine Terminal EPP<br>Volume 6E: Environmental Alignment Sheets<br>Volume 7: Risk Assessment and Management of Pipeline and Facility Spills<br>• Sections 2.0, 3.0, 4.0, 6.0, 7.0 and 8.0 | **Volume 8A: Marine Transportation**<br>• **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<br>• Section 7.0<br>Volume 5B: ESA - Socio-Economic<br>• Section 7.0<br>Volume 6B: Pipeline EPP<br>Volume 6C: Facilities EPP<br>Volume 6D: Westridge Marine Terminal EPP<br>Volume 7: Risk Assessment and Management of Pipeline and Facility Spills<br>• Sections 2.0, 4.0, 6.0, 7.0 and 8.0 | **Volume 8A: Marine Transportation**<br>• **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<br>• Section 7.0<br>Volume 5B: ESA - Socio-Economic<br>• Section 7.0 | **Volume 8A: Marine Transportation**<br>• **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<br>• Section 7.0<br>Volume 5B: ESA - Socio-Economic<br>• Section 7.0 | **Volume 8A: Marine Transportation**<br>• **Section 4.3** | --- |
| 3. | Evaluate significance of residual adverse environmental and socio-economic effects against the defined criteria. | Volume 5A: ESA - Biophysical<br>• Section 7.0<br>Volume 5B: ESA - Socio-Economic<br>• Section 7.0 | **Volume 8A: Marine Transportation**<br>• **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<br>• Section 7.0<br>Volume 5B: ESA - Socio-Economic<br>• Section 7.0 | **Volume 8A: Marine Transportation**<br>• **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<br>• Section 8.0<br>Volume 5B: ESA - Socio-Economic<br>• Section 8.0 | **Volume 8A: Marine Transportation**<br>• **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<br>• Section 8.0<br>Volume 5B: ESA - Socio-Economic<br>• Section 8.0 | **Volume 8A: Marine Transportation**<br>• **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<br>• Section 8.0<br>Volume 5B: ESA - Socio-Economic<br>• Section 8.0 | **Volume 8A: Marine Transportation**<br>• **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<br>• Section 8.0<br>Volume 5B: ESA - Socio-Economic<br>• Section 8.0 | **Volume 8A: Marine Transportation**<br>• **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:<br>• consider the various components, phases and activities associated with the applicant's project that could interact with other physical work or activities;<br>• provide a description of the extent of the cumulative effects on valued components; and<br>• 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<br>• Section 8.0<br>Volume 5B: ESA - Socio-Economic<br>• Section 8.0 | **Volume 8A: Marine Transportation**<br>• **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<br>• Section 8.0<br>Volume 5B: ESA - Socio-Economic<br>• Section 8.0 | **Volume 8A: Marine Transportation**<br>• **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<br>• Section 8.0<br>Volume 5B: ESA - Socio-Economic<br>• Section 8.0 | **Volume 8A: Marine Transportation**<br>• **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<br>• Section 8.0<br>Volume 5B: ESA - Socio-Economic<br>• Section 8.0 | **Volume 8A: Marine Transportation**<br>• **Section 4.4** | --- |
| 3. | Evaluate the significance of adverse residual cumulative effects against the defined criteria. | Volume 5A: ESA - Biophysical<br>• Section 8.0<br>Volume 5B: ESA - Socio-Economic<br>• Section 8.0 | **Volume 8A: Marine Transportation**<br>• **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<br>• Section 8.0<br>Volume 5B: ESA - Socio-Economic<br>• Section 8.0 | **Volume 8A: Marine Transportation**<br>• **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<br>• Section 7.0<br>Volume 5B: ESA - Socio-Economic<br>• Section 7.0<br>Volume 6A: Environmental Compliance<br>Volume 6B: Pipeline EPP<br>Volume 6C: Facilities EPP<br>Volume 6D: Westridge Marine Terminal EPP | **Volume 8A: Marine Transportation**<br>• **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<br>• Section 7.0<br>Volume 5B: ESA - Socio-Economic<br>• Section 7.0<br>Volume 6A: Environmental Compliance<br>Volume 6B: Pipeline EPP<br>Volume 6C: Facilities EPP<br>Volume 6D: Westridge Marine Terminal EPP | **Volume 8A: Marine Transportation**<br>• **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<br>• Sections 9.0 and 10.0<br>Volume 5B: ESA - Socio-Economic<br>• Sections 9.0 and 10.0<br>Volume 6A: Environmental Compliance<br>Volume 6B: Pipeline EPP (Socio-Economic Management Plan of Appendix C) | **Volume 8A: Marine Transportation**<br>• **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<br>• Section 10.0<br>Volume 5B: ESA - Socio-economic<br>• 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<br>• Sections 5.0, 6.0 and 7.0 | N/A | --- |
| Soil and soil productivity | | Volume 5A: ESA - Biophysical<br>• Sections 5.0, 6.0, 7.0 and 8.0<br>Volume 5C: ESA - Biophysical Technical Reports<br>• Soil Assessment Technical Report<br>Volume 7: Risk Assessment and Management of Pipeline and Facility Spills<br>• Section 5.3, 6.0 and 7.0 | N/A | --- |
| Water quality and quantity (onshore and marine) | | Volume 5A: ESA - Biophysical<br>• Sections 5.0, 6.0, 7.0 and 8.0<br>Volume 5C: ESA - Biophysical Technical Reports<br>• Groundwater Technical Report<br>• Fisheries (Alberta) Technical Report<br>• Fisheries (British Columbia) Technical Report<br>• Wetland Evaluation Technical Report<br>• Marine Sediment and Water Quality – Westridge Marine Terminal Technical Report<br>Volume 7: Risk Assessment and Management of Pipeline and Facility Spills<br>• Section 7.0<br>• Quality Ecological Risk Assessment of Pipeline Spills Technical Report | **Volume 8A: Marine Transportation**<br>• **Sections 4.2, 4.3, 4.4, 5.6 and 5.7**<br>Volume 8B: Technical Reports<br>• Ecological Risk Assessment of Marine Transportation Spills Technical Report | --- |
| Air emissions (onshore and marine) | | Volume 5A: ESA - Biophysical<br>• Sections 5.0, 6.0, 7.0 and 8.0<br>Volume 5C: ESA - Biophysical Technical Reports<br>• Marine Air Quality and Greenhouse Gas – Marine Transportation Technical Report<br>• Air Quality and Greenhouse Gas Emissions Technical Report<br>Volume 7: Risk Assessment and Management of Pipeline and Facility Spills<br>• Section 7.0 | **Volume 8A: Marine Transportation**<br>• **Sections 4.2, 4.3, 4.4, 5.6 and 5.7**<br>Volume 8B: Technical Reports<br>• Marine Air Quality and Greenhouse Gas Emissions | --- |
| Greenhouse gas emissions (onshore and marine) | | Volume 5A: ESA - Biophysical<br>• Sections 5.0, 6.0 and 7.0<br>Volume 5C: ESA - Biophysical Technical Reports<br>• Air Quality and Greenhouse Gas Emissions Technical Report | **Volume 8A: Marine Transportation**<br>• **Sections 4.2 and 4.3**<br>Volume 8B: Technical Reports<br>• Marine Air Quality and Greenhouse Gas Emissions | --- |
| Acoustic environment (onshore and marine) | | Volume 5A: ESA - Biophysical<br>• Sections 5.0, 6.0, 7.0, and 8.0<br>Volume 5C: ESA - Biophysical Technical Reports<br>• Acoustic Environment Technical Report | **Volume 8A: Marine Transportation**<br>• **Sections 4.2, 4.3 and 4.4**<br>Volume 8B: Technical Reports<br>• Marine Noise (Atmospheric) | --- |
| Fish and fish habitat (onshore and marine), including any fish habitat compensation required | | Volume 5A: ESA - Biophysical<br>• Sections 5.0, 6.0, 7.0 and 8.0<br>Volume 5C: ESA - Biophysical Technical Reports<br>• Fisheries (Alberta) Technical Report<br>• Fisheries (British Columbia) Technical Report<br>• Marine Resources - Westridge Marine Terminal Technical Report<br>Volume 7: Risk Assessment and Management of Pipeline and Facility Spills<br>• Sections 6.0, 7.0 and 8.0<br>• Qualitative Ecological Risk Assessment of Pipeline Spills Technical Report | **Volume 8A: Marine Transportation**<br>• **Sections 4.2, 4.3, 4.4, 5.6 and 5.7**<br>Volume 8B: Technical Reports<br>• Marine Resources – Marine Transportation Technical Report<br>• 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<br>• Sections 5.0, 6.0, 7.0 and 8.0<br>Volume 5C: ESA - Biophysical Technical Reports<br>• Wetland Evaluation Technical Report<br>Volume 7: Risk Assessment and Management of Pipeline and Facility Spills<br>• Sections 7.0 and 8.0<br>• Qualitative Ecological Risk Assessment of Pipeline Spills Technical Report | N/A | --- |
| | Vegetation | Volume 5A: ESA - Biophysical<br>• Sections 5.0, 6.0, 7.0 and 8.0<br>Volume 5C: ESA - Biophysical Technical Reports<br>• Vegetation Technical Report<br>Volume 7: Risk Assessment and Management of Pipeline and Facility Spills<br>• Sections 7.0 and 8.0<br>• Qualitative Ecological Risk Assessment of Pipeline Spills Technical Report | N/A | --- |
| | Wildlife and wildlife habitat (onshore and marine) | Volume 5A: ESA - Biophysical<br>• Sections 5.0, 6.0, 7.0 and 8.0<br>Volume 5C: ESA - Biophysical Technical Reports<br>• Wildlife and Wildlife Habitat Technical Report<br>• Wildlife Modeling and Species Accounts Report<br>• Marine Resources –Westridge Marine Terminal Technical Report<br>• Marine Birds – Westridge Marine Terminal Technical Report<br>Volume 7: Risk Assessment and Management of Pipeline and Facility Spills<br>• Sections 6.0, 7.0 and 8.0<br>• Qualitative Ecological Risk Assessment of Pipeline Spills Technical Report | **Volume 8A: Marine Transportation**<br>• **Sections 4.2. 4.3, 4.4, 5.6 and 5.7**<br>Volume 8B: Technical Reports<br>• Marine Resources – Marine Transportation Technical Report<br>• Marine Birds – Marine Transportation Technical Report<br>• 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<br>• Sections 5.0, 6.0, 7.0 and 8.0<br>Volume 5C: ESA - Biophysical Technical Reports<br>• Fisheries (Alberta) Technical Report<br>• Fisheries (British Columbia) Technical Report<br>• Vegetation Technical Report<br>• Wildlife and Wildlife Habitat Technical Report<br>• Wildlife Modeling and Species Accounts Report<br>• Marine Resources –Westridge Marine Terminal Technical Report<br>• Marine Birds – Westridge Marine Terminal Technical Report<br>Volume 7: Risk Assessment and Management of Pipeline and Facility Spills<br>• Sections 6.0, 7.0 and 8.0<br>• Qualitative Ecological Risk Assessment of Pipeline Spills Technical Report | **Volume 8A: Marine Transportation**<br>• **Sections 4.2. 4.3, 4.4, 5.6 and 5.7**<br>Volume 8B: Technical Reports<br>• Marine Resources – Marine Transportation Technical Report<br>• Marine Birds – Marine Transportation Technical Report<br>• Marine Transportation Spills Ecological Risk Assessment Technical Report | --- |
| | Human occupancy and resource use (onshore and marine) | Volume 5B: ESA - Socio-Economic<br>• Sections 5.0, 6.0, 7.0 and 8.0<br>Volume 5D: ESA - Socio-Economic Technical Reports<br>• Socio-Economic Technical Report<br>• Managed Forest Areas Technical Report<br>• Agricultural Assessment Technical Report<br>Volume 7: Risk Assessment and Management of Pipeline and Facility Spills<br>• Sections 6.0, 7.0 and 8.0 | **Volume 8A: Marine Transportation**<br>• **Sections 4.2, 4.3, 4.4, 5.6 and 5.7**<br>Volume 8B: Technical Reports<br>• Marine Commercial, Recreational and Tourism Use – Marine Transportation Technical Report | --- |

| Filing # | Filing Requirement | In Application? References | Applicable Marine Transportation Elements | Not in Application? Explanation |
|---|---|---|---|---|
| | Heritage resources | Volume 5B: ESA - Socio-Economic<br>• Sections 5.0, 6.0 and 7.0<br>Volume 7: Risk Assessment and Management of Pipeline and Facility Spills<br>• Section 6.3.3 | N/A | --- |
| | Navigation and navigation safety | Volume 5B: ESA - Socio-Economic<br>• Sections 5.0, 6.0 and 7.0<br>Volume 5D: ESA - Socio-Economic Technical Reports<br>• Socio-Economic Technical Report | **Volume 8A: Marine Transportation**<br>• **Section 5.2** | --- |
| | Traditional land and resource use | Volume 5B: ESA - Socio-Economic<br>• Sections 5.0, 6.0, 7.0 and 8.0<br>Volume 5D: ESA - Socio-Economic Technical Reports<br>• Traditional Land and Resource Use Report<br>• Pipeline and Facilities Human Health Risk Assessment Technical Report<br>Volume 7: Risk Assessment and Management of Pipeline and Facility Spills<br>• Sections 6.0, 7.0 and 8.0<br>• Qualitative Ecological Risk Assessment of Pipeline Spills Technical Report | **Volume 8A: Marine Transportation**<br>• **Sections 4.2, 4.3, 4.4, 5.6 and 5.7**<br>Volume 8B: Technical Reports<br>• Traditional Marine Use Report for Marine Transportation<br>• Marine Transportation Human Health Risk Assessment Technical Report | --- |
| | Social and cultural well-being | Volume 5B: ESA - Socio-Economic<br>• Sections 5.0, 6.0, 7.0 and 8.0<br>Volume 5D: ESA - Socio-Economic Technical Reports<br>• Socio-Economic Technical Report<br>Volume 7: Risk Assessment and Management of Pipeline and Facility Spills<br>• Sections 6.0, 7.0 and 8.0 | N/A | --- |
| | Human health and aesthetics | Volume 5B: ESA - Socio-Economic<br>• Sections 5.0, 6.0, 7.0 and 8.0<br>Volume 5D: ESA - Socio-Economic Technical Reports<br>• Socio-Economic Technical Report<br>• Community Health Technical Report<br>• Viewshed Modelling Analysis Technical Report<br>• Pipeline and Facilities Human Health Risk Assessment Technical Report<br>Volume 7 Risk Assessment and Management of Pipeline and Facility Spills<br>• Sections 6.0, 7.0 and 8.0<br>• Qualitative Ecological Risk Assessment of Pipeline Spills Technical Report | Volume 7: Risk Assessment and Management of Pipeline and Facility Spills<br>• Qualitative Human Health Risk Assessment of Westridge Marine Terminal Technical Report<br>**Volume 8A: Marine Transportation**<br>• **Sections 4.2, 4.3, 4.4, 5.6 and 5.7**<br>Volume 8B: Technical Reports<br>• Marine Transportation Human Health Risk Assessment Technical Report<br>• Marine Transportation Spills Human Health Risk Assessment Technical Report | --- |
| | Infrastructure and services | Volume 5B: ESA - Socio-Economic<br>• Sections 5.0, 6.0, 7.0 and 8.0<br>Volume 5D: ESA - Socio-Economic Technical Reports<br>• Socio-Economic Technical Report<br>• Community Health Technical Report<br>Volume 7: Risk Assessment and Management of Pipeline and Facility Spills<br>• Sections 6.0, 7.0 and 8.0 | **Volume 8A: Marine Transportation**<br>• **Sections 4.2, 4.3, 4.4, 5.6 and 5.7**<br>Volume 8B: Technical Reports<br>• Marine Commercial, Recreational and Tourism Use – Marine Transportation Technical Report | --- |
| | Employment and economy | Volume 5B: ESA - Socio-Economic<br>• Sections 5.0, 6.0, 7.0 and 8.0<br>Volume 5D: ESA - Socio-Economic Technical Reports<br>• Socio-Economic Technical Report<br>• 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:<br>• Pipeline capacity before and after and size of increment<br>• 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:<br>• theoretical and sustainable capabilities of the existing and proposed facilities versus the forecasted requirements<br>• 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<br>• Locations and dimensions of known temporary work space and drawings of typical dimensions<br>• 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:<br>• Section 7.0<br>Volume 5B ESA - Socio-economic:<br>• Section 7.0<br>Volume 7 Risk Assessment and Management of Pipeline and Facility Spills<br>**Volume 8A Marine Transportation:**<br>• **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:<br>• Section 8.0<br>Volume 5B ESA - Socio-economic:<br>• Section 8.0<br>**Volume 8A Marine Transportation:**<br>• **Section 4.4** |
| the significance of the effects referred to in paragraph (a); | s.19.1(b) | Volume 5A ESA - Biophysical:<br>• Sections 7.0 and 8.0<br>Volume 5B ESA - Socio-economic:<br>• Sections 7.0 and 8.0<br>**Volume 8A Marine Transportation:**<br>• **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<br>Volume 3B Aboriginal Engagement<br>Volume 3C Landowner Relations<br>Volume 5A ESA - Biophysical:<br>• Section 3.0<br>Volume 5B ESA - Socio-economic:<br>• Section 3.0<br>**Volume 8A Marine Transportation:**<br>• **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:<br>• Sections 7.0 and 8.0<br>Volume 5B ESA - Socio-economic:<br>• Sections 7.0 and 8.0<br>Volume 5C ESA – Biophysical Technical Reports<br>Volume 5D ESA - Socio-economic Technical Reports<br>Volume 6B Pipeline Environmental Protection Plan<br>Volume 6C Facilities Environmental Protection Plan<br>Volume 6D Westridge Marine Terminal Environmental Protection Plan<br>Volume 6E Environmental Alignment Sheets<br>**Volume 8A Marine Transportation:**<br>• **Sections 4.3, 4.4 and 5.0**<br>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:<br>• Section 10.0<br>Volume 5B ESA - Socio-economic:<br>• Section 10.0 |
| the purpose of the designated project; | s.19.1(f) | Volume 5A ESA - Biophysical:<br>• Section 2.0<br>Volume 5B ESA - Socio-economic:<br>• Section 2.0<br>**Volume 8A Marine Transportation:**<br>• **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:<br>• Sections 2.0 and 4.0<br>Volume 5B ESA - Socio-economic:<br>• Sections 2.0 and 4.0<br>**Volume 8A Marine Transportation:**<br>• **Section 2.2** |
| any change to the designated project that may be caused by the environment; | s.19.1(h) | Volume 5A ESA - Biophysical:<br>• Section 7.10<br>**Volume 8A Marine Transportation:**<br>• **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**<br>Volume 8B Technical Reports<br>Volume 8C TERMPOL Reports<br>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:<br>• Sections 5.0, 6.0, 7.0 and 8.0<br>Volume 5B ESA - Socio-economic:<br>• Sections 5.0, 6.0, 7.0 and 8.0<br>Volume 5C ESA - Biophysical Technical Reports<br>Volume 5D ESA - Socio-economic Technical Reports<br>**Volume 8A Marine Transportation:**<br>• **Sections 4.2, 4.3 and 4.4**<br>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:<br>• Sections 5.0, 6.0, 7.0 and 8.0<br>Volume 5C ESA - Biophysical Technical Reports<br>**Volume 8A Marine Transportation:**<br>• **Sections 4.2, 4.3, 4.4 and 5.0**<br>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:<br>• Sections 5.0, 6.0, 7.0 and 8.0<br>Volume 5C ESA - Biophysical Technical Reports<br>**Volume 8A Marine Transportation:**<br>• **Sections 4.2, 4.3, 4.4 and 5.0**<br>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:<br>• Sections 5.0, 6.0, 7.0 and 8.0<br>Volume 5C ESA - Biophysical Technical Reports<br>**Volume 8A Marine Transportation:**<br>• **Sections 4.2, 4.3, 4.4 and 5.0**<br>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:<br>• Section 7.0<br>Volume 5B ESA - Socio-economic:<br>• Section 7.0 |

## CONCORDANCE TABLE WITH THE *CEA ACT, 2012*

| ***CEA Act, 2012* Requirement** | **Section in *CEA Act, 2012*** | **Application Volume and Section** |
|---|---|---|
| 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<br>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:**<br>• **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: | | |
| health and socio-economic conditions; | s.5(1)(c)(i) | Volume 5B ESA - Socio-economic:<br>• Sections 5.0, 6.0, 7.0 and 8.0<br>Volume 5D ESA - Socio-economic Technical Reports<br>**Volume 8A Marine Transportation:**<br>• **Sections 4.3 and 4.4**<br>Volume 8B Technical Reports |
| physical and cultural heritage; | s.5(1)(c)(ii) | Volume 5B ESA - Socio-economic:<br>• 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:<br>• Sections 5.0, 6.0, 7.0 and 8.0<br>Volume 5D ESA - Socio-economic Technical Reports<br>**Volume 8A Marine Transportation:**<br>• **Sections 4.3 and 4.4**<br>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:<br>• Sections 5.0, 6.0 and 7.0 |

# 1.0 INTRODUCTION

## 1.1 Project Overview

Trans Mountain Pipeline ULC (Trans Mountain) is a Canadian corporation with its head office located in Calgary, Alberta (AB). 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 2015/2016 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.

While Trans Mountain does not own or operate the vessels calling at the Westridge Marine Terminal, it is responsible for ensuring the safety of the terminal operations. In addition to Trans Mountain's own screening process and terminal procedures, all vessels calling at Westridge must operate according to rules established by the International Maritime Organization (IMO), Transport Canada, the Pacific Pilotage Authority (PPA), and Port Metro Vancouver (PMV). Although Trans Mountain is not responsible for vessel operations, it is an active member in the maritime community and works with BC maritime agencies to promote best practices and facilitate improvements to ensure the safety and efficiency of tanker traffic in the Salish Sea. Trans Mountain is a member of the Western Canada Marine Response Corporation (WCMRC), and works closely with WCMRC and other members to ensure that WCMRC remains capable of responding to spills from vessels loading or unloading product or transporting it within their area of jurisdiction.

Currently, in a typical month, five vessels are loaded with heavy crude oil, primarily diluted bitumen, at the terminal. The expanded system will be capable of serving 34 Aframax class vessels per month, with actual demand driven by market conditions. The maximum size of vessels (Aframax class) served at the terminal will not change as part of the Project. Similarly, the future cargo will continue to be crude oil, primarily diluted bitumen. Of the 141,500 $m^3$/d (890,000 bbl/d) capacity of the expanded system, up to 100,200 $m^3$/d (630,000 bbl/d) may be delivered to the Westridge Marine Terminal for shipment.

In addition to tanker traffic, the terminal typically loads three barges with oil per month and receives one or two barges of jet fuel per month for shipment on a separate pipeline system that serves Vancouver International Airport (YVR). Barge activity is not expected to change as a result of the expansion.

## 1.2 Scope of Volume 8A

To understand the potential effects of the Project-related increase on marine traffic, Trans Mountain undertook an Environmental and Socio-Economic Assessment (ESA), as well as a quantitative marine risk assessment of the potential for oil spills in the marine environment. The results of these activities are incorporated in Volume 8A, Marine Transportation, and address the requirements of the NEB's List of Issues (July 29, 2013), the Canadian Environmental Assessment Act, 2012 (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). Trans Mountain has initiated the Technical Review Process of Marine Terminal Systems and Transshipment Sites (TERMPOL) under Transport Canada's jurisdiction. TERMPOL is a federal review process focusing on safety and marine transportation components of a project (Section 1.4.1.8).

Trans Mountain has contracted a number of studies, including the previously mentioned quantitative risk assessment, to provide recommendations to Transport Canada, the TERMPOL Review Committee, and other relevant responsible authorities to improve the safety of marine transportation related to the Project. These studies were also used as the basis for Volume 8A, Marine Transportation.

The purpose of Volume 8A, Marine Transportation, is to provide the NEB with information to understand the environmental and socio-economic effects resulting from the increase in marine traffic related to the Project. The results of the studies to meet the TERMPOL requirements have been incorporated into the ESA where relevant and the referenced studies are included in Volume 8C.

Volume 8A, Marine Transportation, is supported by two volumes of technical studies:

- Volume 8B: Technical Reports includes all of the technical reports developed in support of the ESA in Volume 8A.
- Volume 8C: TERMPOL Study Reports includes all of the technical reports prepared in support of the TERMPOL process.

## 1.3 Geographic Considerations

The discussion of the increase in marine transportation related to the Project takes place within a geographic area extending between the Westridge Marine Terminal and a location known as "Buoy J" (*i.e.*, the 12 mile nautical territorial limit) at the entrance to the Juan de Fuca Strait, covering the internationally established shipping lanes and the waters and lands closely adjoining these lanes (Figure 1.3.1).

Figure 1.3.1 shows the established international vessel traffic separation scheme (TSS) that is the foundation of the existing marine transportation network in the Salish Sea, including tankers and vessels bound for and leaving the Westridge Marine Terminal.


TRANS MOUNTAIN

**FIGURE 1.3.1**

**REGIONAL LOCATION OF MARINE SHIPPING LANES**

**TRANS MOUNTAIN EXPANSION PROJECT**

- Reference Kilometre Post (RK)
- Kilometre Post (KP)
- Trans Mountain Pipeline (TMPL)
- Trans Mountain Expansion Project Proposed Pipeline Corridor
- Terminal
- Existing Pump Station
- Highway
- Road
- 12 Nautical Mile Limit (Territorial Sea)
- Limit of Exclusive Economic Zone (EEZ)
- International Boundary
- Marine Vessel Outbound Shipping Lane
- Marine Vessel Inbound Shipping Lane
- Traffic Separation Scheme
- City / Town / District Municipality
- Indian Reserve / Métis Settlement
- National Park
- Provincial / State Park
- Protected Area/Natural Area/ Provincial Recreation Area/Wilderness Provincial Park/Conservancy Area



Projection: 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: BC Forests, Lands and Natural Resource Operations, 2012 & ESRI, 2005; Geopolitical Boundaries: IHS Inc., 2011, BC FLNRO, 2007 & ESRI, 2005, Natural Resources Canada, 2012; First Nation Lands: Government of Canada, 2013 & IHS Inc., 2011; Hydrology: IHS Inc., 2004, United States National Imagery and Mapping Agency, 2000, Natural Resources Canada, 2010; Parks and Protected Areas: Natural Resources Canada, 2013, BC FLNRO, 2008; CHS: provided by KMC, 2013; Marine Shipping Lanes: Moffatt and Nichol, 2013; Hillshade: TERA, derived from Geobase; 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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| DATE: December 2013 | TERA REF.: 7894 | REVISION: 0 |
| SCALE: 1:650,000 | PAGE SIZE: 11x17 | DISCIPLINE: MR |
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ALL LOCATIONS APPROXIMATE

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## 1.4 Regulatory Framework for Marine Transportation

An existing regulatory framework emphasizing navigational safety, accident prevention, emergency preparedness and response, and financial liability/compensation in the case of an oil spill in a marine environment in Canada governs existing and future marine vessel traffic calling at the Westridge Marine Terminal.

The following sub-sections provide an overview of the legislative tools and international conventions relevant to the Project-related increase in marine traffic (Section 1.4.1), and the roles and responsibilities of the Canadian and American organizations that would be involved in managing the increase in marine traffic related to the Project (Section 1.4.2).

Section 1.4.3 illustrates how the various legislative instruments and agencies work together to ensure the navigational safety, and thus spill prevention, for a tanker transiting Canadian waters to and from the Westridge Marine Terminal.

Section 1.4.4 illustrates how the various parties described in Section 1.4.2 work together to provide emergency preparedness and response capability in the event of an oil spill in a marine environment in Canadian waters.

Lastly, Section 1.4.5 describes the various federal and provincial initiatives underway to improve marine transportation in Canada.

### *1.4.1 Legislation and Conventions*

Shipping activities within the jurisdiction of Canada are regulated through various legislative tools. Acts, regulations and international conventions that are relevant to Project-related marine transportation are briefly described in the following sub-sections.

#### *1.4.1.1 Canada Shipping Act, 2001 and Regulations*

The *Canada Shipping Act, 2001* is the principal legislation governing safety in marine transportation, as well as protection of the marine environment in Canada. It applies to Canadian vessels operating in all waters and to all vessels operating in Canadian waters, including those calling at the Westridge Marine Terminal.

The *Canada Shipping Act, 2001* makes use of modern legislative practices and supports the application of risk management techniques. The *Canada Shipping Act, 2001*, combined with international conventions, provides the legislative framework for Transport Canada to fulfill its mandate related to marine safety, pollution prevention, enforcement, and oil spill preparedness and response programs (Section 1.4.2).

The *Response Organizations and Oil Handling Facilities Regulation* under the *Canada Shipping Act, 2001* establishes certified response organizations to provide emergency response capability, leadership and support in the case of an oil spill in a marine environment. With respect to the Project, WCMRC is certified by Transport Canada to respond to oil spills on the West Coast of Canada (Section 1.4.2, WCMRC). Trans Mountain is a shareholder and member of WCMRC.

Under the *Canada Shipping Act, 2001*, the following parties must have an arrangement for emergency response services in place with a certified response organization in order to operate in Canadian waters:

- ships and barges greater than 150 gross tonnage carrying oil as a cargo;
- all other ships greater than 400 gross tonnage that carry oil as fuel for their own use; and
- oil handling facilities (*i.e.*, terminals, such as the Westridge Marine Terminal) that transfer oil to or from the ships.

*Canada Shipping Act, 2001* recognizes and incorporates international shipping conventions (Section 1.4.1.9), which include those on ship construction (*i.e.*, oil tankers in Canadian Waters must be double-hulled), safety, prevention of pollution, training of seafarers, ship routing, salvage, search and rescue, minimum crewing requirements and crew welfare. *Canada Shipping Act, 2001* harmonizes Canada's shipping rules and regulations with international shipping laws, rules and regulations. *Canada Shipping Act, 2001* is applicable to persons, ships and oil handling facilities, and any individual or corporation violating the law may be assessed penalties that are determined based on the seriousness of each violation.

The *Canada Shipping Act, 2001* could be further strengthened by the Government of Canada's proposed amendments (Bill C-3) that would (Transport Canada 2013a):

- strengthen the current requirements for pollution prevention and response at oil handling facilities;
- increase Transport Canada's oversight and enforcement capacity by equipping marine safety inspectors with the tools to enforce compliance;
- introduce new offences for contraventions of the *Canada Shipping Act, 2001* and extend penalties relating to pollution; and
- enhance response to oil spill incidents by removing legal barriers that could otherwise block agents of Canadian response organizations from participating in clean-up operations.

#### *1.4.1.2 Canada Marine Act*

Pursuant to the *Canada Marine Act,* in January 2008 the Government of Canada established the Vancouver Fraser Port Authority, doing business as PMV. PMV is a non-shareholder, financially self-sufficient corporation accountable to the federal Minister of Transport. The Westridge Marine Terminal is within PMV and calling vessels are subject to PMV's rules and regulations (Section 1.4.2.4).

#### *1.4.1.3 Pilotage Act*

As established within the *Pilotage Act,* the PPA is responsible for enacting regulations regarding the operation, maintenance and administration of pilotage services (*i.e.*, marine pilots for certain types of vessels in designated areas) including compulsory pilotage and the qualifications for holders of Licences and Pilotage Certificates within the PPA's jurisdiction.

A marine pilot is a mariner who guides vessels through hazardous or congested waters. Marine pilots are expert ship-handlers who possess detailed navigational knowledge of local waterways and have control over the speed, direction, and movement of a vessel to ensure it safely reaches its destination.

The transit of inbound and outbound tankers (*i.e.,* tankers carrying oil) to and from the Westridge Marine Terminal is also governed by the rules established by the PPA and in cooperation with PMV. With respect to tankers inbound and outbound from the Westridge Marine Terminal, the rules include:

- Mandatory pilotage for empty tankers inbound to the Westridge Marine Terminal. Tankers pick up a pilot from the Victoria pilot station at Brotchie Ledge. Empty tankers inbound to the Westridge Marine Terminal do not require a tug escort prior to entering PMV; however, a tug escort is required through the Second Narrows Movement Restriction Area (MRA).
- Tankers of the Aframax size are limited to crossing the Second Narrows MRA during daylight hours only, whether empty or laden. This rule and other requirements for the MRA including tug escorts and draft limitations are defined in PMV's Harbour Operations Manual which was developed with input from the PPA.
- Mandatory dual pilotage for laden tankers outbound from the Westridge Marine Terminal. Two pilots, each carrying a Portable Pilotage Unit (PPU), guide laden tankers from the Westridge Marine Terminal back to the Victoria pilot station near Brotchie Ledge, from where the laden tanker proceeds out to the Pacific Ocean under the guidance of the shipmaster, monitored by the Canadian Coast Guard (CCG) and United States (US) Coast Guard (USCG). The PPU is a computer based portable navigation system that incorporates GPS and other technology to provide the pilot an accurate navigation system that is independent of the ship's own systems.
- The PPA requires all laden bulk liquid vessels, including crude oil tankers, over 40,000 dead weight tonnage (DWT) (*i.e.,* this would include all tankers outbound from the Westridge Marine Terminal) to have a tethered tug escort from 2.0 nautical miles (NM) north of East Point in the Boundary Pass/Haro Strait to Victoria. The tug is untethered after Victoria, but remains in close proximity escort of the tanker until it clears Race Rocks.

#### *1.4.1.4 Canadian Environmental Protection Act*

The *Canadian Environmental Protection Act* (CEPA) declares that the protection of the environment is essential to the well-being of Canadians and that the primary purpose of the CEPA is to contribute to sustainable development through pollution prevention. CEPA recognizes the responsibility of users and producers in relation to toxic substances, pollutants and wastes, and has adopted the "polluter pays" principle. If an enforcement officer has reasonable grounds to believe that the owner or master of a ship has committed an offence under the CEPA, the enforcement officer may make a detention order in respect of the ship. The CEPA applies to all vessels calling at the Westridge Marine Terminal.

#### *1.4.1.5 Transportation of Dangerous Goods Act and Regulation*

Transport Canada, based on risks, develops safety standards and regulations, provides oversight and gives expert advice through the Canadian Transport Emergency Centre, on accidents related to dangerous goods that are transported by all modes and regulated under the *Transportation of Dangerous Goods Act* and associated regulations (Transport Canada 2013b).

#### *1.4.1.6 Marine Liability Act*

The *Marine Liability Act* (*MLA*) establishes the framework for handling marine liability and compensation in Canada and reflects Canada's membership to international conventions administered by the International Oil Pollution Compensation (IOPC) Funds (*i.e.*, the IOPC Fund and the Supplementary Fund Protocol; or the international funds) and the *Civil Liability Convention*.

The *MLA* also establishes the Ship-source Oil Pollution Fund (SOPF) that provides funding for spills from all classes of vessels in Canadian waters. The SOPF provides funding in addition to the funding available under the international funds. The classes of claims for which the SOPF may be liable include: claims for oil pollution damage; claims for costs and expenses of oil spill clean-up, preventive measures and monitoring; and claims for oil pollution damage and clean-up costs where the cause of the oil pollution damage is unknown (Transport Canada 2013c). As well, a widely defined class of parties in the Canadian fishing industry may claim against the SOPF for loss of income caused by an oil spill from a vessel and not recoverable otherwise under the *MLA* (Transport Canada 2013d).

Both Canada's and the international frameworks are based on the principle of "polluter pays", which makes the polluter liable for all response costs and damages associated with an oil spill (Transport Canada 2013c). In the event of an oil spill from a tanker in Canadian waters, the owner of a tanker (*i.e.*, the Responsible Party) would be liable for the cost of clean-up and compensation to affected parties subject to the limits of their liability.

The international funds are financed through levies paid by parties in member countries, such as Canada, that receive crude or fuel oil. In Canada the contribution is paid by the SOPF on behalf of Canadian oil receivers. Under the *MLA*, it is mandatory for a party that receives more than 150,000 tons of oil annually to report the quantity to the SOPF administrator who consolidates the national figure and makes payment to the international funds.

The unit of account in the international funds is the Special Drawing Right (SDR). The International Monetary Fund calculates SDR currency amounts daily by summing the value of a number of currencies (*i.e.,* the US dollar, the Japanese Yen, the Euro, and pound sterling), based on market values and in US dollars (International Monetary Fund 2013, International Oil Pollution Fund Compensation Funds 2012). The currency conversions provided in the following paragraphs are in Canadian dollars and are based on the amounts reported by the Ship-source Oil Pollution Fund Annual Report 2012 to 2013 (Chenier pers. comm.).

In the event of an oil spill in a marine environment, funding is available in a tiered system:

- The first level of funding for emergency response, clean-up and compensation to affected parties is from the responsible party's protection and indemnity insurance. Ship owners and operators obtain insurance coverage against third-party liability through a protection and indemnity association of ship owners and operators (P&I Club), which would be a member of the International Group of

P&I Clubs (Transport Canada 2013c). The responsible party's liability is limited based on vessel tonnage to a maximum of about $136.76 million.

- If the responsible party's insurance is not adequate to cover costs and compensation, funds are available through the International Oil Pollution Compensation Fund ($172.50 million) and the Supplementary Fund Protocol ($833.34 million).
- Lastly, Canada maintains its own source of funding called the SOPF, which has up to $161.29 million of funding available.

In total, there is approximately $1.3 billion in funding available to address the costs of emergency response, clean-up and compensation in the event of an oil spill from a tanker.

The SOPF can also be a fund of first resort for claimants, including the Crown. Any party may file a claim with the SOPF administrator respecting loss or damage related to oil pollution from a vessel in Canadian waters. The SOPF administrator has the duty to investigate and assess claims filed with the SOPF. While a potential claim is paid out of the SOPF, the administrator is obliged to take all reasonable measures to recover the amount of compensation paid to the claimant from the responsible party.

#### *1.4.1.7 Marine Transportation Security Act*

The *Marine Transportation Security Act* (MTSA) provides for the security of marine transportation and is aligned with similar international regulations. In accordance with regulations established under the MTSA, PMV and the Westridge Marine Terminal established a Marine Security Level relevant to the conditions at the time. All vessels arriving at PMV or Westridge Marine Terminal must ensure that those conditions are in effect onboard prior to the vessel's arrival. The MTSA will continue to apply to tankers calling at the Westridge Marine Terminal after the Project is in operation.

#### *1.4.1.8 TERMPOL*

As noted, Trans Mountain requested to undertake a TERMPOL process focused on the increase in marine transportation related to the Project. The review process is chaired and led by Transport Canada and has involved other federal departments and stakeholders, as required. The review may consider safety measures above and beyond existing regulations to address site-specific circumstances.

In general and for any project, the TERMPOL process focuses on the marine transportation components of a project and examines the safety of tankers entering Canadian waters, navigating through channels, approaching berthing at a marine terminal and loading or unloading oil or gas.

With respect to the increase in existing marine traffic related to the TMEP, the TERMPOL process focuses on the effects of the incremental increase in marine traffic related to the Project. To fulfill the requirements of TERMPOL, Trans Mountain undertook a number of studies (Table 1.4.1). The relevant results of these studies have been incorporated into the ESA (Volume 8A, Sections 4.0 and 5.0). In particular, the results of a quantitative risk assessment informed the assessment of accidents and malfunctions, the description of spill prevention, emergency preparedness and response, and the identification of improved practices

(Volume 8A, Section 5.0). The relevant TERMPOL studies referenced in Volume 8A are provided in Volume 8C.

**TABLE 1.4.1**

**TERMPOL STUDIES COMPLETED FOR TMEP**

| TERMPOL Identifier | Title of Study | Where to Find in Volume 8C |
|---|---|---|
| TERMPOL 3.1 | Introduction | 8C-1 |
| TERMPOL 3.2 | Origin, Destination and Marine Traffic Volume Survey | 8C-2 |
| TERMPOL 3.3 | Fishery Resources Survey | 8C-3 |
| TERMPOL 3.5 | Route Analysis, Approach Characteristics and Navigability Survey | Combined with TERMPOL 3.12 |
| TERMPOL 3.6 | Special Underkeel Clearance Survey | 8C-4 |
| TERMPOL 3.7 | Transit Time and Delay Survey | 8C-5 |
| TERMPOL 3.8 | Casualty Data Survey | 8C-6 |
| TERMPOL 3.9 | Ship Specifications | 8C-7 |
| TERMPOL 3.10 | Site TERMPOL Plans and Technical Data | 8C-8 |
| TERMPOL 3.11 | Cargo Transfer and Transshipment Systems | 8C-9 |
| TERMPOL 3.12 | Channel, Manoeuvring, and Anchorage Elements | 8C-10 |
| TERMPOL 3.13 | Berth Procedures and Provisions | 8C-11 |
| TERMPOL 3.15 | General Analysis and Intended Methods of Reducing Risks | 8C-12 |
| TERMPOL 3.16 | Port Information Book | 8C-13 |
| TERMPOL 3.17 | Terminal Operations Manual | 8C-14 |
| TERMPOL 3.18 | Contingency Planning | 8C-15 |
| TERMPOL 3.19 | Oil Handling Facilities Requirements | 8C-16 |

**Note:** TERMPOL 3.4 and 3.14 are not relevant to the Project. Due to similarities in content the requirements of 3.5 and 3.12 have been combined into a single study to avoid repetition.

Trans Mountain has provided all of the TERMPOL studies listed in Table 1.4.1 to Transport Canada for review. In addition, Trans Mountain is seeking endorsement from Transport Canada on the proposed measures to improve navigational safety outlined in Volume 8A, Section 5.4.2, as Trans Mountain has no regulatory authority to implement the proposed measures. A summary of the TERMPOL process is provided in Volume 8C-1 (TERMPOL 3.1, TR 8C-1).

#### *1.4.1.9 International Conventions*

International conventions and standards developed by the IMO, in conjunction with regulatory instruments of its members such as Canada, aim to promote cooperation in reducing pollution and the risk of major incidents worldwide related to marine transportation. These international conventions address issues such as standards for ship construction, training and qualification of crew, and the safety of navigation.

Canada is a founding member of the IMO and has ratified all IMO conventions. There are several IMO conventions relevant to the Project that allow Transport Canada to fulfill its role regulating marine matters and also in the prevention and preparedness of marine oil pollution incidents (Transport Canada 2013e).

Some of the conventions more commonly referred to are listed below:

- The International Convention for the Prevention of Pollution from Ships (MARPOL) seeks to eliminate intentional pollution of the marine environment resulting from vessel operations and to minimize accidental discharges of pollutants. Transport Canada administers and enforces this convention through the *Canada Shipping Act, 2001* and regulations, which apply to all vessels calling at Westridge Marine Terminal.
- The International Convention on Oil Pollution Preparedness, Response and Cooperation is a framework that allows Canada to provide assistance to major incidents in other member states when requested and to seek assistance of international parties if required.
- The International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW), sets qualification standards for masters, officers and watch personnel on seagoing merchant ships. It has established global standards for basic and advanced requirements on training, certification and watchkeeping for seafarers on an international level. Tanker crews have to carry special STCW qualification certification in order to be employed on such vessels. The IMO audits the training standards of countries to ensure uniform standards are being met across the shipping industry.
- The International Convention for the Safety of Life at Sea (SOLAS) specifies minimum standards for the construction, equipment and operation of ships, compatible with their safety. Flag states are responsible for ensuring that ships under their flag comply with the requirements of SOLAS, and a number of certificates are prescribed in the convention as proof that this has been done. Control provisions also allow signatory governments, such as Canada, to inspect ships of other signatory states if there are clear grounds for believing that the ship and its equipment do not substantially comply with the requirements of the convention - this procedure is known as Port State Control (IMO 2013a).
- Canada is a signatory to both the Paris and Tokyo memoranda of understanding (MOU) on Port State Control. Port State Control is the inspection of foreign ships in national ports to verify that the condition of the ship and its equipment complies with the requirements of international regulations and that the ship is manned and operated in compliance with these rules (IMO 2013b). This mechanism enables Transport Canada to inspect foreign vessels before they enter Canadian waters, with the objective of barring the entry of sub-standard vessels.

#### *1.4.1.10 Trans-boundary Cooperation*

Canada participates in joint activities with the US to manage vessel traffic in the trans-boundary waters of the Juan de Fuca Strait. The current regulations, procedures and practices for marine navigation to and from the Westridge Marine Terminal through the Juan de Fuca Strait, described in Volume 8A, Sections 1.3 and 1.4, are based in part on the 1979 Agreement for the Cooperative Vessel Management System for the Juan de Fuca Region.

Canada, through the CCG, participates with the USCG to establish emergency preparedness and response capability in the event of an oil spill in or affecting trans-boundary waters. This cooperation was established formally under the Canada-US Joint Marine Pollution Contingency Plan.

### *1.4.2 Roles and Responsibilities for Navigational Safety, Emergency Response and Preparedness*

#### *1.4.2.1 Transport Canada*

Transport Canada is responsible for Canada's transportation policies and programs whereby it promotes safe, secure, efficient and environmentally responsible transportation. With respect to marine transportation, Transport Canada's regulations and standards fall under the *Canada Shipping Act, 2001* and the *Arctic Waters Pollution Protection Act*. Marine transportation in Canadian waters is also regulated by complementary international regulations established by the IMO. All of these regulatory tools provide the framework for Transport Canada's comprehensive marine safety inspection and enforcement programs. Transport Canada is also responsible for the *Navigable Waters Protection Act*, which requires approval for any works that may affect the navigability of certain navigable waters in Canada by a vessel of any size.

Canada is a signatory of the Paris and Tokyo MOU and conventions on international coordination of inspection requirements, and these requirements are also reflected in the *Canada Shipping Act, 2001*. Transport Canada inspects all foreign tankers before they enter Canadian waters on their first arrival, and annually after that. The use of international databases has helped prevent sub-standard vessels from accessing Canada's ports. Under international MOUs, Transport Canada can access the records from inspections by other signatory jurisdictions and shares Canadian results. Convention signatories publish annual reports ranking the performance of flag states, which are used as a basis to accept or deny entry of vessels.

Transport Canada has a National Aerial Surveillance Program for vessels within Canadian waters. Under the National Aerial Surveillance Program, Transport Canada performs aerial surveillance over all Canadian waters to detect pollution from ships, deterring potential polluters from dumping oil and other pollution while transiting Canadian waters. In 2011 to 2012, Transport Canada crews observed more than 12,000 vessels and detected 135 pollution occurrences nationally, with an estimated total volume of 1,014 litres of oil. There is an obligation for owners of vessels and operators of oil handling facilities to report marine spills to the CCG.

Transport Canada may recommend that marine polluters be prosecuted under the related acts based on evidence gathered by the National Aerial Surveillance Program crew as part of its duties to help enforce domestic and international laws. Transport Canada investigations have led to numerous successful prosecutions against marine polluters over the years, with some financial penalties reaching more than $100,000.

One part of Transport Canada's broad mandate that is relevant to the Project-related increase in marine transportation is Canada's Marine Oil Spill Preparedness and Response Regime (the Regime). Transport Canada is the lead federal regulatory agency response for the Regime, which was established in 1995 and is built on a partnership between industry and other government agencies, such as the CCG (Transport Canada 2013f).

Within the framework of the regime, Transport Canada sets the guidelines and regulatory structure for the preparedness and response to marine oil spills. Specific activities include (Transport Canada 2013g):

- regime management and oversight;
- development of regulations and standards;
- enforcement and implementation of regulations relating to response organizations (*e.g.*, WCMRC);
- enforcement and implementation of regulations relating to oil handling facilities;
- overseeing an appropriate level of national preparedness;
- monitoring marine activity levels, conducting risk assessments and making adjustments to the Regime, as required;
- monitoring and prevention of marine oil spills through the implementation of the National Aerial Surveillance Program;
- implementation and facilitation of the Regional Advisory Council;
- providing leadership within the IMO;
- providing leadership on Canadian Arctic interests relating to marine transportation; and
- providing post-incident reporting for oil spill response exercises and incidents, both nationally and internationally, to ensure that recommendations or lessons learned are considered and implemented as appropriate to enhance the Regime.

In order to demonstrate to Transport Canada that parties are in compliance with the *Canada Shipping Act, 2001* and the Regime, the following must be in place:

- for vessels: a Shipboard Oil Pollution Emergency Plan (SOPEP);
- for oil handling facilities such as the Westridge Marine Terminal: an Oil Pollution Emergency Plan (OPEP) and an on-site Oil Pollution Prevention Plan (OPPP); and
- for both vessels and oil handling facilities:
  - a certificate outlining the arrangement with a response organization;
  - proof of financial responsibility; and
  - the name of the person(s) authorized to implement the plan.

Currently, Transport Canada certifies the response organization based on its capacity to respond to marine oil pollution incidents in Canada on a tiered basis. The highest tier (Tier 4) certified response organization is deemed capable of responding to a 10,000 tonne oil spill within prescribed timelines, standards, and operating environments. In addition to other issues, the threshold of 10,000 tonnes is currently under review by the Federal Tanker Safety Expert Panel (the Panel) (Section 1.4.5). The response organization's emergency plan and procedures are documented in its information handbook and in its Oil Spill Response Plan (OSRP).

The Regime is built on the principle of cascading resources, which means that in the event of a spill, the resources from a specific area can be supplemented with those from other regions or from international partners, as needed.

#### *1.4.2.2 Fisheries and Oceans Canada – Canadian Coast Guard*

The CCG, as a Special Operating Agency of Fisheries and Oceans Canada (DFO), owns and operates the federal government's civilian fleet, and provides various maritime services related to navigation, spill response, communication, security, and search and rescue. The CCG supports Canada's Marine Oil Spill Preparedness and Response Regime by providing preparedness capacity through a National Response Team.

In the event of an oil spill in a marine environment in Canadian waters, CCG would assume the role of the Federal Monitoring Officer, monitoring the overall response effort of the response organization to ensure it is timely, effective, and appropriate to the incident. In the event the Responsible Party (*i.e.*, the polluter) is unable or unwilling to assume the lead role (*i.e.*, on-scene commander) to respond to an oil spill from a vessel, CCG would step in to assume the lead role in managing the response (Section 1.4.4).

Fisheries and Oceans Canada supports international marine transportation by providing necessary information on tides, currents and weather data. The Canadian Hydrographic Service provides nautical charts and navigational products that help ensure the safe navigation of Canada's waterways. The Canadian Hydrographic Service collaborates and shares these charts with other national organizations and hydrographic service organizations, as they are the road maps that guide mariners safely from port to port.

#### *1.4.2.3 Pacific Pilotage Authority*

The PPA is the federal organization responsible for the administration of the *Pilotage Act* on the West Coast of Canada. The mandate of the PPA is to provide safe, reliable and efficient marine pilotage and related services in the Coastal Waters of BC including the Fraser River.

The British Columbia Coast Pilots Association (BCCPA) is the organization that provides service to the PPA under the *Pilotage Act* and the *Canada Shipping Act, 2001*. Pilots have to meet rigorous knowledge and experience requirements and then be examined and licensed by the PPA.

Empty tankers inbound for Westridge Marine Terminal are required to pick up a pilot at the Victoria pilot station at Brotchie Ledge. Under the pilot's guidance, and with the supervision from the CCG's Marine Communications Traffic Services (MCTS), the tanker navigates through established shipping lanes to PMV and the Westridge Marine Terminal. Laden tankers leaving the Westridge Marine Terminal are required to have two pilots to guide navigation on the return trip to the Pacific Ocean, through the Burrard Inlet, Strait of Georgia, and the Juan de Fuca Strait. The two pilots on the laden tanker leaving Westridge Marine Terminal disembark from the tanker at the Victoria pilot station at Brotchie Ledge (Section 1.4.3). The PPA also sets in place escort requirements for tankers transiting the Haro Straits and Boundary Pass. In addition, through Instructions to Pilots, the PPA establishes procedures that guide the pilots' actions in specific areas along the coast of BC.

#### *1.4.2.4 Port Metro Vancouver*

Port Metro Vancouver is the busiest port in Canada and the fourth largest tonnage port in North America. PMV facilitates trade with more than 160 world economies, with 95 per cent of port activity focused on Canadian import/export markets. In 2011, PMV moved a record 122 million tonnes of cargo (PMV 2013a).

Under the *Canada Marine Act*, PMV sets rules and regulations within its jurisdiction focused on maintaining the safe and efficient movement of marine traffic and cargo. PMV's marine operation responsibilities range from the administration of all waterborne activities, to the development of marine safety rules and procedures, to a rotating on-call duty Harbour Master to deal with incidents. Waterborne activities include managing vessel movements within PMV's jurisdiction in order to ensure navigation and environmental safety, and undertaking marine patrols, ship inspections, upgrade projects, and permitting of dangerous goods movements. The extent of PMV's jurisdiction is generally bounded by a line south from Point Atkinson, in West Vancouver, to the Canada-US border, encompassing the inlet waters to the east of this imaginary north-south line (Figure 1.4.1). The Westridge Marine Terminal is located within PMV.

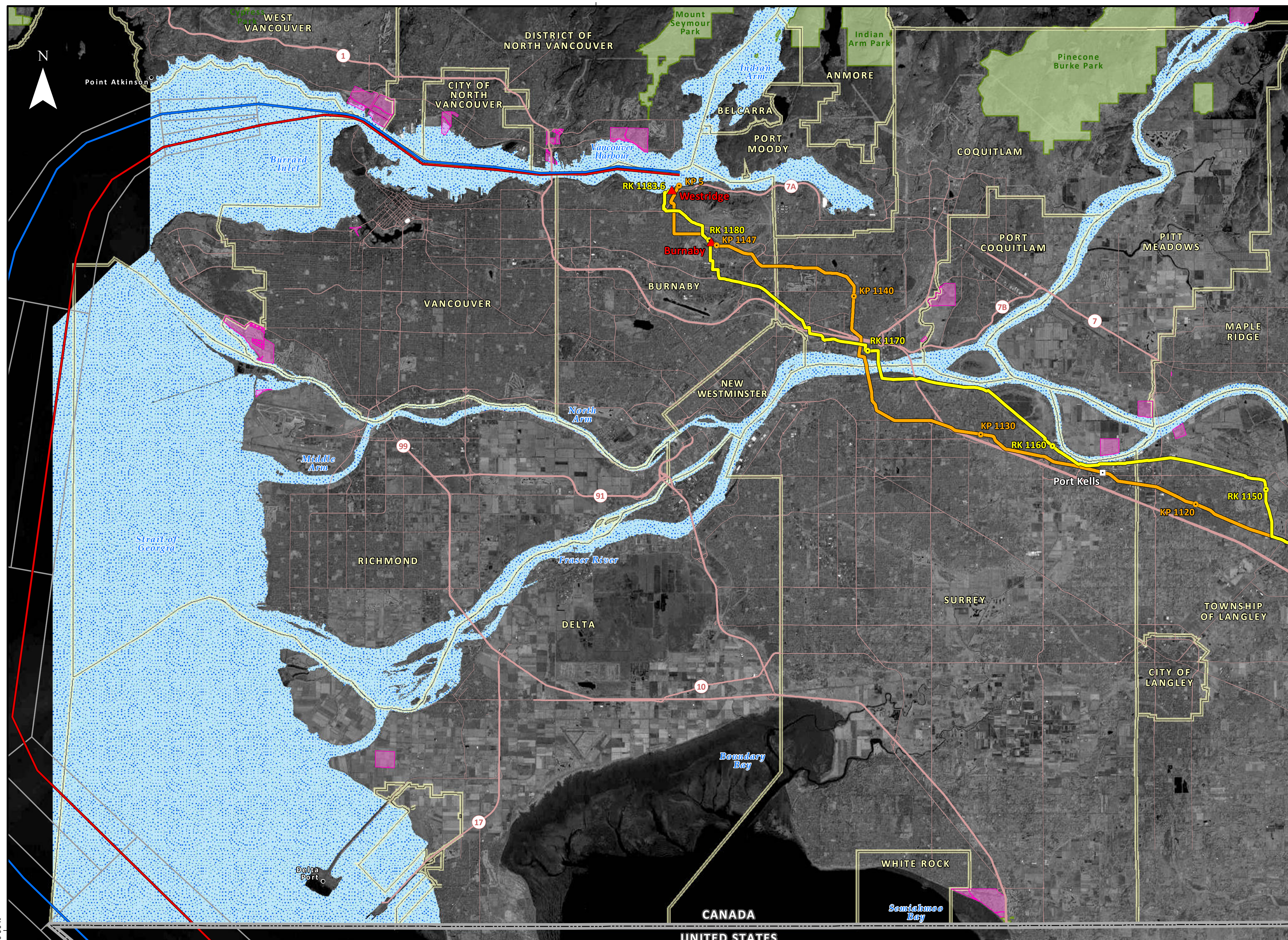


**FIGURE 1.4.1**

**JURISDICTION OF PORT METRO VANCOUVER**

**TRANS MOUNTAIN EXPANSION PROJECT**

- Kilometre Post (KP)
- Reference Kilometre Post (RK)
- Trans Mountain Pipeline (TMPL)
- Trans Mountain Expansion Project Proposed Pipeline Corridor
- Terminal
- Existing Pump Station
- Highway
- Road
- Marine Vessel Outbound Lane
- Marine Vessel Inbound Lane
- Traffic Separation Scheme
- International Boundary
- Municipal Boundary
- Port of Metro Vancouver Navigational Jurisdiction
- Indian Reserve
- Provincial Park



Projection: NAD 1983 UTM Zone 10N. Baseline TMPL & Facilities: provided by KMC, 2012; Proposed Pipeline Corridor V6: provided by UPI, Aug. 23, 2013; Roads: BC FLNRO, 2012; Populated Places: BC FLNRO, 2007; Hydrology: BC FLNRO 2008, IHS 2004; First Nation Lands: Geobase, 2013; Parks and Protected Areas: BC FLNRO, 2008, Natural Resources Canada, 2013, ESRI 2005; US State Boundary: ESRI, 2005; Marine Vessel Traffic Lanes: Moffat and Nichol, 2013; Port Metro Vancouver Navigational Jurisdiction: Port Metro Vancouver, November 2013; B/W Imagery: NASA Geospatial Interoperability Program 2005.

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.*

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Port Metro Vancouver works in partnership with a broad range of stakeholders including local municipalities, police forces and federal agencies.

Port Metro Vancouver operates five working harbour patrol vessels with crew and offers 24-hours per day, 7-day per week on-water services including emergency response, vessel inspections, harbour monitoring and various support services to the marine community.

Key requirements for operating within PMV are described within the Harbour Operations Manual: Practices and Procedures for the Vancouver Fraser Port Authority (or the *"Harbour Operations Manual"*). The Harbour Operations Manual is a collection of practices and procedures covering a wide range of port operation safety matters. The practices and procedures relevant to the movement of tankers into and out of the Westridge Marine Terminal include:

- The Second Narrows MRA: this document regulates the movement of vessel traffic within the Second Narrows, a geographically constricted area within the Burrard Inlet through which vessels calling at the Westridge Marine Terminal must pass. Regulations restrict the size and draft of tankers in relation to the available width of the channel, which is controlled by the tidal cycle. Aframax tankers are only permitted to transit during daylight regardless of whether they are empty or laden. Trans Mountain's Tanker Acceptance Standard reflects the size and draft restrictions stated in the Harbour Operations Manual. As well, Trans Mountain's scheduling process abides by the tidal timing restrictions in the Second Narrows MRA.
- Ship Anchoring: PMV manages anchoring of vessels in the waters within its jurisdiction and maintains the safe operating procedures for ships using these anchorages. Anchorages may be used by tankers calling at the Westridge Marine Terminal to wait in the event that scheduling does not permit direct berthing of a vessel at the Westridge Marine Terminal.
- Bunkering Operations: the Harbour Operations Manual contains regulations on bunkering of ships within PMV to ensure that bunkering is undertaken safely and without harm to the marine environment. Bunkering is the process of re-fuelling a vessel. The majority of bunkering operations in PMV involves transfer of fuel from a bunker barge to a vessel at anchor. In the event of an oil spill within PMV's jurisdiction, WCMRC will respond upon notification and call-out by the master of the vessel. PMV staff would become part of the Unified Command in the ICS.

#### *1.4.2.5 Western Canada Marine Response Corporation*

Western Canada Marine Response Corporation (formerly Burrard Clean Operations) is certified by Transport Canada as a response organization under the *Canada Shipping Act, 2001* with a mandate to ensure emergency preparedness and response capacity in the event an oil spill occurs in the marine environment on the West Coast of BC. In the event of an oil spill in the marine environment, WCMRC would focus its response efforts to recover the spilled oil and mitigate the consequences of the spill on the public and the environment. WCMRC is federally certified as having the capacity to undertake response for an oil spill of 10,000 tonnes and its actual capacity exceeds this.

Western Canada Marine Response Corporation maintains its certification under the *Canada Shipping Act, 2001* by undertaking a number of equipment deployment exercises, tabletop exercises, and oil spill response training courses and scenarios within the certification period (WCMRC 2013a). The current capacity of WCMRC to respond to an oil spill is further detailed in Section 5.5.1.

All large vessels and oil handling facilities in Canadian waters are required to maintain an arrangement with a certified spill response organization. The arrangement (or membership) is a commitment from WCMRC to provide oil spill response services if called upon by the holder. WCMRC has over 2,000 members including oil handling facilities, barging companies, tankers, ferries, cruise ships, vessels undertaking innocent passage through western Canadian waters, forest industry facilities, fish camps, and float plane companies. While these memberships are an important source of revenue for WCRMC, the majority of funding for the corporation comes from a Bulk Oil Cargo Fee that is charged at oil handling faculties on a per tonne basis for oil that is unloaded within or exported from WCMRC's Geographic Area of Response. The revenues from membership fees and the Bulk Oil Cargo fee essentially fund the corporation's standby capability. If called upon to respond to a spill, WCMRC charges members for response services based on published rates. The corporation is run on a cost-of-service basis.

As a shareholder of WCMRC, Trans Mountain is a co-founder of Burrard Clean Operations, an industry co-op created in 1976. Following changes to the *Canada Shipping Act* in 1995 which mandated the use of response organizations, Burrard Clean Operations was transformed into WCMRC and its mandate expanded to serve all shipping and oil handling facilities on the West Coast.

As a member of WCMRC, Trans Mountain maintains an oil handling facility arrangement with WCMRC with respect to the Westridge Marine Terminal operations. Trans Mountain collects the Bulk Oil Cargo fee from pipeline shippers who use the terminal and remits these funds to WCMRC.

In the event of an oil spill in the marine environment on the West Coast of Canada, WCMRC would support the Incident Commander of the emergency response by providing the equipment and resources to clean up the spill (Section 1.4.4).

With respect to the Project, Trans Mountain will continue to work with WCMRC to implement relevant recommendations from the TERMPOL process, any recommendations from the Panel and any mandated improvements to existing emergency preparedness and response measures as necessary to address the effects of the Project-related increase in tanker traffic (Section 5.5.2).

#### *1.4.2.6 Province of British Columbia*

The BC Ministry of Environment has an Environmental Emergency Management Program (EEMP) to lead the province's commitment to prevent, prepare for, mitigate, and respond to spills that affect the environment (WCMRC 2012). Spill response plans and operational guidelines are the foundation of the EEMP and the province, through the Ministry of Environment staff, plays a direct role with spills that threaten or impact shorelines. WCMRC's spill response activities and planning are complementary to the ministry's spill response planning. In addition, the ministry staff cooperate on the Regional Environmental Emergency Team (REET), providing expert advice about local sensitivities to WCMRC and the incident commander in the event of an oil spill.

#### *1.4.2.7 Regional Environmental Emergency Team*

The REET is a multi-agency, multi-disciplinary group specializing in environmental emergencies. A REET is designed to provide consolidated, locally relevant environmental advice in the event of an environmental emergency such as an oil spill (WCMRC 2012). REET members include federal, provincial, and municipal departments, Aboriginal communities, private sector agencies, and local individuals. Environment Canada and the BC Ministry of Environment co-chair the REET in BC. In the event of an oil spill in a marine environment on the West Coast of BC, the REET would provide advice to WCMRC and the incident commander.

#### *1.4.2.8 Canada-US*

As described in Section 1.4.1, Canada and the US jointly manage vessel traffic in the trans-boundary waters in the Juan de Fuca Strait to ensure vessels calling at Canadian and American ports in the Salish Sea region are managed in a manner that avoids collisions and accidents, which could result in an unplanned release of oil or other pollutants into the marine environment.

In addition, Canada, through the CCG, currently cooperates with the US, through the USCG, to ensure there is adequate emergency preparedness and response capability in the event of an oil spill in trans-boundary waters. The CCG and USCG hold joint planning and response exercises in the Juan de Fuca Strait on an annual basis. In the event of an oil spill in Canadian or trans-boundary waters that exceeds the response capacity of the CCG and WCMRC, the USCG could be called on for support.

#### *1.4.2.9 Tanker Owners and Operators*

Tanker owners and operators and the authorities of countries where the vessels are registered (ship registering countries are referred to as the vessel's flag state; they are all members of the IMO, as is Canada) are ultimately responsible for the safety of their vessels and the navigation of their vessels within Canadian waters, meeting all applicable regulations, standards, and procedures under the jurisdiction of Transport Canada, and also under PMV while transiting the Burrard Inlet.

All foreign vessels entering Canadian waters must be initially inspected and regugarly on an annual basis by Transport Canada. As well, under the *Canada Shipping Act, 2001*, all tankers must maintain membership for oil spill response support with a certified response organization, which is WCMRC on the BC Coast. Under the *Canada Shipping Act, 2001*, all vessels must maintain a SOPEP pproved by its classification society.

A Classification Society is an organization that establishes and maintains technical standards for the construction and operation of ships. The society validates that construction is according to these technical standards and carries out regular inspections and surveys to ensure compliance with the standards. Often flag states authorise classification societies to certify and inspect the vessels in their registry on their behalf.

In the event of an accident resulting in an oil spill from a vessel in Canadian waters, the master of the tanker, as the responsible party (RP) and in accordance with the law, would notify CCG as per the procedure in the approved SOPEP. As the RP, the tanker's master or a representative of the tanker owner would assume the role of incident commander. If the tanker operator were unable or unwilling to assume the role of incident commander, the role would automatically transfer to the CCG. The designation of incident commander is typically clarified in the SOPEP to avoid confusion. Response in such case would involve the RP activating the response organization (*i.e.*, WCMRC) mentioned in the prior paragraph to provide the equipment and resources to respond to the oil spill (Section 1.4.4). If the RP does not activate the prior agreed response organization and the CCG determines that response was inadequate or required the response organization to be activated, the CCG is empowered to activate the response organization.

Ultimately, the tanker owner is liable to pay for the costs of emergency response, clean-up, damage to the environment, compensation to affected parties and all other costs related to an oil spill (Section 1.4.1.6) subject to the limits of liability. As the tanker owner reaches its limits of liability, it would then pass to the international and Canadian regime for oil spill compensation as described in Sections 1.4.2 and 5.5.3.

#### *1.4.2.10 Pipeline Shippers*

Pipeline shippers are the parties that own the product shipped on the TMPL system. They pay a fee to ship their product from Edmonton, AB, to the Westridge Marine Terminal on the pipeline. Pipeline shippers are also responsible for chartering tankers to call at the Westridge Marine Terminal to transport the product that arrives at the Westridge Marine Terminal.

As directed in Trans Mountain's Tanker Acceptance Standard, pipeline shippers are required to submit a Vessel Proposal Form to Trans Mountain prior to the pipeline shipper's first batch of product leaving from Edmonton, AB, to the Westridge Marine Terminal. Based on the information in the Vessel Proposal Form, and on the history of inspection activities for the vessel, which are maintained on an international database, Trans Mountain has the right to reject any vessel proposed by the pipeline shipper that does not meet the standards and criteria set by the harbour master for PMV, and/or by Trans Mountain.

Pipeline shippers also have their own tanker screening and selection process, which ensures that tankers calling on the Westridge Marine Terminal meet international regulations and Trans Mountain's Tanker Acceptance Standard.

#### *1.4.2.11 Trans Mountain*

Trans Mountain is responsible for the safe operation of the Westridge Marine Terminal, ensuring the public, workers, and the environment are protected during the operation, maintenance, and expansion of this facility. While Trans Mountain is not responsible for the operation of the vessels that call at the Westridge Marine Terminal, Trans Mountain continues to play a supporting and influencing role to promote safety in marine transportation. This includes the promotion of navigation and operational safe practices, which help minimize the possibility of navigation accidents that may result in an oil spill. Trans Mountain, directly and through its involvement with WCMRC, supports capacity development for emergency preparedness and response on the West Coast of Canada, where the vessels that call at the Westridge Marine Terminal transit.

As noted in Section 1.4.2.10, Trans Mountain maintains a Tanker Acceptance Standard, which governs the acceptance or rejection of all tankers calling at the Westridge Marine Terminal. Prior to any cargo transfers involving a tanker berthed at the Westridge Marine Terminal, Trans Mountain conducts a two-stage acceptance process.

First, when a tanker is nominated Trans Mountain conducts a pre-screening, reviewing information provided by the pipeline shipper and information available through international databases. Once Trans Mountain deems the tanker acceptable to call at the Westridge Marine Terminal, the tanker can be scheduled for berthing.

Second, prior to commencing any cargo operation, the tanker is physically inspected by the Trans Mountain loading master to confirm both the information presented in the pre-screening and the condition of the vessel. Any deficiencies noted have to be rectified before cargo loading can commence.

This two-stage process is performed every time a tanker is scheduled to arrive in PMV for the purpose of cargo transfer at the Westridge Marine Terminal. The process is conducted regardless of whether or not the vessel has been accepted at the Westridge Marine Terminal during a previous voyage. However, once accepted, and if the schedule requires, the vessel may berth multiple times during a single voyage to allow cargo to be transferred in separate loadings.

Trans Mountain has the final decision whether a vessel would be accepted or denied to call at the Westridge Marine Terminal.

Trans Mountain is of the view that the current emphasis on navigational safety in the Salish Sea region prevents tanker-vessel collisions and accidents involving tankers that could result in an accidental release of oil from the tanker’s hull. Despite the existing highly effective navigational safety measures in place, there remains a low probability that an incident would occur resulting in an oil spill in the marine environment. With respect to ensuring there is the capability to respond to an oil spill in the marine environment and to help mitigate the effects and consequences of such an oil spill, should it occur, Trans Mountain is an active shareholder and member of WCMRC.

As an oil-handling facility member of WCMRC, Trans Mountain collects fees from pipeline shippers and provides those to WCMRC to ensure it continues to be a certified response organization with the capacity to effectively respond to an oil spill in the event one should occur in the marine environment on the West Coast. Annual fees are also collected by WCMRC from other petroleum terminals on the West Coast. With respect to the Project, Trans Mountain will continue to work with WCMRC to implement relevant recommendations from the TERMPOL process, identifying where improvements to existing emergency preparedness and response measures are necessary to address the effects of the Project-related increase in tanker traffic should the Project proceed (Section 5.5.2).

In addition to being a shareholder and member of WCMRC, Trans Mountain has been an active participant in other initiatives to improve navigational safety in the Salish Sea Region:

- Participated in PMV’s review of the Harbour Operations Manual including the Second Narrows MRA rules (2004 to 2010). This initiative resulted in a modernization of the Second Narrows MRA rules and the escort techniques used in the harbour. Following this initiative, a similar process was undertaken by the PPA to improve escort requirements for Boundary Pass and Haro Strait.
- Contributed to the expert review of escort techniques in the Salish Sea region (2007).
- Contributed to the logistics for the live trial of escort techniques (2007).
- Contributed to improved pilotage equipment (purchase of PPUs) (2009).

- Supported the joint pilot and tug master training program (2009).
- Supported the improvement of navigational aids for the Second Narrows MRA (2010).
- Contributed to the British Columbia Institute of Technology (BCIT) Marine Simulator upgrade (2011).

Lastly, Trans Mountain has been active in providing input to the Panel that was appointed by the Government of Canada earlier in 2013. A copy of Trans Mountain's submission to the Panel is included in Appendix A (Section 1.4.5). Trans Mountain anticipates that improvements recommended by the Panel that are relevant to tankers calling at the Westridge Marine Terminal would be known and implemented or planned for implementation prior to the Project commencing operation in Q4 2017.

### *1.4.3 Journey of a Tanker*

The following description follows the journey of a tanker to and from the Westridge Marine Terminal, illustrating the current roles, responsibilities and requirements set out in Sections 1.4.1 and 1.4.2 that contribute to navigational safety and thus spill prevention in Canadian waters.

Before coming to Canada, tankers are required to meet high standards of design and construction:

- Tankers are built according to regulations established by the IMO and adopted by their flag state.
- Ship construction and repairs are inspected and documented by a classification society to ensure construction meets these regulations and specifications.
- Tankers are built with double hulls and segregated cargo holds to reduce the possibility of cargo spills and to minimize any potential spill volume, if the tanker were to collide with another vessel or run aground, damaging the structure of the tanker.
- With respect to oil tankers calling at the Westridge Marine Terminal, all oil tankers are of double-hull construction, (*i.e.,* the cargo tanks are protected within the ship's outer hull by an inner steel hull) and have segregated cargo holds. When the tanker is loaded, the space between the outer and inner hulls (*i.e.*, outside boundary of the cargo tanks) is kept empty. TERMPOL 3.9 Ship Specifications in Volume 8C (TR 8C-7) illustrates the general specifications for a double-hulled tanker, including Aframax and Panamax class tankers that would call at the Westridge Marine Terminal.

On an ongoing basis throughout operations, tankers are:

- Inspected by their flag state, by classification societies and by insurers.
- Vetted by charterers and terminals.
- Inspected in other ports of call by inspectors of the respective local national authorities, including those that are signatories to the various international

conventions on port state control (ship inspection programs) to which Canada is also a member.

Upon coming to Canada, tankers are scrutinized to ensure they are compliant with Canadian and Trans Mountain's requirements. These requirements include:

- Vessels proposed by a pipeline shipper to receive oil at the Westridge Marine Terminal are pre-screened by the Trans Mountain loading master using industry databases and the company's own records before being accepted or rejected for scheduling purposes.
- The pipeline shipper arranges for a local shipping agent to assist the vessel with local logistical requirements, interactions with local authorities, check and pass information on the vessel's certificates to the authorities and pay any fees, dues or invoices on behalf of the vessel's owner/operator.
- The *Canada Shipping Act, 2001* requires that a tanker must have an arrangement with a Transport Canada certified response organization (*e.g.*, WCMRC) for spill response services and a SOPEP before entering Canadian waters.
- A tanker must contact the CCG for permission to enter Canadian waters before entry.

Upon arrival in Canadian waters, tankers must follow strict communications and guidance protocols:

- The tanker is only allowed to travel into the Juan de Fuca Strait using the IMO approved traffic separation scheme, which is managed by the Joint Coordinating Group of the Cooperative Vessel Traffic Service (CVTS) between Canada and the US. Traffic Separation Schemes are used worldwide and have been proven to reduce the possibility of collision between vessels by regulating the flow of crossing traffic (Figure 1.3.1).
- The CCG and USCG monitor ship traffic through the shipping lanes in the Salish Sea Region. Four traffic zones are monitored:
    - Tofino traffic (entrance to Juan de Fuca Strait, CCG);
    - Seattle traffic (Juan de Fuca Strait, USCG);
    - Victoria traffic (Salish Sea, CCG); and
    - Vancouver traffic (Vancouver Harbour, CCG).
- The tanker remains in communication with the CCG MCTS and the tanker's position is monitored throughout the transit. It is handed off between traffic zones as it moves from one to the other. A combination of radar, automatic information system and direct radio communication is used to coordinate safe conduct of the vessel with other masters and pilots.

- Empty tankers headed for the Westridge Marine Terminal pick up a PPA certified BCCPA pilot at the Victoria pilot station near Brotchie Ledge (Figure 1.3.1).
- Under the pilot's guidance, and monitored by the MCTS, the ship continues to navigate through the established shipping lanes to PMV. Ships travelling to and from the Westridge Marine Terminal transit the Juan de Fuca Strait, Haro Strait, Boundary Pass, Strait of Georgia and the Burrard Inlet (Figure 1.3.1).
- The established shipping lanes maintain separation between inbound and outbound traffic, which is particularly important in different areas of the Juan de Fuca Strait and Strait of Georgia, where many different types of vessels use the shipping lanes to access the ports and terminals of the Puget Sound, various ferry terminals, Robert's Bank terminal, the mouths of the Fraser River, and the Burrard Inlet/Vancouver Harbour.

Once a tanker enters the jurisdiction of PMV (east of a line south from Point Atkinson in West Vancouver to the US border), a series of additional established operating rules and protocols currently apply. After the Project is in operation, these same practices are expected to apply subject to improvements resulting from the TERMPOL process and from other federal and provincial reviews currently underway:

- PMV rules for conduct of shipping within its jurisdictional area are documented in its Harbour Operations Manual.
- The agent would have requested PMV operations to assign an anchorage for the tanker based on availability and operational requirements. A tanker may anchor at one of the designated locations in English Bay or off the Westridge Marine Terminal, depending on the timing of tides, the Westridge Marine Terminal loading schedule, and the tanker's own requirements for provisioning and maintenance. In some cases, the tanker may proceed directly to berth.
- Pilots leave the tanker when it is at anchor, but are aboard anytime it moves, even if from anchor to the dock and back.
- The tanker is inspected by Transport Canada upon its first arrival in Canada and once per year after that. This might occur at anchor or alongside the Westridge Marine Terminal.

When a tanker berths at the Westridge Marine Terminal:

- The tanker is assisted by docking and mooring tugs are tethered to the tanker at the Westridge Marine Terminal dock.
- The Trans Mountain loading master boards the tanker to conduct a physical inspection and to conduct a ship-shore safety meeting with the master and terminal operators.
- The Westridge Marine Terminal loading facility is operated in accordance with regulations established by the NEB, Transport Canada, and others as required.

- A spill containment boom is deployed to enclose the tanker and terminal. A second boom is on-hand as a back-up in case of an emergency. WCMRC moors a skimming vessel at Trans Mountain's utility dock west of the loading dock.

- Loading arms and vapour recovery lines are connected to the tanker. The Westridge Marine Terminal vapour destruction system is started and loading commences. Loading typically takes 24 to 36 hours depending on the size of the vessel.

- The Loading Master stays aboard the tanker throughout the loading process. The Trans Mountain loading master has the authority to request the vessel to rectify any issues that might develop during the vessel's stay and to stop the loading process at any time should concerns arise. The Loading Master also acts as the key shipside contact for communication with the terminal.

- Terminal operating procedures include an emergency response plan (Volume 7A). Terminal staff are trained in emergency response and regular exercises are held to practice these procedures.

- In addition to Trans Mountain's own spill response equipment and as required by Transport Canada, Trans Mountain has an arrangement with WCMRC for marine spill response services. WCMRC has spill response equipment staged on the water in Vancouver Harbour and a main base of operations very close to the Westridge Marine Terminal in Burnaby. Similarly, WCMRC maintains equipment caches on Vancouver Island for response in the Salish Sea.

When a tanker loading is complete and the vessel departs:

- The Loading Master stays on board until pilots come to move the vessel away from the dock.

- After the tugs are made fast, the tanker is cast off and typically goes to anchorage to wait for tide for the Second Narrows transit, as required by PMV's Harbour Operations Manual.

- Two PPA certified pilots come aboard to ensure the tanker safely navigates out of Canadian waters. The PPA requires laden tankers to have two PPA-certified pilots on board, one to ensure safe conduct of the vessel and one to monitor the bridge crew and ship systems. During the passage the two pilots would switch roles as part of an overall fatigue management process.

- PMV's Harbour Operations Manual defines the Second Narrows MRA and the rules for MRA transit, including daylight transit, size restrictions, required tug escorts, and speed restrictions. Only one vessel at a time is allowed in the Second Narrows MRA and First Narrows. The MCTS monitors the tankers' progress and other vessels' traffic in the Vancouver Harbour.

- Before the transit begins, MCTS declares a clear narrows and the CN Railway is contacted to raise their rail bridge, which spans the Second Narrows.

- PMV's rules require that two large tugs be tethered to the stern and at least one tug to the bow for the Second Narrows MRA transit. The two large tugs tethered to the stern are required for the transit through the remainder of Vancouver Harbour.
- After clearing the First Narrows, the escort tugs fall away and the tanker transits without escort until it approaches the East Point on Saturna Island.
- The PPA has established escort requirements for the Salish Sea region, in particular in Haro Strait through Boundary Pass. The PPA requires a single large tug to tether to the tanker 1.7 NM before East Point and remain tethered until Victoria. The tug remains in untethered escort until the tanker passes Race Rocks.
- The two PPA-certified pilots disembark at the Victoria pilot station near Brotchie Ledge.
- The tug leaves the tanker at Race Rocks as the tanker enters the Juan de Fuca Strait.
- No pilotage or escort is required through the Juan de Fuca Strait; however, as with all inbound traffic, the tanker and all other traffic are monitored by the MCTS.
- US industries fund a rescue tug at Neah Bay, Washington, to assist any vessels in distress in the Juan de Fuca Strait.
- Upon clearing the Juan de Fuca Strait, the tanker continues to its destination.

Figure 1.3.1 illustrates the separated shipping lanes used by tankers transiting to and from Westridge Marine Terminal.

### *1.4.4 Canada's Marine Oil Spill Preparedness and Response Regime*

The initial procedures to respond to an oil spill in the marine environment are set out in the tanker's Ship Oil Pollution Emergency Plan and in the response organization's OSRP. These follow the principles of the ICS model. ICS is a management system used for the command, control and coordination of emergency response efforts. ICS provides the organizational structure for incident management, clearly identifying the roles and responsibilities for parties involved in emergency response, and it also provides the process for planning, building, and adopting the system.

All tankers are required to have a contract for spill response services in place with WCMRC before entering Canadian waters. In the event of a spill the tanker owner is the party responsible for initiating and directing the response efforts with guidance and assistance from WCMRC. CCG is the federal monitoring agency that oversees the response efforts and is empower to take over and lead response efforts in the event that the tanker owner is unable. Liability; however remains with the tanker owner as required under the MLA (section 1.4.1.6). Environment Canada is the federal agency designated to monitor and advise on environmental priorities. The British Columbia Ministry of Environment has regulatory authority for shorelines. Under ICS a Unified Command would be established to allow affected municipalities, Aboriginal groups, and other agencies to participate in leadership of the response.

### *1.4.5 Federal and Provincial Initiatives*

#### *1.4.5.1 Federal Tanker Safety Expert Panel*

On March 18, 2013, the Government of Canada announced a number of measures toward the creation of a “World-Class Tanker Safety System” (Transport Canada 2013a). The new measures include:

- The number of inspections will increase to ensure that all foreign tankers are inspected on their first visit to Canadian waters, and annually thereafter, to ensure they comply with applicable rules and regulations, especially with respect to double hulls.
- An expanded national aerial surveillance program designed to monitor shipping traffic and detect oil spills.
- The establishment of a new CCG Incident Command System (ICS) to integrate its operations with key partners (Section 1.4.4).
- A review of the existing tanker escorting system.
- More ports designated for traffic control.
- Scientific research: the Government of Canada will conduct scientific research on non-conventional petroleum products, such as diluted bitumen, to enhance the understanding of these substances and how they behave when spilled in the marine environment.
- New and modified navigational aids: the CCG will ensure that a system of aids to navigation comprised of buoys, lights and other devices to warn of obstructions and to mark the location of preferred shipping routes is installed and maintained. The CCG will also develop options for enhancing Canada’s current navigation system by fall 2013 for consideration by the Government of Canada.
- The establishment of a tanker safety panel.

The Panel was appointed in spring 2013 and is in the process of conducting an evidence-based review and assessment of Canada’s tanker safety regime to make recommendations to the Government of Canada on the development of a world-class system. Specifically, the Panel is assessing the regime’s structure, functionality, and its overall efficiency and effectiveness.

The Panel’s review will have two components. The first component will focus on the system currently in place south of 60° north latitude, while the second component will focus on the requirements needed for the Arctic as well as a national review of the requirements for hazardous and noxious substances, including liquefied natural gas (Transport Canada 2013e).

In particular, the Panel will focus on three questions (Transport Canada 2013e):

- Is the current regulated response capacity of 10,000 tonnes a world-class standard and what would be the costs and benefits of changing this requirement?

- How effective is the current regime's structure, including the private-public model, funding and fee arrangements, and placement of response assets?
- Is there a need to expand the current system to other substances and create a cost-effective preparedness and response system in the north?

To date, Trans Mountain has provided input to the panel on June 21, 2013 (Appendix A, Trans Mountain Submission to the Federal Tanker Safety Expert Panel). Trans Mountain's recommendations in its June 21, 2013 submission to the panel are integrated into Sections 5.4.2 and 5.5.2. In parallel to the panel's assessment of Canada's tanker safety regime, Trans Mountain continues to work with WCMRC to identify improvements to WCMRC's existing capacity for emergency response to an oil spill from a tanker (Section 5.5.2).

##### *1.4.5.2 Senate Standing Committee on Energy, the Environment and Natural Resources Report*

Trans Mountain has reviewed the Senate Standing Committee on Energy, the Environment and Natural Resources Report released on August 22, 2013 and concurs with the recommendations included therein related to pipeline and tanker safety. In particular, Trans Mountain is supportive of the following recommendations:

- The Transportation Safety Board should expand and modernize its database to provide detailed information on ship-sourced spills, including the type of ship and the volume and type of product released.
- The current spill preparedness and response capacity of 10,000 tonnes within prescribed time frames should be increased to fit the assessed needs of each region as determined by Transport Canada.
- The federal government should provide umbrella protection to Canadian marine response organizations for all non-ship source spills including marine spills from pipelines, trains and trucks.
- The CCG's mandated spill preparedness and response capabilities should be certified by Transport Canada or an independent, third-party agency periodically.
- In certain areas and under specified circumstances, certified marine response organizations should be pre-approved to use dispersant, initiate controlled burning and take other prescribed counter-measures to control and clean-up an oil spill when they would result in a net environmental benefit.

##### *1.4.5.3 BC Provincial Initiatives*

In light of the different proposals to transport crude oil from the West Coast of BC, the Government of BC released a policy paper titled Requirements for British Columbia to Consider Support for Heavy Oil Pipelines (Government of British Columbia 2012). The document outlines five minimum conditions that would need to be met for the Government of British Columbia to consider supporting a proposed heavy oil pipeline. The document also outlines a number of recommendations the Government of British Columbia advances to improve marine spill preparedness and response systems in the province (Government of British Columbia 2012). Trans Mountain's views on provincial initiatives are discussed in detail in Volume 1.

# 2.0 DESCRIPTION OF MARINE TRANSPORTATION ACTIVITIES

## 2.1 Existing Marine Transportation

### *2.1.1 Existing Traffic Routes*

The marine traffic network considered within Volume 8A is located on the West Coast of BC. Existing traffic calling at the Westridge Marine Terminal in this marine network will encounter other vessels and navigational features such as pilot boarding stations, restricted channels, channel bends, and marine traffic crossings. The vessels will also need to be aware of other activities occurring in these areas, such as military operations, exploratory work, seaplane activities, commercial fisheries, and recreational activities.

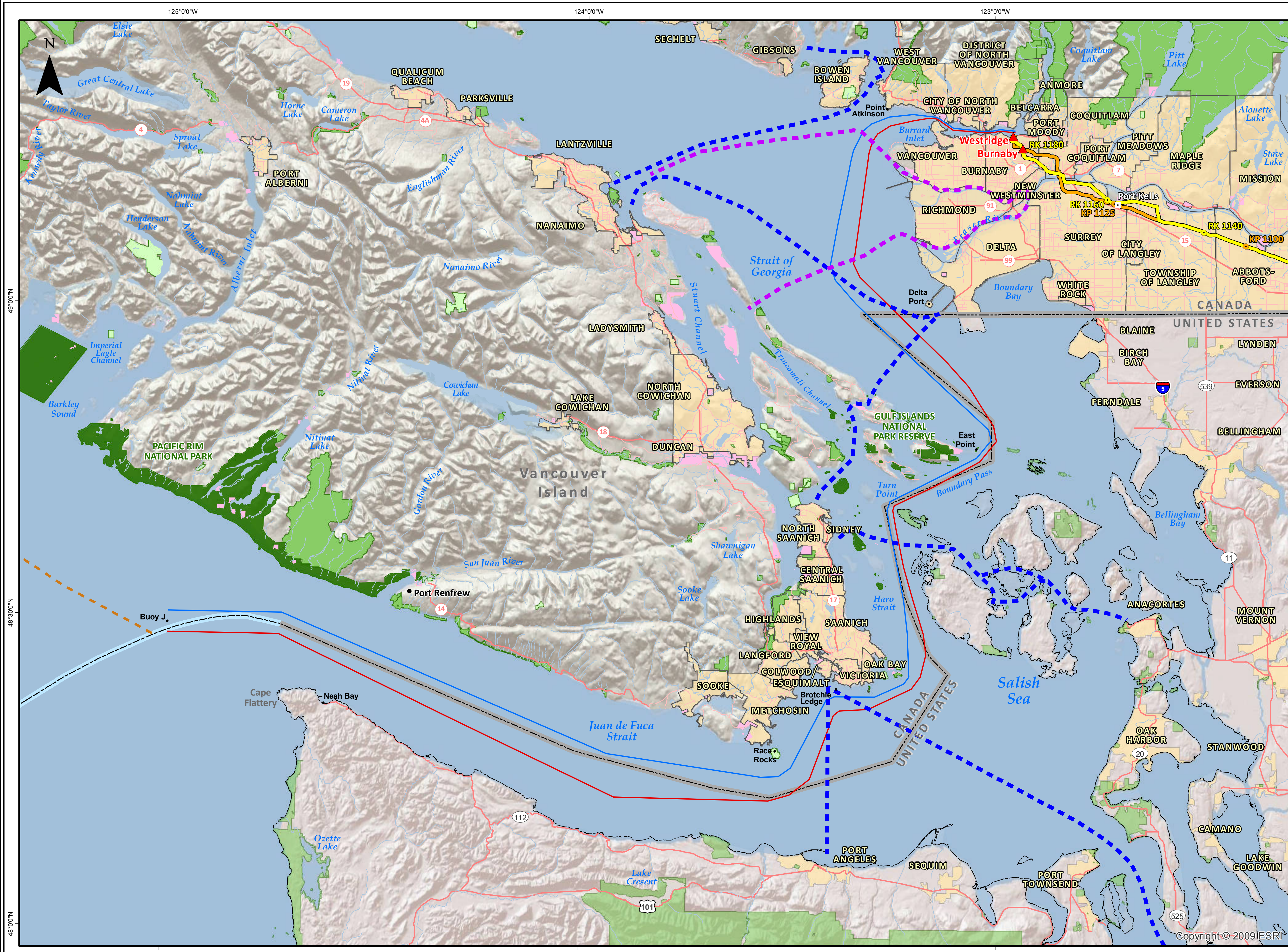
There are about 475,000 vessel movements per year on the West Coast, and tankers accounted for about 1,500 movements (0.3 per cent) in 2009 to 2010 (Transport Canada 2013h). Oil tankers have been moving safely and regularly along Canada's West Coast since the 1930s (Transport Canada 2013h). Oil is moved mostly via the ports of Vancouver, Prince Rupert and Kitimat. Transport Canada records show that in 2009, about 8.4 million tonnes of oil were shipped out of Vancouver (Transport Canada 2013h). Much of this oil is transported in barges to and from communities along the West Coast. Varying quantities of oil are also carried on board container ships, domestic and international ferries, and other types of commercial and private vessels, primarily as fuel (Transport Canada 2013h).

The major traffic route between the PMV area and the Pacific Ocean is an established shipping route for all types of vessels. The route transits the Salish Sea region, which includes the Vancouver Harbour, the Strait of Georgia, Boundary Pass, Haro Strait, and the Juan de Fuca Strait. Project-related marine traffic will continue to use these established shipping lanes inbound and outbound to and from the Westridge Marine Terminal (the Route), as shown on Figure 1.3.1.

The Route has many established traffic crossing locations due to ferry traffic and commercial traffic. Of particular note are six main passenger ferry routes transiting between the mainland and the islands (*i.e.,* the Gulf Islands, the San Juan Islands, and Vancouver Island). Five of these routes directly cross the Route to and from Vancouver Harbour. Ferry vessels do not have pilots but have crews that are familiar with the various waterways and all ferries are monitored by Vessel Traffic Services (VTS). The major ferry routes are outlined below:

- Victoria, BC - Port Angeles, WA;
- Victoria, BC - Seattle, WA;
- Sidney, BC - Anacortes, WA;
- Swartz Bay, BC - Tsawwassen, BC;
- Duke Point, BC - Tsawwassen, BC; and
- Horseshoe Bay, BC - Departure Bay, BC.

There are two main commercial traffic routes that cross the Route at the North and South Arm of the Fraser River. This commercial traffic is primarily barge traffic. Figure 2.1.1 shows in greater detail the other transit routes intersected by vessels calling at the Westridge Marine Terminal.




TRANS MOUNTAIN

**FIGURE 2.1.1**

**TRANSIT ROUTES INTERSECTED BY WESTRIDGE MARINE TERMINAL VESSELS**

**TRANS MOUNTAIN EXPANSION PROJECT**

- Reference Kilometre Post (RK)
- Kilometre Post (KP)
- Trans Mountain Pipeline (TMPL)
- Trans Mountain Expansion Project Proposed Pipeline Corridor
- Terminal
- Existing Pump Station
- Highway
- Road
- 12 Nautical Mile Limit (Territorial Sea)
- Ferry Traffic Route
- Commercial Traffic Route
- Limit of Exclusive Economic Zone (EEZ)
- International Boundary
- Marine Vessel Outbound Shipping Lane
- Marine Vessel Inbound Shipping Lane
- Traffic Separation Scheme
- City / Town / District Municipality
- Indian Reserve / Métis Settlement
- National Park
- Provincial / State Park
- Protected Area/Natural Area/ Provincial Recreation Area/Wilderness Provincial Park/Conservancy Area



Projection: 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: BC Forests, Lands and Natural Resource Operations, 2012 & ESRI, 2005; Geopolitical Boundaries: IHS Inc., 2011, BC FLNRO, 2007 & ESRI, 2005, Natural Resources Canada, 2012; First Nation Lands: Government of Canada, 2013 & IHS Inc., 2011; Hydrology: IHS Inc., 2004, United States National Imagery and Mapping Agency, 2000, Natural Resources Canada, 2010; Parks and Protected Areas: Natural Resources Canada, 2013, BC FLNRO, 2008; CHS: provided by KMC, 2013; Marine Shipping Lanes & Traffic Routes: Moffatt and Nichol, 2013; Hillshade: TERA, derived from Geobase; 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.*

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### *2.1.2 Marine Vessel Types and Design*

There are a variety of vessel types that currently transit the West Coast. These different vessel types are described in Table 2.1.1. Pictures of each vessel type are provided in Appendix B (Marine Vessel Types).

**TABLE 2.1.1**

**DESCRIPTION OF MARINE VESSELS TRANSITING PMV**

| Vessel Type | Purpose |
|---|---|
| General cargo vessels | • Carry a variety of goods such as machinery, forest products, vehicles, food, etc.<br>• General cargo vessels in PMV import construction tools and materials such as rebar, heavy machinery, steel, and pipes, and export logs, lumber, wood pulp, and paper for example. |
| Dry-bulk cargo vessels (bulk carriers) | • Carry loose commodity materials such as coal, grain or ore.<br>• Vessels are segmented into large holding bins to store various materials.<br>• PMV primarily imports sugar and exports coal, grain, sulphur and potash. |
| Container cargo vessels | • Carry steel box containers designed to integrate with onshore semi-trucks.<br>• Containers carry a wide variety of consumer goods.<br>• PMV primarily imports household goods (electronics and clothing) and exports lumber and specialty crops such as peas and chickpeas. |
| Tankers | • Designed to carry a variety of liquid bulk materials including crude and refined petroleum oil, liquefied petroleum gas, ammonia, chlorine, fresh water, etc.<br>• Carry a single type of cargo.<br>• Transit is governed by unique requirements and restrictions depending on the area. |
| Tugs | • Smaller vessels designed to aid in the manoeuvrability of ships or to tow or push various materials.<br>• Account of the majority of traffic movements on the coast of BC.<br>• Capable of towing materials such as logs, barges, containers, dry bulk cargo, oil, etc. |
| Passenger vessels and pleasure craft | • Vessels or cruise ships designed to carry passengers for recreational voyages. Does not include commercial passenger ferries (see below).<br>• Seasonal vessels typically used in the summer months.<br>• Pleasure craft are specifically less than 30 m in length. |
| Government vessels and warships | • Include CCG vessels, government survey ships, larger frigates and destroyers. |
| Commercial passenger ferries | • Major contributor to traffic movement on the West Coast of BC and Washington State.<br>• Six major ferry providers operate year-round with an increase in vessel sailings in the summer months.<br>• Smaller ferry providers operate as a recreational service in the summer months. |
| Floatplanes | • Activity occurs primarily in the Vancouver Harbour Aerodrome, which is the 34th busiest in Canada (Statistics Canada 2012). |
| Commercial fishing vessels | • Three types of commercial fishing vessels: purse seine, gillnet, and troll.<br>• Purse seine are the largest commercial fishing vessel and use a large hydraulic boom and a take-up drum mounted aft to pick up the net.<br>• Gillnets are smaller commercial fishing vessels that extend nets designed to entangle fish. Fish are then removed as the net is hauled on board by a drum. These nets can extend as much as 550 m behind the vessel at 10 m depth.<br>• Trollers fit long lines with leaders and lures that are paid out and trolled behind the vessel. |

**Source:** PMV 2012

Within PMV, bulk carriers are the largest component of cargo traffic, making up 68 per cent of total cargo tonnage in 2012 (PMV 2012a).

Ships are subject to compulsory pilotage if the vessel is over 350 gross tonnes for non-pleasure craft vessels and over 500 gross tonnes for pleasure craft vessels. Compulsory pilotage does not apply to government vessels, ferries, or US government ships under 10,000 gross tonnes (Government of Canada 2009). The PPA licenses competent pilots to ensure safe, reliable, and efficient marine pilotage (Section 1.4.2.3). Licensed pilots are employed by the BCCPA.

MCTS communicates with vessels operating in Canadian waters and provides Vessel Traffic Service (VTS) to ensure navigational safety. Ships required to participate in VTS are 20 m or more in length, ships engaged in towing or pushing any vessel, combined length of the ship and any vessel or object towed or pushed by the ship is 45 m or more in length, or the length of the vessel or object being towed or pushed by the ship is 20 m or more in length. Exceptions to ships required to participate in VTS are towing or pushing inside a log booming grounds, pleasure yacht less than 30 m in length, fishing vessels that are less than 24 m in length and not more than 150 tonnes gross (CCG 2013a).

### *2.1.3 Existing Marine Traffic at Westridge Marine Terminal*

The existing Trans Mountain Westridge Marine Terminal is located in the eastern portion of Burrard Inlet and to the east of the Second Narrows. Figure 2.1.2 shows the location of the Westridge Marine Terminal in relation to neighbouring terminals and anchorages within the Burrard Inlet.

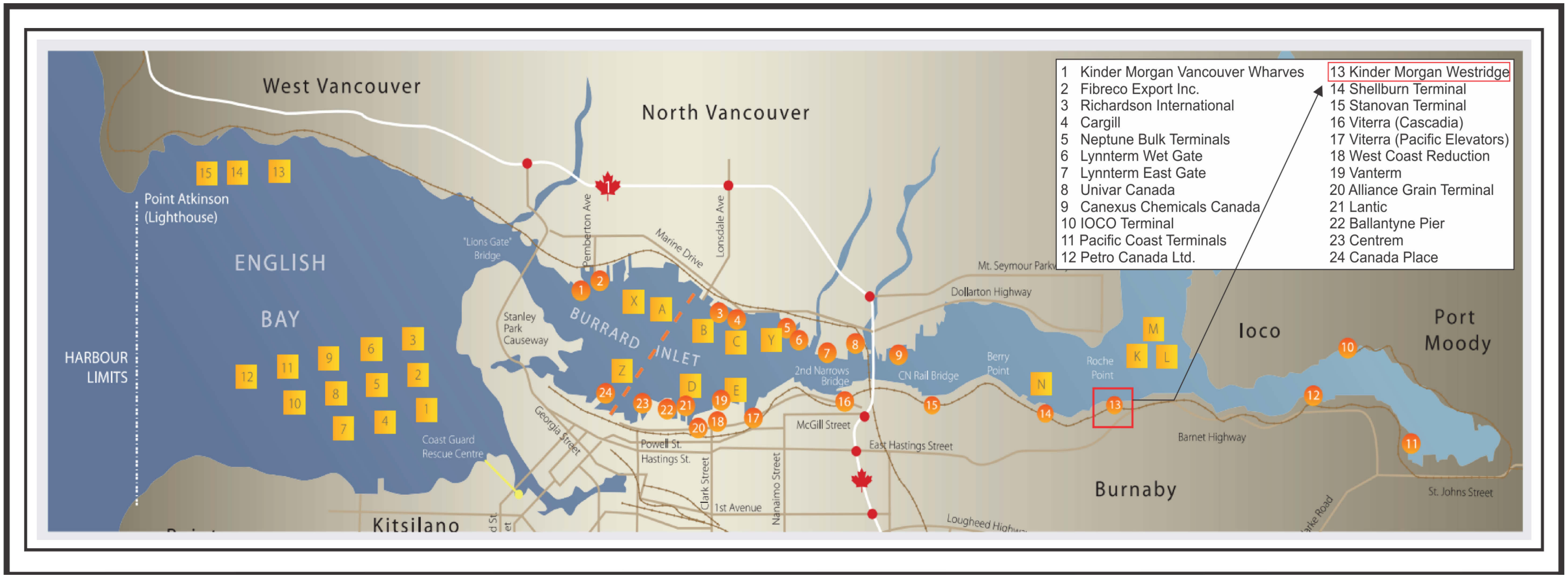
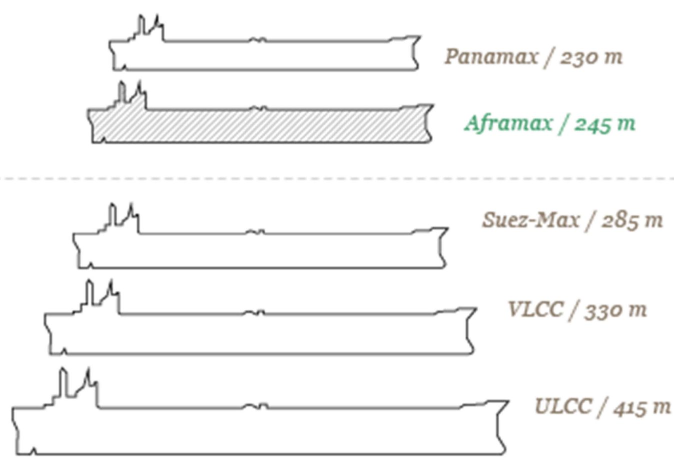



**Figure 2.1.2 Location of Westridge Marine Terminal within Burrard Inlet**

The size of tankers calling at the Westridge Marine Terminal is the Panamax (less than 75,000 metric tonnes DWT) or Aframax (75,000 to 120,000 metric tonnes DWT) class of vessel, the Aframax vessel being the larger of the two. Some Aframax tankers have a volumetric capacity of approximately 130,000 m$^3$ (or 820,000 barrels). All tankers calling Westridge Marine Terminal are constructed to meet global and Canadian standards for safety and pollution prevention, including double hull design and construction. TERMPOL 3.9 Ship Specifications in Volume 8C (TR 8C-7) provides additional information about the class of tankers calling at the Westridge Marine Terminal.

Figure 2.1.3 shows the different classes of tankers by size used throughout the world (http://www.transmountain.com/marine-plans).




**Source:** http://www.transmountain.com/marine-plans

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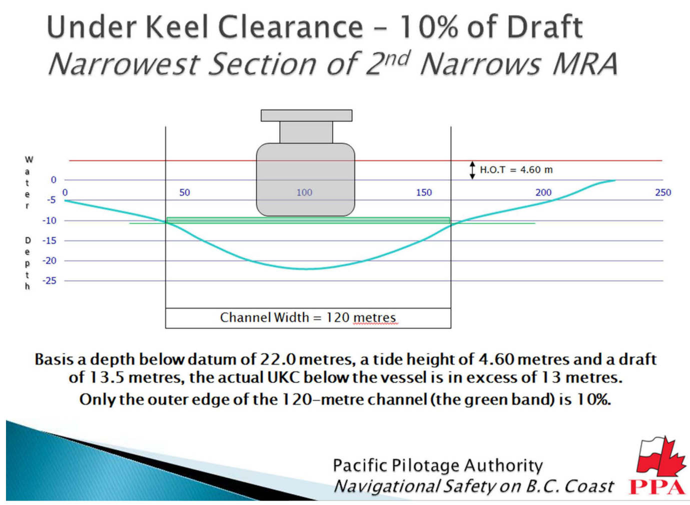
**FIGURE 2.1.3**
**OIL TANKER CLASSES AND SIZES**

**Figure 2.1.3 Oil Tanker Classes and Sizes**

### *2.1.4 Considerations within the Second Narrows Marine Restricted Area*

Restrictions on tanker movements to and from the Westridge Marine Terminal are stated in PMV's Harbour Operations Manual Second Narrows MRA Regulations. The maximum immersed depth (*i.e.,* draft) for vessels transiting the Second Narrows is limited by PMV's MRA rules to 13.5 m. In practice the allowable draft is currently limited to 13.0 m by the PPA as part of a phased implementation of the MRA rules following their revision in 2010 (PPA 2013a). It is reasonable to expect that the phased implementation will be complete by the time the Project comes into service and the 13.5 m limit will be in effect.

The MRA rules define the allowable beam (*i.e.,* width) and draft (*i.e.,* depth) of tankers in relation with the channel. Tankers have to maintain an under keel clearance of 10 per cent over a channel width of 2.85 times the vessel's beam and are restricted to daylight transit. Since the center of the channel is relatively deep in comparison to the vessel's draft it is typically the width of the channel that determines the allowable draft and therefore the extent to which a tanker can be loaded. Figure 2.1.4 provides an illustration of the 10 per cent under keel clearance requirement (Obermeyer pers. comm.). Additional information on under keel clearance is provided in TERMPOL 3.6 Special Underkeel Clearance Survey in Volume 8C (TR 8C-4).




**Source:** Obermeyer pers. comm.

**Note:** This cross section represents the narrowest portion of the Second Narrows MRA passage.

TRANS MOUNTAIN
KINDER MORGAN CANADA

**FIGURE 2.1.4**
**10 PER CENT UNDER KEEL CLEARANCE REQUIREMENT**

**Figure 2.1.4 10 Per Cent Under Keel Clearance Requirement**

Since channel width varies with tidal height so then does the extent to which tankers can be loaded. Occasionally, under the largest high tides, Aframax tankers can load up to about 90,000 tonnes (approximately 80 per cent DWT capacity) of cargo and based on the average density of heavy crude oil loaded at Westridge Marine Terminal this is equivalent to about 98,000 $m^3$ (615,000 bbls). However, over the tidal cycle the average cargo loaded would be about 550,000 bbls (equivalent to about 70 per cent DWT capacity). The effect of the draft restrictions on cargo capacity were taken into consideration by Trans Mountain when estimating the extent of tanker traffic that might result from the Project. This estimate was used in the quantitative risk assessment (TERMPOL 3-15, Volume 8C-12) of an oil spill occurring from one of these tankers.

## 2.2 Project-Related Changes to Marine Transportation and Traffic Volumes

### *2.2.1 Vessel Type and Marine Traffic Volume*

As a result of the Project, marine traffic volume calling at the Westridge Marine Terminal will increase. The types of vessels calling at the Westridge Marine Terminal (*i.e.*, barges, Panamax and Aframax size tankers) will not change as a result of the Project. As well, the vessels calling at the Westridge Marine Terminal after the Project is in operation will continue to use the existing marine transportation routes depicted in Figure 1.3.1.

The existing Westridge Marine Terminal typically loads five tankers and two or three barges per month. With approval of the Project only the number of tankers is expected to increase with the typical number of tanker loadings increasing to up 34 per month. In practice several factors will affect the actual number of tankers loaded monthly.

The design capacity of the dock includes an allowance for spot capacity, the use of which will vary with market conditions. If the spot capacity is not used the number of vessels will be lower. Through an “open season” process shippers have contracted with Trans Mountain for the majority of the 141,500 $m^3$/d (890,000 bbl/d) capacity of the expanded system and have indicated Westridge Marine Terminal as the preferred destination for up to 93,500 $m^3$/d (588,000 bbl/d). In addition to this firm capacity the Project includes an allowance for up to 6,700 $m^3$/d (42,000 bbl/d) of spot capacity for a total of up to 100,200 $m^3$/d (630,000 bbl/d). The actual deliveries of firm and spot volumes will be driven by market conditions and shippers will have the ability to redirect contracted volumes from Westridge to Puget Sound.

The number of vessels required to lift the delivered capacity depends on vessel size. Trans Mountain does not nominate, own, or operate the tankers that call Westridge Marine Terminal. Trans Mountain believes that the large majority of tankers nominated by shippers will be of the Aframax class, the largest size currently allowed by PMV, as these vessels will allow shippers the greatest economies of scale. The estimate of 34 tanker loadings per month is based on an all Aframax class case. However, the number could also be influenced by the substitution, by shippers, of some Panamax class tankers, which have less capacity than Aframax class tankers. If substitution occurs, there may be a slight increase in the number of loadings. Trans Mountain has calculated that a 25 per cent Panamax class substitution could add two or three loadings per month. These vessels and their characteristics are described in TERMPOL 3.9 in Volume 8C (TR 8C-7).

As described in Section 2.1.4, due to Second Narrows MRA restrictions, the extent of loading is determined by tidal height and varies with the tidal cycle. The number of vessels required will increase during periods of lower high tides and decrease during periods of higher high tides. Similarly draft is also affected by product density, which varies between petroleum types. There is also a general trend within the tanker industry to higher capacity tankers (within each class) and tankers carrying “light” synthetic crude oil will be able to load more cargo on a volumetric basis than those carrying “heavy” crude oil.

The maximum cargo loadable on a tanker is, therefore, subject to a combination of many factors, including the individual tanker’s dimensions (*i.e.,* cargo capacity, draft, and breadth), the cargo density, and tidal cycle. While substitutions by Panamax class tankers would have the tendency to slightly increase the number of loadings, that tendency would be offset by fluctuations in demand and greater cargo volumes per tanker as a result of the combination of factors discussed. As a result of these factors, Trans Mountain believes that 34 Aframax tanker loadings per month is a reasonable estimate for purpose of assessing Project-related effects (Table 2.2.1).

**TABLE 2.2.1**

**EXISTING AND FUTURE MARINE TRAFFIC AT WESTRIDGE MARINE TERMINAL**

| Vessel type | Existing (monthly average) | Predicted 2018 (monthly average)* | Predicted Increase |
|---|---|---|---|
| Tanker loading | 5 | 34 | +29 |
| Barge (crude oil) loading | 2 to 3 | 2 to 3 | 0 |
| Barge (jet fuel) discharge | 1 to 2 | 1 to 2 | 0 |

**Note:** * Based on Aframax tankers

The number of barges calling at the Westridge Marine Terminal is not expected to change as a result of the Project. Tables 2.2.2 and 2.2.3 show the Project-related increase in marine traffic in the context of predicted marine traffic volume within the Burrard Inlet and within the Juan de Fuca Strait (*i.e.*, including traffic to and from US ports).

**TABLE 2.2.2**

**SUMMARY OF AVERAGE MONTHLY LARGE VESSEL MOVEMENTS WITHIN BURRARD INLET**

| Vessel Type | 2012 (monthly average) | Predicted 2018 (monthly average) | Predicted Increase in Vessel Movements (2012 to 2018) | Per Cent of Each Vessel Type (2012) | Per Cent of Each Vessel Type (2018) |
|---|---|---|---|---|---|
| Cargo Vessels | 264 | 278 | 14 | 78.6 | 67.0 |
| Passenger Vessels (including ferries) | 40 | 42 | 2 | 11.8 | 10.1 |
| Tankers (not Project-related) | 22 | 27 | 5 | 6.5 | 6.5 |
| Tankers (Project-related) | 10 | 68 | 58 | 3.0 | 16.4 |
| All Large Vessels (Total) | 336 | 414 | 78 | | |

**Source:** Extrapolated from TERMPOL 3.2 in Volume 8C (TR 8C-2); information is based on inbound and outbound vessel movements

Within the Burrard Inlet, Trans Mountain predicts the Project-related increase in marine traffic will represent 16.4 per cent of total marine traffic volume, compared to the current 3.0 per cent. Within the Juan de Fuca Strait, Trans Mountain predicts the Project-related increase in marine traffic will represent 6.6 per cent of total marine traffic volume, compared to 1.1 per cent currently.

**TABLE 2.2.3**

**SUMMARY OF AVERAGE MONTHLY LARGE VESSEL MOVEMENTS WITHIN THE JUAN DE FUCA STRAIT**

| Vessel type | 2012 (monthly average) | Predicted 2018 (monthly average) | Predicted Increase in Vessel Movements (2012 to 2018) | Per Cent of Each Vessel Type (2012) | Per Cent of Each Vessel Type (2018) |
|---|---|---|---|---|---|
| Cargo Vessels | 641 | 674 | 33 | 69.7 | 65.5 |
| Passenger Vessels (including ferries) | 179 | 188 | 9 | 19.4 | 18.3 |
| Tankers (not Project-related) | 90 | 99 | 9 | 9.8 | 9.6 |
| Tankers (Project related) | 10 | 68 | 58 | 1.1 | 6.6 |
| All Large Vessels (Total) | 920 | 1,029 | 109 | | |

**Source:** Extrapolated from TERMPOL 3.2 in Volume 8C (TR 8C-2); information is based on inbound and outbound vessel movements

Existing marine traffic for the Salish Sea region was assessed based on Automated Information System (AIS) data and other vessel traffic information for 2012. Using a combination of economic forecasting, regional project announcements, and interviews, the amount of future traffic has been forecast for 2018, 2020, 2025, and 2030. These projected traffic volumes were used in TERMPOL 3.15 (Volume 8C, TR 8C-12) to estimate the probability of spills both with and without the proposed TMEP traffic for the years 2018 and 2028. The former is expected to be the first full year of service for TMEP; the latter is used to assess the effect of additional traffic growth on risk after 10 years of operation. The forecast is used to assess the effect of TMEP-related increased in marine traffic on other users of the waterways and vice versa. The traffic study is discussed in detail in TERMPOL 3.2 (Volume 8C, TR 8C-2).

The effect of increased tanker movements on other waterway users particularly at the Second Narrows MRA has been assessed and is expected to be minimal. This is because movement restrictions at the Second Narrows are more stringent for tankers, especially Aframax vessels, than for non-tankers and vessels of lesser size. These other vessels have significantly more opportunities to transit the Second Narrows MRA during each tidal cycle either before or immediately after laden tankers have passed. Furthermore, non-tankers are allowed to transit the Second Narrows MRA at night and avail of those tides as well. Un-laden tankers will also have a large number of transit opportunities.

The effect of increased tanker movements on anchorages was also assessed. It was concluded that the four existing anchorages are sufficient to meet the needs of the TMEP-related marine traffic as well as all other terminals east of Second Narrows MRA for the foreseeable future.

These assessments are described in TERMPOL 3.7 (Volume 8C, TR 8C-5), which also includes information that can be used by PMV and PPA to refine vessel traffic management plans including the management of Indian Arm anchorages if necessary.

### *2.2.2 Alternatives Considered*

Although Trans Mountain does not have legal responsibility or authority over management of marine transportation related to the Project, Trans Mountain has played an influencing role with respect to the consideration of alternatives related to marine transportation and the Project, engaging the public, Aboriginal communities, and regulatory authorities. The consideration of alternatives in this section was based on qualitative discussion, not a quantitative analysis.

Through its consultation activities, Trans Mountain identified one area for consideration of alternatives related to marine transportation and the Project: the class of tanker.

Currently, Aframax and Panamax class of tankers call at Westridge Marine Terminal to transport oil. The Aframax class of tanker is the largest size that is allowed into PMV. As well, the height of the Second Narrows Bridge poses a restriction and the Aframax class of tankers is the largest size tanker that could move through the Second Narrows MRA.

If vessels smaller than the Aframax or Panamax class of tanker were used as a result of the Project, the increase in volume of the product to be transported would require more tankers and thus, more tanker movements, as compared to using the Aframax or Panamax class of tanker. In addition, Trans Mountain identified the following effects from using smaller tankers *vs.* Aframax or Panamax classes of tankers as a result of discussions with stakeholders and its own qualitative assessment:

- More tanker movements related to the use of smaller vessels would mean the probability of an oil spill would increase; however, there would be a decrease in the size of a potential oil spill as the smaller vessel would carry less oil cargo.
- The number of movements through the Second Narrows MRA would increase, creating more pressure on PMV and other users of this waterway in PMV, such as the CN rail bridge, to manage the increase in transportation and anchorages.
- Due to economies of scale, the cost of shipping multiple smaller loads may be less economic over long distances where larger vessels have typically been used to reduce the per barrel freight cost of oil. The increase in freight rates combined with smaller cargo size would result in an increased cost of transportation on a per-barrel-of-oil basis, affecting the total delivered cost of Canadian oil in overseas markets.

Based on these considerations, Trans Mountain concluded that using a majority of Aframax with some Panamax size tankers as opposed to smaller tankers would strike an acceptable balance between the frequency of tanker movements, the increased management of marine transportation as a result of the Project, and probability of an oil spill from an oil tanker in transit from the Westridge Marine Terminal.

Alternatives related to the tanker shipping lanes and traffic patterns were not considered as the shipping lanes established in the Salish Sea region have proven effective at safely managing the existing volumes of marine traffic in this region.

# 3.0 PUBLIC CONSULTATION AND ABORIGINAL ENGAGEMENT

Trans Mountain has implemented and continues to conduct open, extensive and thorough public consultation and Aboriginal engagement programs. These programs were designed to reflect the unique nature of the TMEP as well as the diverse and varied communities along the proposed pipeline and marine corridors. These programs were based on Aboriginal community and stakeholder group 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 stakeholder engagement (Section 3.1) and Aboriginal engagement (Section 3.2) programs, as well as outcomes specific to the marine transportation elements considered in the ESA (Section 4.0). The full description of the Public Consultation and Aboriginal Engagement programs are located in Volumes 3A and 3B, respectively. The outcomes of the consultation and engagement activities for the pipeline and facilities component of the Project are located in other volumes of the application. Table 3.1 provides information on where other consultation and engagement considerations are located.

**TABLE 3.1**

**CONSULTATION INFORMATION LOCATION**

| Consultation Information | Application Location |
|---|---|
| **Pipeline and Facilities** | |
| Public Consultation | Volume 3A<br>Section 3.1 of Volume 5A<br>Section 3.1 of Volume 5B |
| Aboriginal Engagement | Volume 3B<br>Section 3.2 of Volume 5A<br>Section 3.2 of Volume 5B |
| Landowner Relations | Volume 3C<br>Section 3.3 of Volume 5A<br>Section 3.3 of Volume 5B |
| **Marine Transportation** | |
| Public Consultation | Volume 3A<br>Volume 8A (Sections 3.1 and 3.2) |
| Aboriginal Engagement | Volume 3B<br>Volume 8A (Section 3.3) |

## 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 marine transportation aspects of the Project and describes how stakeholder and public comments relating to the Marine Transportation ESA were gathered as well as how these comments have been incorporated into the application.

### *3.1.1 Design of Marine Public Consultation Program*

In consideration of the potential effects to the marine environment from the proposed increase in tanker traffic as a result of the Project, Trans Mountain extended the stakeholder engagement program to include coastal communities, beyond the pipeline terminus at Westridge Marine Terminal (Burnaby, BC). In recognition of this and the high level of stakeholder interest in marine shipments of petroleum products, Trans Mountain has engaged communities on Vancouver Island and the Gulf Islands along established marine shipping corridors transited by oil tanker traffic, as well as communities in and around PMV. Engagement with these communities has broadly discussed the greater terrestrial (pipeline) Project effects, but more specifically in this coastal region, consultation efforts have focused on maritime matters related to the proposed increase in Project-related marine vessel traffic and the expansion of the Westridge Marine Terminal.

The Project team received feedback from public open houses, workshops, one-on-one meetings, public presentations, online discussion and comment forms 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 3A. Overall, engagement activities have provided feedback on the following:

- determining the scope and nature of the ESA;
- identifying potential mitigation measures to reduce environmental and socio-economic effects; and
- identifying potential local or regional benefits associated with the Project.

The stakeholder engagement program is designed to foster input from the public who have an interest in the marine aspects of the Project. The program also sought meaningful consultation with stakeholders regarding the Project; environmental effects; and socio-economic effects and benefits. The stakeholder engagement program also shared timely information with stakeholders to keep them informed throughout the process. Through a preliminary evaluation, stakeholder groups that were identified to have a potential interest in the marine aspects of the Project have been identified in the Table 3.1.1.

**TABLE 3.1.1**

**INDENTIFIED STAKEHOLDER GROUPS FOR VICINITY OF MARINE SHIPPING LANES**

| Stakeholder Type | Stakeholder Type Sub-Categories |
|---|---|
| Government Authorities | • Government of Canada (federal agencies)<br>• Government of BC<br>• municipal governments<br>• regional governments<br>• Transit Authority |
| Environmental Non-Governmental Organizations (ENGOs) | • local stewardship groups in Burrard Inlet and coastal communities<br>• provincial and Canadian (nationwide) groups with particular interests in marine-related biodiversity, marine protected areas and / or groups with interests in the environmental effects of shipping |

**TABLE 3.1.1**

**INDENTIFIED STAKEHOLDER GROUPS FOR VICINITY OF MARINE SHIPPING LANES (continued)**

| Stakeholder Type | Stakeholder Type Sub-Categories |
|---|---|
| Interest Groups | • chambers of commerce<br>• economic development associations<br>• recreation groups<br>• labour groups<br>• local interest groups<br>• local and regional associations and organizations |
| Industry | • terminal operators in Burrard Inlet (including other petroleum product terminals)<br>• oil and gas industry (*e.g.,* Canadian Association of Petroleum Producers [CAPP])<br>• maritime industry<br>• Trans Mountain shippers potential suppliers and contractors |
| Public | • public living or working in marine shipping lanes communities<br>• public living outside marine communities |

#### *3.1.1.1 Public*

The stakeholder engagement program focused on building 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 in the vicinity of the marine shipping lanes.

#### *3.1.1.2 Focus Participants*

The stakeholder engagement program involved focused discussions with small groups of interested stakeholders. Stakeholders had the opportunity to provide feedback on the marine studies as well as the approach to the ESA for the marine transportation component. These participants included representatives from local governments, community organizations, economic development organizations, 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 the Marine 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 proposed pipeline corridor communities (those potentially affected directly by the proposed pipeline and related facilities) and marine communities (those potentially affected by the increase in Project-related marine vessel traffic). In addition, pipeline and marine communities were further divided into the following five regions.

- AB;
- BC Interior;

- Lower Mainland/Fraser Valley;
- Mainland Coastal; and
- Island Coastal.

As Trans Mountain proceeds through the life of the Project, the stakeholder engagement program allows for the identification of new information and additional stakeholders. The initial grouping of 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 CORRIDOR AND MARINE COMMUNITIES

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

**Notes:** 1 The District of Hope, while a member of FVRD, is reported for the purposes of this application under the BC Interior Region and the FVRD is reported under the Lower Mainland/Fraser Valley Region.

2 For the purposes of this application on matters relating to the pipeline and associated facilities, the City of Burnaby and the Metro Vancouver Regional District will be reported under the pipeline communities in the Lower Mainland/Fraser Valley Region. There are also marine aspects of TMEP engagement with the City of Burnaby and the Metro Vancouver Regional District. Therefore, TMEP engagement with the City of Burnaby and the Metro Vancouver Regional District are also reported under 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.

The stakeholder engagement program has been designed to foster positive relationships with the stakeholders as well as provide opportunities for stakeholders to be involved in the engagement process. The following section provides information on communications and engagement activities that took place during the first three phases of engagement activities conducted between the time of the Project announcement in May 2012 and the end of Phase 3 on July 31, 2013.

#### *3.1.3.1 Communications Activities*

The communications initiatives supported engagement activities by providing notification about the various engagement opportunities including public open houses, ESA technical workshops, and online discussion activities.

From producing printed newsletters to talking about Project details on social media channels to answering public and media inquiries, the communications program used a variety of methods to reach various audiences. The communications initiatives included:

- a comprehensive website with information about various components of the Project and the industry;
- proactively distributing Project updates via email to people who signed up through the Project website, at open houses or through other means;
- Twitter and YouTube posts to reach people who used 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 could engage with members of the Project team – in person or online.

The Trans Mountain communications program provided those interested in the Project with a range of sources of information and platforms to encourage discussion and education, rather than engage in activities that merely help boost the profile of the Project.

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

The first phase of engagement focused on Project introduction, identifying interested stakeholders in government, municipalities and local communities, and identifying locally-appropriate means for engagement. Trans Mountain provided information through mail, email, and website posts as well as hand delivering information to stakeholders at Project introduction meetings.

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

Phase 2 of the stakeholder engagement program continued the outreach and discussions with municipalities and other stakeholders. In addition, Trans Mountain focused on engaging stakeholders through open house style information sessions and seeking input through conversation, feedback forms, online discussion, and Project-specific social media accounts. Content and format varied by the needs and interests of the communities, and where applicable. Trans Mountain provided stakeholders with information on the following:

- a Project overview and introductory information;
- the scope of the land and marine environmental assessments;
- the scope of the socio-economic assessment;
- introduction of the routing process; and
- an overview the regulatory process.

#### 3.1.3.1.3 Public Open House Format

Public open houses in the Marine communities started in November 2012 and continued to mid-January 2013. The two to three hour sessions 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 large poster boards positioned throughout the venue. Corporate leadership and technical experts including representatives from marine biological science, maritime navigation and industry, 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 to these experts, representatives from the Port of PMV, the WCMRC, PPA, and Seaspan and/or SMIT Harbour Towage Inc (SMIT) were invited to provide to the public information on their role in maintaining or regulating marine safety along the shipping corridors. These outside representatives set up their own displays along with their own hand out materials. Their participation in the open houses was not meant to indicate any support or approval for

Trans Mountain, rather their involvement was to provide information to attendees about maritime matters in the context of increased tanker traffic.

#### 3.1.3.1.4 Phase 3 Engagement: Community Conversations, February to July 2013

Phase 3 Engagement continued the discussion through a series of ESA Workshops, Community Workshops, and Routing Open Houses. Trans Mountain continued to reach out to previously unidentified stakeholder groups, and held focused discussions with local government and previously identified stakeholder groups. Project updates meetings and presentations for stakeholders continued.

### *3.1.3.2 Marine ESA Workshops*

The Marine ESA Workshops in Phase 3 provided information on the proposed approach to the completion of the ESA for the marine transportation and Westridge Marine Terminal expansion components. Regional Marine ESA Workshops, held in Langford, on May 22, 2013, and North Vancouver on May 23, 2013, targeted local and regional subject matter experts. These workshops were consistent with the format of the pipeline community ESA Workshops (Volume 3A); however, the Marine ESA Workshops provided attendees with a proposed overview of the Marine ESA approach for the Project and sought feedback on particular modules of the ESA including biological, physical, and human impacts under normal operations and ecological and human impacts under an accident or malfunction circumstance. Input was solicited online for two weeks after each workshop. Trans Mountain conducted these workshops in response to feedback received during the early stages of engagement regarding community interests and needs.

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

The goals of the Phase 4 stakeholder engagement and communications program will include community and economic benefit presentations in conjunction with chambers of commerce, attending events, one on one meetings, emergency response workshops, and presentations/speaking opportunities. In addition, 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.

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

Additional engagement and communications phases will be developed to support the regulatory process and, if successful, the construction phases of the Project. The goals of this engagement and communication phase will include sharing results of any new studies or work being completed on the Project, to communicate any changes and or updates 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 and communications activities will be undertaken through a number of initiatives, including but not limited to, open houses, workshops, one on one meetings, presentations, website, online discussion forums, printed materials, and digital media including social media.

Engagement continues with coastal stakeholders related to environmental aspects of the Project. Direct outreach to large and small conservation groups (including local ENGOs) on the coast remains a focus during this phase to identify their interests and concerns and possible opportunities in mitigation or partnerships in conservation offset projects. Trans Mountain is also encouraging new relationships between local environmental groups and certified spill responders so that more information can be shared about areas of high ecological value on BC's southwest coast.

Engagement and communication initiatives will be documented and provided as updates to the NEB at logical intervals.

##### 3.1.3.2.3 Phase 6 Engagement: Ongoing Operational Consultation, Post-Construction Throughout Operational Life

Kinger Morgan Canada Inc.'s (as the operator of TMPL) neighbours, governments and Aboriginal communities play an important role in how business is conducted. Kinder Morgan Canada Inc.'s success depends on earning the trust, respect, and cooperation of all community members.

Trans Mountain, as the Project applicant, and Kinder Morgan Canada Inc., as the operator of TMPL, are 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 hosting facility open houses, providing newsletters and Project updates, making safety and public awareness presentations, participating in community events, regulatory processes, and ongoing informal meetings with stakeholders.

Initiatives to be activated during this phase will be developed in the lead up to construction. Kinder Morgan Canada Inc., as the operator of TMPL, is committed to ongoing consultation in the communities in which it operates.

### *3.1.4 Summary of Outcomes of the Public Consultation Program*

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 those stakeholders. Trans Mountain has tracked these conversations and relayed the key topics to the appropriate Project representative to be considered and incorporated in the application where applicable. Appendix C (Summary of Outcomes of the Public Consultation Program) provides a summary of key stakeholder interests and concerns relating to the marine transportation component of the Project and where these topics are addressed in the application. Specific disciplines consulted with federal, provincial, regional and municipal authorities regarding the marine environmental and socio-economic effects assessment. For each environmental or socio-economic element, a summary table in Appendix C 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.

## 3.2 Aboriginal Engagement

Since April 2012, Trans Mountain has engaged with Aboriginal communities who might have an interest in the Project or have Aboriginal interests potentially affected by the increase in Project-related marine vessel traffic based on their assertion of traditional and cultural use of marine resources to maintain a traditional lifestyle. Trans Mountain respects the Aboriginal and treaty rights, unique culture, diversity, languages, and traditions of Aboriginal peoples. 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. In order to build relationships for the long-term, the program is based on the principles of accountability, communication, local focus, mutual benefit, relationship building, respect, responsiveness, shared process, sustainability, timeliness, and transparency.

This subsection provides information on the Aboriginal Engagement Program for the Project and describes how the results of Project engagement activities relating to marine transportation 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. Volume 3B provides detailed information on the Trans Mountain approach to the Aboriginal Engagement Program as well as detailed information on the Trans Mountain vision and the principles and goals of the program.

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 the Marine Aboriginal Engagement Program*

#### *3.2.1.1 Identification of Aboriginal Communities*

Using an inclusive approach beginning in 2011, Trans Mountain worked in collaboration with the federal government and provincial ministries to identify marine Aboriginal communities in BC for engagement.

For purposes of identifying marine Aboriginal communities that might have an interest in the Project or have Aboriginal interests potentially affected by the Project, the Aboriginal Affairs and Northern Development Canada (AANDC) asserted territory maps for Aboriginal communities who are negotiating treaties within the BC Treaty Commission process were used. The Transport Canada shipping lanes provided guidelines and all territories were included where potential effects and cumulative effects could extend in the marine environment, thereby potentially effecting traditional use of the marine environment.

For communities not currently engaged in the BC treaty process, Trans Mountain reviewed territory maps for each community (or maps of associations or tribal councils with which the community is affiliated) using the same guidelines to identify Aboriginal communities for engagement.

Upon further discussion with AANDC, Trans Mountain contacted the BC Ministry of Aboriginal Relations and Reconciliation and received guidance on the development of engagement lists for the Project. In addition to engagement with the federal and provincial ministries regarding communities and groups to include in the Marine Aboriginal Engagement Program, further engagement took place in early 2012 with representatives from:

- the Major Projects Management Office (MPMO);
- the NEB;
- Transport Canada; and
- the BC Oil and Gas Commission (OGC).

The final list was a compilation guided by both levels of government as well as an existing list of Aboriginal communities held by KMC, where existing relationships were in place as a result of the operating TMPL system. The result was a comprehensive list of 20 marine Aboriginal communities and 7 inlet Aboriginal communities with traditional territories located within the marine transportation corridor identified by the Project.

As the Project develops, Trans Mountain continues to consult with these departments and agencies in addition to the Aboriginal communities, to ensure all that might have an interest in the Project or have Aboriginal interests potentially affected by the Project are included in the Aboriginal Engagement Program.

#### *3.2.1.2 Marine Aboriginal Communities Engaged*

Trans Mountain is engaging with 27 Aboriginal communities in proximity to the marine transportation corridor that might have an interest in the Project or have Aboriginal interests potentially affected by the Project (Tables 3.2.1 and 3.2.2).

**TABLE 3.2.1**

**ABORIGINAL COMMUNITIES LOCATED IN THE BURRARD INLET REGION**

| |
|---|
| Katzie First Nation |
| Kwikwetlem First Nation |
| Musqueam Indian Band |
| Semiahmoo First Nation |
| Squamish Nation |
| Tsawwassen First Nation |
| Tsleil-Waututh Nation |

**TABLE 3.2.2**

**ABORIGINAL COMMUNITIES LOCATED IN THE MARINE CORRIDOR**

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

#### *3.2.1.3 Engagement Method*

The Marine Aboriginal Engagement Program uses a comprehensive Aboriginal engagement process led by experienced engagement advisors in BC. The process for engagement with Trans Mountain about 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. In addition to the field advisors, the Aboriginal engagement team is made up of professionals working in the areas of Aboriginal relations, law, economic development, education, training, employment and procurement.

The Marine Aboriginal Engagement Program focuses on:

- establishing trusting and respectful relationships;
- sharing Project information – Project scope, routing options, safety and emergency response, scheduling, 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 marine resource use (TMRU) studies;
- identifying potential impacts and addressing concerns;
- discussing the adequacy of planned impact mitigation and opportunities; and,
- identifying education, training, employment and procurement opportunities.

#### *3.2.1.4 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 letter of understanding/capacity agreement;
- host community information session(s);
- conduct TMRU studies;
- identify interests and concerns;
- review key 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 marine Aboriginal communities that have been identified as having an interest in the Project or have Aboriginal interests potentially affected by the Project.

Engagement with 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. In addition, details related to the TMRU studies completed with participating Aboriginal communities can be found in Section 4.0. Details related to studies completed with participating Aboriginal communities for the proposed pipeline corridor and Westridge Marine Terminal can be found in Volumes 5A and 5B.

#### *3.2.1.5 Incorporating Aboriginal Traditional Marine Resource Use Studies*

TERA Environmental Consultants (TERA) was commissioned to assist in the collection of traditional marine resource use information with potentially affected Aboriginal communities that focused on the current use of traditional marine resources potentially affected by the increases in Project-related vessel traffic.

TERA acknowledges the unique relationship that has evolved between the Aboriginal people and their surrounding physical environment. This physical environment includes the lands, waters, resources and events that have shaped and sustained the local Aboriginal people, their culture, and their communities.

The aim of the TMRU studies is to identify and mitigate effects of the increase in Project-related marine vessel traffic on current use of traditional marine resources. This is achieved by meeting the following objectives:

- determine the extent and general nature of each community's current use of marine resources for traditional activities relative to shipping lanes;
- identify existing concerns and potential effects of the Project on traditional marine resource use for baseline scoping and selection of social or environmental indicators for the effects assessment;
- provide traditional knowledge, where appropriate, for the assessment of potential effects of Project-related marine vessel traffic on traditional marine resource use; and
- recommend appropriate mitigation measures to address concerns raised relative to the Project-related marine vessel traffic regarding traditional marine resource use.

Following Project initiation, Trans Mountain began facilitation of the TMRU studies conducted by interested Aboriginal communities for the Project (see the Traditional Marine Resource Use – Marine Transportation Technical Report of [Volume 8B, TR 8B-5]). The Project scope, timetable and location were discussed. Project information packages, which included a description of the Project, facts on the nature, timing, scope and location of the Project, and relevant contact information for communication with Trans Mountain and TERA, were sent to each community and meetings were subsequently scheduled. Communities were also provided with copies of the proposed TMRU study methods and a draft outline of TERA's TMRU study work plan. The initiation of TMRU studies, either as TERA-facilitated or community-directed using a third-party consultant, was discussed with Aboriginal communities based on an indicated interest in participating in these studies.

Trans Mountain provided funding to assist Aboriginal communities that elected to conduct their own community-directed TMRU studies. These communities often engaged other consultants to provide technical support and assistance with their TMRU studies for the Project. During these studies, community representatives are asked to contribute to the discussion of potential Project-related effects on TMRU and to participate in the discussion of potential mitigation measures to reduce potential Project-related effects.

TERA has prepared a separate Traditional Marine Resource Use – Marine Transportation Technical Report that outlines Trans Mountain's information collection efforts for the assessment of potential adverse effects of the Project on current use of marine resources for traditional purposes (Volume 8B, TR 8B-5). The technical report also provides a description of how TMRU studies were developed for each interested Aboriginal community. The traditional marine resource use information collected has been incorporated into the Traditional Marine Resource Use – Marine Transportation Technical Report (Volume 8B, TR 8B-5) and used to assist in the assessment of the potential effects of the increase in Project-related marine vessel traffic.

Appendix A of Volume 3B provides a summary of the meetings and interviews that took place for the traditional marine resource use component of the ESA. The issues that were raised and where they are considered in the traditional marine resource use assessment are also summarized in Table 3.2.1.

### *3.2.2 Implementation*

#### *3.2.2.1 Engagement Activity*

The Trans Mountain Marine Aboriginal Engagement Program was designed to provide meaningful engagement with marine Aboriginal communities using multiple forms of engagement detailed in Volume 3B, including Project letters, meetings, phone conversations, email dialogue, newsletters, public information sessions and the Project website.

Utilized specifically for engagement with marine Aboriginal communities, an expanded version of the presentation titled "Aboriginal Engagement Program: Trans Mountain Expansion Project" is used during meetings to share Project details with attendees (Appendix D). The presentation deck is similar to the presentation included in Volume 3B however includes additional details about the marine environment such as tankers, safety and the West Coast Marine Response Corporation.

A number of methods have been used to inform Aboriginal communities, obtain feedback and identify issues about the Project including: including Project letters, meetings, phone conversations, email dialogue, newsletters, public information sessions and 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 traditional marine resource use (Section 3.2.1.4) have contributed to the development of the marine transportation assessment, including mitigation and enhancement measures. A detailed summary of engagement with each Aboriginal community is available in Volume 3B.

#### *3.2.2.2 Procurement, Employment, Education and Training*

Trans Mountain is committed to supporting the sustainability of Aboriginal communities through procurement opporutnities, 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 Procurement Policy and the Training Policy for Aboriginal Peoples to enhance employment opportunities with all interested communities, including marine communities.

#### *3.2.2.3 TERMPOL Review Process*

Transport Canada's Aboriginal engagement process for the TERMPOL Review Process evolved during 2013, while TMEP Aboriginal engagement was already taking place. As recommended by Transport Canada in a letter addressed to Trans Mountain on August 30, 2013 (Appendix F) Trans Mountain is engaging with marine Aboriginal communities on this process in the following ways:

- provide sufficient information about the Project to enable participants understanding of the project;

- listen to concerns raised by Aboriginal groups and, where possible, address these concerns;
- provide Aboriginal groups an opportunity to review and comment on the draft surveys and studies of interest, and consider Aboriginal groups' comments;
- document efforts to engage Aboriginal groups' comments;
- document efforts to engage Aboriginal groups, including a written communication log, a summary of issues raised, how the proponent has addressed concerns (as applicable), and a description of outstanding issues; and
- provide Aboriginal groups an opportunity to review and validate the summary of issues raised.

In November/December 2013, Trans Mountain invited Aboriginal marine communities to review the TERMPOL studies. Trans Mountain continues to actively engage with Transport Canada and marine Aboriginal communities in the TERMPOL Review Process.

### *3.2.3 Summary of Outcomes of the Marine Aboriginal Engagement Program*

The results of engagement have helped refine the ESA for the Project. With this information, Trans Mountain identified issues, responded to questions and addressed concerns. 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:

- potential environmental effects of spills on the marine environment and the related effects to traditional activities;
- increases of Project-related vessel traffic on traditional hunting and fishing areas, travelways and sacred areas;
- rehabilitation and protection of the Salish Sea;
- effect of increased vessel traffic through Burrard Inlet;
- additional economic incentives including preferred procurement opportunities, revenue sharing, community enhancement opportunities and equity participation; and
- ongoing respectful and meaningful engagement including capacity funding and TMRU study funding.

Results of the engagement have been considered and incorporated throughout the marine transportation assessment where relevant, including the mitigation measures and effects assessment. The issues identified by participating Aboriginal communities through engagement activities for the Project and references to where they are considered in this application are presented in Appendix E (Interests or Concerns Identified Through Engagement Activities with Aboriginal Communities for the Project). Detailed information on engagement activities conducted and opportunities provided for Project input to date with each Aboriginal community can be found in Appendix A of Volume 3B.

### *3.2.4 Future Aboriginal Engagement Activities*

Following submission of the application to the NEB, including Volume 8A, Trans Mountain will continue its engagement with Aboriginal communities to provide updates on the status of the Project and discuss key mitigation measures in place and additional recommendations for the Project. Information updates will continue to be sent to marine Aboriginal communities. From information sharing to ongoing TMRU studies to address interests and concerns, Trans Mountain is committed to the continuation of an effective engagement program that satisfies all parties.

The outcomes of meetings and remaining TMRU study engagement efforts will be documented and filed with the NEB (see Section 4.5). 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 who have an interest in the Project or interests potentially affected by the Project.

# 4.0 ENVIRONMENTAL AND SOCIO-ECONOMIC ASSESSMENT

## 4.1 Introduction

### *4.1.1 Overview of Marine Transportation and Shipping Activities*

There are a variety of vessel types that currently transit the West Coast, including general cargo vessels, dry-bulk cargo vessels, container cargo vessels, tankers, tugs, passenger vessels, pleasure crafts, government vessels and warships, commercial passenger ferries, float planes, and commercial fishing vessels.

There are about 475,000 vessel movements per year on the West Coast and tankers accounting for about 1,500 movements (0.3 per cent) in 2009 to 2010 (Transport Canada 2013h). Oil tankers have been moving safely and regularly along Canada's West Coast since the 1930s (Transport Canada 2013h). Oil is moved mostly via the ports of Vancouver, Prince Rupert and Kitimat. Transport Canada records show that in 2009, about 8.4 million tonnes of oil were shipped out of Vancouver (Transport Canada 2013h). Much of this oil is transported in barges to and from communities along the BC coast. Varying quantities of oil are also carried on-board container ships, domestic and international ferries, and other types of commercial and private vessels, primarily as fuel (Transport Canada 2013h).

Existing traffic and Project-related marine vessel traffic calling at the Westridge Marine Terminal in this marine network will encounter other vessels and navigational features, such as pilot boarding stations, narrow channels, channel bends and marine traffic crossings.

Legislation exists in Canadian and American waters to be transited by Project-related vessels to ensure safety and environmental protection. MCTS communicate with vessels operating in Canadian waters and provide VTS to ensure navigational safety. The following requirements apply for mandatory participation in VTS:

- ships 20 m or more in length;
- ships engaged in towing or pushing any vessel;
- combined length of the ship and any vessel or object towed or pushed by the ship is 45 m or more in length; and/or
- the length of the vessel or object being towed or pushed by the ship is 20 m or more.

In addition, ships are subject to compulsory pilotage if the vessel is over 350 gross tons for non-pleasure craft vessels and over 500 gross tons for pleasure craft vessels. Compulsory pilotage does not apply to government vessels, ferries, or US government ships under 10,000 gross tons (Government of Canada 2009). The PPA is responsible for providing competent, licensed pilots to ensure safe, reliable and efficient marine pilotage. Project-related marine vessel traffic will be subject to PPA legislation.

As a result of the Project, marine traffic volume calling at the Westridge Marine Terminal will increase. The types of vessels calling at the Westridge Marine Terminal (*i.e.*, barges and 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. The existing and future marine traffic volumes calling at the Westridge Marine Terminal are described in Table 4.1.1.1, which shows the Project-related change.

**TABLE 4.1.1.1**

**EXISTING AND FUTURE MARINE TRAFFIC AT THE WESTRIDGE MARINE TERMINAL**

| Vessel type | Existing (monthly average) | Predicted 2018 (monthly average)* | Predicted Increase |
|---|---|---|---|
| Tanker loading | 5 | 34 | +29 |
| Barge (crude oil) loading | 2 to 3 | 2 to 3 | 0 |
| Barge (jet fuel) discharge | 1 to 2 | 1 to 2 | 0 |

**Note:** * Based on Aframax tankers

The regional location of the proposed increased Project-related marine vessel traffic is shown on Figure 4.1.1.


![TRANS MOUNTAIN]

**FIGURE 4.1.1**

**REGIONAL LOCATION OF THE MARINE SHIPPING LANES**

**TRANS MOUNTAIN EXPANSION PROJECT**

- Reference Kilometre Post (RK)
- Kilometre Post (KP)
- Trans Mountain Pipeline (TMPL)
- Trans Mountain Expansion Project Proposed Pipeline Corridor
- Terminal
- Existing Pump Station
- Highway
- Road
- 12 Nautical Mile Limit (Territorial Sea)
- Limit of Exclusive Economic Zone (EEZ)
- International Boundary
- Marine Vessel Outbound Shipping Lane
- Marine Vessel Inbound Shipping Lane
- Traffic Separation Scheme
- City / Town / District Municipality
- Indian Reserve / Métis Settlement
- National Park
- Provincial / State Park
- Protected Area/Natural Area/ Provincial Recreation Area/Wilderness Provincial Park/Conservancy Area
- Regional District Boundary



Projection: UTM Zone 10N.
Routing: Baseline TMPL & Facilities: provided by KMC, 2012; Proposed Pipeline Corridor V6: provided by UPI, Aug. 23, 2013; Transportation: BC Forests, Lands and Natural Resource Operations, 2012 & ESRI, 2005; Geopolitical Boundaries: IHS Inc., 2011, BC FLNRO, 2007 & ESRI, 2005, Natural Resources Canada, 2012; First Nation Lands: Government of Canada, 2013 & IHS Inc., 2011; Hydrology: IHS Inc., 2004, United States National Imagery and Mapping Agency, 2000, Natural Resouces Canada, 2010; Parks and Protected Areas: Natural Resources Canada, 2013, BC FLNRO, 2008; CHS: provided by KMC, 2013; Marine Shipping Lanes: Moffat and Nichol, 2013; Hillshade: TERA, derived from Geobase; US Hillshade: Copyright:© 2013 Esri.

TERA ENVIRONMENTAL CONSULTANTS



| MAP NUMBER | | PAGE |
|---|---|---|
| 201308_MAP_TERA_MR_00378_REV0 | | SHEET 1 OF 1 |
| DATE: December 2013 | TERA REF.: 7894 | REVISION: 0 |
| SCALE: 1:650,000 | PAGE SIZE: 11x17 | DISCIPLINE: MR |
| DRAWN: AJS | CHECKED: TGG | DESIGN: TGG |

SCALE: 1:650,000

0 5 10 15 20 25 km

ALL LOCATIONS APPROXIMATE

201308_MAP_TERA_MR_00378_Rev0.mxd

### *4.1.2 Purpose of the Environmental Assessment*

Early in the Project planning process, Trans Mountain recognized that the increased Project-related marine transportation was an important issue to many stakeholders. Trans Mountain initiated an ESA, which included public consultation and Aboriginal engagement activities to assist in identifying potential adverse environmental and socio-economic effects and mitigation measures resulting from the increased Project-related marine transportation. The purpose of the ESA is to describe:

- the potential environmental and socio-economic effects and cumulative effects of the increased Project-related marine vessel traffic;
- the mitigation and enhancement measures that will be in place to anticipate, prevent, reduce and manage potentially adverse environmental and socio-economic effects over the life of the Project;
- consultation undertaken to notify those potentially affected, identify their concerns, and the measures to be taken to address those concerns; and
- an assessment of the significance of potential effects, after applying proposed mitigation measures.

With respect to regulatory requirements, Trans Mountain is required to prepare an ESA as the Project is considered a designated project under the *CEA Act, 2012*.

Although marine transportation is not regulated by the NEB, the NEB has included the potential effects of increased marine transportation on the Project List of Issues for review (NEB 2013a). The NEB provided further clarification of its requirements to consider the environmental and socio-economic effects of the increase in marine tanker traffic in its Filing Requirements Related to the Potential Environmental and Socio-Economic Effects of Increased Marine Shipping Activities, Trans Mountain Expansion Project (September 10, 2013) (NEB 2013b), effectively determining the scope of the ESA and the factors to be assessed.

Although the NEB Filing Manual (2013c) does not provide guidance directed towards marine transportation effects, the general outline of this volume and methodology of effects assessment follow guidance set out in the NEB Filing Manual (2013c) to maintain consistency with Volumes 5A and 5B.

This ESA for the increased Project-related marine vessel traffic has been prepared following the guidance in the NEB Filing Manual (NEB 2013c) and direction provided in guidance documents issued by the CEA Agency. Trans Mountain directed TERA to conduct an assessment to meet the requirements of both the NEB Filing Manual (2013c) and Section 19(1) of the *CEA Act, 2012*.

Additional federal and other regulatory authorities may have environmental regulatory interests associated with the Project, although regulatory responsibilities are evolving and actual interests will be confirmed through ongoing consultation with the regulatory authorities. Authorities with interests may include:

- Environment Canada pursuant to the *CEPA*, the *Species at Risk Act* and the *Migratory Birds Convention Act*;
- DFO pursuant to the *Fisheries Act*;

- PMV pursuant to Section 56 of the *Canada Marine Act*; and
- Transport Canada engaged through the voluntary TERMPOL and the authority responsible for marine emergency response.

The roles and responsibilities of these regulatory authorities, as they relate to the Project and marine transportation, were previously described in Section 1.4.

#### *4.1.3 Overview of Marine Transportation Environmental and Socio-Economic Assessment*

Section 4.0 (ESA for the increased Project-related marine vessel traffic) has been prepared as a detailed report of the potential effects of increased Project-related marine vessel traffic on environmental and socio-economic conditions. Marine transportation spill scenarios are presented in Section 5.7. Mitigation measures and additional supporting information are detailed in Volume 8B, Technical Reports. Section 4.0 is divided into the following sections.

**4.1 Introduction:** Provides background information pertaining to the Project, the scope of the assessment and the outline of Section 4.0.

**4.2 Environmental and Socio-Economic Setting:** Provides a description of the current environmental and socio-economic conditions in the vicinity of the marine shipping lanes.

**4.3 Environmental and Socio-Economic Effects Assessment:** Describes the effects assessment and identifies the potential environmental and socio-economic effects, mitigation measures and predicted residual effects as well as an assessment of their significance for the increased Project-related marine vessel traffic.

**4.4 Cumulative Effects Assessment:** Provides a description of the contribution of increased Project-related marine vessel traffic to potential adverse cumulative effects as well as an assessment of its significance.

**4.5 Supplemental Studies:** Provides information regarding additional information that may be required to supplement the application.

**4.6 Conclusion:** Provides conclusions related to the significance of potential adverse residual effects and cumulative effects associated with the increased Project-related marine vessel traffic.

#### *4.1.4 Scope of the Assessment*

Scoping is the process of identifying the physical works and activities to include within the ESA, and which biophysical and socio-economic elements are likely to be affected. Proper scoping reduces the risk of including unimportant or irrelevant information in the assessment or excluding factors that should be assessed (NEB 2013c). This ESA relies, in part, on information developed in support of the Transport Canada TERMPOL process.

In addition to the environmental assessment report completed by the NEB under the *CEA Act, 2012*, the proponent is required to submit an ESA to the NEB. The environmental assessment report and ESA will meet the requirements of the complete federal ESA process including the *CEA Act, 2012* and NEB requirements. The environmental assessment considers the mandatory factors listed in Section 19(1) of the *CEA Act, 2012*, as well as the factors listed in the NEB Filing Manual (NEB 2013c), and pertinent issues and concerns identified through Aboriginal engagement and regulatory authority, stakeholder, and public consultation.

The assessment considers the potential effects of the increased Project-related marine vessel traffic on the environment and socio-economic conditions 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 proposed physical activities associated with the increased Project-related marine vessel traffic;
- the natural variation of a population, or environmental or socio-economic component;
- the time required for an effect to become evident;
- the time required for a population or environmental or socio-economic component to recover from an effect and return to a pre-effect condition;
- the area directly affected by proposed physical activities; and
- the area in which a population or environmental or socio-economic component functions and within which a Project effect may be felt.

The spatial boundaries consider one or more of the following areas, as summarized below.

- 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 the increased Project-related marine vessel traffic. This generally represents a buffer from the centre of the marine shipping lanes. Detailed descriptions of the element-specific LSAs are provided in Section 4.2 and associated rationales are provided in Section 4.3.
- 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 increased Project-related marine vessel traffic on the individual element. Detailed descriptions of the element-specific RSAs are provided in Section 4.2 and associated rationales are provided in Section 4.3.

Individually established environmental or socio-economic boundaries are described within the discussions in Section 4.2 for each applicable element. Spatial environmental and socio-economic boundaries were determined by the distribution, movement patterns and potential zones of interaction between an element and the Project.

Desktop studies considered the width of the shipping lanes at a minimum.

The environmental assessment also considers 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.

#### *4.1.5 Project Team*

Table 4.1.5.1 provides the companies that assisted with the preparation of Section 4.0.

**TABLE 4.1.5.1**

**PROJECT TEAM**

| Application Component | Team |
|---|---|
| Overview of Marine Transportation and Shipping Activities | Trans Mountain |
| Air Emissions and Greenhouse Gas Emissions Assessment<br>Noise Impact Assessment | Rowan Williams Davies and Irwin Inc. |
| Marine Resources Assessment (Marine Fish and Marine Mammals)<br>Marine Bird Assessment<br>Marine Sediment and Water Quality Assessment<br>Species At Risk Assessment<br>Accidents and Malfunctions Assessment | Stantec Consulting Ltd. (Stantec) |
| Traditional Marine Resource Use Assessment | TERA |
| Human Health Risk Assessment for Normal Operations | Intrinsik Environmental Sciences Inc. (Intrinsik) |
| Marine Commercial, Recreational and Tourism Use Assessment | Vista Strategy Corp. (Vista Strategy)<br>TERA |

Supporting technical reports are provided in Volume 8B. The technical reports provide discipline-specific background information as well as the research conducted in support of this ESA. These technical reports and previous surveys and studies provide an information base for the marine transportation component of the Project. The authors of the supporting technical reports also participated in the identification of potential effects, the development of mitigation measures and the evaluation of significance of residual effects within their respective disciplines.

### 4.2 Environmental and Socio-Economic Setting

The following subsections present a summary of the environmental and socio-economic setting of the marine transportation component of the Project. The setting was compiled based on the following sources:

- desktop reviews of physical oceanography, marine sediment and water quality, air emissions, greenhouse gas (GHG) emissions, acoustic environment, marine fish and fish habitat, marine mammals, marine birds, marine species at risk, traditional marine resource use, marine commercial, recreational and tourism use (MCRTU), and human health;
- 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, government agencies, stakeholders, and the general public.

Aboriginal traditional knowledge relevant to each element is summarized in each subsection. Methods of obtaining resource material included library and internet searches, and sourcing and receiving documents directly from government agencies. References used in the preparation of the setting are cited in Section 4.6.

Detailed methodology for the collection of information on existing conditions is provided in the applicable supporting studies of Volume 8B.

The potential Project-related effects of increased marine vessel traffic and mitigation are presented in Section 4.3. The spatial boundaries of elements discussed in the socio-economic setting are also described in detail in Section 4.3. An element is defined as a technical discipline or discrete component of the biophysical or human environment identified in the NEB Filing Manual (NEB 2013c).

This section provides information regarding overall environmental and biophysical conditions as well as specific information regarding indicators. An indicator is a biophysical, social, or economic property or variable that society considers important and is assessed to predict Project-related changes and focus the impact assessment on key issues. Indicators are selected (one or more) and used as surrogates to describe the present and predicted future condition of an element. Societal views reflect published information such as management plans and engagement with regulatory authorities, the public, Aboriginal, and other interested groups.

### *4.2.1 Regional Overview*

The designated marine shipping lanes run through the Strait of Georgia, Boundary Pass, and the Haro and Juan de Fuca straits. These waterways are all located within the Salish Sea (Figure 4.2.1), an inland sea that extends from Olympia, Washington State in the US northward to Campbell River, BC. The Salish Sea has an areal extent of approximately 17,000 km$^2$ and 7,500 km of coastline (Gaydos and Pearson 2011). Major bodies of water within the Salish Sea include the Strait of Georgia, Juan de Fuca Strait and Puget Sound. The inland waterways are partially separated from the open Pacific Ocean by Vancouver Island and the Olympic Peninsula and are, therefore, partially shielded from Pacific Ocean storms. Marine vessels can also find shelter from storms among inlets and bays of smaller islands in this area. These waters encompass a bi-national ecosystem that is home to the first inhabitants of the region, the Coast Salish. Oceanographic processes, influenced by freshwater inflows and wind-driven surface currents, exchange biota, sediments and nutrients throughout the larger ecosystem.

For the purposes of this assessment, the marine shipping lanes are defined to include the normal tanker transit patterns from the Westridge Marine Terminal to the 12 nautical mile limit, including transit within Burrard Inlet and transit in the internationally designated marine shipping lanes.


Westridge Marine Terminal
Town / City
Marine Vessel Inbound Shipping Lane
Marine Vessel Outbound Shipping Lane
International Border
Canadian 12 Nautical Mile Territorial Boundary
Bathymetry
Watercourse
Existing Trans Mountain Pipeline
Trans Mountain Expansion Proposed Pipeline Corridor
Waterbody
Provincial Park
Traffic Separation Scheme
Land of British Columbia
Land of Washington State
Boundaries of the Salish Sea
Marine RSA (Transportation)

Stantec

SCALE: 1:2,000,000

0 10 20 30 40 km

ALL LOCATIONS APPROXIMATE

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| MAP NUMBER | | PAGE |
|---|---|---|
| 10494_EA_TRANS_MAR_04_02_01 | | SHEET 1 OF 1 |
| DATE Nov 2013 | REF. 7894 | REVISION 0 |
| SCALE 1:2,000,000 | PAGE SIZE 8.5x11 | DISCIPLINE SD |
| DRAWN SS | CHECKED DP | DESIGN SD |

Projection: UTM Zone 10N; Marine Vessel Inbound Shipping Lane: Moffatt & Nichol, 2013a; Marine Vessel Outbound Shipping Lane: Moffatt & Nichol, 2013b; International Border: British Columbia Ministry of Energy and Mines, 2013; Canadian 12 Nautical Mile Territorial Boundary and Traffic Separation Scheme: Canadian Hydrographic Service, 2013; 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; Provincial Park: BC MFLNRO, 2008a; Land of British Columbia: National Topographic Data Base, 2007; Land of Washington State: Washington State Department of Ecology, 1994; Salish Sea Boundary: Bartnik et al., 2002.

*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: 4.2-1**

**BOUNDARIES OF THE SALISH SEA**

**TRANS MOUNTAIN EXPANSION PROJECT**

To the east, shipping lanes are bounded by the mainland coasts of BC and Washington, and the Fraser River Delta which drains into the Strait of Georgia. The Olympic Peninsula in Washington is to the southwest. The shipping lanes transit among the numerous islands and islets belonging to either the Gulf Islands or San Juan Islands, forming an archipelago of diverse marine habitats.

The shipping lanes extend across the Strait of Georgia and the Juan de Fuca Marine Ecodistricts within the Georgia Basin Marine Ecoregion. The physiographic, oceanographic and biological characteristics of these classifications described in Harding (1997) are summarized in Table 4.2.1.1.

**TABLE 4.2.1.1**

**CHARACTERISTICS OF MARINE ECOREGION AND ECODISTRICTS**

| Marine Ecoregion/Ecodistrict | Physiographic Characteristics | Oceanographic Characteristics | Biological Characteristics |
|---|---|---|---|
| Georgia Basin Marine Ecoregion | Large strait characterized by numerous channels, fjords, islands and adjacent coastal lowlands. | Enclosed basin with large freshwater input (including Fraser River); high turbidity; generally well stratified with estuarine-like circulation patterns. | Neritic, estuarine plankton species. Productive and protected habitats for juvenile fish and invertebrates, some productive benthic invertebrate areas. Marine mammals such as seals are abundant. Feeding area for marine birds (shorebirds, waterfowl and seabirds). |
| Strait of Georgia Ecodistrict | Broad shallow basin surrounded by coastal lowlands (Georgia Depression). | Warm, protected coastal waters with substantial freshwater input, high turbidity; seasonally stratified. | Neritic plankton community. Nursery area for Pacific salmon and herring. Abundant shellfish habitat. |
| Juan de Fuca Marine Ecodistrict | Deep trough, a major structural feature accentuated by glacial scour. | Semi-protected coastal waters with strong estuarine circulation (coast-hugging, buoyancy-driven current to north) and major water exchange conduit with inland sea. | Mixture of neritic and oceanic plankton species; migratory corridor for anadromous fish (Pacific salmon); moderately productive. |

The existing conditions for each element are described with respect to a LSA, RSA, or both (Table 4.2.1.2). Separate spatial boundaries have been established for Marine Air Quality (Section 4.2.3), Marine Birds (Section 4.2.8), and Human Health Risk Assessment (HHRA) (Section 4.2.12). These element-specific spatial boundaries are described in their respective subsections.

- **Marine LSA -** includes the inbound and outbound marine shipping lanes, the area between the shipping lanes, where it exists, and a 2 km buffer extending from the outermost edge of each shipping lane. The shipping lanes extend from the Westridge Marine Terminal in Burnaby, through Burrard Inlet, south through the southern part of the Strait of Georgia, the Gulf Islands and Haro Strait, then westward past Victoria and through Juan de Fuca Strait out to the 12 nautical mile limit of Canada's territorial sea, corresponding to the line of longitude of Buoy J.

- **Marine RSA -** comprised of a large portion of the Salish Sea, including the inland marine waters of the southern Strait of Georgia and Juan de Fuca Strait and their connecting channels, passes and straits. The RSA is generally centred on the marine shipping lanes, which extend from the Westridge Marine Terminal through Burrard Inlet, south through the southern part of the Strait of Georgia, the Gulf Islands and Haro Strait, westward past Victoria and through Juan de Fuca Strait out to the 12 nautical mile limit of Canada's territorial sea. The western boundary of the Marine RSA extends further out to sea than the western boundary of the Salish Sea and the northern boundary of the Marine RSA is limited to the southern portion of the Strait of Georgia. Puget Sound is excluded from the Marine RSA.

Puget Sound is excluded from the Marine RSA due to its distance from the shipping lanes and because it is partially separated from the Juan de Fuca Strait by the archipelago of islands that lie at its northern end.

The study areas also follow guidance indicated by the NEB in the letter titled Filing Requirements Related to the Potential Environmental and Socio-Economic Effects of Increased Marine Shipping Activities (NEB 2013b), received by Trans Mountain on September 10, 2013. The letter indicates that the marine transportation assessment should take place out to the 12 nautical mile limit of Canada's territorial seas.

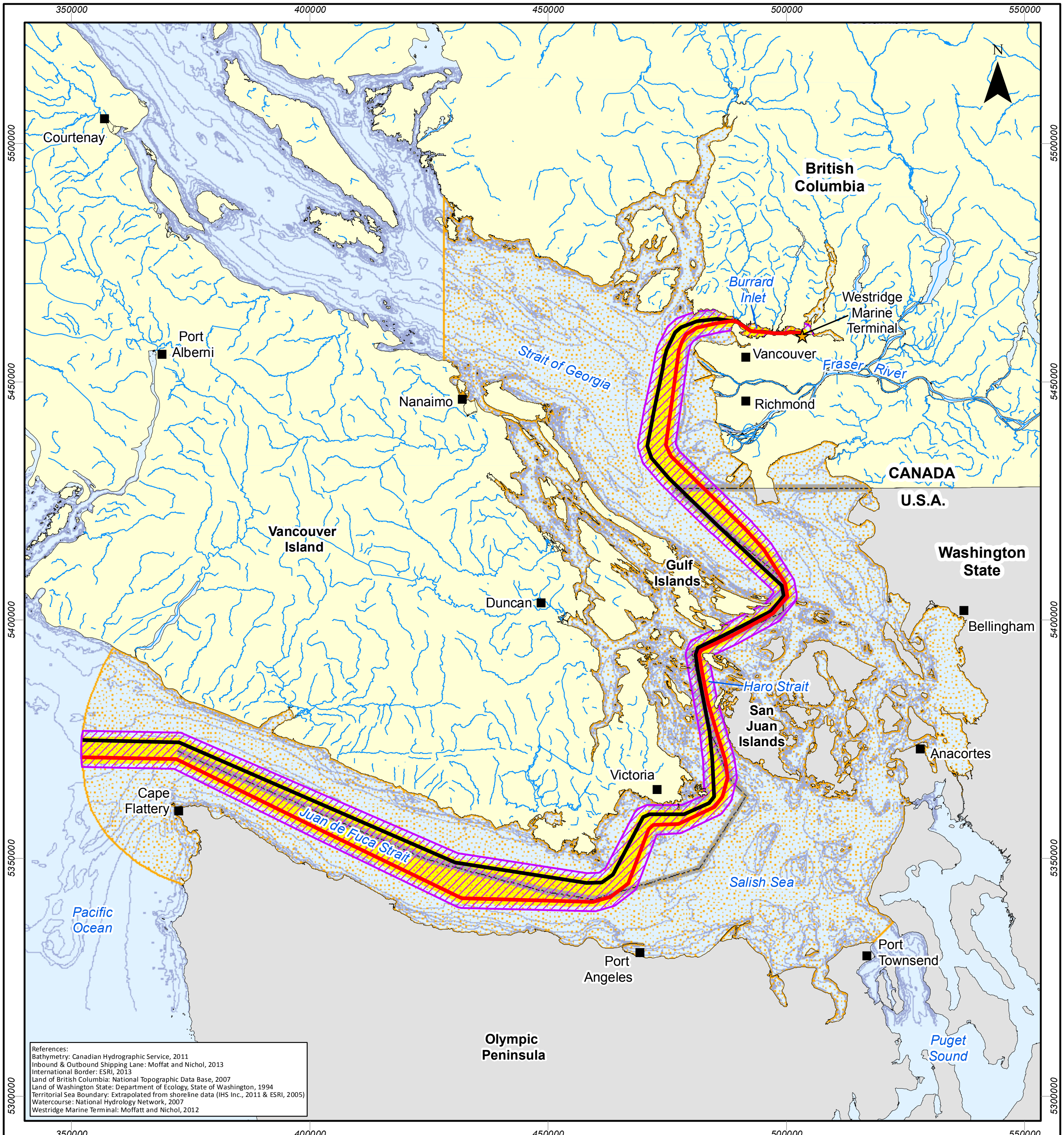
**TABLE 4.2.1.2**

**MARINE LOCAL STUDY AREA AND MARINE REGIONAL STUDY AREA ELEMENTS**

| **Spatial Boundary** | |
|---|---|
| **Marine LSA[1]** | **Marine RSA** |
| Marine Acoustic Environment, Marine Fish and Fish Habitat, Traditional Marine Resource Use, and MCRTU | Marine Acoustic Environment, Marine Fish and Fish Habitat, Marine Mammals, Marine Birds, Traditional Marine Resource Use, and MCRTU |

**Note:** [1] The LSA for traditional marine resource use includes the area that encompasses the Marine LSA (for Marine Fish and Fish Habitat) as well as the Marine Birds LSA since traditional marine resource use is dependent on these resources.

Spatial boundaries (excluding the Marine Air Quality and HHRA spatial boundaries) are shown on Figure 4.2.2.




Stantec

- Westridge Marine Terminal
- Town / City
- Inbound Shipping Lane
- Outbound Shipping Lane
- International Border
- Bathymetry
- Watercourse
- Land of British Columbia
- Land of Washington State
- Waterbody
- Marine RSA
- LSA (1 km Buffer) for Marine Birds
- LSA (2 km Buffer) for
  - Marine Noise
  - Marine Fish and Fish Habitat
  - Traditional Marine Resource Use
  - Marine Commercial, Recreational, and Tourism Use

TRANS MOUNTAIN

SCALE: 1:1,150,000

0 10 20 30 40 km

ALL LOCATIONS APPROXIMATE

**FIGURE: 4.2-2**

**MARINE LOCAL AND REGIONAL STUDY AREAS**

| MAP NUMBER | | PAGE |
|---|---|---|
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**TRANS MOUNTAIN EXPANSION PROJECT**

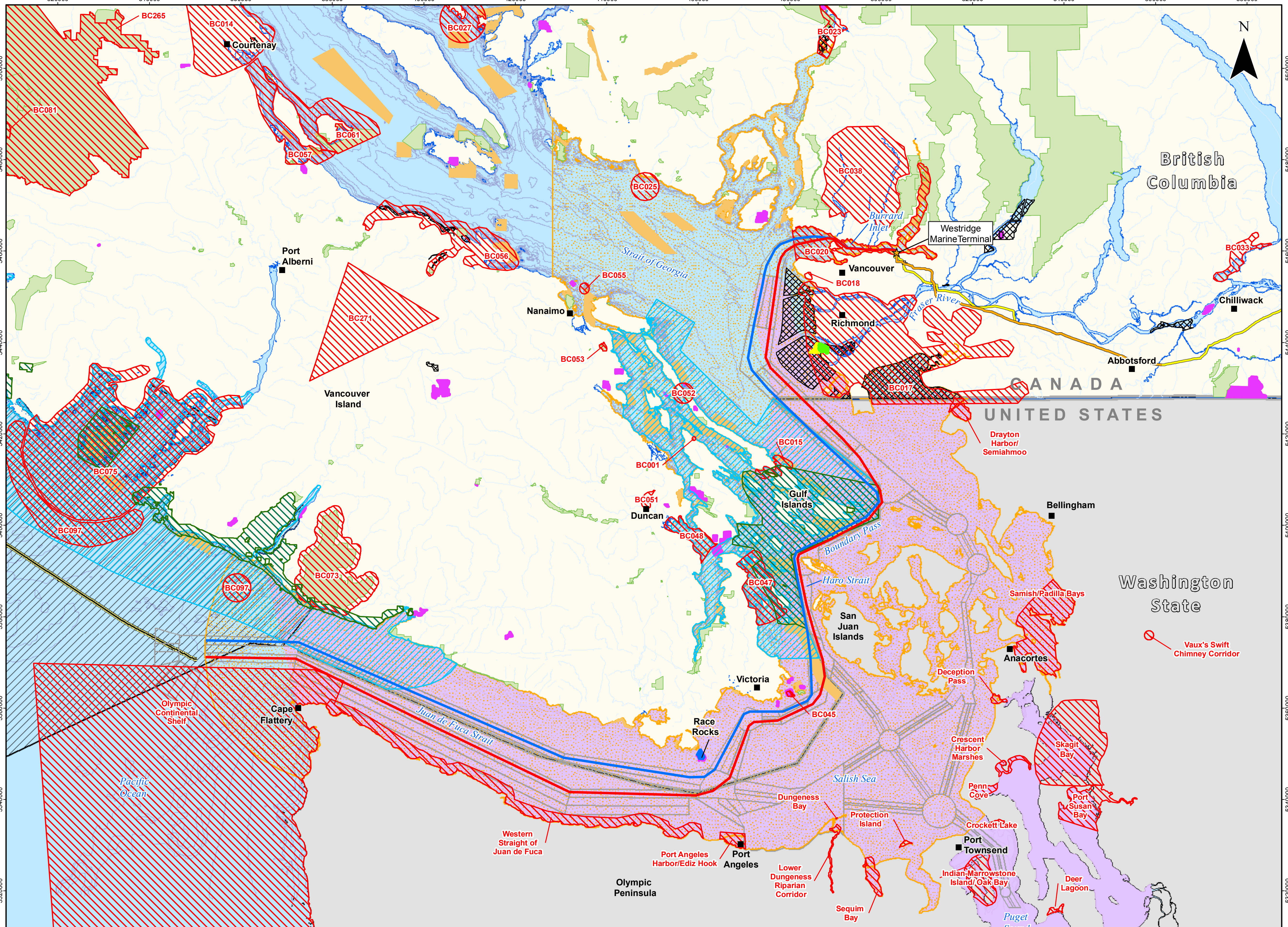
#### *4.2.1.1 Existing Habitat Disturbances*

Like many other coastal zones around the world, the inland sea ecosystem that is to be used by the Project-related marine vessel traffic is currently affected by a growing human population and conversion of shoreline habitat to urban/industrial development. Consequences have included contamination of sediments and species and an overharvesting of resources. In recent history, marine shorelines in Burrard Inlet have been dramatically altered for industrial or residential use, with the exception of some federally and provincially designated conservation areas. The increased Project-related marine vessel traffic will use the existing anchorages and shipping lanes for 100 per cent of their route. The potential disturbances to marine species and habitats from the Project should be considered within the context of a large volume of existing small and large vessel traffic.

#### *4.2.1.2 Conservation Areas*

The provincial component of the region includes provincial Marine Protected Areas (MPAs), Important Bird Areas (IBAs), Ecological Reserves, Provincial Parks and Wildlife Management Areas (WMAs). Federal protection designations include Migratory Bird Sanctuaries (Canadian Wildlife Service [CWS]), Fisheries and Oceans Canada (DFO) MPAs, Rockfish Conservation Areas (RCAs), National Marine Conservation Areas (Parks Canada), National Parks of Canada (Parks Canada), National Wildlife Areas (NWAs), and Critical Habitat (*Species at Risk Act* [*SARA*]). Figure 4.2.3 shows the conservation areas described. The Gulf Islands National Park Reserve in the Strait of Georgia supports approximately 36 km$^2$ of terrestrial and marine habitat on 15 islands and various islets and reefs (Parks Canada 2013a). As part of the Pacific Flyway, both pelagic and coastal waters are used seasonally by a wide variety of breeding, foraging and over-wintering marine birds especially in extensive tidal mudflats, eelgrass beds, rocky offshore islets and old-growth forests (Parks Canada 2009a).

While there is the potential for additional conservation areas (*e.g.*, MPAs) to be designated in the vicinity of the established shipping lanes, these areas are not likely to impede the passage of ships.




TRANS MOUNTAIN

FIGURE: 4.2-3

# CONSERVATION AREAS IN AND NEAR THE MARINE RSA

## TRANS MOUNTAIN EXPANSION PROJECT

- Westridge Marine Terminal
- Town / City
- Marine Vessel Inbound Shipping Lane
- Marine Vessel Outbound Shipping Lane
- International Border
- Canadian 12 Nautical Mile Territorial Boundary
- Bathymetry
- Watercourse
- Existing Trans Mountain Pipeline
- Trans Mountain Expansion Proposed Pipeline Corridor
- Waterbody
- Land of British Columbia
- Land of Washington State
- Traffic Separation Scheme
- Marine RSA (Transportation)
- National Marine Conservation Area
- Marine Protected Area
- National Park
- Provincial Park
- Ecological Reserve
- Rockfish Conservation Area
- Important Bird Area
- Wildlife Management Area
- Migratory Bird Sanctuary
- National Wildlife Area
- Southern Resident Killer Whale Critical Habitat
- Humpback Whale Critical Habitat



Projection: UTM Zone 10N; Marine Vessel Inbound Shipping Lane: Moffatt & Nichol, 2013a; Marine Vessel Outbound Shipping Lane: Moffatt & Nichol, 2013b; International Border: British Columbia Ministry of Energy and Mines, 2013; Canadian 12 Nautical Mile Territorial Boundary and Traffic Separation Scheme: Canadian Hydrographic Service, 2013; 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; Land of British Columbia: National Topographic Data Base, 2007; Land of Washington State: Washington State Department of Ecology, 1994; National Marine Conservation Area: Parks Canada, 2013; Marine Protected Area: Parks Canada, 2012; National Park: Natural Resources Canada, 2005; Provincial Park: BC MFLNRO, 2008a; Ecological Reserve: BC MFLNRO, 2008a; Rockfish Conservation Area: DFO, 2008; Important Bird Area: Important Bird Areas Canada, 2011; National Audubon Society, May 2013; Wildlife Management Area: BC MFLNRO, 2008b; Migratory Bird Sanctuary: Environment Canada, 1972; National Wildlife Area: Environment Canada, 1972; Southern Resident Killer Whale Critical Habitat: DFO, 2011; Humpback Whale Critical Habitat: DFO, 2013b.

Stantec

*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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SCALE: 1:800,000

0 5 10 15 20 km

ALL LOCATIONS APPROXIMATE

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#### *4.2.1.3 Species of Conservation Concern Designations*

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) uses the best available biological information to assess species that are in danger of becoming extinct. This information is compiled by COSEWIC into Status Reports and recommendations to the federal government for species designations as Extinct, Extirpated, Endangered, Threatened, Special Concern, Not at Risk, or Data Deficient. Marine species of conservation concern receive federal legal protection under *SARA*, which is a commitment to prevent at risk wildlife species from becoming extinct and to secure the necessary actions for their recovery. *SARA* also provides for the conservation of biological diversity. Under Schedule 1 of *SARA* S.C. 2002, c. 29, Section 32 (1) “No person shall kill, harm, harass, capture or take an individual of a wildlife species that is listed as an Extirpated, Endangered or Threatened species as that species has legal protection related to species’ residence and critical habitats”.

The BC List Status is assigned by the British Columbia Conservation Data Centre (BC CDC) and depends upon the provincial (S) ranking or conservation status of that species. S rankings are: (1) critically imperiled, (2) imperiled, (3) special concern, (4) apparently secure, and (5) secure.

The federal and provincial conservation designations that apply to species discussed in this ESA are defined as follows:

Federal (*SARA* and COSEWIC Status) (Government of Canada 2013a, b):

- **Endangered** - a species facing imminent extirpation or extinction;
- **Threatened** - a species that is likely to become Endangered if limiting factors are not reversed;
- **Special Concern** - a species with characteristics that make it sensitive to human activities or natural events;
- **Not at Risk** – a species that has been evaluated and found to be not at risk; and
- **Data Deficient** – a species for which there is insufficient scientific information to support status designations.

Provincial (BC List Status) (BC CDC 2013):

- **Red** – an indigenous species or subspecies that is a candidate to become Extirpated, Endangered or Threatened in BC;
- **Blue** – an indigenous species or subspecies of Special Concern in BC and that is sensitive to human activity or natural events;
- **Yellow** – a species that has secure populations;
- **Accidental** – a species occurring infrequently or unpredictably outside of its usual range;
- **Unknown** – provincial status is unknown due to extreme uncertainty (*i.e.*, more inventory or data gathering is needed); and

- **Exotic** – not native to BC.

*4.2.1.4 Physical Environment*

A summary of the general physical oceanographic characteristics of the Strait of Georgia and Juan de Fuca Strait Marine Ecodistricts described in Thomson (1981) is provided in the following descriptions.

**4.2.1.4.1 Physical Oceanography**

**Strait of Georgia**

The Strait of Georgia is a portion of the Georgia Basin that lies between the Coast Mountain range and Vancouver Island. Eastern portions of the Strait are characterized by fjords and a complex of islands, sounds and passages. Western portions are characterized by few inlets and a more regular coastline. The Strait is approximately 222 km long, an average of 28 km wide and an average of 155 m deep. Only 5 per cent of the total of area of the Strait has depths that exceed 360 m and the maximum recorded depth is 420 m immediately south of Texada Island.

The main sources of freshwater that discharge into the Strait of Georgia are the Fraser River, which empties directly into the basin near Vancouver and the Squamish River that enters the Strait via Howe Sound. Other sources of freshwater input into the Strait include the Cowichan, Chemainus, Nanaimo, and Courtenay rivers on Vancouver Island and the numerous rivers that empty into the inlets on the eastern side of the Strait.

The water column in the Strait of Georgia has a two-layer structure based on temperature and salinity; the upper layer occurs at depth of less than 50 m and the lower layer extends from 50 to 420 m depth. Water temperatures in the upper layer vary by season and location and range from 5 to 20°C. Temperatures are coldest between February and March when they average 5 to 6°C and warmest in July and August when they can exceed 20°C in middle portions of the Strait and sheltered areas. Water temperatures in the lower layer are nearly uniform throughout the year, ranging from 8 to 10°C.

Salinity also varies in the upper layer depending on season and distance from the mouth of the Fraser River estuary where salinity levels are comparatively low due to the large freshwater input. From December to April, the salinity level in areas under direct influence of the Fraser River can be as low as 2.5 per cent in the upper layer, while salinities in other areas range from 2.7 to 2.9 per cent during this period. From May to July, runoff from the Fraser River can result in a salinity level of only 1.5 per cent in the upper layer of most central and southern areas of the Strait. Northern areas of the Strait have an average salinity of 2.5 per cent or greater during this period. Salinity at the top of the lower layer averages 2.9 per cent, while near-bottom values of salinity average 3.0 per cent in summer and 3.1 per cent in winter.

Wind patterns in the Strait of Georgia are influenced by seasonal weather patterns and by the funnelling effects of Juan de Fuca Strait, Puget Sound and the Fraser Valley. The prevailing winds are from the northwest in summer and southeast in winter in exposed areas of the Strait.

The tidal range along the BC coast is usually 3 to 5 m, with greater ranges during June and December and smaller ranges during March and September. Tides in BC, including the Strait of Georgia, are predominantly mixed diurnal and semidiurnal, with only a few days each month having purely diurnal or semidiurnal tides. Mixed tides on the West Coast have a diurnal inequity, meaning there is a difference in tidal heights between successive high tides and successive low tides. There is also a cyclic 14 day variation in the diurnal inequity during which high tide becomes continually higher and low tide continually lower for about 7 days and then high tides become lower and low tides become higher for the next 7 days.

Currents in the Strait of Georgia are highly complex and are influenced by tides, winds, river discharge, channel bathymetry, the Coriolis force and centrifugal forces. The relative importance of these factors varies along the length of the Strait, resulting in a diversity of circulation patterns. In general, there is a counterclockwise circulation pattern in the Strait and a smaller counterclockwise gyre to the south of Sand Heads and Active Pass. Central and southern portions of the Strait are characterized by strong tidal streams and by the influence of the Fraser River runoff, which directs waters southwesterly toward the Gulf Islands and enhances wind-generated currents. In summer, outflow speeds near the mouth of the Fraser River can reach 2.5 m/s near low water during large tides and speeds of 1.0 to 1.5 m/s during less extreme low tides, decreasing to around 0.5 m/s within 5 km of the river mouth. Outflow speeds are typically below 0.5 m/s at high tide. Current speeds of 0.5 to 1.0 m/s are common in other areas of the central Strait, driven by winds, tides and poorly understood residual currents. Tidal currents in the southern Strait can attain speeds of 0.5 m/s during normal tides. The northern portion of the Strait is characterized by weak and variable tidal currents which attain speeds of about 0.1 m/s in most areas.

**Juan de Fuca Strait**

Juan de Fuca Strait is a submarine valley between Vancouver Island and the Olympic Mountains. The Strait has a gently sloping U-shaped profile east of the line between Jordan River and Pillar Point and a V-shaped profile to the west of this line to the Pacific Ocean entrance off Cape Flattery. Further seaward of the Pacific entrance, the channel turns to the southwest and becomes irregular with deep incisions such as the Juan de Fuca Canyon. A cross-channel sill cuts across the Strait south of Victoria, BC.

Juan de Fuca Strait has a total length of approximately 160 km and averages 22 to 28 km wide from its entrance to about 100 km eastward. It narrows to about 18 km in width between Race Rocks and Port Angeles before widening again to about 40 km width to the eastern boundary at Whidbey Island. Overall, Juan de Fuca Strait is shallower than the Strait of Georgia. The maximum depth of Juan de Fuca Strait is about 250 m at mid-channel near the Pacific entrance. The depth decreases gradually inland to approximately 180 m east of Cape Flattery. Shallower depths of about 55 m are found over the sill south of Victoria. There are several shallow banks east of the sill with deeper channels that lead into Haro Strait, Rosario Strait, Admiralty Inlet, and Deception Pass.

Water temperatures in Juan de Fuca Strait are cold year-round, ranging from 8 to 14°C at the surface due to its direct exposure to the Pacific Ocean, upwelling and mixing by strong tidal streams. Temperatures may also decrease a few degrees with increasing depth. In summer, surface waters can reach a maximum of 12 to 14°C with localized solar heating and input of warmer waters from the Strait of Georgia. In winter, surface temperatures range from 8 to 10°C, with the coldest waters occurring in the eastern portions of the Strait. Bottom temperatures remain cold year-round. In general, salinity in Juan de Fuca Strait increases from top to bottom and from east to west. In winter, salinity averages 3 to 3.1 per cent in the surface waters and 3.3 per cent in bottom waters near the Strait entrance. In spring and summer, average salinity of the surface waters decreases to 2.6 to 2.8 per cent in Haro Strait and to 2.8 to 3 per cent in the eastern portions of Juan de Fuca Strait due to freshwater runoff from the Fraser River.

Wind patterns in Juan de Fuca Strait are influenced by seasonal weather patterns and by the adjacent mountain terrain of the Olympic Mountains. Prevailing winds in Juan de Fuca Strait are from the east in winter and from the west in summer. Winds greater than 15 m/s occur an average of 10 to 15 days per month in winter and only 1 to 2 days per month in summer. Wind speeds tend to increase from east to west along the Strait, with weak and variable winds prevailing over easterly portions of the Strait.

As with the Strait of Georgia, tides in Juan de Fuca Strait are characterized by mixed diurnal and semidiurnal tides, with a diurnal inequality. From the Pacific entrance of the Strait east to Race Rocks, the tides are mainly semidiurnal, and from Race Rocks east to the southern Strait of Georgia, the tides are mainly diurnal. Tidal range varies along the Strait, with the average tidal range decreasing from 2.4 m off Cape Flattery to a minimum of 1.8 m near Victoria, before increasing again to 2.4 m around Haro Strait. Tidal range also varies between the Canadian and US sides of the Strait, with the US side having a larger tidal range.

Currents in Juan de Fuca Strait are influenced by tides, freshwater runoff, winds and atmospheric pressure differences, channel curvature and bathymetry and the Coriolis force. Flood currents during incoming tides move northward along the Washington coast, turn into Juan de Fuca Strait north of Cape Flattery and are then directed down-channel parallel to the axis of the Strait before moving northwest into the Strait of Georgia. At maximum flood, tidal currents in the Strait reach speeds of 0.7 to 1.3 m/s on large spring tides. In the eastern portion of the Strait, speeds of 1.8 m/s can occur on large tides in the eastern portion of the Strait. Currents in narrow channels in the vicinity of Race Rocks and Victoria can reach speeds of 2.5 m/s at times. Ebb currents generally flow in the opposite direction of flood currents. Ebb currents are noticeably stronger and of longer duration than flood currents in the upper 100 m due to river runoff into the Strait of Georgia and Puget Sound; however, flood currents are stronger and of longer duration below this depth as oceanic water moves inward to replace the water carried to the Pacific in the surface layer. Estuarine processes produce residual currents in Juan de Fuca Strait that are poorly understood and can lead to unpredictable current patterns.

#### 4.2.1.4.2 Wave Conditions

The general wave conditions in the Strait of Georgia and Juan de Fuca Strait are described in Thomson (1981) and summarized in the following text.

**Strait of Georgia**

Wave heights in the Strait of Georgia are primarily limited by the distance over open water that wind has blown (fetch) and to a lesser extent, wind strength and duration. The Strait has a length of about 222 km; however, the total fetch is further limited by obstructions such as Texada and Lasqueti islands.

Wave conditions were studied at three buoy locations in the Strait of Georgia between 1973 and 1976, including West Vancouver in Burrard Inlet, Sturgeon Bank and Roberts Bank (Thompson 1981). The significant wave heights (average wave height of the highest third of waves) recorded during the observation period did not exceed 2.7 m at Sturgeon Bank and 2.1 m at Roberts Bank with corresponding maximum wave heights less than 4.0 m and 3.3 m, respectively. Significant wave heights off West Vancouver were always less than 1.0 m. Average wave heights at Sturgeon Bank and Roberts Bank exceeded 0.8 m ten per cent of the time. Maximum wave heights at these locations exceeded 1.2 m 10 per cent of the time, and

0.3 m 60 per cent of the time. At the West Vancouver buoy, maximum wave heights were greater than 0.6 m 10 per cent of the time and greater than 0.3 m 30 per cent of the time.

**Juan de Fuca Strait**

Studies of wave conditions in Juan de Fuca Strait are limited, and empirical wind-wave relationships are often used to estimate wave heights. As with the Strait of Georgia, wave heights are limited by the total fetch of 160 km and the strength and duration of the wind. Waves generated by winds in Juan de Fuca Strait are expected to generate wave conditions similar to the Strait of Georgia. However, the western portion of Juan de Fuca Strait is exposed to the Pacific Ocean, so long-period swells with larger wave heights propagate inland along the entire length of the Strait from open waters, regardless of winds. Wave heights from these swells gradually decrease as they travel east along the Strait. Wave records from the West Coast of Vancouver Island indicate that maximum probable wave heights near the Strait entrance exceed 6 m at least ten per cent of the time in winter and exceed 3 m about ten per cent of the time in summer, with an average period of 9 to 10 seconds.

The federal government maintains 16 offshore buoys in Canadian Pacific waters. There are three of these buoys located in the vicinity of the marine shipping lanes including Halibut Bank and Patricia Bay in the Strait of Georgia and La Pérouse Bank off Vancouver Island, northeast of the entrance to Juan de Fuca Strait (DFO 2009a). Table 4.2.1.3 shows the maximum, minimum and average significant wave heights from historical buoy data from DFO (2013a). Significant wave height is defined as the average wave height of the highest third of waves observed during a defined observation period. Heights are measured as the vertical distance between successive crests and troughs.

**TABLE 4.2.1.3**

**WAVE OBSERVATIONS AT SELECTED BUOY LOCATIONS NEAR THE MARINE SHIPPING LANES**

| Parameter | C46146 (Halibut Bank) | C46134 (Patricia Bay) | C46206 (La Pérouse Bank) |
|---|---|---|---|
| Latitude | 49° 20.4' N | 48° 39.4' N | 48° 50.1' N |
| Longitude | 123° 43.6' W | 123° 29.0 W | 125° 59.9' W |
| Depth (m) | 43 | 65 | 73 |
| Start Date | Mar. 13, 1992 | Feb. 19, 2001 | Nov. 22, 1988 |
| End Date | May 27, 2013 | May 27, 2013 | May 27, 2013 |
| Maximum significant wave height (m) during observation period | 4.93 | 4.33 | 19.51 |
| Minimum significant wave height (m) during observation period | 0.00 | 0.00 | 0.00 |
| Average significant wave height (m) during observation period | 0.33 | 0.06 | 2.23 |

**Note:** Significant wave height is defined as the average wave height of the highest third of waves observed. Heights are measured as the vertical distance between successive crests and troughs.

#### *4.2.1.5 United States of America Waters*

Physical oceanography and wave conditions are generally similar across US and Canadian waters in Juan de Fuca Strait. In addition, existing habitat disturbances are similar in type as well as frequency. The Washington State Department of Fish and Wildlife (WDFW) has set aside certain areas of Puget Sound marine waters for the protection and preservation of marine species and/or habitats. These are generally known as MPAs and include 9 Conservation Areas, 16 Marine Preserves and 2 Sea Cucumber and Sea Urchin Commercial Harvest Exclusion Zones. The greater San Juan Island archipelago holds the most MPAs. The north coast of the state has the largest MPA, the Olympic Coast National Marine Sanctuary. Several state parks, IBAs, federal historical parks, and federal marine sanctuaries are also present in Puget Sound (Van Cleve *et al.* 2009, WDFW 2013a) as well as MPAs administered by other agencies, such as the Department of Natural Resources.

### *4.2.2 Marine Water and Sediment Quality*

This subsection provides a general description of marine water and sediment quality along the marine shipping lanes, from the Westridge Marine Terminal to the 12 nautical mile limit of Canada's territorial sea (shown in Figure 4.2.1). Information about Burrard Inlet east of First Narrows is provided in the Marine Sediment and Water Quality – Westridge Marine Terminal Technical Report of Volume 5C.

Information pertaining to marine sediment and water quality in US waters can be found in Section 4.2.2.2. A discussion of the potential effects of the increased Project-related marine vessel traffic on marine sediment and water quality is located in Section 4.3.2.

#### *4.2.2.1 General Information*

Marine water and sediment quality is influenced by general oceanographic processes and, in some areas, strongly influenced by freshwater inputs (Section 4.2.1.4). In the Strait of Georgia, the Fraser River contributes a large sediment load annually within its delta, and the freshwater plume (surface lens) extends well into the Strait, particularly during spring freshet. There are similar but more localized influences around the numerous smaller rivers that enter the Salish Sea.

There is some baseline water and sediment quality information available in the vicinity of the marine shipping lanes and in the broader Georgia Basin Marine Ecoregion. Marine monitoring studies are typically developed for specific purposes, for example, to document the effects of specific contaminant sources, where the approach, parameters of interest and results differ, depending on the study purpose. There are no available studies documenting ambient contaminant levels over the marine shipping lanes. Results from the following long-term monitoring programs indicate good water quality, particularly in well-mixed areas.

- University of British Columbia Oceanography Department, Stratogem Project three-year study (2001-2004) of oceanography (currents, salinity, temperature, and oxygen) and productivity (phytoplankton chlorophyll a and zooplankton) of the Strait of Georgia. The study investigated the role of natural physical variability and changing human influences (climate change and nutrient regimes) in regulating biological production and factors influencing salmon populations (University of British Columbia 2004).

- Washington State Department of Ecology (2013a) long-term marine water quality dataset (several stations sampled monthly since 1977 in Puget Sound and eastern Juan de Fuca Strait for temperature, salinity, dissolved oxygen, chlorophyll, and pH).
- Coast Salish Tribal Journey Water Quality Project (2013), the Coast Salish Nation and Swinomish Indian Tribal Community in partnership with US Geological Survey have collected temperature, salinity, dissolved oxygen, pH and turbidity data since 2008 on summer canoe journeys along the coast of the Salish Sea (US Geological Survey 2013).
- Puget Sound Georgia Basin Ecosystem Initiative (undated), a partnership of Environment Canada and the US Environmental Protection Agency, which included seasonal surveys of water stratification (temperature and salinity) at numerous locations from 1999 to 2004, to identify areas with potential sensitivity to human activities.

Within the Georgia Basin Marine Ecoregion, there are major population centers (Vancouver and Victoria, BC and Seattle, Washington) and smaller communities where human activities can contribute contaminants to marine water. Within the well-mixed waters of the shipping lanes; however, any contaminants are likely to be diluted. The shipping lanes through the Strait of Georgia out through Juan de Fuca Strait are not adjacent to human activities. The exception is Burrard Inlet. Industrial activities within Burrard Inlet include railways, wood treatment, concrete and cement manufacture, marinas, port terminals and operations, lumber mills, cruise ships, fishing and boat maintenance, shipyards, metal and auto recycling, fish processing, animal by-product rendering, and aquaculture. These activities can be sources of pesticides, fertilizers, nutrients, bacteria, metals, hydrocarbons, and chlorinated organic compounds. Point (*e.g.*, treated and untreated sewage) and non-point (*e.g.*, recreational vessels, road runoff) source discharges also contribute contaminants. The ambient monitoring program for Burrard Inlet (Nautilus Environmental 2006) has included bi-annual surveys of water, sediment and biota at seven locations since 2006 (water parameters include pH, nutrients, metals, oil and grease, bacteria, salinity). There are ongoing water and sediment monitoring programs associated with wastewater treatment plant discharges (*e.g.,* Metro Vancouver programs for Lions Gate and Iona Wastewater Treatment Plants [Metro Vancouver 2013]; Capital Regional District [CRD] programs for Macauly and Clover Point outfalls [CRD 2011] and stormwater discharges (*e.g.,* CRD 2010, 2012). Baseline water quality data were collected on Roberts Bank for the Deltaport Third Berth Project environmental assessment (Hemmera Envirochem 2005). The Fraser River Action Plan included numerous studies of contaminant levels and effects of human activities on conditions in the Fraser River watershed that provide historical context (to the mid-1990s) for sediment conditions in the river and the delta (Fraser River Action Plan. Undated). Sediment surveys have been conducted in the southern Strait of Georgia and Juan de Fuca Strait for the Washington State Department of Ecology since 1989 (Dutch *et al.* 2008, Partridge *et al.* 2013). This includes monitoring at ten locations at a five-year interval for particle size, total organic carbon, metals, butyl tins, organic compounds including polycyclic aromatic hydrocarbons, chlorinated pesticides, polychlorinated bi-phenyls and polybrominated dichloroethylene in sediment, with results presented in Washington State Department of Ecology (2013b).

Shipping activities have the potential to affect water quality through release of ballast or bilge water. However, these activities are regulated through the *Canada Shipping Act* (2001), apply to Canadian vessels operating in all waters and to all vessels operating in Canadian waters and are not expected to be sources of contaminants in the marine shipping lanes. Ballast water is required to be exchanged mid-Pacific to avoid introduction of invasive alien species at a terminal (as discussed in Section 7.6 of Volume 5A). However, subject to Port guidance, a vessel is allowed to release ballast water while taking on cargo. Bilge water must be treated to remove oils and grease prior to discharge. Therefore, any releases of oily water would be due to an accident or malfunction (Section 4.3.13) and not routine operations. Reports of marine oil spills and sheens are addressed through the Regional Marine Information Centre, which coordinates a response through various agencies, including the CCG. Given that spills and sheens can originate from land or sea (commercial or recreational marine vessels), it can be challenging to identify a source.

##### *4.2.2.2 US Waters*

Contaminant sources and concentrations are expected to be similar in US and Canadian waters, given the similar types of activities in Washington and BC. Three of the monitoring programs discussed in Section 4.2.2.1 include sampling stations in both US and Canadian waters.

#### ***4.2.3 Marine Air Emissions***

This subsection provides a general description of marine air emissions along the marine shipping lanes, from the Westridge Marine Terminal to the 12 nautical mile limit of Canada's territorial sea (shown in Figure 4.2.1). More detailed technical information pertaining to marine air emissions is presented in the Marine Air Quality and Greenhouse Gas – Marine Transportation Technical Report (Volume 8B, TR 8B-3).

Information pertaining to marine air emissions in US waters can be found in Section 4.2.3.9. A discussion of the potential effects of the increased Project-related marine vessel traffic and associated mitigation as well as a discussion of the spatial boundaries for marine air emissions are located in Section 4.3.3.

##### *4.2.3.1 Spatial Boundaries*

The existing air quality conditions are described within the Marine Air Quality RSA and Lower Fraser Valley Photochemical Model Domain (LFV), as illustrated on Figure 4.2.4.

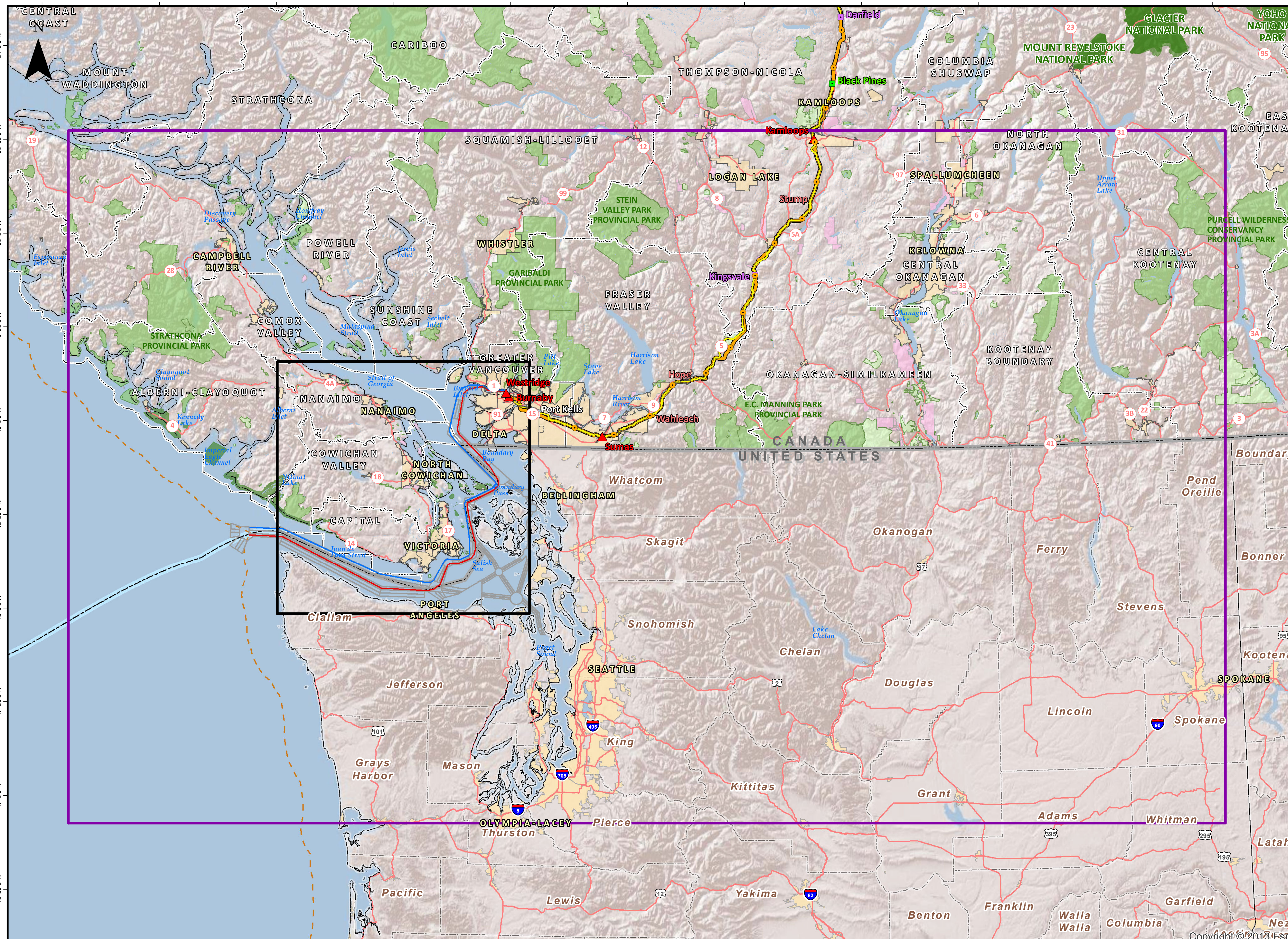
- **Marine Air Quality RSA** - a 150 km × 150 km area. The Marine Air Quality RSA is generally centered on the marine shipping lanes, which extend from the Westridge Marine Terminal through Burrard Inlet, south through the southern part of the Strait of Georgia, the Gulf Islands and Haro Strait, westward past Victoria and Juan de Fuca Strait out to the 12 nautical mile limit of Canada's territorial sea.
- **LFV** - a 412 km × 688 km area at 4 km resolution centred on the Lower Fraser Valley 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 × 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 × 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 the Project will be implemented over the inner 4 km resolution domain, with the boundary condition determined from baseline 36 km and 12 km model results.

TRANS MOUNTAIN

# FIGURE 4.2-4

## AIR QUALITY SPATIAL BOUNDARIES

## TRANS MOUNTAIN EXPANSION PROJECT




- Kilometre Post (KP)
- 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
- Road
- Lower Fraser Valley Study Area
- Marine Air Quality RSA
- 12 Nautical Mile Limit (Territorial Sea)
- Limit of Exclusive Economic Zone (EEZ)
- International Boundary
- Marine Vessel Outbound Shipping Lane
- Marine Vessel Inbound Shipping Lane
- Traffic Separation Scheme
- City / Town / District Municipality
- Indian Reserve / Métis Settlement
- National Park
- Provincial / State Park
- Protected Area/Natural Area/ Provincial Recreation Area/Wilderness Provincial Park/Conservancy Area
- Regional District Boundary



Projection: Modified Lambert Conformal Conic (LCC). Routing: Baseline TMPL Route Revision 0, provided by KMC, May 2012. Proposed Corridor V6 provided by UPI, August 23, 2013.; Transportation: BC Forests, Lands and Natural Resource Operations, 2012 & ESRI, 2005; Geopolitical Boundaries: IHS Inc., 2011, BC FLNRO, 2007, ESRI, 2005, & ESRI, 2013, Natural Resources Canada, 2012; First Nation Lands: Government of Canada, 2013 & IHS Inc., 2011; Hydrology: IHS Inc., 2004, United States National Imagery and Mapping Agency, 2000, Natural Resouces Canada, 2010; Parks and Protected Areas: Natural Resources Canada, 2013, BC FLNRO, 2008 & ESRI, 2005; CHS Marine Features: Government of Canada, 2013; Marine Vessel Inbound/Outbound Shipping Lanes: Moffatt and Nichol, 2013; Hillshade: ESRI, 2009.

RWDI

*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 |
|---|---|---|
| 1202006_TMEP_RWDI_AQ_FIG4.2-4 | | SHEET 1 OF 1 |
| DATE December 2013 | TERA REF. 7894 | REVISION 0 |
| SCALE 1:2,200,000 | PAGE SIZE 11x17 | DISCIPLINE AIR |
| DRAWN NBN | CHECKED AKH | DESIGN TGG |

0 15 30 45 60 75 km

ALL LOCATIONS APPROXIMATE

1202006_TMEP_RWDI_AQ_FIG4.2-4.mxd

#### *4.2.3.2 Indicators*

Four indicators were selected to represent potential effects from Project-related marine vessel traffic on marine air emissions:

- primary emissions of criteria air contaminants (CACs) such as sulphur dioxide ($SO_2$), nitrogen dioxide ($NO_2$), carbon monoxide (CO), particulate matter (PM);
- primary emissions of volatile organic compounds, such as BTEX (defined as the sum of benzene, toluene, ethyl benzene, and xylene);
- formation of secondary PM and ozone; and
- visibility.

The marine air emissions indicators represent common sources of air quality contaminants and their effects in the atmosphere. See Section 4.3 for more information regarding indicators.

#### *4.2.3.3 Legislation*

The North American Emission Control Area, under MARPOL, came into effect on August 1, 2012, bringing in stricter controls on air emissions from ships trading off the coasts of Canada, the US and the French overseas collectivity of Saint-Pierre and Miquelon. Under the legislation, emissions of NOx and SOx are expected to decrease within the Emissions Control Area, which extends approximately 200 nautical miles off the Pacific Coast.

New energy efficiency standards were also adopted by the IMO in July 2011. These standards require all vessels to carry a Ship Energy Efficiency Management Plan. In addition, these standards set requirements for new vessels built after June 30, 2013 to have calculated their Energy Efficiency Design Index (EEDI) and to meet its required efficiency target. The EEDI provides a standardized indicator of a new vessel's energy efficiency. These EEDI requirements are expected to improve air emissions from new vessels in the future.

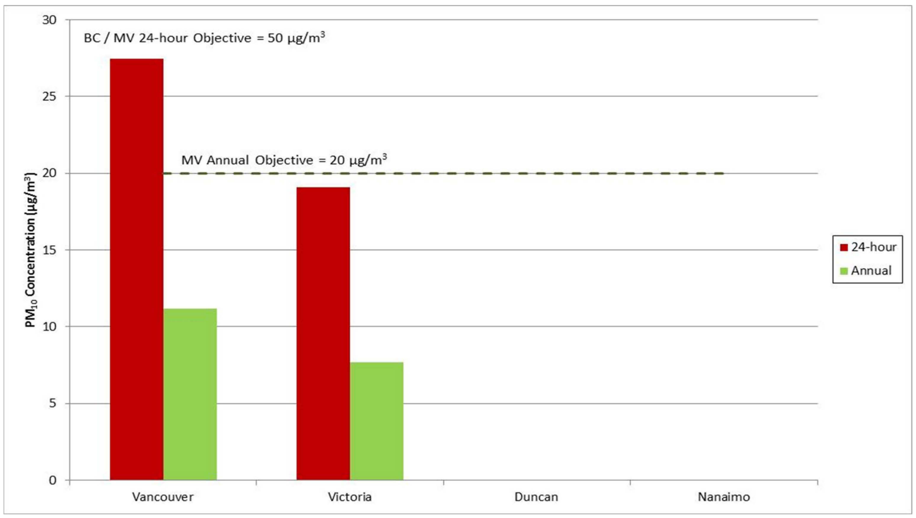
This legislation is detailed in the Marine Air Quality and Greenhouse Gas - Marine Transportation Technical Report (Volume 8B, TR 8B-3).

#### *4.2.3.4 Existing Air Quality – Criteria Air Contaminants*

Existing air quality conditions can be defined by ambient measurements from several stations that have been operating for a number of years. Ambient monitoring data of CACs are available from a number of stations operated by Metro Vancouver and the BC Ministry of Environment (MOE). CACs include PM, CO, $NO_2$ and $SO_2$. These stations are centered in urban areas and, therefore, it was deemed impractical to use these data to determine a single background concentration for the entire Marine Air Quality RSA which encompasses a wide range of land uses including water, urban and agricultural areas. The stations selected to represent the air quality setting at urban areas within the Marine Air Quality RSA were Vancouver-Kitsilano, Victoria-Topaz, Duncan-Cairnsmore, and Nanaimo-Labieux.

Overall, ambient concentrations of CACs have decreased over the last decade in the Marine Air Quality RSA. Both BC and Metro Vancouver have air quality objectives, which are shown on the figures in this subsection (more information can be found in the Marine Air Quality and Greenhouse Gas – Marine Transportation Technical Report (Volume 8B, TR 8B-3). A summary of existing ambient concentrations based on 2011, or the most recent year if 2011 was not available, is shown in Figures 4.2.5 to 4.2.9. Overall, existing ambient concentrations of CACs are low, with a few exceedances of the relevant ambient air quality objectives only for $PM_{2.5}$.

Ambient concentrations of CACs in urban areas tend to be influenced by vehicle traffic and residential heating and tend to be higher in more populated areas, such as Vancouver and Victoria. $PM_{2.5}$ concentrations; however, were highest in Duncan on Vancouver Island and are likely a result of the industrial contribution to air quality in that area. Notable industrial facilities near the Duncan-Cairnsmore monitoring station include aggregate facilities, steel recycling and forestry.




**Notes:** There were no $PM_{10}$ observations from the Duncan-Cairnsmore and Nanaimo Labieux stations.

MV = Metro Vancouver

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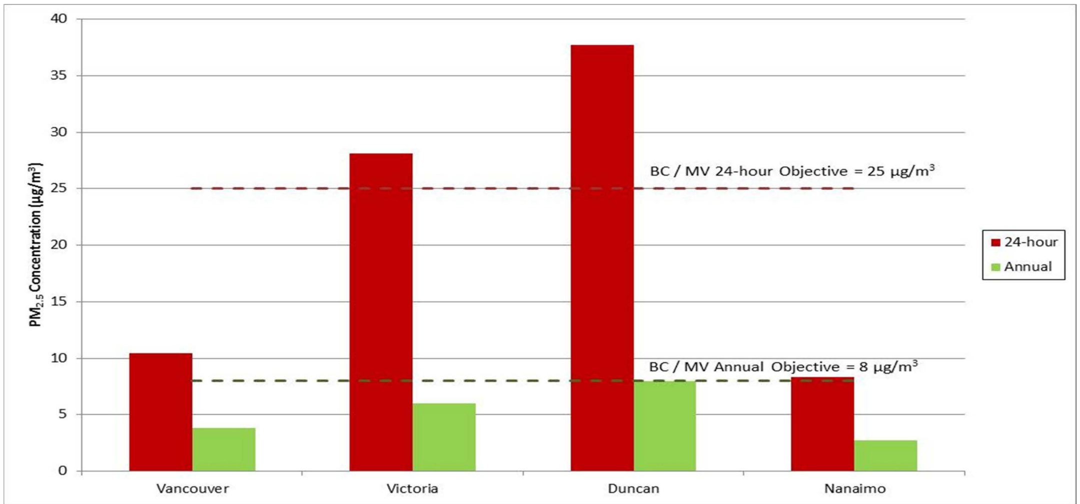
FIGURE 4.2.5

OBSERVED $PM_{10}$ CONCENTRATIONS IN 2011 FOR MARINE AIR QUALITY REGIONAL STUDY AREA (in µg/$m^3$)

**Figure 4.2.5 Observed $PM_{10}$ Concentrations in 2011 for Marine Air Quality Regional Study Area (in µg/$m^3$)**




**Notes:** There was no $PM_{2.5}$ data from the Vancouver-Kitsilano station in 2011. Data from 2008 are presented.

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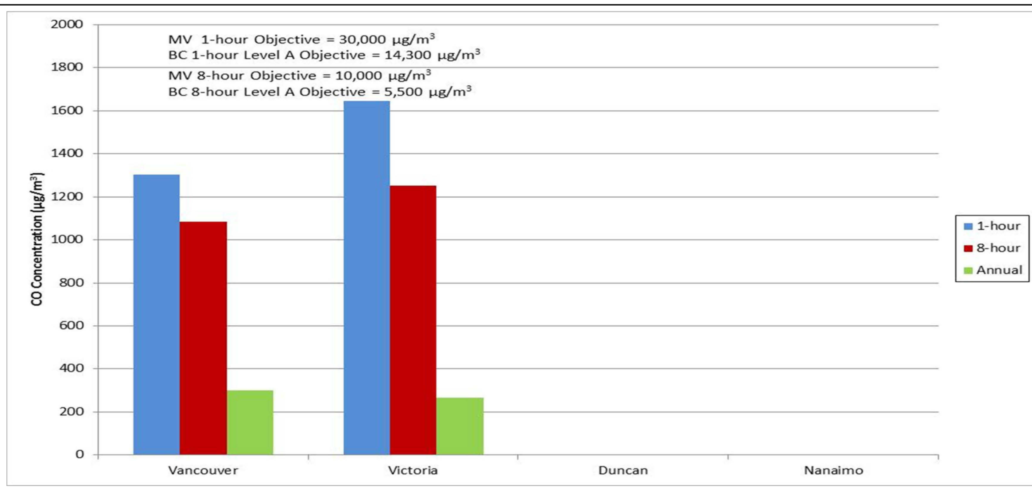
**FIGURE 4.2.6**
**OBSERVED $PM_{2.5}$ CONCENTRATIONS IN 2011 FOR THE MARINE AIR QUALITY REGIONAL STUDY AREA (in µg/m$^3$)**

**Figure 4.2.6 Observed $PM_{2.5}$ Concentrations in 2011 for the Marine Air Quality Regional Study Area (in µg/m$^3$)**




**Notes:** There were no CO observations from the Duncan-Cairnsmore and Nanaimo Labieux stations.

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**FIGURE 4.2.7**

**OBSERVED CO CONCENTRATIONS IN 2011 FOR THE MARINE AIR QUALITY REGIONAL STUDY AREA (in µg/m$^3$)**

**Figure 4.2.7 Observed CO Concentrations in 2011 for the Marine Air Quality Regional Study Area (in µg/m$^3$)**

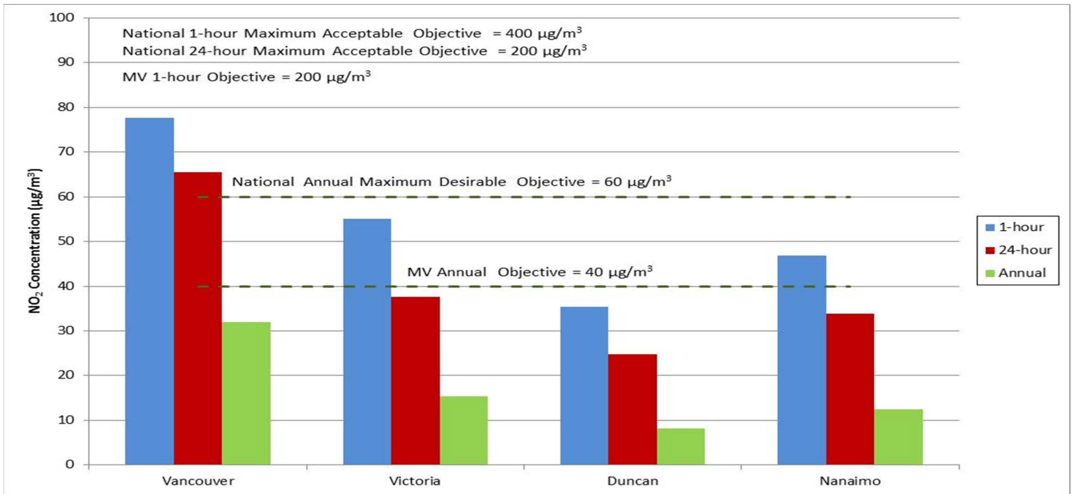
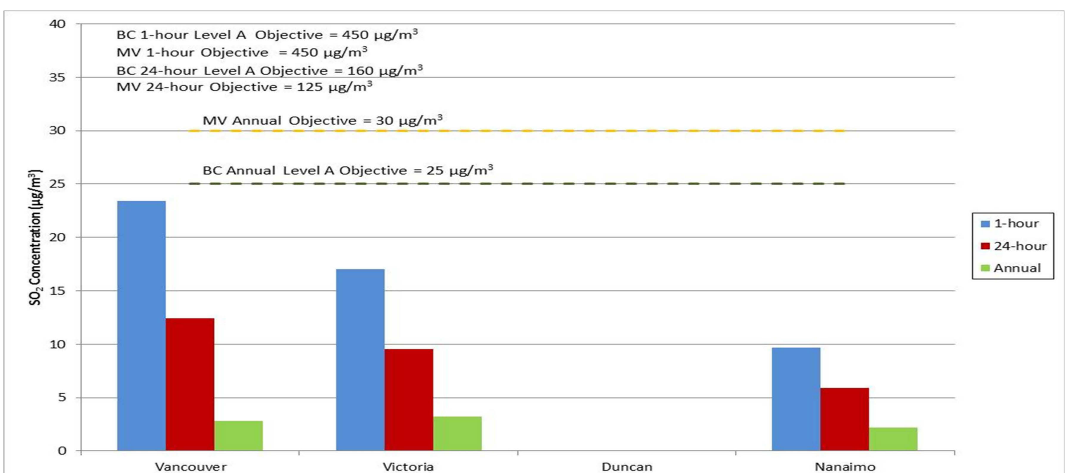



FIGURE 4.2.8

OBSERVED $NO_2$ CONCENTRATIONS IN 2011 FOR THE MARINE AIR QUALITY REGIONAL STUDY AREA (in µg/m$^3$)

**Figure 4.2.8 Observed $NO_2$ Concentrations in 2011 for the Marine Air Quality Regional Study Area (in µg/m$^3$)**




**Notes:** There were no $SO_2$ observations from the Duncan-Cairnsmore station.

FIGURE 4.2.9

OBSERVED SO2 CONCENTRATIONS IN 2011 FOR THE MARINE AIR QUALITY REGIONAL STUDY AREA (in µg/m$^3$)

**Figure 4.2.9 Observed $SO_2$ Concentrations in 2011 for the Marine Air Quality Regional Study Area (in µg/m$^3$)**

#### *4.2.3.5 Existing Air Quality – BTEX*

Monitoring records of BTEX are available from Environment Canada's National Air Pollution Surveillance Program (Environment Canada 2013a). Stations at Robson Square (in Vancouver) and Saturna Island were selected to represent existing BTEX concentrations in the Marine Air Quality RSA. BTEX concentrations for the 10-year period from 2002 to 2011 are illustrated in Figures 4.2.10 and 4.2.11. BTEX concentrations in the Marine Air Quality RSA have decreased since 2002 and are considerably higher in Robson Square than in Saturna Island due to a greater amount of surrounding human activity and related emission sources such as vehicular traffic. BC MOE and Metro Vancouver do not produce air quality objectives for BTEX.

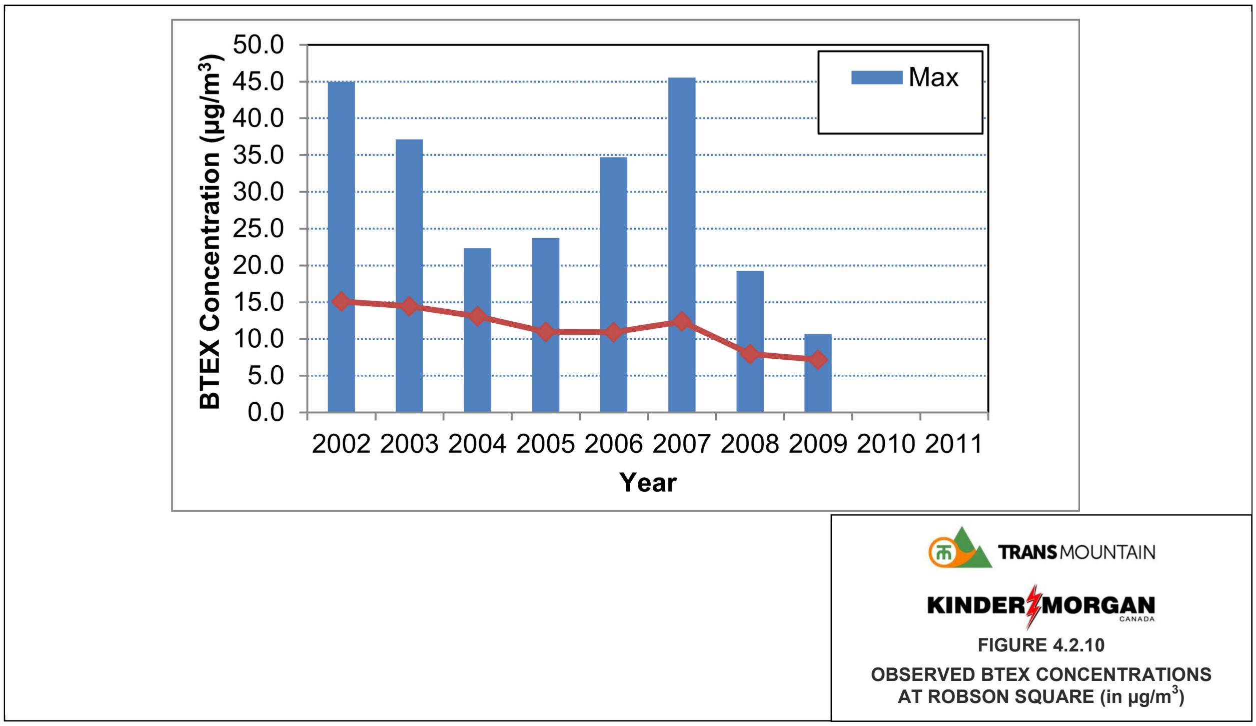



**Figure 4.2.10 Observed BTEX Concentrations at Robson Square (in µg/m³)**

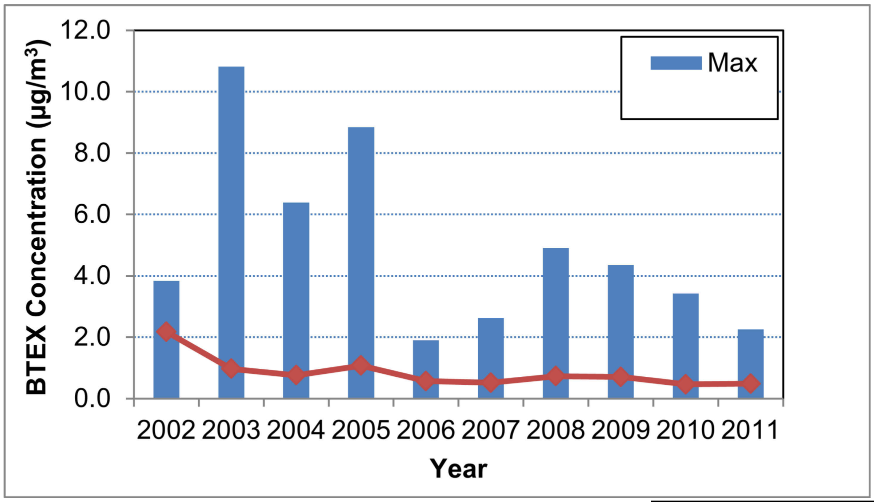



**Figure 4.2.11 Observed BTEX Concentrations at Saturna Island (in µg/m$^3$)**

#### *4.2.3.6 Existing Air Quality – Ozone*

Ozone monitoring data from Vancouver-Kitsilano, Victoria-Topaz, Duncan-Cairnsmore and Nanaimo-Labieux stations (same as those for CACs, see Section 4.2.3.3) were selected to represent existing ozone concentrations in the Marine Air Quality RSA. Ozone concentrations have increased over the last decade except in Victoria, where ozone concentrations have remained relatively constant. Existing ozone concentrations based on 2011 are illustrated in Figure 4.2.12.

Ozone concentrations are highest in Vancouver and may be attributable to large quantities of precursor $NO_x$ and volatile organic compound emissions from urban and industrial sources in the region. Ozone concentrations at the Vancouver-Kitsilano monitoring station in 2011 exceeded the 1-hour Metro Vancouver objective of 82 parts per billion (ppb) 3.4 per cent of the time, and the 8-hour Metro Vancouver objective of 65 ppb approximately 33 per cent of the time. Ozone concentrations in Victoria, Duncan and Nanaimo also exceeded the national ambient air quality objectives up to 3.9 per cent of the time, but there were no exceedances of the numerical value of the 2015 Canadian Ambient Air Quality Standard of 63 ppb.

Ozone concentrations at all four locations tend to be highest in the spring and in the afternoon. This reflects the influence of solar radiation and temperature on ozone formation. Sunlight directly affects the photolysis reactions involved in ozone formation. High temperatures are typically associated with greater solar radiation, low wind speeds and stagnant atmospheric circulation, which suppress mixing and promote build-up of precursor concentrations.

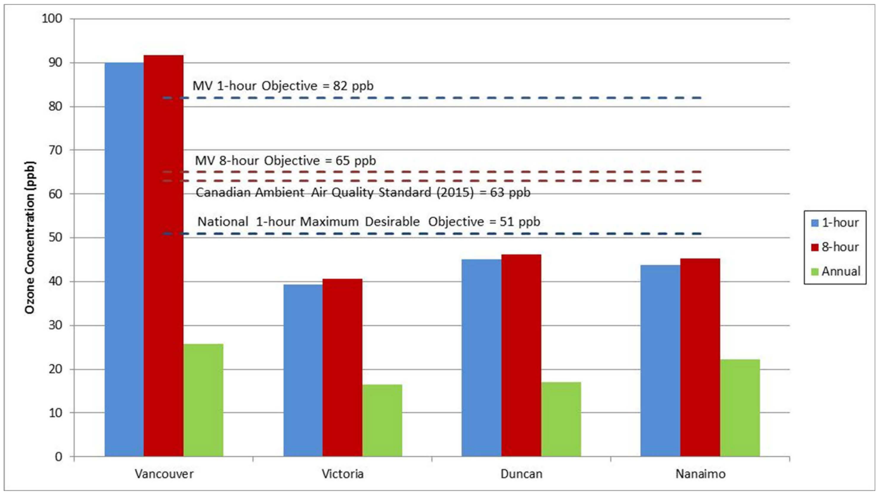



FIGURE 4.2.12

OBSERVED OZONE CONCENTRATIONS IN 2011 FOR THE MARINE AIR QUALITY REGIONAL STUDY AREA (in ppb)

**Figure 4.2.12 Observed Ozone Concentrations in 2011 for the Marine Air Quality Regional Study Area (in ppb)**

### *4.2.3.7 Existing Emissions*

Table 4.2.3.1 shows the existing annual emissions due to marine traffic in the Marine Air Quality RSA, based on the 2005 Corbett inventory (Wang *et al.* 2008). These emissions provide context for increased emissions from the increased Project-related marine vessel traffic.

**TABLE 4.2.3.1**

**EXISTING 2005 EMISSIONS FROM MARINE VESSEL TRAFFIC IN THE MARINE AIR QUALITY REGIONAL STUDY AREA**

| Contaminant | Annual Emissions (t/y) |
|---|---|
| Total suspended particulate (TSP) | 66.2 |
| CO | 60.1 |
| $NO_x$ | 913.5 |
| $SO_2$ | 524.6 |
| Total hydrocarbon (HC) | 31.9 |

### *4.2.3.8 Existing Visibility Conditions*

Visibility, in addition to being an aesthetic value, is often used as a gauge for air quality. Light can be scattered by particulate matter in the atmosphere and absorbed by gases such as $NO_x$, which results in a degradation of visibility. Monthly visibility observations from Vancouver

International Airport and Victoria International Airport, based on Environment Canada climate normal data (Environment Canada 2013b), are presented in Tables 4.2.3.2 and 4.2.3.3, respectively. Overall, existing visibility conditions in the Marine Air Quality RSA are good, with visibility greater than 9 km over 90 per cent of the time. The fewest hours with low visibility and the most hours with high visibility tend to be observed in the spring and summer months (March to August). Victoria tends to have more hours with high visibility and fewer hours with low visibility than Vancouver, which may be reflective of the lower $PM_{10}$ and $NO_x$ concentrations and/or the lesser amount of precipitation in the area. Vancouver's air quality is also influenced by being located in the Fraser Valley air shed geography.

### TABLE 4.2.3.2

### MONTHLY VISIBILITY OBSERVATIONS FROM VANCOUVER INTERNATIONAL AIRPORT FOR THE PERIOD OF 1971 TO 2000

| Parameter | January | February | March | April | May | June | July | August | September | October | November | December | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Visibility (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 |
| Visibility (hours with 1 to 9 km) | 134.4 | 81.0 | 46.4 | 26.7 | 18.0 | 19.1 | 13.2 | 23.4 | 50.7 | 111.4 | 94.5 | 122.7 | 741.6 |
| Visibility (hours with > 9 km) | 578.8 | 584.6 | 694.8 | 693.0 | 725.9 | 700.7 | 730.6 | 720.2 | 664.6 | 605.7 | 611.5 | 596.3 | 7,906.5 |

**Source:** Environment Canada 2013b

### TABLE 4.2.3.3

### MONTHLY VISIBILITY OBSERVATIONS FROM VICTORIA INTERNATIONAL AIRPORT FOR THE PERIOD OF 1971 TO 2000

| Parameter | January | February | March | April | May | June | July | August | September | October | November | December | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Visibility (hours with < 1 km) | 16.6 | 8.9 | 3.6 | 0.6 | 1.0 | 0.7 | 0.8 | 2.2 | 5.5 | 18.8 | 10.8 | 14.5 | 83.9 |
| Visibility (hours with 1 to 9 km) | 127.2 | 91.8 | 47.3 | 19.7 | 14.8 | 14.2 | 10.9 | 20.9 | 38.3 | 101.5 | 99.9 | 131.6 | 718.0 |
| Visibility (hours with > 9 km) | 600.2 | 577.3 | 693.1 | 699.6 | 718.3 | 705.1 | 732.3 | 721.0 | 676.2 | 623.8 | 609.4 | 597.8 | 7,964.1 |

**Source:** Environment Canada 2013b

### *4.2.3.9 US Waters*

Two stations were selected to represent air quality over US waters of the Marine Air Quality RSA, namely Cheeka Peak and Port Townsend, both located in the Olympic Peninsula. Cheeka Peak is part of the US Environmental Protection Agency National Core multi-pollutant monitoring network and is located in a rural setting, while Port Townsend is located in a suburban setting and measures $PM_{2.5}$.

A summary of 2011 concentrations of CACs and ozone observed at Cheeka Peak and Port Townsend stations are illustrated in Figures 4.2.13 to 4.2.16. There were no exceedances of the US Environmental Protection Agency National Ambient Air Quality Standards (NAAQS). The maximum 24-hour $PM_{2.5}$ concentrations were less than half the standard and the maximum CO and $SO_2$ concentrations were less than 10 per cent of the standards.

There were no exceedances of the eight-hour ozone NAAQS at Cheeka Peak in 2011. However, observed concentrations are relatively high for a rural location and is expected to be a result of episodic trans-Pacific ozone transport (McKendry 2006).

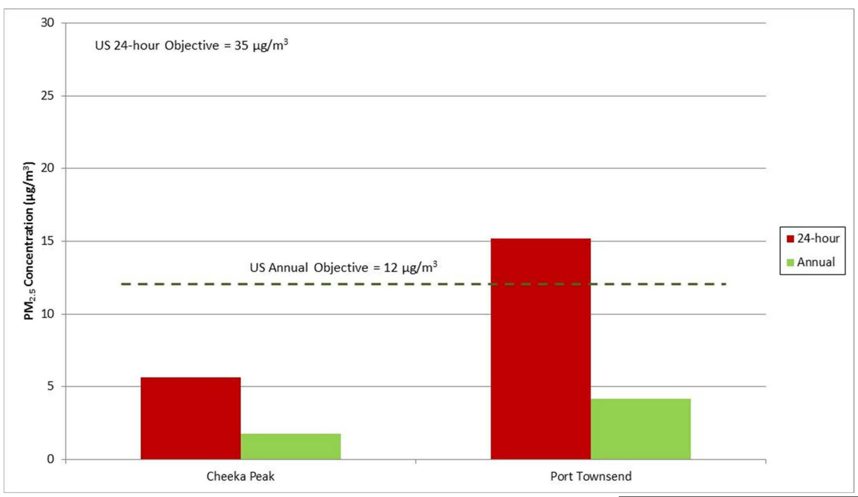



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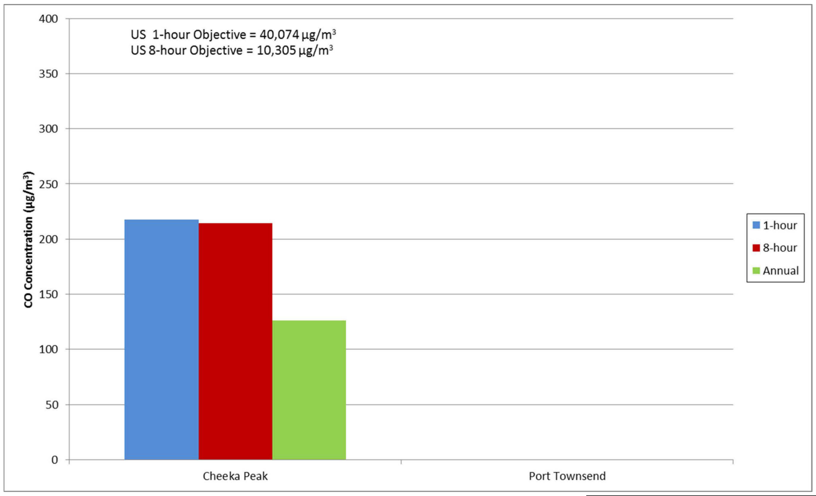
**FIGURE 4.2.13**
**OBSERVED $PM_{2.5}$ CONCENTRATIONS IN 2011 FOR US WATERS (in µg/m³)**

**Figure 4.2.13 Observed $PM_{2.5}$ Concentrations in 2011 for US Waters (in µg/m³)**




**Notes:** There were no CO observations from the Port Townsend station.

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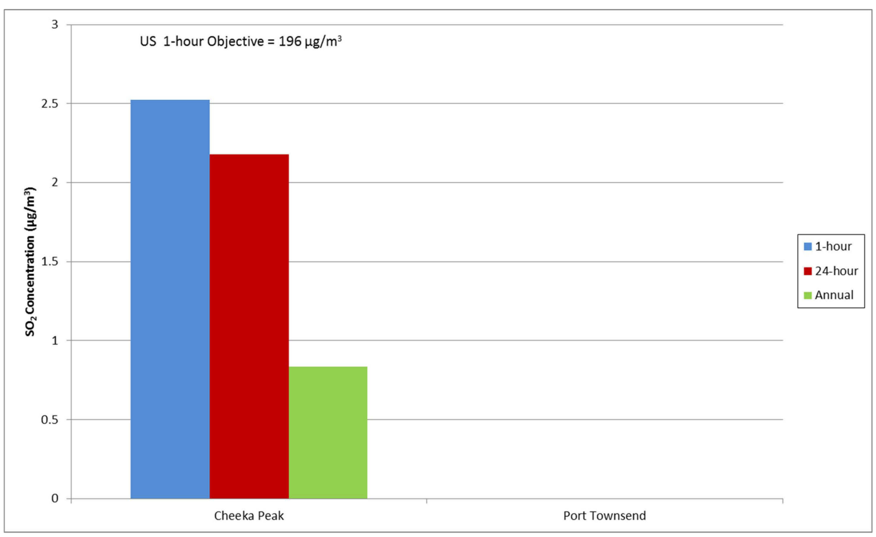
**FIGURE 4.2.14**

**OBSERVED CO CONCENTRATIONS IN 2011 FOR US WATERS (in µg/m$^3$)**

**Figure 4.2.14 Observed CO Concentrations in 2011 for US Waters (in µg/m$^3$)**




**Notes:** here were no $SO_2$ observations from the Port Townsend station.

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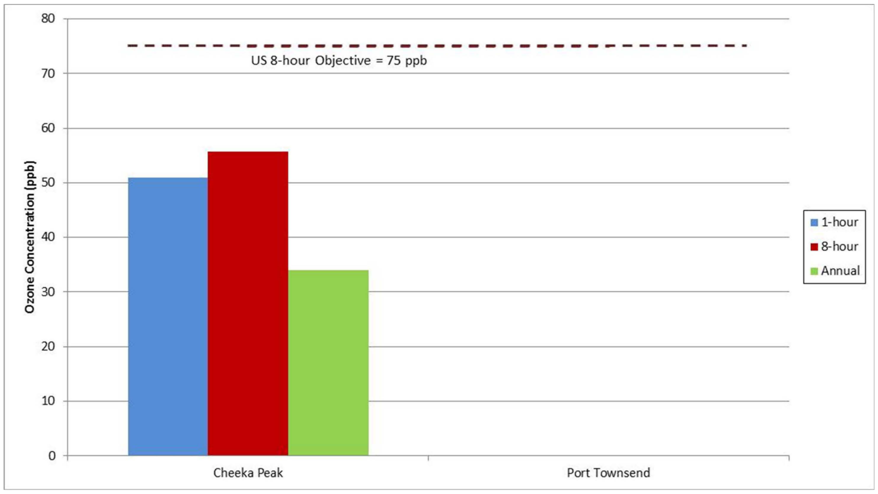
**FIGURE 4.2.15**

**OBSERVED $SO_2$ CONCENTRATIONS IN 2011 FOR US WATERS (in µg/m$^3$)**

**Figure 4.2.15 Observed $SO_2$ Concentrations in 2011 for US Waters (in µg/m$^3$)**




**Notes:** There were no ozone observations from the Port Townsend station.

FIGURE 4.2.16
OBSERVED OZONE CONCENTRATIONS IN 2011 FOR US WATERS (in ppb)

**Figure 4.2.16 Observed Ozone Concentrations in 2011 for US Waters (in ppb)**

The 2005 Corbett inventory, summarized in Section 4.2.3.6, includes emissions from both Canadian and US waters. A separation of emissions by jurisdiction is not available.

Visibility measurements at Cheeka Peak and Port Townsend vary from 13 km to 349 km, with higher visibility observed at Cheeka Peak than at Port Townsend. Visibility measurements over US waters are considerably higher than those in Vancouver and Victoria, possibly due to the better air quality in less urban areas and/or different measurement techniques.

### *4.2.4 Greenhouse Gas Emissions*

Environment Canada's National Inventory Report estimates total GHG emissions from Canada to be 692 megatonnes (Mt) in 2010, consisting of 545 Mt of carbon dioxide ($CO_2$), 4.3 Mt of methane ($CH_4$) and 0.15 Mt of nitrous oxide ($N_2O$). Of the 692 Mt, 6.7 Mt (6,350 kilotonnes [kt] $CO_2$, 0.5 kt $CH_4$, 1 kt $N_2O$) was estimated to be from domestic marine traffic. In BC alone, the total GHG emissions in 2010 were estimated to be 56.1 Mt (43,700 kt $CO_2$, 400 kt $CH_4$, 7.8 kt $N_2O$), with 2.7 Mt (2,590 kt $CO_2$, 0.2 kt $CH_4$, 0.4 kt $N_2O$) generated from domestic marine traffic (Environment Canada 2012).

The 2005 Corbett inventory (Wang *et al.* 2008) estimates a total of 35,872 tonnes (or 35.9 Mt) of $CO_2$ emissions from existing marine traffic in the Marine Air Quality RSA. Emissions of other GHGs, namely $CH_4$ and $N_2O$, are not available from the 2005 Corbett inventory.

#### *4.2.4.1 US Waters*

The 2008 National Emissions Inventory (US Environmental Protection Agency 2013) estimates total GHG emissions from Washington to be 39.8 Mt. These include emissions from burning, on-road vehicles and non-road equipment; emissions from marine traffic were not readily available. However, a first-order estimate of GHG emissions from commercial marine vessels can be determined by scaling from CO emissions and was estimated to contribute an additional 2.3 Mt.

### *4.2.5 Marine Acoustic Environment*

This subsection provides a general description of marine acoustic environment along the marine shipping lanes, from the Westridge Marine Terminal to the 12 nautical mile limit of Canada's territorial sea (shown in Figure 4.2.1). More detailed technical information pertaining to the marine acoustic environment is presented in the Marine Noise (Atmospheric) – Marine Transportation Technical Report (Volume 8B, TR 8B-4).

Information pertaining to the marine acoustic environment in US waters can be found in Section 4.2.5.4. A discussion of the potential effects of the increased Project-related marine vessel traffic and associated mitigation as well as a discussion of the spatial boundaries for marine acoustic environment are located in Section 4.3.5.

Information pertaining to underwater noise is discussed in Section 4.2.7, Marine Mammals.

#### *4.2.5.1 Indicators*

Atmospheric sound levels are the indicator selected to represent potential effects from Project-related increased marine vessel traffic on the marine acoustic environment. See Section 4.3 for more information regarding indicators.

#### *4.2.5.2 Existing Noise Levels*

Existing atmospheric noise levels will vary along the length of the marine shipping lanes, due to variations in proximity to the shore and the presence of noise from wind, waves, and spray (surface agitation). The focus of this discussion is on shoreline areas nearest the shipping lanes. A combination of available measured baseline data and published data is used to establish the expected existing atmospheric noise levels within the Marine LSA.

Details on the baseline measurement program methods and results are summarized in the Marine Noise (Atmospheric) – Marine Transportation Technical Report (Volume 8B, TR 8B-4) and provided in full detail in the Terrestrial Noise and Vibration Technical Report of Volume 5C. Atmospheric noise levels are measured in A-Weighted decibels or dBA, a filtering system that matches the response of the human ear. The values reported are equivalent energy levels or Leq, which is a commonly used indicator for environmental sound since it accounts for the natural variation that occurs over time.

As the amount of shoreline exposure varies throughout the Marine LSA, the existing sound levels are described for the relevant segments as described in Figure 4.2.17. In Burrard Inlet (Segments 1 and 2), shoreline areas from the Westridge Marine Terminal to First Narrows lie within the Marine LSA. Land use in these segments is generally dense urban development with a mix of residential, commercial, industrial and urban park development. Ambient noise measurements made at the Westridge Marine Terminal are expected to be representative of sound levels in residential areas along Burrard Inlet. Results of the measurement program indicate the existing daytime sound levels to be approximately 51 dBA and nighttime sound levels to be approximately 46 dBA and included a ship at the Westridge Marine Terminal as well as normal marine traffic in the inlet. This is similar to expected ambient sound levels estimated using the BC OGC methods of 56 dBA day and 46 dBA night (BC OGC 2009).

No shoreline areas or islands are located within the Marine LSA through English Bay and the Strait of Georgia (Segments 3 and 4) or Juan de Fuca Strait (Segment 7).

In the Haro Strait to Boundary Pass (Segment 5) and Victoria to Race Rocks (Segment 6), various islands are located within the Marine LSA. These locations are either not inhabited or sparsely developed. Ambient measurements have not been conducted for these locations. The measurements conducted for the Westridge Marine Terminal indicate that even though there is port activity near the location, the measured data are similar to expectations for existing conditions in the BC OGC Guidance. Therefore, the ambient sound levels of 45 dBA day and 35 dBA night as defined for rural and undeveloped areas in the BC OGC Guidance are used to represent existing conditions for these locations (BC OGC 2009).

#### *4.2.5.3 Existing Sound Emissions from Ship Traffic*

Current marine traffic levels in the Marine RSA are high, with a small contribution from marine vessels associated with existing Trans Mountain operations. The following focuses on atmospheric sound emissions from current marine vessel traffic associated with existing Trans Mountain operations.

The existing sound level attenuation curves from the Project tankers travelling along the shipping lanes were calculated using the sound emissions established through empirical formulae, and calculated through various distances in the outdoor environment based on International Standards Organization ISO9613 algorithms (ISO 1996). Details on the calculation methods and results are summarized in the Marine Noise (Atmospheric) – Marine Transportation Technical Report (Volume 8B, TR 8B-4).

The resulting attenuation curves are estimated in Figures 4.2.18a, 18b and 18c. The figures provide an estimate of “pass-by” sound levels or the amount of atmospheric sound generated by a single tanker by distance for each tanker/tug boat combination. Currently, there are a maximum of two tankers on the shipping lanes on any given day, with a total of five tankers per month that may generate sound.

The estimated sound emission levels from the tugs and tankers for use in calculation of sound levels at distance calculations are listed in Table 4.2.5.1. The table provides sound power level, in dBA, for each type of vessel considered.

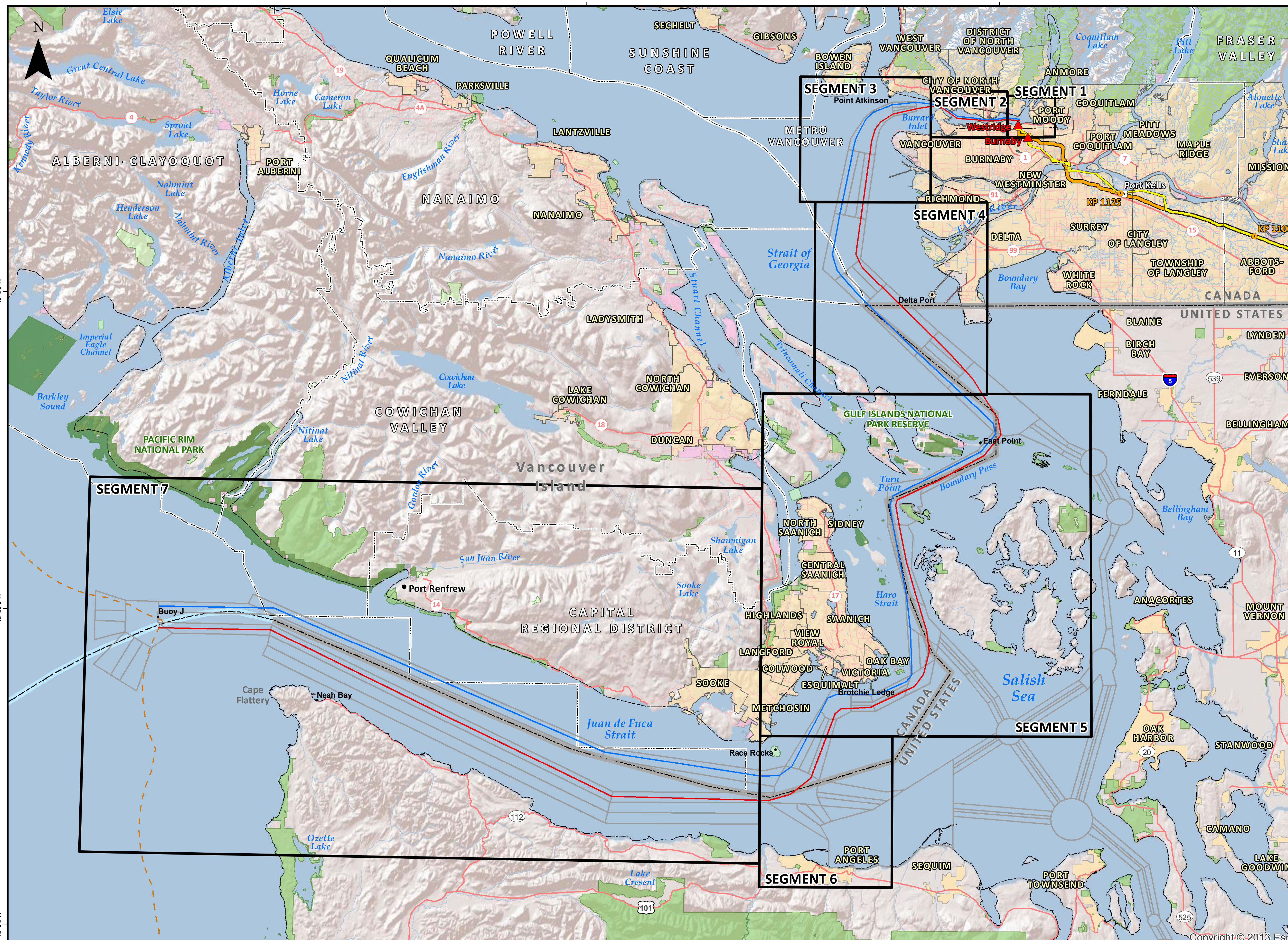
## TABLE 4.2.5.1

## SOUND POWER LEVELS FOR EXISTING VESSELS ASSOCIATED WITH THE WESTRIDGE MARINE TERMINAL OPERATIONS

| Source | Octave Spectrum (dB) | | | | | | | | | Overall Sound Power [1, 2] | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 31.5 | 63 | 125 | 250 | 500 | 1,000 | 2,000 | 4,000 | 8,000 | dBA | dB |
| Hawk Stern-pull Harbour Tugboat | 127.8 | 115.2 | 107.8 | 101.9 | 99.3 | 101.9 | 102.1 | 100.6 | 92.6 | 107.9 | 128.2 |
| Kestrel Bow-pull Harbour Tugboat | 129.9 | 117.5 | 110.6 | 104.3 | 101.2 | 103.5 | 103.4 | 101.8 | 93.8 | 109.4 | 130.3 |
| Commodore Haro-Strait Tugboat | 128.5 | 115.6 | 107.7 | 102.1 | 99.7 | 102.6 | 102.7 | 101.3 | 93.3 | 108.5 | 128.8 |
| Panamax Tanker in Open Water | 113.4 | 109.4 | 115.4 | 111.4 | 103.4 | 99.6 | 94.2 | 87.7 | 79.7 | 107.1 | 119.1 |
| Panamax Tanker in Haro-Strait | 110.4 | 106.4 | 112.4 | 108.4 | 100.4 | 96.5 | 91.2 | 84.7 | 76.7 | 104.1 | 116.1 |
| Aframax Tanker in Open Water | 118.6 | 114.6 | 120.6 | 116.6 | 108.6 | 104.7 | 99.1 | 91.6 | 83.6 | 112.3 | 124.3 |
| Aframax Tanker in Haro-Strait | 115.6 | 111.6 | 117.6 | 113.6 | 105.6 | 101.7 | 96.1 | 88.6 | 80.6 | 109.2 | 121.3 |

**Notes:** 1 Manufacturer’s data were used for engine performance.

2 Sound power was calculated from engine specifications using empirical formulae (Crocker 2007).




# FIGURE 4.2-17

## ATMOSPHERIC NOISE ROUTE SEGMENTS

## TRANS MOUNTAIN EXPANSION PROJECT

- Kilometre Post (KP)
- Trans Mountain Pipeline (TMPL)
- Trans Mountain Expansion Project Proposed Pipeline Corridor
- Terminal
- Existing Pump Station
- Highway
- Road
- 12 Nautical Mile Limit (Territorial Sea)
- Limit of Exclusive Economic Zone (EEZ)
- International Boundary
- Marine Vessel Outbound Shipping Lane
- Marine Vessel Inbound Shipping Lane
- Traffic Separation Scheme
- Marine Traffic Segments
- City / Town / District Municipality
- Indian Reserve / Métis Settlement
- National Park
- Provincial / State Park
- Protected Area/Natural Area/ Provincial Recreation Area/Wilderness Provincial Park/Conservancy Area
- Regional District Boundary



Projection: UTM Zone 10N.
Routing: Baseline TMPL Route Revision 0, provided by KMC, May 2012. Proposed Corridor V6 provided by UPI, August 23, 2013.; Transportation: BC Forests, Lands and Natural Resource Operations, 2012 & ESRI, 2005; Geopolitical Boundaries: IHS Inc., 2011, BC FLNRO, 2007 & ESRI, 2005, Natural Resources Canada, 2012; First Nation Lands: Government of Canada, 2013 & IHS Inc., 2011; Hydrology: IHS Inc., 2004, United States National Imagery and Mapping Agency, 2000, Natural Resouces Canada, 2010; Parks and Protected Areas: Natural Resources Canada, 2013, BC FLNRO, 2008 & ESRI, 2005; CHS Marine Features: Government of Canada, 2013; Marine Vessel Inbound/Outbound Shipping Lanes: Moffatt and Nichol, 2013; Hillshade: ESRI, 2009.

*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: NBN | CHECKED: AKH | DESIGN: TGG |

0 5 10 15 20 25 km

ALL LOCATIONS APPROXIMATE

1202006_TMEP_MR_NOISE_FIG4.2-17.mxd

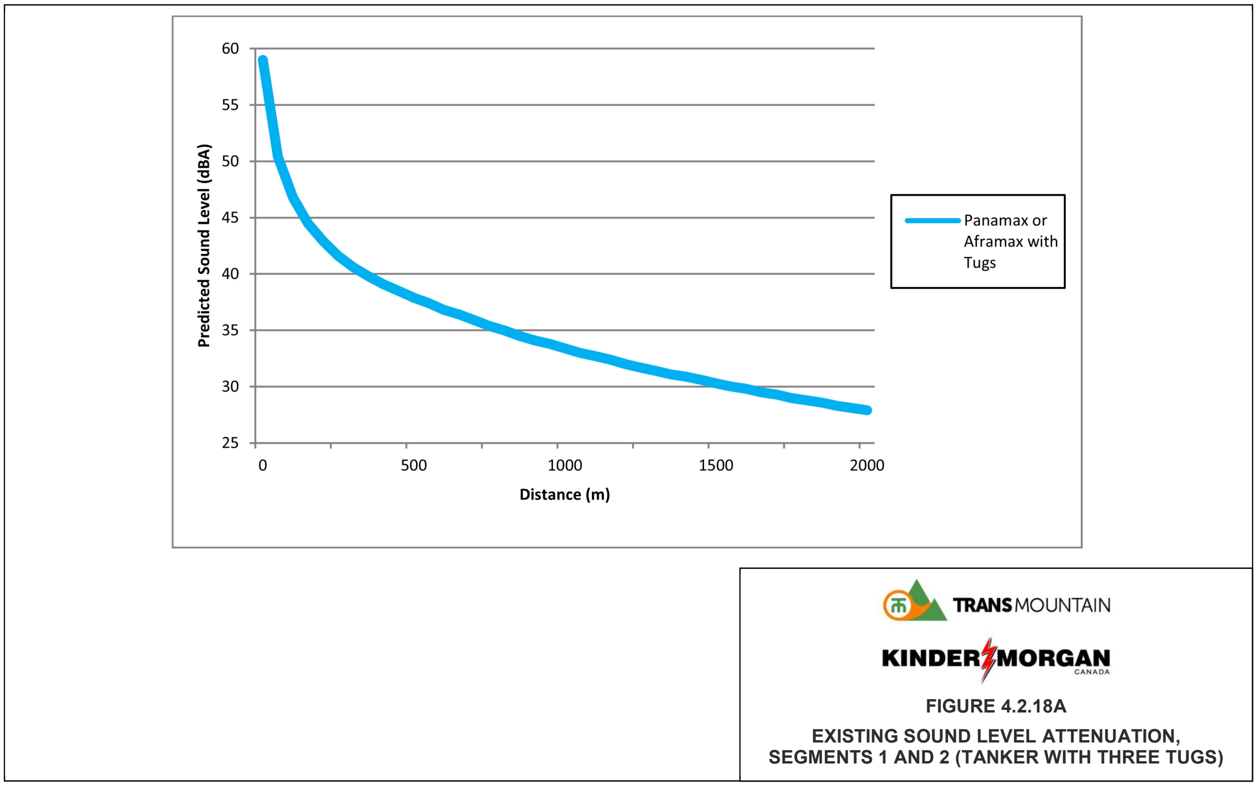



**Figure 4.2.18a Existing Sound Level Attenuation, Segments 1 and 2 (Tanker with Three Tugs)**

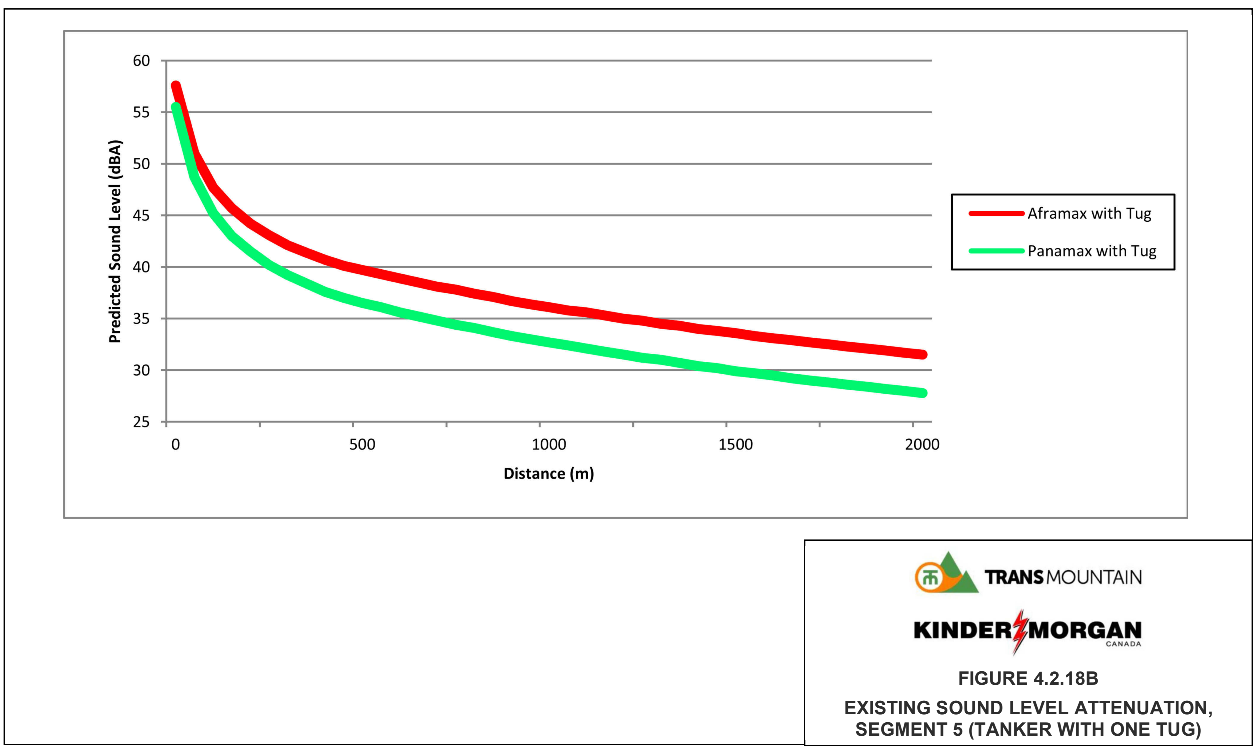



**Figure 4.2.18b Existing Sound Level Attenuation, Segment 5 (Tanker with One Tug)**

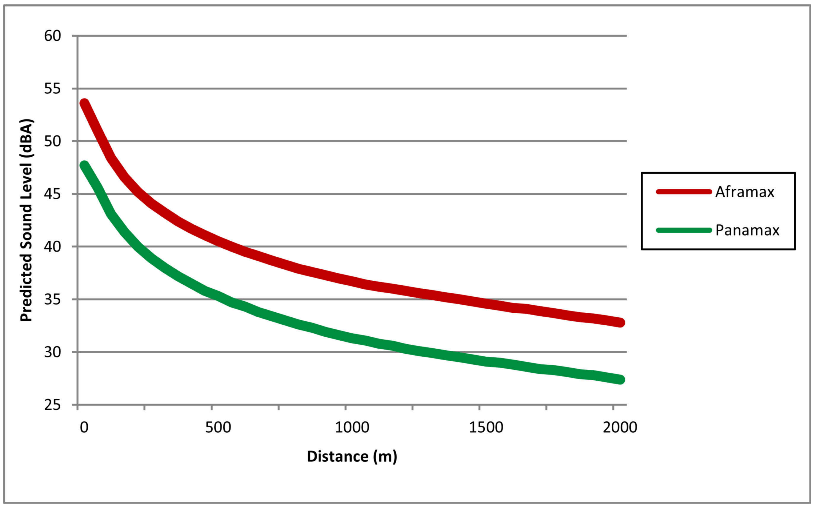



FIGURE 4.2.18C
EXISTING SOUND LEVEL ATTENUATION, SEGMENT 6 (TANKER)

**Figure 4.2.18c Existing Sound Level Attenuation, Segment 6 (Tanker)**

#### *4.2.5.4 US Waters*

Existing sound levels in US waters, specifically the various shoreline areas in US waters, are expected to be similar to those in Canadian waters. Similar vessels will have similar sound emissions. Existing conditions in US waters are expected to mirror Canadian conditions.

### *4.2.6 Marine Fish and Fish Habitat*

This subsection provides a broad description of the marine fish species (including marine invertebrates) and habitats along the marine shipping lanes, from the Westridge Marine Terminal to the 12 nautical mile limit of Canada's territorial sea (shown in Figure 4.2.1). More detailed technical information pertaining to marine fish and fish habitat is presented in the Marine Resources – Marine Transportation Technical Report (Volume 8B, TR 8B-1).

Aboriginal traditional knowledge pertaining to marine fish and fish habitat is summarized in Section 4.2.6.6. Information pertaining to marine fish and fish habitat in US waters can be found in Section 4.2.6.7. A discussion of the potential effects of the increased Project-related marine vessel traffic and associated mitigation as well as a discussion of the spatial boundaries for marine fish and fish habitat are located in Section 4.3.6.

#### *4.2.6.1 General Information*

A total of 409 species of marine fish have been reported in Canadian Pacific waters (Peden 2013). A number of these species are targeted or captured incidentally in commercial, recreational and Aboriginal fisheries, including salmon, groundfish (*e.g.*, flounder, lingcod, rockfish), pelagics (*e.g.*, herring), and shellfish (*e.g.*, crab, prawn and shrimp) (DFO 2012a). Marine fish contribute to healthy marine ecosystems and food webs. For example, Pacific herring are an important forage fish for many species of fish, birds and marine mammals, including Pacific salmon and killer whales (Gustafson *et al.* 2006, Livingston 1993, Saulitis *et al.* 2000). Pacific salmon support marine, estuarine, freshwater, and terrestrial food webs by providing nutrients to the ecosystem during their migration from the ocean to rivers and streams to spawn (DFO 2013b, Hart 1973).

Fish habitat is defined under Section 34(1)(e) of the *Fisheries Act* as "spawning grounds and nursery, rearing, food supply, and migration areas on which fish depend directly or indirectly in order to carry out their life processes". The shipping lanes extend across the Strait of Georgia and the Juan de Fuca Marine Ecodistricts within the Georgia Basin Marine Ecoregion (Harding 1997). While these broad classifications provide a framework for categorizing marine habitats at a regional scale, marine habitats also vary at a smaller scale (*e.g.*, site-specific) based on localized differences in physical and biological characteristics (Burd *et al.* 2008, Howes *et al.* 1994, Levings *et al.* 1983, Williams 1993).

#### *4.2.6.2 Field Data Collection*

Information on marine resources within the Marine RSA is readily available in published literature and is deemed to be sufficient to assess potential effects of the increased Project-related marine vessel traffic on marine fish and fish habitat. Therefore, Project-specific field studies for this aspect of data gathering were not considered warranted.

#### *4.2.6.3 Database and Information Gathering*

The marine fish and fish habitat knowledge base is derived from a review of relevant scientific literature, government reports and documents, and electronic resources including:

- DFO Canadian Science Advisory Secretariat (CSAS) publications (DFO 2013c);
- DFO WAVES Online Catalogue (DFO 2013d);
- DFO Mapster v3 (DFO 2013e);
- COSEWIC assessments and status reports (COSEWIC 2013);
- Species at Risk Public Registry (Government of Canada 2013a);
- BC Coastal Resource Information Management System (2013);
- BC Species and Ecosystems Explorer (BC CDC 2013);
- BC Marine Conservation Analysis (BC MCA) (2013); and
- Washington State Coastal Atlas (Washington State Department of Ecology 2006).

#### *4.2.6.4 Conservation Status*

Based on a review of COSEWIC assessments and status reports, the federal *SARA* public registry list (Schedule 1), and the BC CDC Red and Blue Lists, a total of 19 marine fish and invertebrate species or populations of conservation concern have been identified as potentially occurring within the Marine RSA (Table 4.2.6.1). Of these, eight are listed under Schedule 1 of *SARA* and two are listed under the BC *Wildlife Act* (BC CDC 2013, Government of Canada 2013a).

**TABLE 4.2.6.1**

**CONSERVATION STATUS OF MARINE FISH SPECIES IN THE MARINE REGIONAL STUDY AREA**

| Species Name | Population(s) | Taxon | BC List Status[1] | COSEWIC Status[1] | *SARA* Status[1] |
|---|---|---|---|---|---|
| Basking shark *Cetorhinus maximus* | Pacific Ocean | Fish | No status | Endangered | Endangered – Schedule 1 |
| Bluntnose sixgill *Shark Hexanchus griseus* | Pacific Ocean | Fish | No status | Special Concern | Special Concern – Schedule 1 |
| Bocaccio *Sebastes paucispinis* | Pacific Ocean | Fish | No status | Threatened | No status |
| Canary rockfish *Sebastes pinniger* | Pacific Ocean | Fish | No status | Threatened | No status |
| Chinook salmon *Oncorhynchus tshawytscha* | Okanagan population | Fish | No status | Threatened | Yellow |
| Coho salmon *Oncorhynchus kisutch* | Interior Fraser population | Fish | No status | Endangered | No status |
| Darkblotched rockfish *Sebastes crameri* | Pacific Ocean | Fish | No status | Special Concern | No status |
| Eulachon *Thaleichthys pacificus* | Fraser River population | Fish | No status | Endangered | Blue |
| Longspine thornyhead *Sebastolobus altivelis* | Pacific Ocean | Fish | No status | Special Concern | Special Concern – Schedule 1 |
| North Pacific spiny dogfish *Squalus suckleyi* | Pacific Ocean | Fish | No status | Special Concern | No status |
| Northern abalone *Haliotis kamtschatkana* | Pacific Ocean | Mollusc | Red | Endangered | Endangered – Schedule 1 |
| Olympia oyster *Ostrea lurida* | Pacific Ocean | Mollusc | Blue | Special Concern | Special Concern – Schedule 1 |
| Pacific sardine *Sardinops sagax* | Pacific Ocean | Fish | No status | Not at Risk | Special Concern – Schedule 3 |
| Quillback rockfish *Sebastes maliger* | Pacific Ocean | Fish | No status | Threatened | No status |
| Rougheye rockfish type I *Sebastes sp. type I & II* | Pacific Ocean | Fish | No status | Special Concern | Special Concern – Schedule 1 |
| Sockeye salmon *Oncorhynchus nerka* | Cultus population, Sakinaw population | Fish | No status | Endangered | No status |
| Tope *Galeorhinus galeus* | Pacific Ocean | Fish | No status | Special Concern | Special Concern – Schedule 1 |
| Yelloweye rockfish *Sebastes ruberrimus* | Pacific Ocean outside waters population, inside waters population | Fish | No status | Special Concern | Special Concern – Schedule 1 |
| Yellowmouth rockfish *Sebastes reedi* | Pacific Ocean | Fish | No status | Threatened | No status |

**Sources:** BC CDC 2013, Government of Canada 2013a. Last updated on November 25, 2013.

**Note:** 1 See Section 4.2.1.3 for definitions of COSEWIC, *SARA* and BC List status.

### *4.2.6.5 Indicator Species and Habitat*

Three indicators were selected to represent potential effects from Project-related increased marine vessel traffic on marine fish and fish habitat: intertidal habitat, Pacific herring, and Pacific salmon. Marine habitat can be divided into three broad zones based on physical and biological characteristics: the marine riparian (backshore) zone, the intertidal zone, and the subtidal zone (Howes *et al.* 1994, Williams 1993). Intertidal habitat is the area of habitat between the higher high water mark and the mean lower low water line for spring tides (Williams 1993) and is present along shorelines in the Marine RSA. The Marine RSA encompasses areas used by Pacific herring and Pacific salmon for spawning, rearing, foraging, and migration. See Section 4.3 for more information regarding indicators.

#### 4.2.6.5.1 Intertidal Habitat

Intertidal habitat is strongly influenced by a range of physical and biological factors including substrate type, slope, wave exposure, shore width, tidal range, salinity, light, temperature, and vegetation (Burd *et al.* 2008, Howes *et al.* 1994, Levings *et al.* 1983, Williams 1993). Common intertidal species in BC include marsh plants, seagrasses, algae, invertebrates, and fish (Williams 1993).

BC's intertidal zone provides spawning, rearing, migration and foraging habitat for a diverse range of marine fish species. Pacific salmon are known to use the intertidal zone of estuaries as rearing and migration habitat (Healey 1980, Levings and Jamieson 2001, Levings and Thom 1994). Salmon also feed on organisms that originate in the intertidal zone (Levings and Jamieson 2001, Levings and Thom 1994). Marine vegetation in the intertidal zone provides spawning substrate for Pacific herring (Hart 1973, Humphreys and Hourston 1978, Levings and Thom 1994, Taylor 1964).

The Government of BC has developed a Biophysical Shore-Zone Mapping System for describing the biophysical character of the province's shore zone (Howes *et al.* 1994, Searing and Frith 1997). Physical and biological information about the shore zone is collected during spring low tides using high-quality aerial video imagery. Professional geoscientists use this information to divide the shore zone into discrete sections of coastline known as "shore units" that are continuous and homogenous in the alongshore direction in terms of morphology and sediment type (Howes *et al.* 1994).

The total length of shoreline in the Marine RSA is approximately 3,861 km, of which approximately 2,315 km is located within Canada. The distribution of shore types in the Marine RSA is shown in Figure 4.2.19, with further details shown in the inset maps on Figures 4.2.19a through 4.2.19d. The length and relative abundance of shore types in the Canadian portion of the Marine LSA and Marine RSA are shown in Table 4.2.6.2. A discussion of shore types in the US portion of the Marine RSA is provided in Section 4.2.6.7. A total of 15 different shore types have been identified within the Marine RSA. "Rock cliff" is the most common shore type in the Marine RSA, covering about 596 km or 25.8 per cent of the total shoreline (BC Ministry of Forest, Land and Natural Resource Operations [MFLNRO] 2005). "Rock, sand and gravel beach" and "rock with gravel beach" shore types are the second and third most common in the Marine RSA, covering 14.2 per cent and 12.9 per cent of the shoreline, respectively (BC MFLNRO 2005).

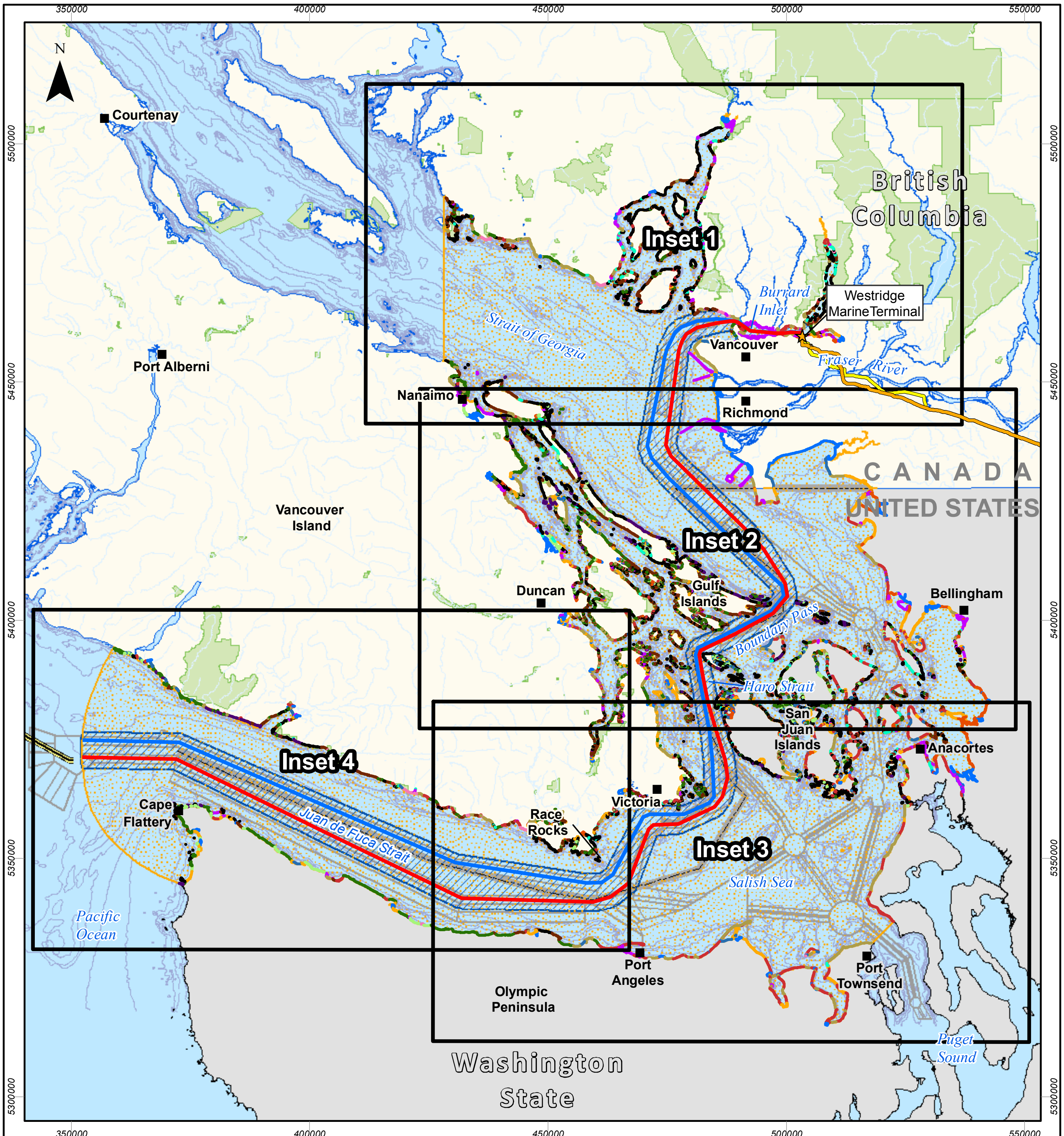
The total length of shoreline in the Canadian portion of the Marine LSA is approximately 109 km, along which a total of 13 different shore types have been identified (BC MFLNRO 2005). "Man-made" is the most common shore type in the Marine LSA, covering about 49 km or

44.7 per cent of the total shoreline (BC MFLNRO 2005). “Sand and gravel flat” and “rock cliff” shore types are the second and third most common in the Marine LSA, covering 11.2 per cent and 10.2 per cent of the shoreline, respectively (BC MFLNRO 2005).

**TABLE 4.2.6.2**

**LENGTH AND RELATIVE ABUNDANCE OF SHORE TYPES IN THE CANADIAN PORTION OF THE MARINE LSA AND MARINE RSA**

| Shore Type | Marine LSA - Length (km) | Marine LSA - % Total Length | Marine RSA - Length (km) | Marine RSA - % Total Length |
|---|---|---|---|---|
| Channel | 0.0 | 0.0 | 1.3 | 0.1 |
| Estuary, marsh or lagoon | 0.8 | 0.8 | 177.3 | 7.7 |
| Gravel beach | 1.6 | 1.5 | 54.1 | 2.3 |
| Gravel flat | 2.7 | 2.5 | 16.1 | 0.7 |
| Man-made | 48.7 | 44.7 | 222.8 | 9.6 |
| Mud flat | 1.8 | 1.6 | 30.5 | 1.3 |
| Rock cliff | 11.1 | 10.2 | 596.3 | 25.8 |
| Rock platform | 1.6 | 1.5 | 83.5 | 3.6 |
| Rock with gravel beach | 8.3 | 7.6 | 298.6 | 12.9 |
| Rock, sand and gravel beach | 8.5 | 7.8 | 328.3 | 14.2 |
| Rock with sand beach | 0.0 | 0.0 | 42.8 | 1.8 |
| Sand and gravel beach | 9.9 | 9.1 | 133.9 | 5.8 |
| Sand and gravel flat | 12.2 | 11.2 | 186.5 | 8.1 |
| Sand beach | 0.4 | 0.4 | 39.4 | 1.7 |
| Sand flat | 1.1 | 1.0 | 103.7 | 4.5 |
| Total | 108.9 | 100.0 | 2,315.0 | 100.0 |




Stantec

SCALE: 1:1,150,000

0 10 20 30 40 km

ALL LOCATIONS APPROXIMATE

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Westridge Marine Terminal
Town / City
Marine Vessel Inbound Shipping Lane
Marine Vessel Outbound Shipping Lane
International Border
Canadian 12 Nautical Mile Territorial Boundary
Bathymetry
Watercourse
Existing Trans Mountain Pipeline
Trans Mountain Expansion Proposed Pipeline Corridor

Waterbody
Provincial Park
Traffic Separation Scheme
Land of British Columbia
Land of Washington State
Marine Fish and Fish Habitat LSA (Transportation)
Marine RSA (Transportation)

**Shore Type**
Channel
Gravel Beach
Gravel Flat
Man-made
Mud Flat
Rock Cliff
Rock Platform
Rock with Gravel Beach
Rock with Sand Beach
Rock, Sand and Gravel Beach
Sand Beach
Sand Flat
Sand and Gravel Beach
Sand and Gravel Flat
Estuary, Marsh or Lagoon

Projection: UTM Zone 10N; Marine Vessel Inbound Shipping Lane: Moffatt & Nichol, 2013a; Marine Vessel Outbound Shipping Lane: Moffatt & Nichol, 2013b; International Border: British Columbia Ministry of Energy and Mines, 2013; Canadian 12 Nautical Mile Territorial Boundary and Traffic Separation Scheme: Canadian Hydrographic Service, 2013; 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; Provincial Park: BC MFLNRO, 2008a; Land of British Columbia: National Topographic Data Base, 2007; Land of Washington State: Washington State Department of Ecology, 1994; BC Shore Types: BC MFLNRO, 2005; Washington Shore Types: Washington State DNR, 2006.

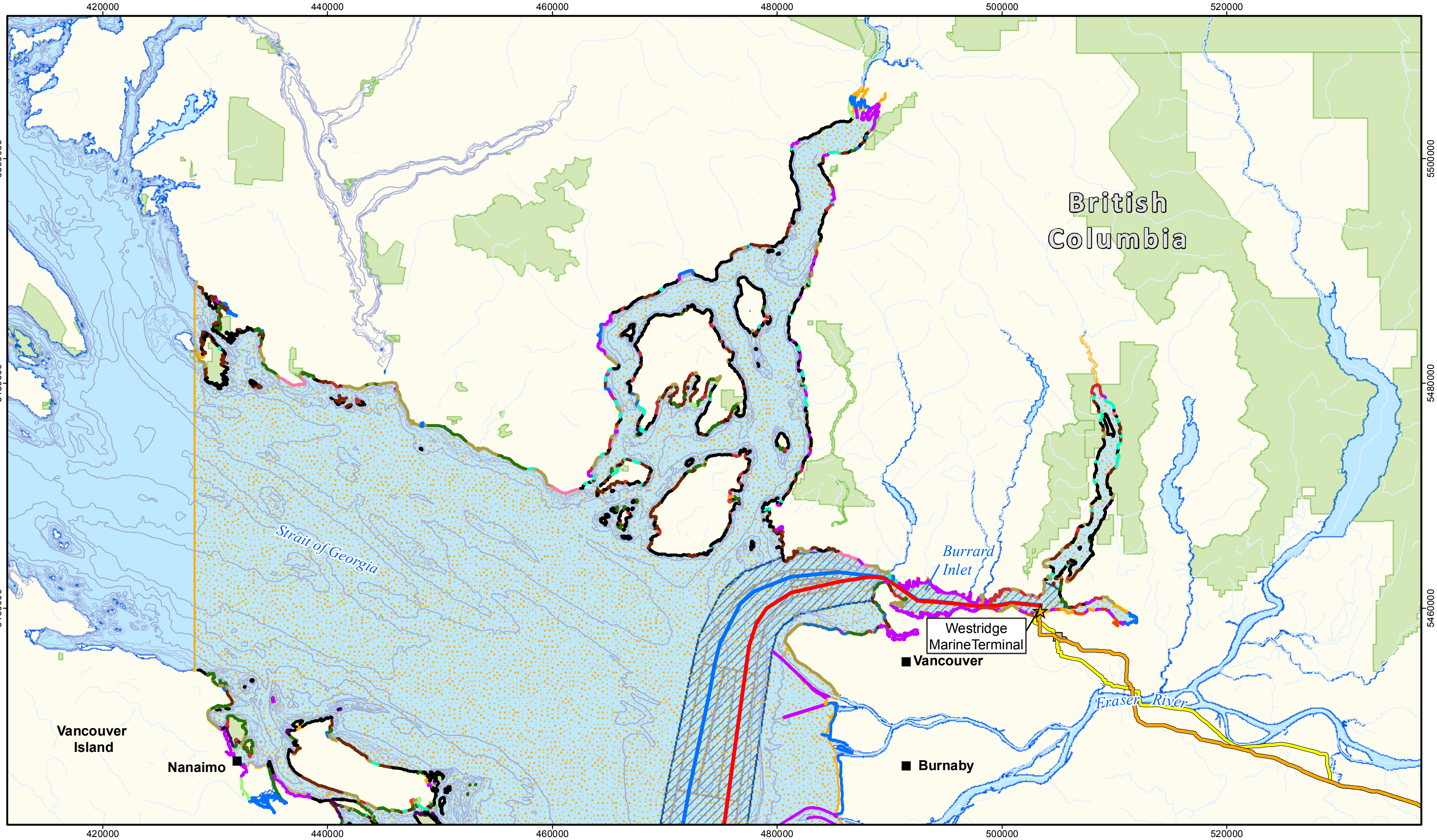
*Although there is no reason to believe that there are any errors associated with the data used to generate this product or in the product itself, users of these data are advised that errors in the data may be present.*

TRANS MOUNTAIN

**FIGURE: 4.2-19**

**DISTRIBUTION OF SHORE TYPES IN THE MARINE RSA OVERVIEW**

**TRANS MOUNTAIN EXPANSION PROJECT**

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| DRAWN SS | CHECKED SD | DESIGN SD |

Westridge Marine Terminal
Town / City
Marine Vessel Inbound Shipping Lane
Marine Vessel Outbound Shipping Lane
Bathymetry
Watercourse
Existing Trans Mountain Pipeline
Trans Mountain Expansion Proposed Pipeline Corridor
Waterbody
Provincial Park
Traffic Separation Scheme
Land of British Columbia
Land of Washington State
Marine RSA (Transportation)
Marine Fish and Fish Habitat LSA (Transportation)

**Shore Type**
Channel
Gravel Beach
Gravel Flat
Man-made
Mud Flat
Rock Cliff
Rock Platform
Rock with Gravel Beach
Rock with Sand Beach
Rock, Sand and Gravel Beach
Sand Beach
Sand Flat
Sand and Gravel Beach
Sand and Gravel Flat
Estuary, Marsh or Lagoon

Projection: UTM Zone 10N; Marine Vessel Inbound Shipping Lane: Moffatt & Nichol, 2013a; Marine Vessel Outbound Shipping Lane: Moffatt & Nichol, 2013b; International Border: British Columbia Ministry of Energy and Mines, 2013; Canadian 12 Nautical Mile Territorial Boundary and Traffic Separation Scheme: Canadian Hydrographic Service, 2013; 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; Provincial Park: BC MFLNRO, 2008a; Land of British Columbia: National Topographic Data Base, 2007; Land of Washington State: Washington State Department of Ecology, 1994; BC Shore Types: BC MFLNRO, 2005; Washington Shore Types: Washington State DNR, 2006.

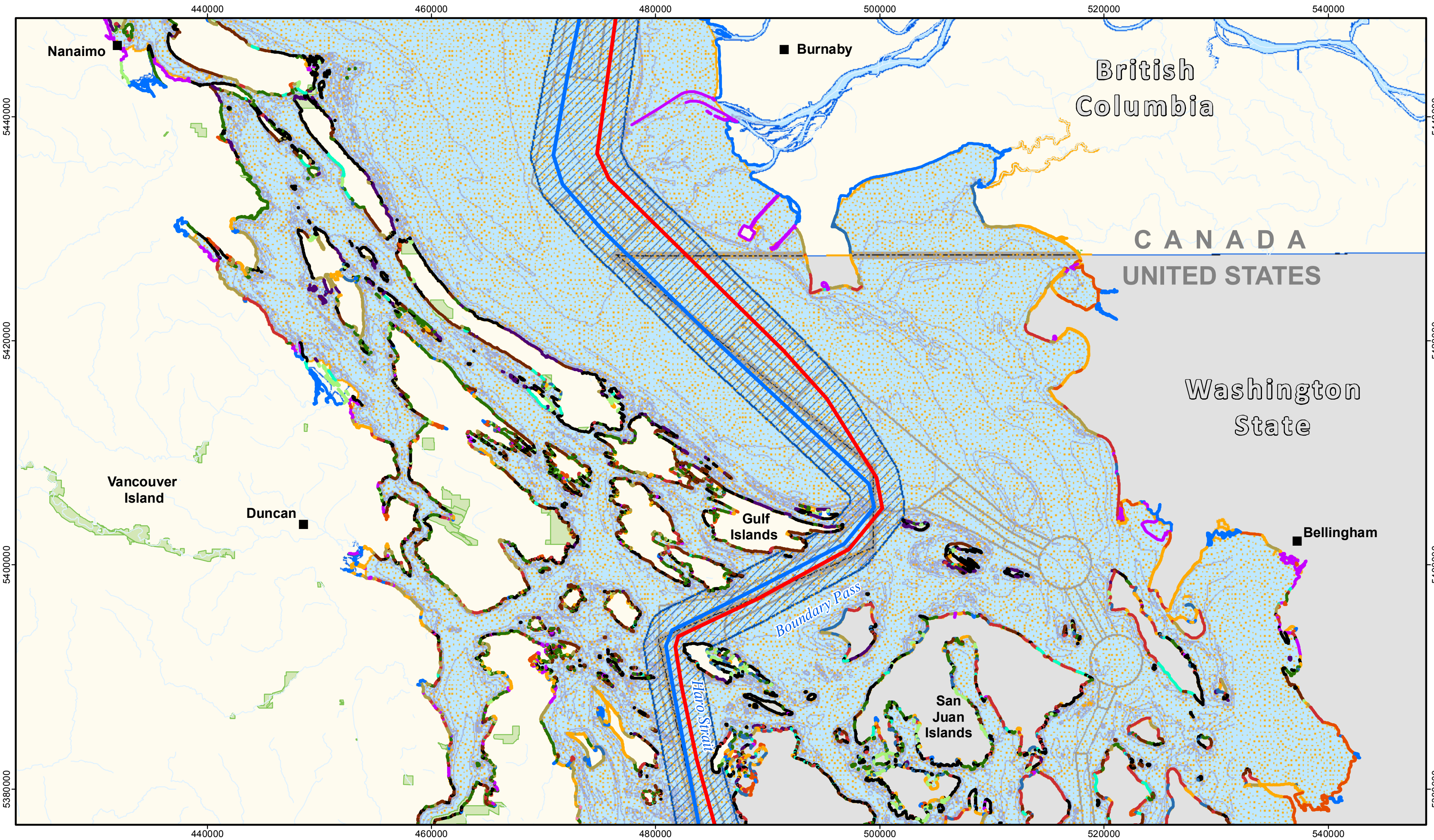


TRANS MOUNTAIN

**FIGURE: 4.2-19a**

**DISTRIBUTION OF SHORE TYPES IN THE MARINE RSA INSET 1**

**TRANS MOUNTAIN EXPANSION PROJECT**

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| DRAWN SS | CHECKED SD | DESIGN SD |

- Westridge Marine Terminal
- Town / City
- Marine Vessel Inbound Shipping Lane
- Marine Vessel Outbound Shipping Lane
- International Border
- Bathymetry
- Watercourse
- Waterbody
- Provincial Park
- Traffic Separation Scheme
- Land of British Columbia
- Land of Washington State
- Marine RSA (Transportation)
- Marine Fish and Fish Habitat LSA (Transportation)

**Shore Type**

- Channel
- Gravel Beach
- Gravel Flat
- Man-made
- Mud Flat
- Rock Cliff
- Rock Platform
- Rock with Gravel Beach
- Rock with Sand Beach
- Rock, Sand and Gravel Beach
- Sand Beach
- Sand Flat
- Sand and Gravel Beach
- Sand and Gravel Flat
- Estuary, Marsh or Lagoon

Projection: UTM Zone 10N; Marine Vessel Inbound Shipping Lane: Moffatt & Nichol, 2013a; Marine Vessel Outbound Shipping Lane: Moffatt & Nichol, 2013b; International Border: British Columbia Ministry of Energy and Mines, 2013; Canadian 12 Nautical Mile Territorial Boundary and Traffic Separation Scheme: Canadian Hydrographic Service, 2013; 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; Provincial Park: BC MFLNRO, 2008a; Land of British Columbia: National Topographic Data Base, 2007; Land of Washington State: Washington State Department of Ecology, 1994; BC Shore Types: BC MFLNRO, 2005; Washington Shore Types: Washington State DNR, 2006.



TRANS MOUNTAIN

**FIGURE: 4.2-19b**

**DISTRIBUTION OF SHORE TYPES IN THE MARINE RSA INSET 2**

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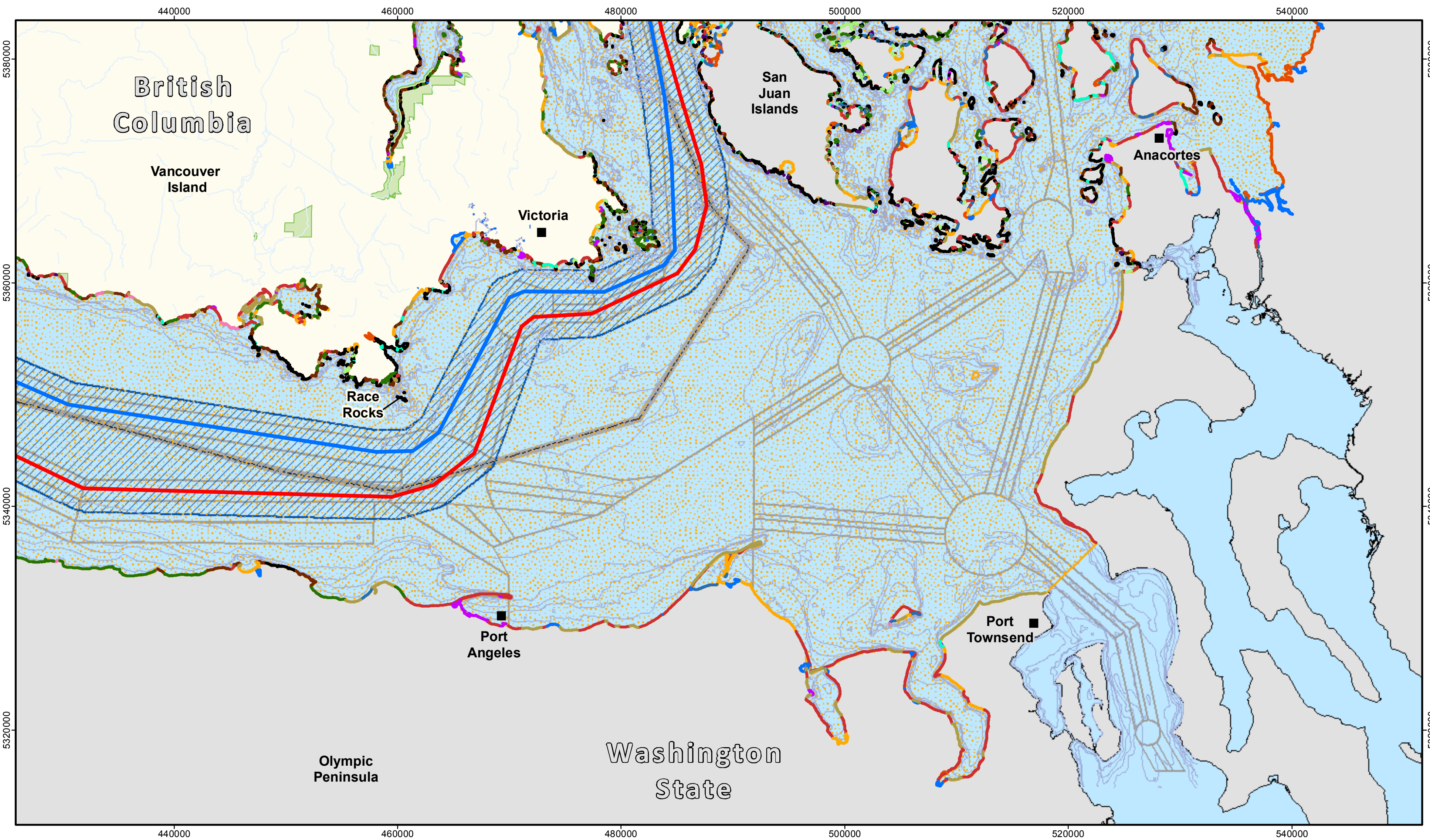


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Westridge Marine Terminal
Town / City
Marine Vessel Inbound Shipping Lane
Marine Vessel Outbound Shipping Lane
International Border
Bathymetry
Watercourse
Waterbody

Provincial Park
Traffic Separation Scheme
Land of British Columbia
Land of Washington State
Marine RSA (Transportation)
Marine Fish and Fish Habitat LSA (Transportation)

**Shore Type**
Channel
Gravel Beach
Gravel Flat
Man-made
Mud Flat
Rock Cliff
Rock Platform
Rock with Gravel Beach
Rock with Sand Beach
Rock, Sand and Gravel Beach
Sand Beach
Sand Flat
Sand and Gravel Beach
Sand and Gravel Flat
Estuary, Marsh or Lagoon

Projection: UTM Zone 10N; Marine Vessel Inbound Shipping Lane: Moffatt & Nichol, 2013a; Marine Vessel Outbound Shipping Lane: Moffatt & Nichol, 2013b; International Border: British Columbia Ministry of Energy and Mines, 2013; Canadian 12 Nautical Mile Territorial Boundary and Traffic Separation Scheme: Canadian Hydrographic Service, 2013; 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; Provincial Park: BC MFLNRO, 2008a; Land of British Columbia: National Topographic Data Base, 2007; Land of Washington State: Washington State Department of Ecology, 1994; BC Shore Types: BC MFLNRO, 2005; Washington Shore Types: Washington State DNR, 2006.

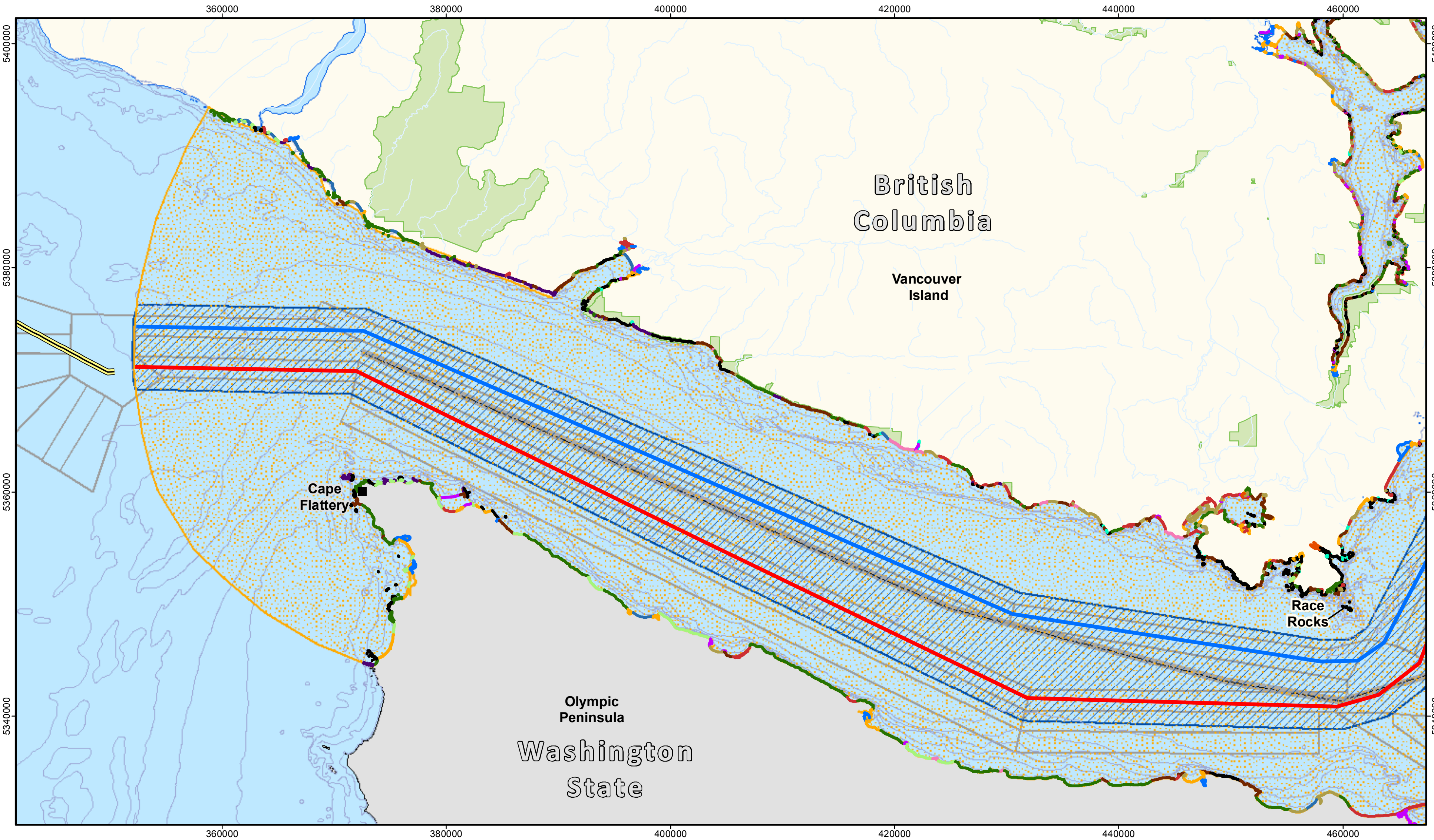


TRANS MOUNTAIN

**FIGURE: 4.2-19c**

**DISTRIBUTION OF SHORE TYPES IN THE MARINE RSA INSET 3**

**TRANS MOUNTAIN EXPANSION PROJECT**

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- Westridge Marine Terminal
- Town / City
- Marine Vessel Inbound Shipping Lane
- Marine Vessel Outbound Shipping Lane
- International Border
- Canadian 12 Nautical Mile Territorial Boundary
- Bathymetry
- Watercourse
- Waterbody
- Provincial Park
- Traffic Separation Scheme
- Land of British Columbia
- Land of Washington State
- Marine RSA (Transportation)
- Marine Fish and Fish Habitat LSA (Transportation)

**Shore Type**

- Channel
- Gravel Beach
- Gravel Flat
- Man-made
- Mud Flat
- Rock Cliff
- Rock Platform
- Rock with Gravel Beach
- Rock with Sand Beach
- Rock, Sand and Gravel Beach
- Sand Beach
- Sand Flat
- Sand and Gravel Beach
- Sand and Gravel Flat
- Estuary, Marsh or Lagoon

Projection: UTM Zone 10N; Marine Vessel Inbound Shipping Lane: Moffatt & Nichol, 2013a; Marine Vessel Outbound Shipping Lane: Moffatt & Nichol, 2013b; International Border: British Columbia Ministry of Energy and Mines, 2013; Canadian 12 Nautical Mile Territorial Boundary and Traffic Separation Scheme: Canadian Hydrographic Service, 2013; 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; Provincial Park: BC MFLNRO, 2008a; Land of British Columbia: National Topographic Data Base, 2007; Land of Washington State: Washington State Department of Ecology, 1994; BC Shore Types: BC MFLNRO, 2005; Washington Shore Types: Washington State DNR, 2006.



TRANS MOUNTAIN

**FIGURE: 4.2-19d**

**DISTRIBUTION OF SHORE TYPES IN THE MARINE RSA INSET 4**

**TRANS MOUNTAIN EXPANSION PROJECT**

#### 4.2.6.5.2 Pacific Herring

Pacific herring are small pelagic fish found along the West Coast of North America from Baja California to the Beaufort Sea, along the coast of Asia from the Yellow Sea to the Bering Sea and along the Eurasian Arctic coast from the Bering Sea to northeast Europe (DFO 2013f, Laakkonen *et al.* 2013). They have a maximum weight of about 550 g and reach a maximum length of about 33 cm, and a life span of over 15 years (DFO 2013f, Ware 1985). Herring are targeted in commercial, recreational and Aboriginal fisheries in BC. They are also considered to be an ecologically important species as they are important forage fish for many species of fish, birds, and marine mammals, including Pacific salmon and killer whales (Gustafson *et al.* 2006, Livingston 1993, Saulitis *et al.* 2000).

Adult Pacific herring form large schools in the water column from the surface to depths of 400 m (National Oceanic and Atmospheric Administration [NOAA] 2012). In southern BC, most Pacific herring populations migrate offshore to feeding grounds located off southwest Vancouver Island during the summer months and begin migrating to inshore spawning areas through Juan de Fuca Strait in November and December (DFO 2013f, Taylor 1964). Small populations in the Strait of Georgia are known to be non-migratory and reside year-round in the inside waters near their spawning grounds (Taylor 1964, Therriault *et al.* 2009). Upon reaching deeper channels near their spawning sites, Pacific herring will school for several weeks before transitioning to sheltered, shallower areas such as bays or estuaries where they spawn in mass aggregations (DFO 2013f).

In the Strait of Georgia, Pacific herring spawn in late winter between January and June, with the peak spawning period occurring in March (DFO 2013f, Hart 1973, Hay 1985, Hay and McCarter 2012). Spawning occurs along the shoreline in the intertidal to shallow subtidal zones between high tide and depths of 11 m (Hart 1973, Rooper *et al.* 1999). The eggs are very sticky and once deposited, adhere in large masses to a variety of substrates, including rocks, pilings, debris and marine vegetation (Hart 1973, Taylor 1964). The dominant substrates are eelgrass (*Zostera marina*) and surfgrass (*Phyllospadix scoulerii*) in sheltered bays and along sandy beaches, rockweed (*Fucus gardneri*) along rocky shores, and kelp (*Laminaria* sp.) in shallow subtidal areas (Hart 1973, Taylor 1964).

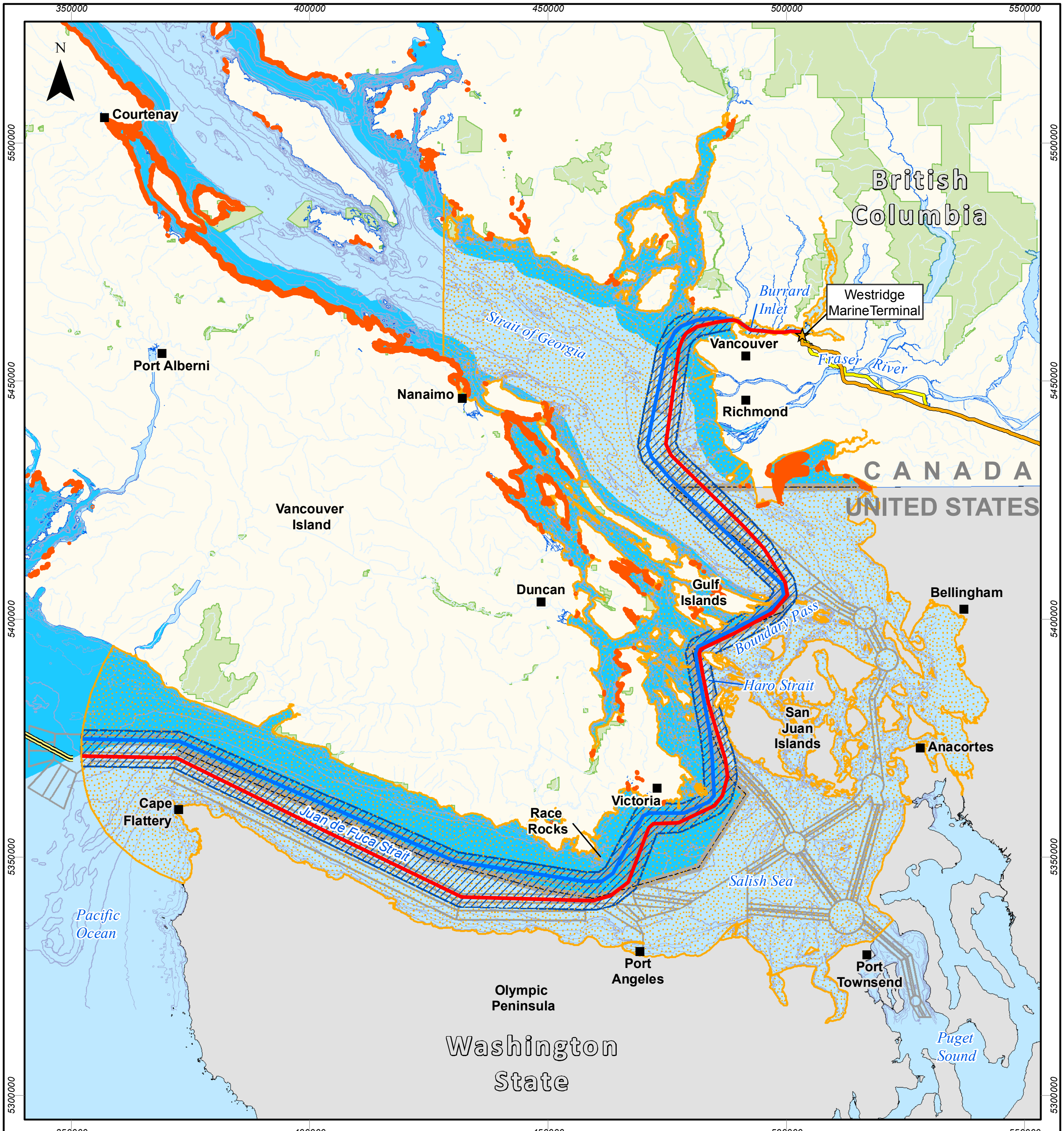
Pacific herring will spawn every year after reaching maturity, and each female may deposit as many as 20,000 eggs (Hay 1985, DFO 2013f). However, the rate of spawn mortality is high with estimates ranging from 56 to 100 per cent depending on the spawning location (Rooper *et al.* 1999, Taylor 1964). Major causes of spawn mortality are predation by birds and the degree of exposure to wave action and to the air (Taylor 1964). The mortality rate attributed to predation by birds is estimated to be 30 to 55 per cent (Taylor 1964).

When spawning is followed by poor weather and increased wave action, marine vegetation can become dislodged or the eggs themselves can break loose and wash up on shore (Hart 1973). Studies on spawn mortality due to wave action during storm events have estimated resulting mortality rates of 26 to 74 per cent (Hart and Tester 1934, Hay and Miller 1982, Rooper 1996). Rooper *et al.* (1999) studied a variety of habitat factors controlling egg loss in Prince William Sound, Alaska including depth of spawn, wave exposure, substrate type, and vegetation type, among others. They found that the depth of spawn was the primary factor determining egg loss. Analysis of wave exposure at spawning sites found that egg loss was consistently higher in protected areas than in exposed areas; however, the factors driving this trend were not known. Substrate type and vegetation type were not found to be major contributors in rates of egg loss. Taylor (1955) notes that spawn survival is highest near zero tide level and in locations partially protected from wave action, and survival is reduced in both exposed and well-protected localities. This suggests that a moderate amount of wave action may improve hatching success (Gustafson *et al.* 2006). According to Hay and Miller (1982), most of the Pacific herring spawn in BC waters is deposited in the subtidal zone and, therefore, is relatively protected from wave action.

Although there is inter-annual variation in specific spawning locations, general spawning areas are relatively consistent from one year to the next (Hay 1985), and Pacific herring spawn over large areas of the Strait of Georgia. Spawning areas and DFO Important Areas for Pacific herring in the Marine RSA are shown in Figure 4.2.20. DFO Important Areas are considered relevant to a species in terms of uniqueness, aggregation and/or fitness (DFO 2013f). According to Therriault *et.al.* (2009) and Hay and McCarter (2012), the most important spawning areas are located in Boundary Bay and along the east side of Vancouver Island, especially near Denman Island. Since the 1980s, the spawning distribution of Pacific herring in the Strait of Georgia has shifted to the northwest, with reduced concentrations of spawning activity in the south and east (Therriault *et al.* 2009). The causes of this shift are unknown; however, they may be related to changing climate conditions in the Salish Sea (Therriault *et al.* 2009).

In BC waters, herring eggs incubate for about three weeks before hatching (Hay and Fulton 1983). After hatching, larvae will feed and develop in sheltered nearshore waters near the spawning grounds for two to three months (NOAA 2012). Juveniles form schools in shallow waters where they feed until the fall, when they migrate to deep waters where they spend two to three years before they begin returning to inshore waters as adults to spawn (NOAA 2012). Once spawning is complete, adult Pacific herring will return to offshore feeding areas (NOAA 2012). The diet of Pacific herring changes as they develop. Young herring feed primarily on small crustaceans, decapod larvae, mollusk larvae, and other zooplankton and phytoplankton. Adults typically prey on small fish and crustaceans (NOAA 2012).

Since 1993, Pacific herring stocks in the Strait of Georgia have been managed by DFO as the Strait of Georgia Stock Assessment Region, one of five such assessment regions in BC (Martell *et al.* 2011). DFO regularly assesses the status of these stocks to inform management of the fishery. In the Strait of Georgia, Pacific herring abundance increased through the 1980s, reaching a historical high in 2003, then declined between 2004 and 2008 before increasing again in 2009 and stabilizing in 2010 (Cleary *et al.* 2009, Cleary and Schweigert 2011, Johannesen and McCarter 2010, Schweigert and Haist 2007, Therriault *et al.* 2009). Changes in herring abundance are largely driven by variation in juvenile survival, which is influenced by a number of factors including ocean conditions (*e.g.,* temperature and salinity), prey availability, predation pressure and anthropogenic stressors (Johannesen and McCarter 2010).




Stantec

SCALE: 1:1,150,000

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ALL LOCATIONS APPROXIMATE

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| MAP NUMBER | | PAGE |
|---|---|---|
| 10494_EA_TRANS_MAR_04_02_20 | | SHEET 1 OF 1 |
| DATE: Dec 2013 | REF.: 7894 | REVISION: 0 |
| SCALE: 1:1,150,000 | PAGE SIZE: 8.5x11 | DISCIPLINE: SD |
| DRAWN: SS | CHECKED: DP | DESIGN: SD |

- Westridge Marine Terminal
- Town / City
- Marine Vessel Inbound Shipping Lane
- Marine Vessel Outbound Shipping Lane
- International Border
- Canadian 12 Nautical Mile Territorial Boundary
- Bathymetry
- Watercourse
- Existing Trans Mountain Pipeline
- Trans Mountain Expansion Proposed Pipeline Corridor
- Waterbody
- Provincial Park
- Traffic Separation Scheme
- Land of British Columbia
- Land of Washington State
- Marine Fish and Fish Habitat LSA (Transportation)
- Marine RSA (Transportation)
- Pacific Herring Spawning Areas
- DFO Important Areas for Pacific Herring

Projection: UTM Zone 10N; Marine Vessel Inbound Shipping Lane: Moffatt & Nichol, 2013a; Marine Vessel Outbound Shipping Lane: Moffatt & Nichol, 2013b; International Border: British Columbia Ministry of Energy and Mines, 2013; Canadian 12 Nautical Mile Territorial Boundary and Traffic Separation Scheme: Canadian Hydrographic Service, 2013; 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; Provincial Park: BC MFLNRO, 2008a; Land of British Columbia: National Topographic Data Base, 2007; Land of Washington State: Washington State Department of Ecology, 1994; Pacific Herring Spawning Areas: Hay and McCarter, 2012; DFO Important Areas for Pacific Herring: DFO 2012a.

*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: 4.2-20**

**PACIFIC HERRING SPAWNING AREAS AND DFO IMPORTANT AREAS FOR PACIFIC HERRING IN THE MARINE RSA**

**TRANS MOUNTAIN EXPANSION PROJECT**

#### 4.2.6.5.3 Pacific Salmon

Pacific salmon belong to the family Salmonidae, which includes whitefishes, graylings, salmon, trout and char. There are five species of Pacific salmon in Canada belonging to the genus *Oncorhynchus,* including pink (*O. gorbuscha*), chum (*O. keta*), sockeye (*O. nerka*), coho (*O. kisutch*) and Chinook (*O. tshawytscha*). Steelhead trout (*O. mykiss*) are also closely related to Pacific salmon. Pacific salmon are considered to be an ecologically important species as they support marine, estuarine, freshwater and terrestrial food webs by providing nutrients to the ecosystem during their migration from the Pacific Ocean to rivers and streams to spawn (DFO 2013b, Hart 1973). They also have great socio-economic importance in BC and are targeted in commercial, recreational and Aboriginal fisheries.

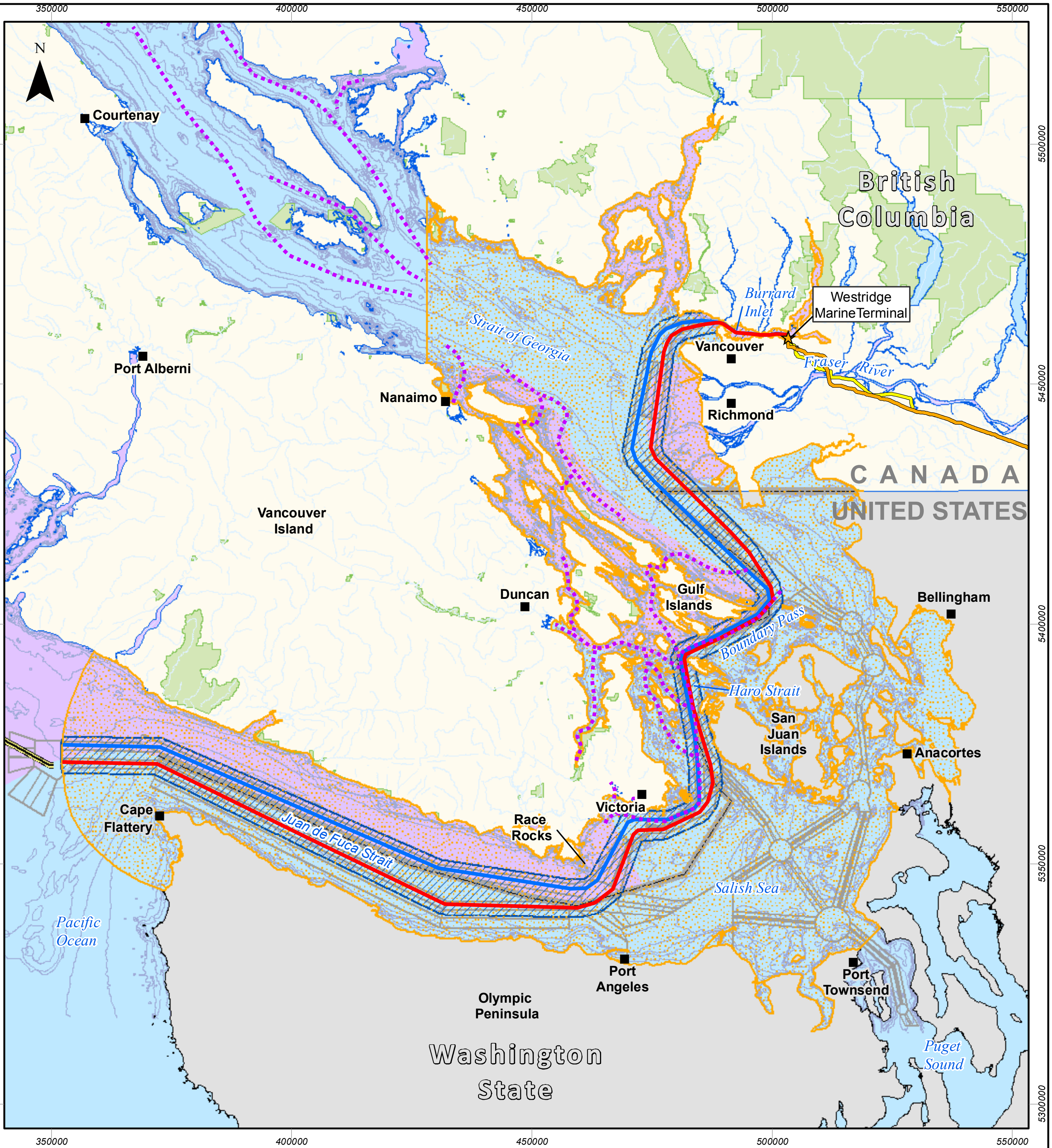
The physical characteristics, life histories, spawning habits, distribution and abundance of Pacific salmon vary from species to species. An overview of this information is provided here. More detailed information about each species of Pacific salmon is presented in the Marine Resources – Marine Transportation Technical Report (Volume 8B, TR 8B-1).

The average adult weights of Pacific salmon range from 1 to 3 kg for pink salmon and up to 6 to 18 kg for Chinook salmon (DFO 2013b). Chinook salmon are known to reach very large sizes. The largest recorded Chinook salmon weighed 57.27 kg (DFO 2013b). The life span of Pacific salmon ranges from 2 years for pink salmon to 7 years for sockeye and Chinook salmon (DFO 2001, 2013b).

Pacific salmon are anadromous, which means that they spawn in fresh water yet spend the majority of their lives in marine waters where they feed until maturity (DFO 2013b). Depending on the species, salmon will spend one to seven years in marine waters before returning to their natal streams to spawn from spring to fall (DFO 2001, 2013b). Spawning female salmon seek out stream beds with gravel substrate to deposit their eggs. The eggs hatch into alevins in mid-winter and emerge as fry in spring, and they remain in freshwater streams and lakes for periods ranging from one week to two years, depending on the species (DFO 2013b). All Pacific salmon are semelparous, meaning that individual fish spawn once in their lifetime and then die. In the ocean, Pacific salmon feed primarily on plankton and crustaceans such as tiny shrimp, while Chinook and coho salmon also eat smaller fish, such as herring (DFO 2013b).

The range of Pacific salmon includes the North Pacific Ocean, Bering Strait, southwestern Beaufort Sea and surrounding freshwater rivers and streams (DFO 2013b). Pacific salmon occur in an estimated 1,300 to 1,500 rivers and streams in BC and the Yukon (DFO 2013b). The most important rivers for Pacific salmon in BC include the Skeena and Nass rivers in the north and the Fraser River in the south, which account for 75 per cent of the salmon population in the province (DFO 2013b). The Fraser River system, which drains into the Marine RSA, is considered the largest single salmon production system in the world (Northcote and Larkin 1989) and accounts for, on average, about 50 per cent of salmon production in BC (Henderson and Graham 1998). The locations of salmon migration routes and DFO Important Areas for Pacific salmon in the Marine RSA are shown in Figure 4.2.21 (Jamieson and Levesque 2012a,b). DFO Important Areas are considered relevant to a species in terms of uniqueness, aggregation and/or fitness (DFO 2013b).

Pacific salmon are sensitive to changes in both marine and freshwater ecosystems (DFO 2013b). Fishing pressure and loss of habitat from human activities such as logging and agriculture are the key threats to Pacific salmon populations (COSEWIC 2002, 2003a,b, 2006; DFO 2001, 2013b). There are four populations of Pacific salmon that have been designated as Species of Conservation Concern by COSEWIC, including one coho population, one Chinook population, and two sockeye populations (see Table 4.2.6.1). No Pacific salmon populations are currently listed under *SARA*. DFO's 2013 salmon outlook identified a number of Pacific salmon stocks of conservation concern in southern BC, including the West Coast of Vancouver Island Chinook stock, the south coast coho stock, Fraser River Chinook stocks, the lower Strait of Georgia Chinook stock and the North Vancouver Island/Johnstone Strait Chinook stock (DFO 2013b).




Stantec

SCALE: 1:1,150,000

0 10 20 30 40 km

ALL LOCATIONS APPROXIMATE

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| MAP NUMBER | | PAGE |
|---|---|---|
| 10494_EA_TRANS_MAR_04_02_21 | | SHEET 1 OF 1 |
| DATE Nov 2013 | REF. 7894 | REVISION 0 |
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| DRAWN SS | CHECKED DP | DESIGN SD |

- Westridge Marine Terminal
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- Marine Fish and Fish Habitat LSA (Transportation)
- Marine RSA (Transportation)
- DFO Important Areas for Pacific Salmon
- Pacific Salmon Migration Routes

Projection: UTM Zone 10N; Marine Vessel Inbound Shipping Lane: Moffatt & Nichol, 2013a; Marine Vessel Outbound Shipping Lane: Moffatt & Nichol, 2013b; International Border: British Columbia Ministry of Energy and Mines, 2013; Canadian 12 Nautical Mile Territorial Boundary and Traffic Separation Scheme: Canadian Hydrographic Service, 2013; 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; Provincial Park: BC MFLNRO, 2008a; Land of British Columbia: National Topographic Data Base, 2007; Land of Washington State: Washington State Department of Ecology, 1994; DFO Important Areas for Pacific Salmon: DFO 2012b; Pacific Salmon Migration Routes: DFO 2012c.

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TRANS MOUNTAIN

FIGURE: 4.2-21

PACIFIC SALMON MIGRATION ROUTES AND DFO IMPORTANT AREAS FOR PACIFIC SALMON IN THE MARINE RSA

TRANS MOUNTAIN EXPANSION PROJECT

### *4.2.6.6 Aboriginal Traditional Knowledge*

Marine fish, invertebrates and algae have been traditionally harvested by coastal Aboriginal communities throughout southern BC, including Burrard Inlet, Strait of Georgia, Gulf Islands and Juan de Fuca Strait. Pacific salmon are of particular importance to the coastal Aboriginal communities for sustenance as well as for social, economic and ceremonial purposes. Sockeye, pink, chum, coho and Chinook salmon can all be found within the Lower Fraser River as well as in marine waters throughout the area. The Fraser River system is used by over 100 Aboriginal communities, including those along Juan de Fuca and Johnstone straits (Canadian Environmental Assessment Agency 2006). The Fraser Canyon, located outside the Marine RSA, is an area where Pacific salmon are most abundant, and conditions for preparing the meat (*i.e.*, wind-drying) are ideal (Carlson 2001).

Available literature indicates that Aboriginal people traditionally harvested at least 71 animal species on the southern coast of BC (Burrard Inlet Environmental Action Program [BIEAP] 2011, 2012; Gardner 2009). Important fish species include: salmon; eulachon; sturgeon; lingcod; Pacific cod; halibut; skate; black cod; dogfish; shiners; herring; flounder; and trout (Esquimalt Nation 2010a, Hul'qumi'num Treaty Group 2005). Important invertebrate species include: barnacles; mussels; butter, horse, littleneck, manila and cockle clams; geoduck; northern abalone; giant red chiton; oysters; scallops; red and green sea urchin; sea cucumber; Dungeness and red rock crab; prawns; and octopus (Esquimalt Nation 2010a, Hul'qumi'num Treaty Group 2005). Numerous species of seaweed have also been traditionally harvested by Aboriginal people, including: kelp; rockweed; sea lettuce; and other green, brown and red algae species. Kelp and eelgrass beds are especially important harvesting areas as they serve as a key habitat for other major food species (Esquimalt Nation 2010b).

### *4.2.6.7 US Waters*

The US portion of the Marine RSA includes southern portions of the Strait of Georgia and Juan de Fuca Strait along the coast of Washington.

#### 4.2.6.7.1 Intertidal Habitat

Intertidal habitat in the US and Canadian portions of the Marine RSA has very similar biophysical characteristics. The Washington State Department of Ecology adopted the BC Biophysical Shore-Zone Mapping System and has mapped the various shore types along the state's shoreline (Washington State Department of Ecology 2006). The distribution of shore types in the US portion of the Marine RSA is shown in Figure 4.2.19. The length and relative abundance of shore types in the US portion of the Marine LSA and Marine RSA are shown in Table 4.2.6.3. A discussion of shore types in the Canadian portion of the Marine RSA is provided in Section 4.2.6.5.

**TABLE 4.2.6.3**

**LENGTH AND RELATIVE ABUNDANCE OF SHORE TYPES IN THE US PORTION OF THE MARINE LSA AND MARINE RSA**

| Shore Type | Marine LSA - Length (km) | Marine LSA - % Total Length | Marine RSA - Length (km) | Marine RSA - % Total Length |
|---|---|---|---|---|
| Channel | 0.0 | 0.0 | 0.2 | 0.0 |
| Estuary, marsh or lagoon | 0.0 | 0.0 | 104.9 | 6.8 |
| Gravel beach | 0.2 | 1.8 | 29.7 | 1.9 |
| Gravel flat | 0.0 | 0.0 | 2.7 | 0.2 |

**TABLE 4.2.6.3**

**LENGTH AND RELATIVE ABUNDANCE OF SHORE TYPES IN THE US PORTION OF THE MARINE LSA AND MARINE RSA (continued)**

| Shore Type | Marine LSA - Length (km) | Marine LSA - % Total Length | Marine RSA - Length (km) | Marine RSA - % Total Length |
|---|---|---|---|---|
| Man-made | 0.0 | 0.0 | 86.8 | 5.6 |
| Mud flat | 0.0 | 0.0 | 76.7 | 5.0 |
| Rock cliff | 8.7 | 88.8 | 312.2 | 20.2 |
| Rock platform | 0.0 | 0.0 | 37.9 | 2.5 |
| Rock with gravel beach | 0.0 | 0.0 | 77.7 | 5.0 |
| Rock, sand and gravel beach | 0.6 | 5.8 | 143.3 | 9.3 |
| Rock with sand beach | 0.0 | 0.0 | 59.2 | 3.8 |
| Sand and gravel beach | 0.2 | 1.7 | 263.9 | 17.1 |
| Sand and gravel flat | 0.0 | 0.0 | 112.1 | 7.3 |
| Sand beach | 0.2 | 2.0 | 80.9 | 5.2 |
| Sand flat | 0.0 | 0.0 | 157.7 | 10.2 |
| Total | 9.8 | 100.0 | 1,545.9 | 100.0 |

A total of 15 different shore types have been identified within the Marine RSA in the US. The total length of shoreline in the US portion of the Marine RSA is approximately 1,546 km. "Rock cliff" is the most common shore type in the Marine RSA covering approximately 312 km and 20.2 per cent of the shoreline (Washington State Department of Ecology 2006). "Sand and gravel beach" and "sand flat" shore types are the second and third most common covering 17.1 per cent and 10.2 per cent of the shoreline, respectively (Washington State Department of Ecology 2006).

The total length of shoreline in the US portion of the Marine LSA is about 10 km, along which a total of five different shore types have been identified (Washington State Department of Ecology 2006). "Rock cliff" is by far the most common shore type in the Marine LSA covering approximately 9 km or 90 per cent of the total shoreline (Washington State Department of Ecology 2006).

#### 4.2.6.7.2 Pacific Herring

The range of Pacific herring populations in the Marine RSA includes both Canadian and US waters, and the border has no biological significance. Pacific herring populations in the Marine RSA are managed by the US National Marine Fisheries Service's Georgia Basin Pacific herring distinct population segment (DPS), which extends from the southern end of Puget Sound proper to the northern end of the Strait of Georgia near Discovery Passage in Canadian waters and westward to Cape Flattery (Gustafson *et al.* 2006, Stout *et al.* 2001). As a whole, the Georgia Basin Pacific DPS demonstrated a trend of increasing abundance between 1990 and 2004 (Gustafson *et al.* 2006). Herring spawning areas within the US portion of the Marine RSA include: Discovery Bay and Dungeness Bay in Juan de Fuca Strait; Semiahmoo Bay; Cherry Point; Samish-Portage Bay; Fidalgo Bay and the northwest San Juan Islands; and the interior San Juan Islands in North Puget Sound/southern Strait of Georgia (Gustafson *et al.* 2006, Stout *et al.* 2001).

In 2004, the US stocks in the Marine RSA, including the northwest San Juan Islands, Cherry Point, and Discovery Bay stocks, were in severe decline. The Fidalgo, Dungeness and Semiahmoo Bays and Interior San Juan Islands stocks had experienced moderate declines, while the Samish-Portage Bay stock was considered healthy (Gustafson *et al.* 2006, Stout *et al.* 2001). In the 2008 stock assessment (the most recent assessment conducted), spawner abundance in all stocks in the US portion of the Marine RSA remained largely unchanged from 2004. The Cherry Point, Discovery Bay and Dungeness Bay stocks were reported to be in critical condition. The Fidalgo Bay and Interior San Juan Island stocks were reported to be depressed. The Semiahmoo Bay stock was reported to be moderately healthy, and the Samish-Portage Bay stock was considered to be healthy (Stick and Lindquist 2009). The exception was the Northwest San Juan Islands stock, which was reported to have disappeared following five years of no observable spawn (Stick and Lindquist 2009).

#### 4.2.6.7.3 Pacific Salmon

While Pacific salmon stocks spawn in rivers and streams on either side of the Canada-US border, they may use all marine waters in the Marine RSA as habitat for migration and foraging. Chinook and coho salmon stocks that spawn in the US portion of the Marine RSA are managed by the Pacific Fishery Management Council as part of the Washington coastal Chinook/coho stocks and the Puget Sound Chinook/coho stocks. The Washington coastal Chinook/coho stocks include Chinook and coho populations from coastal streams north of the Columbia River through the western Juan de Fuca Strait. The Puget Sound Chinook/coho stocks include Chinook and coho populations from tributaries in Puget Sound through the eastern Juan de Fuca Strait (Pacific Fishery Management Council 2012).

Many Pacific salmon stocks along the US West Coast have declined substantially and are now at a fraction of their historical abundance (National Marine Fisheries Service [NMFS] 2011). Contributing factors to these declines include: overfishing; loss of freshwater and estuarine habitat; hydropower development; and poor ocean conditions and hatchery practices (NMFS 2011). In the US, a total of 28 salmon and steelhead stocks along the West Coast have been listed under the Federal *Endangered Species Act*, including the Puget Sound Chinook salmon DPS and the Hood Canal summer chum salmon DPS, which have been classified as Threatened and whose range includes portions of the Marine RSA (NMFS 2011).

### *4.2.7 Marine Mammals*

This subsection provides an overview of the marine mammals that use habitat along the marine shipping lanes, from the Westridge Marine Terminal to the 12 nautical mile limit of Canada's territorial sea (shown in Figure 4.2.1). More detailed technical information pertaining to marine mammals is presented in the Marine Resources – Marine Transportation Technical Report (Volume 8B, TR 8B-1).

Aboriginal traditional knowledge pertaining to marine mammals is summarized in Section 4.2.7.7. Information pertaining to marine mammals in US waters can be found in Section 4.2.7.8. A discussion of the potential effects of the increased Project-related marine vessel traffic and associated mitigation as well as a discussion of the spatial boundaries for marine mammals are located in Section 4.3.7.

#### *4.2.7.1 General Information*

The marine waters of BC are used year-round by a broad range of marine mammal species, including cetaceans (whales, dolphins and porpoises), pinnipeds (seals and sea lions) and sea otters. The productive straits and sounds of southern BC provide important habitat for marine mammal foraging, breeding, socializing and migration. While many species of marine mammal can be observed in the waters along the shipping lanes year-round and, consequently, depend on this environment for all aspects of their life history, other species are predominantly seasonal in their presence, coming to feed for a season or simply passing through during migration.

#### *4.2.7.2 Field Data Collection*

Information on marine mammal resources within the region is readily available in published literature and on government and research group websites and is deemed to be sufficient for the assessment of potential effects of the increased Project-related marine vessel traffic on marine mammals. Therefore, Project-specific field studies for this aspect of data gathering were not considered necessary.

#### *4.2.7.3 Database and Information Gathering*

The marine mammal knowledge base is derived from a review of relevant scientific literature, publications, and technical reports as well as local and regional data including;

- DFO Canadian Science Advisory Secretariat (CSAS) reports;
- COSEWIC assessments and status reports;
- BC Cetacean Sightings Network (BC CSN) data;
- the BC CDC; and
- the BC MCA.

The collection of information from these sources focused on marine mammal life history, broad habitat use, distribution, abundance and effects of underwater noise.

#### *4.2.7.4 Conservation Status*

Based on a review of the COSEWIC reports and *SARA* public registry list (Schedule 1) and the BC CDC Red and Blue lists, nine species of marine mammals of conservation concern have been identified as potentially occurring within the Marine RSA (BC CDC 2013). This includes regular sightings of southern resident and Bigg's (or transient) killer whales, humpback whales, harbour porpoises and Steller sea lions as well as occasional sightings of fin and grey whales, northern fur seals and sea otters.

Table 4.2.7.1 provides an overview of the 33 species (or ecotypes) of marine mammal found in BC, their conservation status and their relative likelihood of occurrence and predicted use of the Marine RSA. Of the eight listed species identified on Schedule 1 of *SARA*, one is Endangered (*i.e.,* southern resident killer whale), three are Threatened (*i.e.,* humpback whale, fin whale and Bigg's killer whale) and four are of Special Concern (*i.e.,* grey whale, harbour porpoise, Steller sea lion, and sea otter). Additionally, northern fur seals are listed as Threatened by COSEWIC; however, they have no status under *SARA.* Many species of marine mammals are wide-ranging, and the categorization of "predicted occurrence" in Table 4.2.7.1 is meant to qualitatively reflect the standard distribution of most species, although specific occurrence within the Marine RSA fluctuates and, therefore, is uncertain at any given time.

## TABLE 4.2.7.1

## MARINE MAMMALS OF BC, THEIR CONSERVATION STATUS AND PREDICTED OCCURRENCE IN AND USE OF THE MARINE RSA

| Species Name | Status | | | Predicted Occurrence In and Use of the Marine RSA |
|---|---|---|---|---|
| | COSEWIC[1] | *SARA*[1] | BC List[1] | |
| **Baleen Whales – Best Represented in the RSA by Humpback Whale Indicator** | | | | |
| Humpback whale *Megaptera novaeangliae* | Special Concern | Threatened Schedule 1 | Blue | Relatively common and abundant, especially during summer and fall. Some presence year-round. The western-most portion of the Marine RSA overlaps critical habitat for this species. Use area primarily for foraging. Individuals may remain resident for several months while others migrate through. Numbers have been increasing in this area in recent years. |
| Blue whale *Balaenoptera musculus* | Endangered | Endangered Schedule 1 | Red | No recorded presence. Unlikely, given understood historical distribution and preferred habitat (*i.e.,* primarily offshore). |
| Fin whale *Balaenoptera physalus* | Threatened | Threatened Schedule 1 | Red | Rare sightings in Juan de Fuca Strait. May occasionally use western portion of Marine RSA for foraging. Understood historical distribution and preferred habitat is primarily offshore. |
| Sei whale *Balaenoptera borealis* | Endangered | Endangered Schedule 1 | Red | No recorded presence. Unlikely, given understood historical distribution and preferred habitat (*i.e.,* primarily offshore). Now extremely rare throughout BC waters due to historical over-exploitation. |
| Minke whale *Balaenoptera acutorostrata* | Not at Risk | Not listed | Yellow | Fairly common but not generally abundant. Likely a year-round resident. Most frequently found in nearshore waters and passages around Haro Strait. |
| Grey whale *Eschrichtius robustus* | Special Concern | Special Concern Schedule 1 | Blue | Fairly common but not generally abundant. Most common to western Vancouver Island, some whales remain resident throughout summer to forage. May also be observed at other times of year during migration. |
| North Pacific Right whale *Eubalaena japonica* | Endangered | Endangered Schedule 1 | Red | One recent sighting in off western portion of Marine RSA; otherwise, no recorded presence. Unlikely, given understood historical distribution and preferred habitat (*i.e.,* primarily offshore). Now extremely rare throughout BC waters due to historical over-exploitation. |

## TABLE 4.2.7.1

## MARINE MAMMALS OF BC, THEIR CONSERVATION STATUS AND PREDICTED OCCURRENCE IN AND USE OF THE MARINE RSA (continued)

| Species Name | Status | | | Predicted Occurrence In and Use of the Marine RSA |
|---|---|---|---|---|
| | COSEWIC[1] | *SARA*[1] | BC List[1] | |
| **Toothed Whales – Best Represented in the Marine RSA by Southern Resident Killer Whale Indicator** | | | | |
| Killer whale – southern resident ecotype *Orcinus orca* | Endangered | Endangered Schedule 1 | Red | Common and regular sightings, particularly during summer and fall, but some presence in all months. Marine RSA overlaps the majority of the identified critical habitat for this species (100% of critical habitat within Canadian waters). |
| Killer whale – northern resident ecotype *Orcinus orca* | Threatened | Threatened Schedule 1 | Red | Occasional visitors, particularly in western extent of Marine RSA; however, less common than southern resident killer whales given this population's generally more northern BC distribution. |
| Killer whale – Bigg's (previously west coast transient) ecotype *Orcinus orca* | Threatened | Threatened Schedule 1 | Red | Regular sightings; however, less predictable than southern resident killer whales. Present year-round primarily for hunting. Wide-ranging, hunt and breed throughout large area. |
| Killer whale – offshore *Orcinus orca* | Threatened | Threatened Schedule 1 | Red | Not well understood. May be occasional visitors; however, uncommon given generally more offshore distribution. |
| Sperm whale *Physeter macrocephalus* | Not at Risk | No Status No Schedule | Blue | Rare sightings. Unlikely, given understood historical distribution and preferred habitat (*i.e.,* primarily offshore). Males move further inshore in summer to feed. Calving may occur offshore. |
| Pacific white-sided dolphin *Lagenorhynchus obliquidens* | Not at Risk | No Status No Schedule | Yellow | Regular sightings in Strait of Georgia. Likely use area for foraging. When observed, often in large schools. |
| Dall's porpoise *Phocoenoides dalli* | Not at Risk | No Status No Schedule | Yellow | Common, use area for foraging and calving. Likely year-round residents. |
| Harbour porpoise *Phocoena phocoena* | Special Concern | Special Concern Schedule 1 | Blue | Common, use area for foraging and calving. Likely year-round residents. Most commonly found in shallow (< 200 m) nearshore areas. |
| Striped dolphin *Stenella coeruleoalba* | Not at Risk | No Status No Schedule | Yellow | No recorded presence. Unlikely – generally an offshore species and only a rare visitor to BC. |
| Common dolphin (short-beaked) *Delphinus delphis* | Not at Risk | No Status No Schedule | Accidental | No recorded presence. Unlikely – generally an offshore species and only a rare visitor to BC. |
| Risso's dolphin *Grampus griseus* | Not at Risk | No Status No Schedule | Yellow | Rare sightings. Unlikely - generally an offshore species. |
| Northern right whale dolphin *Lissodelphis borealis* | Not at Risk | No Status No Schedule | Yellow | Rare sightings. Unlikely - generally an offshore species. |

## TABLE 4.2.7.1

## MARINE MAMMALS OF BC, THEIR CONSERVATION STATUS AND PREDICTED OCCURRENCE IN AND USE OF THE MARINE RSA (continued)

| Species Name | Status | | | Predicted Occurrence In and Use of the Marine RSA |
|---|---|---|---|---|
| | COSEWIC[1] | *SARA*[1] | BC List[1] | |
| Short-finned pilot whale *Globicephala macrorhynchus* | Not at Risk | No Status No Schedule | Yellow | Rare sightings.<br>Unlikely – generally an offshore species and only a rare visitor to BC. |
| False killer whale *Pseudorca crassidens* | Not at Risk | No Status No Schedule | Accidental | Rare sightings.<br>Unlikely – generally a more tropical/subtropical species and only a rare visitor to BC. |
| Baird's beaked whale *Berardius bairdii* | Not at Risk | No Status No Schedule | Unknown | No recorded presence.<br>Unlikely – generally an offshore species. |
| Stejneger's beaked whale *Mesoplodon stejneri* | Not at Risk | No Status No Schedule | Unknown | No recorded presence.<br>Unlikely – generally an offshore species. |
| Hubbs' beaked whale *Mesoplodon carlhubbsi* | Not at Risk | No Status No Schedule | Unknown | No recorded presence.<br>Unlikely – generally an offshore species. |
| Cuvier's beaked whale *Ziphius cavirostris* | Not at Risk | No Status No Schedule | Yellow | No recorded presence.<br>Unlikely – generally an offshore species. |
| Pygmy sperm whale *Kogia breviceps* | Not at Risk | No Status No Schedule | Accidental | No recorded presence.<br>Unlikely – generally an offshore species. |
| Dwarf sperm whale *Kogia simus* | Data Deficient | No Status No Schedule | Accidental | No recorded presence.<br>Unlikely – generally an offshore species. |
| **Pinnipeds – Best represented in the Marine RSA by Steller Sea Lion Indicator** | | | | |
| Steller sea lion *Eumetopias jubatus monteriensis* | Special Concern | Special Concern Schedule 1 | Blue | Common. Year-round presence. Peak numbers in Marine RSA during fall and winter.<br>No rookeries (pupping areas) in Marine RSA.<br>One major year-round haulout (*i.e.,* Carmanah Point) and numerous major winter haulouts, including one at Race Rocks, which is protected within an MPA.<br>Use area to forage and haul out (*e.g.*, to rest, socialize). |
| California sea lion *Zalophus californianus* | Not at Risk | No Status No Schedule | Yellow | Not abundant, but regular sightings off Victoria and at Race Rocks.<br>More common than Steller sea lion in Washington waters.<br>Most likely from September through May when males and sub-adults migrate north while females remain near rookeries off California and Mexico. |
| Harbour seal *Phoca vitulina richardsi* | Not at Risk | No Status No Schedule | Yellow | Common and abundant.<br>Ubiquitous throughout BC.<br>Year-round resident.<br>Use area to forage and breed. |

**TABLE 4.2.7.1**

**MARINE MAMMALS OF BC, THEIR CONSERVATION STATUS AND PREDICTED OCCURRENCE IN AND USE OF THE MARINE RSA (continued)**

| Species Name | Status | | | Predicted Occurrence In and Use of the Marine RSA |
|---|---|---|---|---|
| | COSEWIC[1] | *SARA*[1] | BC List[1] | |
| Northern elephant seal *Mirounga angustirostris* | Not at Risk | No Status No Schedule | Yellow | Uncommon. Recent sightings of small numbers at Race Rocks and other locations in the Marine RSA. Foraging occurs offshore in northern waters – individuals may be seen hauled out within Marine RSA during migration. Winter breeding rookeries and moulting sites in Mexico and California. |
| Northern fur seal *Callorhinus ursinus* | Threatened | No status No schedule | Red | Uncommon. Occasional sightings in Marine RSA. Historical distribution overlaps western-most portion of Marine RSA. Summer is spent at rookeries in Alaska. Winter is spent in the open water off continental shelf and shelf break though some overwinter up inlets. |
| **Other – Not Assessed Explicitly as an Indicator** | | | | |
| Sea otter *Enhydra lutris* | Special Concern | Special Concern Schedule 1 | Blue | Occasional. Most likely in western-most portion of Marine RSA. Year-round residents of central- and northwestern Vancouver Island. Washington population has known sightings around Tatoosh and Waadah Islands. |

**Sources:** Species list taken from Heise *et al*. 2007. Principle sources of information include: COSEWIC Status Reports, DFO Recovery Strategies, Management Plans, and CSAS Reports, the BC CSN, the BC CDC, DFO, NMFS, and WDFW government websites and reports, and professional judgment of the Discipline Lead. List was last updated on November 25, 2013.

**Note:** 1 See Section 4.2.1.3 for definitions of COSEWIC, *SARA* and BC List status.

### *4.2.7.5 Critical Habitat and Important Areas*

Critical habitat for southern resident killer whales has been officially designated for the trans-boundary waters of Haro Strait, Boundary Pass, the eastern portion of Juan de Fuca Strait and the southern portion of the Strait of Georgia (DFO 2009b; see Figure 4.2.22). The area designated as critical habitat under *SARA* is legally protected, and human activities that could potentially destroy the geophysical attributes of critical habitat are prohibited (DFO 2008, 2011). Ecosystem features, such as availability of prey and environmental quality are important to killer whale recovery, and according to DFO (2008), “a variety of legislative and policy tools are available to manage and mitigate threats to these functions of the Resident Killer Whale critical habitat, to individuals and to populations”. Legislative and policy tools include (however, are not limited to) use of the:

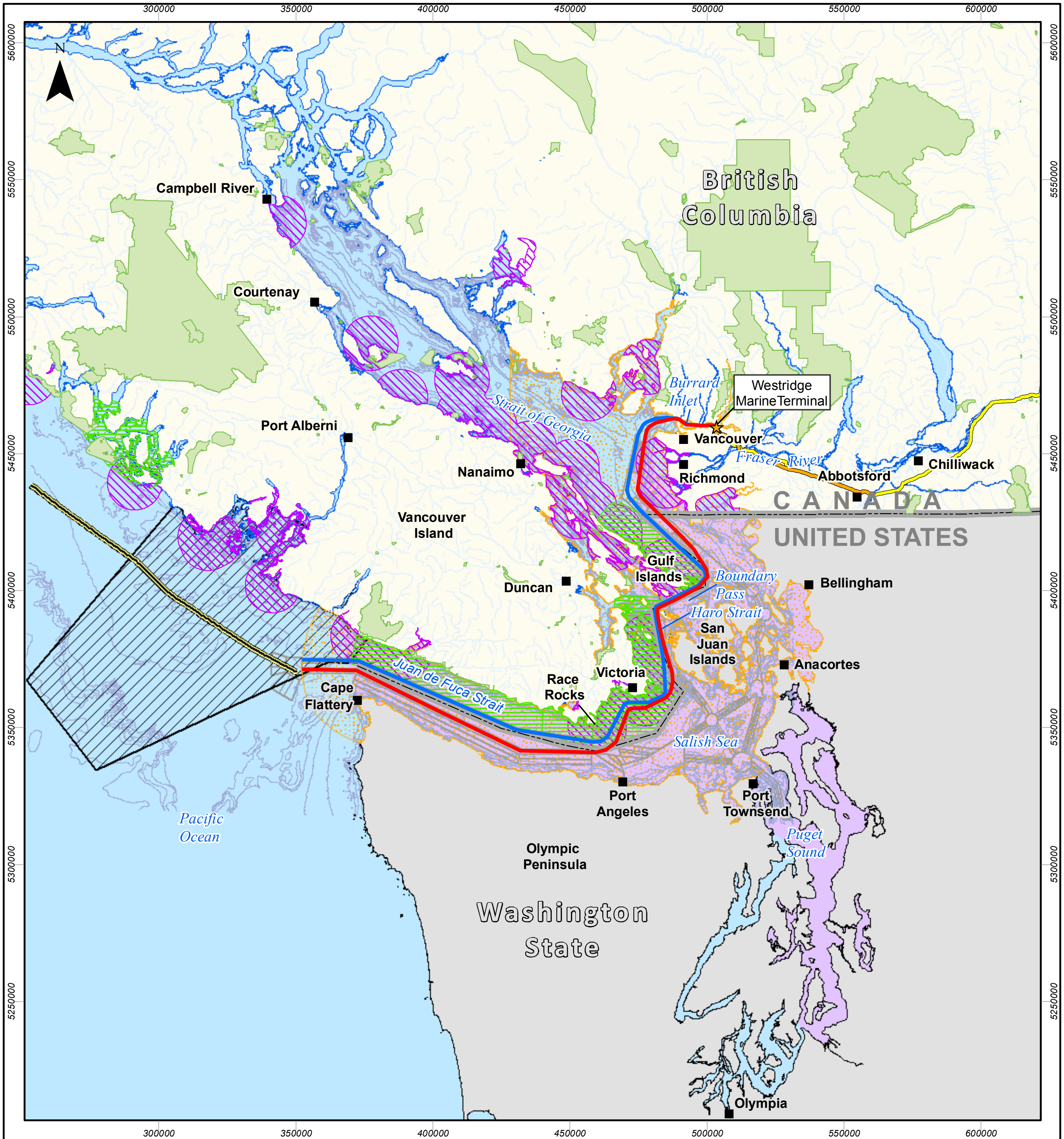
- *Fisheries Act*, 1985;
- Marine Mammal Regulations;
- Whale Watching Guidelines (Wild Whales 2006);

- Statement of Canadian Practice with Respect to the Mitigation of Seismic Sound in the Marine Environment (DFO 2013g);
- CEPA, 1999;
- Wild Salmon Policy (DFO 2005); and
- Integrated Fisheries Management Plans (DFO 2012b).

Critical habitat has also been identified in DFO's 2013 *Recovery Strategy for the North Pacific Humpback Whale (Megaptera novaeangliae) in Canada* (DFO 2013h). While not all potential critical habitat in BC has yet been identified for humpback whales, one of the identified areas includes Swiftsure Bank, southwest Vancouver Island. The western-most portion of the Marine RSA overlaps this critical habitat (see Figure 4.2.22), which has been identified as an area of importance for a potentially distinct sub-population of humpback whales that occupies southern BC and northern Washington waters (DFO 2013h).

DFO Important Areas have been identified for harbour porpoises and harbour seals in the Marine RSA and are also shown in Figure 4.2.22.

There is a major year-round haulout site for Steller sea lions on Carmanah Point and a number of major winter haulouts; however, no rookeries (*i.e.,* breeding colonies) within the Marine RSA (Figure 4.2.22).




Westridge Marine Terminal
Town / City
Marine Vessel Inbound Shipping Lane
Marine Vessel Outbound Shipping Lane
International Border
Canadian 12 Nautical Mile Territorial Boundary
Bathymetry
Watercourse
Existing Trans Mountain Pipeline
Trans Mountain Expansion Proposed Pipeline Corridor
Waterbody
Provincial Park
Traffic Separation Scheme
Land of British Columbia
Land of Washington State
Marine RSA (Transportation)
Humpback Whale Critical Habitat
Southern Resident Killer Whale Critical Habitat
DFO Important Areas for Harbour Seal
DFO Important Areas for Harbour Porpoise

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SCALE: 1:2,000,000

0 10 20 30 40 km

ALL LOCATIONS APPROXIMATE



| MAP NUMBER | | PAGE |
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| 10494_EA_TRANS_MAR_04_02_22 | | SHEET 1 OF 1 |
| DATE Nov 2013 | REF. 7894 | REVISION 0 |
| SCALE 1:2,000,000 | PAGE SIZE 8.5x11 | DISCIPLINE SD |
| DRAWN SS | CHECKED DP | DESIGN SD |

Projection: UTM Zone 10N; Marine Vessel Inbound Shipping Lane: Moffatt & Nichol, 2013a; Marine Vessel Outbound Shipping Lane: Moffatt & Nichol, 2013b; International Border: British Columbia Ministry of Energy and Mines, 2013; Canadian 12 Nautical Mile Territorial Boundary and Traffic Separation Scheme: Canadian Hydrographic Service, 2013; 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; Provincial Park: BC MFLNRO, 2008a; Land of British Columbia: National Topographic Data Base, 2007; Land of Washington State: Washington State Department of Ecology, 1994; Humpback Whale Critical Habitat: DFO, 2013b; Critical Habitat for Southern Resident Killer Whale: DFO, 2011; DFO Important Areas for Harbour Seal: Olesiuk, P. [pers. comm.] in DFO, 2013a. DFO Important Areas for and Harbour Porpoise: Hall, A.H., 2004, DFO, 2013a.

*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: 4.2-22**

**CRITICAL HABITAT AND DFO IMPORTANT AREAS FOR MARINE MAMMALS IN THE MARINE RSA**

**TRANS MOUNTAIN EXPANSION PROJECT**

#### *4.2.7.6 Indicator Species*

Three indicator species were selected to assess potential effects of the increased Project-related marine traffic on marine mammals: southern resident killer whale; humpback whale; and Steller sea lion (see Table 4.2.7.2). These species are intended to broadly represent the overall diversity of life history strategies displayed by the various marine mammal species using the habitats present within the Marine RSA boundaries. All of these species are highly mobile and are, at times, widely distributed throughout the Marine RSA. See Section 4.3 for more information regarding indicators.

**TABLE 4.2.7.2**

**SUMMARY OF SELECTED MARINE MAMMALS INDICATORS**

| Common Name | Scientific Name | *SARA* (Schedule 1 Status)[1] | COSEWIC Status[1] | BC List Status[1] |
|---|---|---|---|---|
| Southern resident killer whale | *Orcinus orca* | Endangered Schedule 1 | Endangered | Red |
| Humpback whale | *Megaptera novaeangliae* | Threatened Schedule 1 | Special Concern | Blue |
| Steller sea lion | *Eumetopias jubatus monteriensis* | Special Concern Schedule 1 | Special Concern | Blue |

**Note:** 1 See Section 4.2.1.3 for definitions of COSEWIC, SARA and BC List status

##### 4.2.7.6.1 Southern Resident Killer Whale

Killer whales are toothed whales (Odontocetes) and the largest member of the dolphin family (Delphinidae) (DFO 2011a). They have a distinctive black and white colouration and recognizable dorsal fin (COSEWIC 2008, Ford *et al.* 2000). Individual killer whales can be distinguished and identified based on the unique shape of their dorsal fin and the pattern of their saddle patch (*i.e.,* a grey to white coloured area at the base of their dorsal fin) (Ford *et al.* 2000).

Killer whales inhabit all of the world's oceans. In BC, they have been seen in almost all marine waters including long inlets, narrow channels, and deep embayments (DFO 2011a). In the Canadian Pacific waters, there are three sympatric population assemblages of killer whales: Bigg's killer whales (previously known as West Coast transients); residents; and offshores (COSEWIC 2008, Ford *et al.* 2000). While their ranges may overlap, there are morphological and genetic differences between these three assemblages as well as differences in acoustics, preferred prey and social structure (Barrett-Lennard and Ellis 2001, Ford *et al.* 1998, 2000). Resident killer whales are further subdivided into a northern and southern population, which are also recognized as separate designatable units, and which do not associate and rarely, if ever, interbreed (Barrett-Lennard and Ellis 2001, COSEWIC 2008).

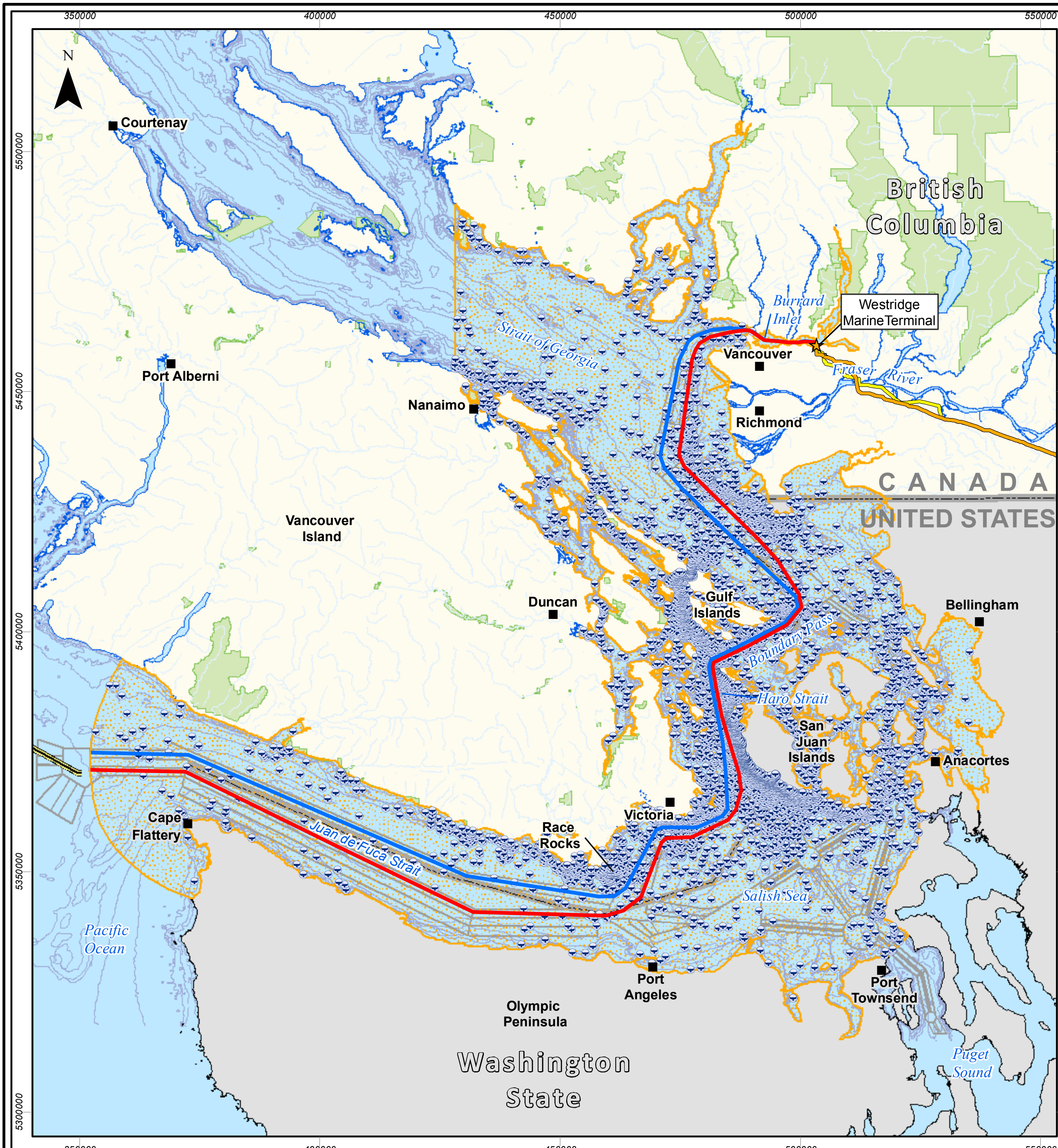
Resident killer whales have a complex social structure, composed of matrilines, pods and clans (Ford 1991, Ford *et al.* 2000). The basic social unit is the matriline – a stable, long-term maternally-related kin group composed of an older female (*i.e.,* matriarch), her sons and daughters and her daughters' offspring. Typical matrilines are composed of two to four generations of whales; whales tend to mate outside their matrilines. The term "pod" is assigned to collections of matrilines that spend most of their time together. The southern resident killer whale population has 3 pods: J, K and L. While northern residents are divided into different clans, based on related vocal dialects, southern residents all belong to the same clan.

The range of the southern resident population extends from Haida Gwaii, BC to Monterey Bay, CA (COSEWIC 2008). The principal prey of southern resident killer whales is Chinook and chum salmon, and their distribution during summer and fall is closely linked to that of the Chinook salmon (Ford and Ellis 2006). Their diet in the winter and spring is largely unknown (DFO 2011a). Killer whales in BC do not migrate to specific breeding or calving areas that are separate from their feeding grounds.

The southern resident population is listed as Endangered under Schedule 1 of *SARA*. This is due in large part to its small population, which was reduced in the 1960s and 70s due to capture for display in aquaria. This population increased from 70 whales in 1973 to 96 whales by 1996, before declining again by 4.4 per cent between 1997 and 2006 (COSEWIC 2008). As of July 1, 2013, there are 82 individuals in the southern resident population (*i.e.,* J Pod = 26, K Pod = 19 and L Pod = 37) (Center for Whale Research 2013). Key threats to the southern resident population include: reductions in the availability or quality of prey (primarily Chinook salmon); physical and acoustic disturbance; and chemical and biological contaminants (COSEWIC 2008, DFO 2011a).

The transboundary area between BC and Washington, which includes the southern portion of the Strait of Georgia, the Southern Gulf Islands, Boundary Pass, Haro Strait and Juan de Fuca Strait, has been designated as critical habitat under *SARA* (DFO 2008, 2009b, 2011a) (see Figure 4.2.22). This is based on consistent and prolonged seasonal occupancy of southern resident killer whales in this area (DFO 2011a). Based on a dataset maintained by the Whale Museum going back to 1976 (Osborne 1999, Osborne *et al.* 2001), on average, J Pod spends some of its time in the Marine RSA during every month of the year. L and K pods are less common in March and April; however, are commonly observed in every other month (the Whale Museum 2011). Opportunistic killer whale sightings in the Marine RSA, compiled by the BC CSN for the period of 1975 to 2013, are shown in Figure 4.2.23 (note that sightings presented on this map do not differentiate between potential killer whale populations). Data obtained from the BC Cetacean Sightings Network were collected opportunistically with limited knowledge of the temporal or spatial distribution of observer effort. As a result, absence of sightings at any location does not demonstrate absence of cetaceans. Killer whales are frequently observed in or within close proximity to the marine shipping lanes.

Further information on killer whales and other toothed whales in the Marine RSA is presented in the Marine Resources – Marine Transportation Technical Report (Volume 8B, TR 8B-1).

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SCALE: 1:1,150,000

0 10 20 30 40 km

ALL LOCATIONS APPROXIMATE

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| MAP NUMBER | | PAGE | |
|---|---|---|---|
| 10494_EA_TRANS_MAR_04_02_23 | | SHEET 1 OF 1 | |
| DATE Nov 2013 | REF. 7894 | REVISION 0 | |
| SCALE 1:1,150,000 | PAGE SIZE 8.5x11 | DISCIPLINE SD | |
| DRAWN SS | CHECKED DP | DESIGN SD | |

- Westridge Marine Terminal
- Town / City
- Marine Vessel Inbound Shipping Lane
- Marine Vessel Outbound Shipping Lane
- International Border
- Canadian 12 Nautical Mile Territorial Boundary
- Bathymetry
- Watercourse
- Existing Trans Mountain Pipeline
- Trans Mountain Expansion Proposed Pipeline Corridor
- Waterbody
- Provincial Park
- Traffic Separation Scheme
- Land of British Columbia
- Land of Washington State
- Marine RSA (Transportation)
- Killer Whale Sighting

Note: Sightings data supplied by the BC Cetacean Sightings Network. Sightings are opportunistic and not corrected for effort. A sighting may be a single or multiple individuals.

Projection: UTM Zone 10N; Marine Vessel Inbound Shipping Lane: Moffatt & Nichol, 2013a; Marine Vessel Outbound Shipping Lane: Moffatt & Nichol, 2013b; International Border: British Columbia Ministry of Energy and Mines, 2013; Canadian 12 Nautical Mile Territorial Boundary and Traffic Separation Scheme: Canadian Hydrographic Service, 2013; 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; Provincial Park: BC MFLNRO, 2008a; Land of British Columbia: National Topographic Data Base, 2007; Land of Washington State: Washington State Department of Ecology, 1994; Killer Whale Sightings: BC Cetacean Sightings Network, 2013.

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TRANS MOUNTAIN

FIGURE: 4.2-23

# BC CSN OPPORTUNISTIC KILLER WHALE SIGHTINGS IN THE MARINE RSA 1975 TO 2013

TRANS MOUNTAIN EXPANSION PROJECT

#### 4.2.7.6.2 Humpback Whale

Humpback whales are large baleen whales (Mysticetes) belonging to the family Balaenopteridae. They have a variable dark grey to black colouration, a short, stubby dorsal fin and white on the undersides of their long pectoral flippers (COSEWIC 2011, Shore 2011). They often raise their tail flukes while diving, and the shape, scars and colour patterns of their flukes can be used to identify individuals. Humpbacks are surprisingly acrobatic for a large whale and common behaviours include breaching, fin and tail slapping.

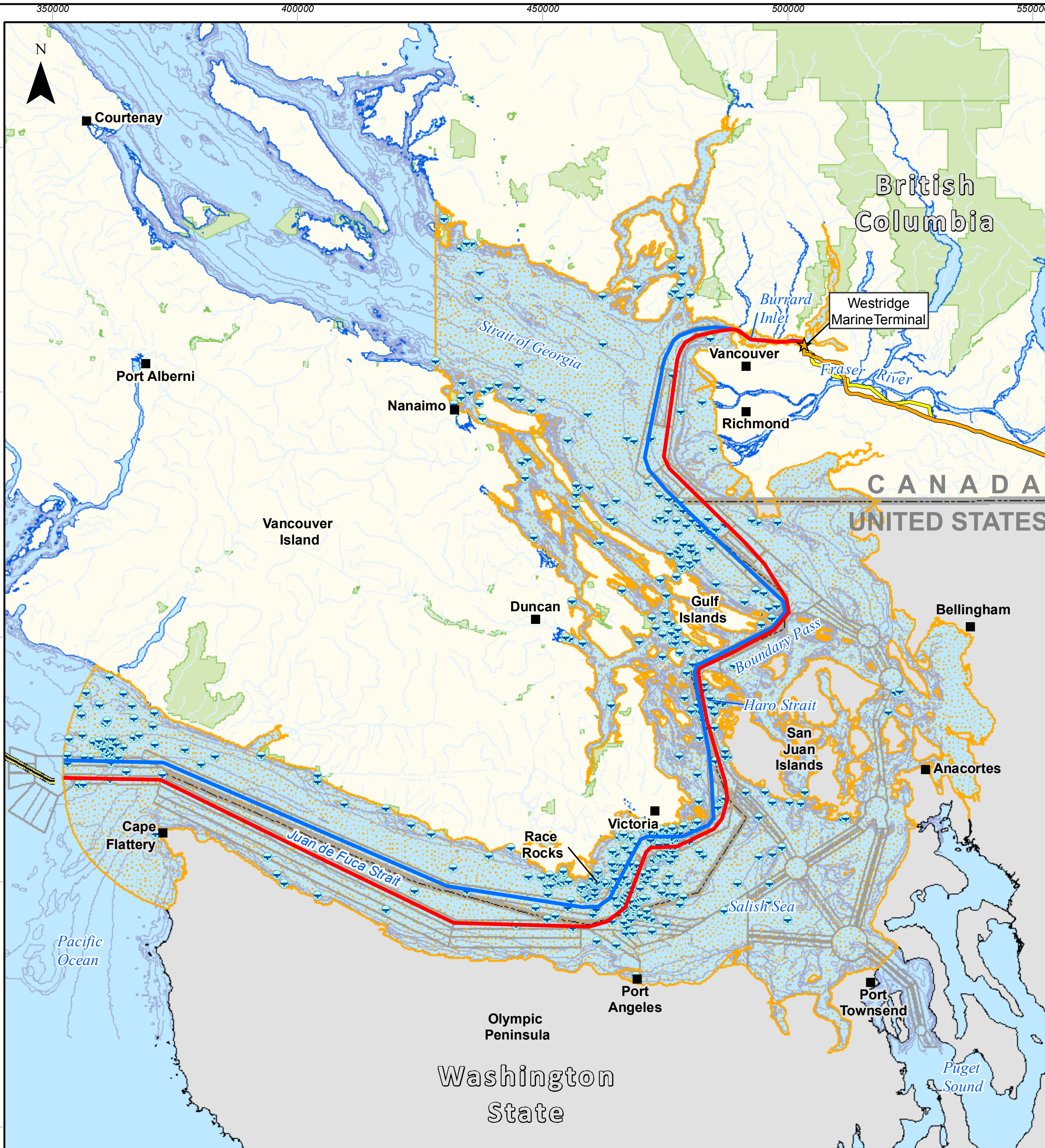
Their diet is highly variable, consisting of zooplankton (primarily euphausiids and copepods), cephalopods and small schooling fish such as Pacific herring, capelin, sandlance, Pacific sardine, juvenile salmon, Pacific cod, mackerel and anchovy (COSEWIC 2011). Many of these species are abundant in BC waters during the summer and fall, attracting humpback whales to the region to feed.

Humpback whales are widely distributed and are found in tropical, temperate and sub-polar waters of the world's oceans. Humpback whales undertake long migrations from breeding to feeding grounds. They breed and calf between November and May near Hawaii, Mexico, Central America, Japan and the Philippines (COSEWIC 2011). In Canadian Pacific waters, humpback whales range the length of the BC coast including both offshore and inshore waters and are most common from May through October. Small numbers may feed in these areas throughout the year (COSEWIC 2011, Dalla Rosa *et al.* 2012, Ford *et al.* 2009, Williams and Thomas 2007). Individual whales show considerable fidelity to feeding sites, where they return annually (COSEWIC 2011, Ford *et al.* 2009, Rambeau 2008).

Humpback whales are among the most commonly observed large cetaceans in BC (COSEWIC 2011, Ford *et al.* 2010, Williams and Thomas 2007). Concentrations of humpback whales have been observed during summer in the area east of Barkley Canyon and between La Pérouse Bank and Nitinat Canyon, and on the shelf edge near the southern portion of Juan de Fuca Canyon (Ford *et al.* 2010). Humpback whales appear to be present in most of the Marine RSA in a comparatively lower density than some other areas of BC (DFO 2013h). DFO has identified portions of humpback whale critical habitat in BC, one of which overlaps with the western-most portion of the Marine RSA off southwest Vancouver Island (DFO 2013h) (see Figure 4.2.22). Opportunistic humpback whale sightings in the Marine RSA, compiled by the BC CSN for the period of 1975 to 2013, are shown in Figure 4.2.24. Humpback whales are regularly observed in or within close proximity to the marine shipping lanes.

Humpback whales in the North Pacific Ocean appear to be recovering from previous heavy exploitation during commercial whaling (Cascadia Research 2008, COSEWIC 2011, Williams and Thomas 2007). The SPLASH project (Structure of Populations, Levels of Abundance and Status of Humpback Whales in the North Pacific) provided the most recent (2006) population size estimate for adult humpback whales in the North Pacific of 18,302 individuals, suggesting an annual increase of about 4.9 per cent since 1993 (Cascadia Research 2008). Regional estimates from SPLASH suggest seasonal (summer/fall) abundances of 3,000 to 5,000 humpback whales in northern BC and southeast Alaska (combined) and 200 to 400 individuals in southern BC and northern Washington (Cascadia Research 2008). Williams and Thomas (2007) estimated a 2005 population size for BC's inner waters of approximately 1,310 humpback whales, based on line transect surveys. A photo-identification study conducted by DFO suggests a 2006 estimate for humpback whales throughout BC waters of around 2,145 individuals (COSEWIC 2011, DFO 2009c, DFO 2013h, Ford *et al.* 2009, Ford *et al.* 2010, Rambeau 2008). Over the period of 1992 to 2006, the BC humpback population is estimated to have grown at an annual rate of approximately 4.1 per cent, which is a reasonable growth rate for a population that is recovering from previous heavy exploitation (COSEWIC 2011, DFO 2009c, DFO 2013h, Ford *et al.* 2009, Ford *et al.* 2010, Rambeau 2008).

In 2011, COSEWIC down-listed the humpback whale from Threatened (in the 2003 assessment) to Special Concern (COSEWIC 2011); however, on the recommendation of the Minister of the Environment, this assessment has recently been referred back to COSEWIC, and the humpback whale remains listed as Threatened under Schedule 1 of *SARA* (Her Majesty the Queen in Right of Canada 2013). Key threats to the eastern North Pacific humpback whale include: noise disturbance; habitat degradation; entanglement in fishing gear and debris, and ship strikes (COSEWIC 2011). Activities identified by DFO as “likely to destroy or degrade critical habitat” include vessel traffic, toxic spills, overfishing, seismic exploration, sonar, and pile driving (DFO 2013h).

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SCALE: 1:1,150,000

0 10 20 30 40 km

ALL LOCATIONS APPROXIMATE

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| MAP NUMBER | | PAGE |
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| DATE Nov 2013 | REF. 7894 | REVISION 0 |
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| DRAWN SS | CHECKED DP | DESIGN SD |

Westridge Marine Terminal
Town / City
Marine Vessel Inbound Shipping Lane
Marine Vessel Outbound Shipping Lane
International Border
Canadian 12 Nautical Mile Territorial Boundary
Bathymetry
Watercourse
Existing Trans Mountain Pipeline
Trans Mountain Expansion Proposed Pipeline Corridor
Waterbody
Provincial Park
Traffic Separation Scheme
Land of British Columbia
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Marine RSA (Transportation)
Humpback Whale Sighting

Note: Sightings data supplied by the BC Cetacean Sightings Network. Sightings are opportunistic and not corrected for effort. A sighting may be a single or multiple individuals.

Projection: UTM Zone 10N; Marine Vessel Inbound Shipping Lane: Moffatt & Nichol, 2013a; Marine Vessel Outbound Shipping Lane: Moffatt & Nichol, 2013b; International Border: British Columbia Ministry of Energy and Mines, 2013; Canadian 12 Nautical Mile Territorial Boundary and Traffic Separation Scheme: Canadian Hydrographic Service, 2013; 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; Provincial Park: BC MFLNRO, 2008a; Land of British Columbia: National Topographic Data Base, 2007; Land of Washington State: Washington State Department of Ecology, 1994; Humpback Whale Sightings: BC Cetacean Sightings Network, 2013.

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TRANS MOUNTAIN

**FIGURE: 4.2-24**

**BC CSN OPPORTUNISTIC HUMPBACK WHALE SIGHTINGS IN THE MARINE RSA 1975 TO 2013**

**TRANS MOUNTAIN EXPANSION PROJECT**

Further information on humpback whales and other baleen whales in the Marine RSA is presented in the Marine Resources – Marine Transportation Technical Report (Volume 8B, TR 8B-1).

#### 4.2.7.6.3 Steller Sea Lion

Steller sea lions are pinnipeds belonging to the family Otariidae (*i.e.,* the eared seals). They inhabit cool temperate and subarctic coastal waters from southern California north to the Bering Strait and south along the Asian coastline of the North Pacific Ocean (COSEWIC 2003c). Pinnipeds spend a considerable amount of time on land at haulouts and rookeries.

Steller sea lions in BC belong to the eastern Pacific stock. In 2009, Phillips *et al.* argued for sub-species designation between the western and eastern stocks of Steller sea lion. In 2012, the Society for Marine Mammalogy Ad-Hoc Committee on Taxonomy recognized these two subspecies of *Eumetopias jubatus* as: the western Steller sea lion (*E. j. jubatus*) and the Loughlin's northern sea lion (*E. j. monteriensis*). It is the latter subspecies that is found in BC. However, since the use of "Loughlin's northern sea lion" is relatively new, and at the time of writing of this document, the term "Steller sea lion" is still used by COSEWIC, the *SARA* registry, and the BC CDC, the more common "Steller sea lion" has been used throughout the application.

Sexually mature individuals use rookeries during the summer, with dispersal to non-breeding areas beginning in late August (DFO 2010a). Female Steller sea lions exhibit strong site fidelity, returning to the rookery where they were born or to a nearby adjacent rookery, to mate and give birth (COSEWIC 2003c). There are four Steller sea lion breeding areas along the coast of BC: the Scott Islands off northwest Vancouver Island (which support 33 per cent of the total eastern population); Cape St. James off the southern tip of Haida Gwaii; the Sea Otter Group off the Central Mainland coast; and off Banks Island on the North Mainland coast (DFO 2010a).

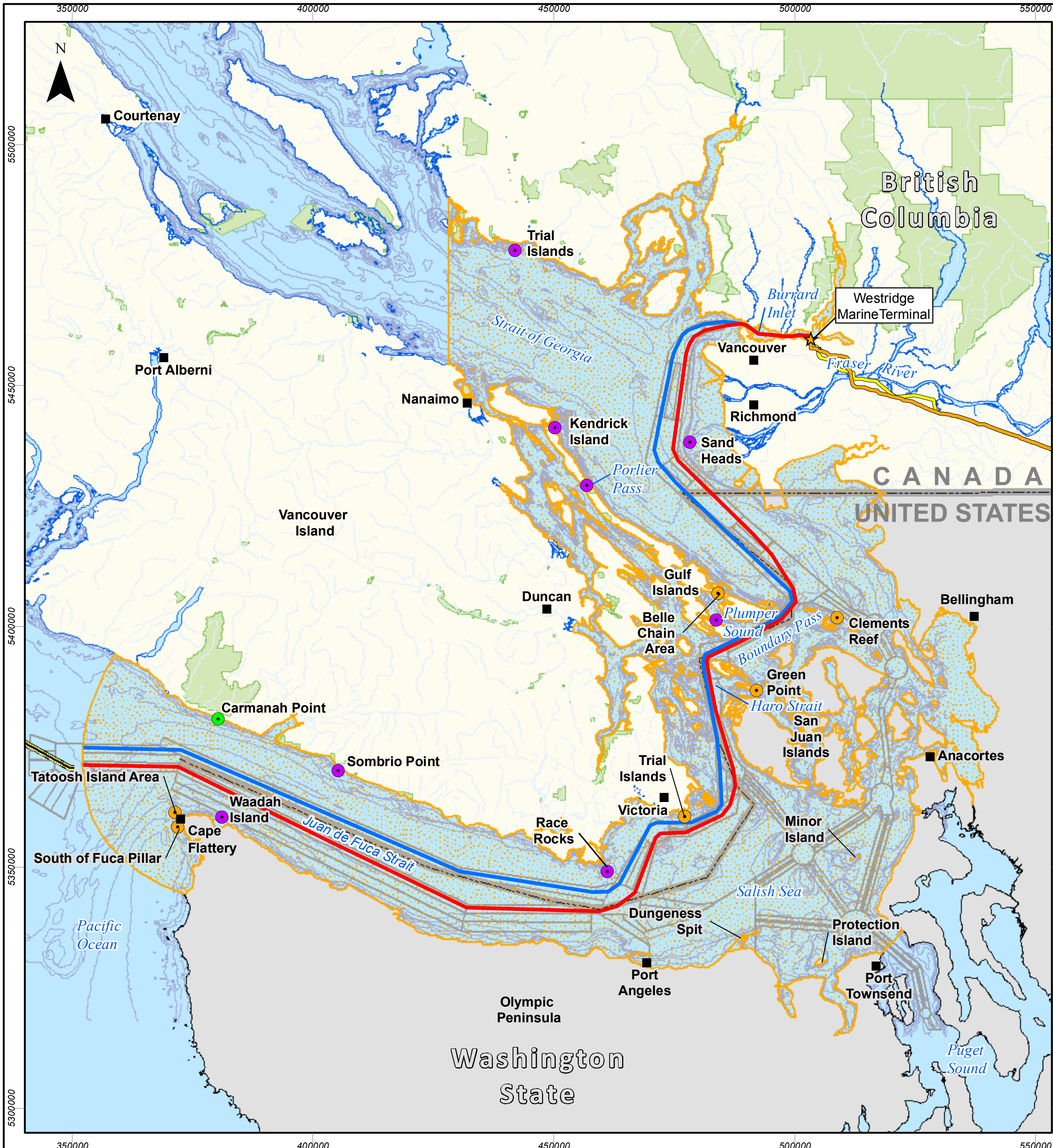
None of the four Canadian breeding areas discussed above is located within the Marine RSA, and the closest rookeries in US waters are in southern Oregon (Allen and Angliss 2012, Jeffries *et al.* 2000). In addition to rookeries, there are at least 23 year-round haulouts in BC and multiple major winter haulouts (DFO 2010a). Both male and female Steller sea lions are present year-round in the Marine RSA. In addition to one year-round haulout at Carmanah Point, and several major winter haulouts, there are several minor haulouts located in the Marine RSA (major year-round and winter haulouts near the Marine RSA are shown in Figure 4.2.25).

The Steller sea lion is listed as Special Concern under Schedule 1 of *SARA* and is the only pinniped species at risk likely to occur on a regular basis in the Marine RSA. Since receiving protection from hunting under the *Fisheries Act* in 1970, the population of Steller sea lions in BC has increased several-fold (DFO 2010a). The *Oceans Act* of 1996 allowed for the creation of a MPA at Race Rocks, which protected an important winter haulout site within the Marine RSA (COSEWIC 2003c) (see Figure 4.2.25). The maximum number of Steller sea lions observed at one time on Race Rocks increased from 7 individuals in 1965 to 680 individuals in 2009 (Edgell and Demarchi 2012).

Threats to Steller sea lions include:

- degradation of or displacement from essential habitat;
- acoustic disturbance in aquatic habitat;

- disturbance on and around terrestrial habitat;
- reproductive impairment from environmental contaminants;
- toxic spills;
- predator control at fish farms;
- incidental mortality from fishing gear and other sources; and
- shifts in prey abundance and distribution (COSEWIC 2003c, DFO 2010a).

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SCALE: 1:1,150,000

0 10 20 30 40 km

ALL LOCATIONS APPROXIMATE

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| MAP NUMBER | | PAGE |
|---|---|---|
| 10494_EA_TRANS_MAR_04_02_25 | | SHEET 1 OF 1 |
| DATE Nov 2013 | REF. 7894 | REVISION 0 |
| SCALE 1:1,150,000 | PAGE SIZE 8.5x11 | DISCIPLINE SD |
| DRAWN SS | CHECKED DP | DESIGN SD |

Westridge Marine Terminal
Town / City
Marine Vessel Inbound Shipping Lane
Marine Vessel Outbound Shipping Lane
International Border
Canadian 12 Nautical Mile Territorial Boundary
Bathymetry
Watercourse
Existing Trans Mountain Pipeline
Trans Mountain Expansion Proposed Pipeline Corridor
Waterbody
Provincial Park
Traffic Separation Scheme
Land of British Columbia
Land of Washington State
Marine RSA (Transportation)

**Steller Sea Lion Haulouts**
Major Winter Haulouts
Year-round Haulout
Haulouts with Timing Unknown

Projection: UTM Zone 10N; Marine Vessel Inbound Shipping Lane: Moffatt & Nichol, 2013a; Marine Vessel Outbound Shipping Lane: Moffatt & Nichol, 2013b; International Border: British Columbia Ministry of Energy and Mines, 2013; Canadian 12 Nautical Mile Territorial Boundary and Traffic Separation Scheme: Canadian Hydrographic Service, 2013; 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; Provincial Park: BC MFLNRO, 2008a; Land of British Columbia: National Topographic Data Base, 2007; Land of Washington State: Washington State Department of Ecology, 1994; Stellar Sea Lion Haulouts: Bigg, 1985; Edgell and Demarchi, 2012; DFO, 2010; Jefferies et al., 2000; NOAA Fisheries Service, 2012.

*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: 4.2-25**

**MAJOR STELLER SEA LION HAULOUTS IN THE MARINE RSA**

**TRANS MOUNTAIN EXPANSION PROJECT**

Further information on Steller sea lions and other pinnipeds in the Marine RSA is presented in the Marine Resources – Marine Transportation Technical Report (Volume 8B, TR 8B-1).

#### *4.2.7.7 Aboriginal Traditional Knowledge*

The literature review indicates that marine resource extraction was, and continues to be, an important activity for coastal Aboriginal communities in the Marine RSA. Marine mammals have traditionally been harvested at the intersection of the Fraser River and the Pacific Ocean, throughout the Gulf Islands, in the Strait of Georgia and along the southern coast. Traditionally hunted marine mammal species included grey whales, Steller sea lions, Pacific white-sided dolphins, killer whales, harbour seals and porpoises (BC Transmission Corporation 2006, Canadian Environmental Assessment Agency 2006, Simonsen *et al.* 1995).

#### 4.2.7.8 *US Waters*

Since the Marine RSA straddles the international border between Canada and the US, the literature search also included a review of US sources for local marine mammal research, such as the Center for Whale Research, the Whale Museum, Orca Network, Cascadia Research Collective, and NMFS. Baseline information regarding marine mammals in US waters is expected to be consistent with baseline information in Canadian waters. Further detail on marine mammal sightings and research conducted in US waters is presented in the Marine Resources – Marine Transportation Technical Report (Volume 8B, TR 8B-1).

### *4.2.8 Marine Birds*

This subsection provides an overview of the marine bird species and habitats along the marine shipping lanes, from the Westridge Marine Terminal to the 12 nautical mile limit of Canada's territorial sea (shown in Figure 4.2.1). More detailed technical information pertaining to marine birds is presented in the Marine Birds – Marine Transportation Technical Report (Volume 8B, TR 8B-2).

Aboriginal traditional knowledge pertaining to marine birds is summarized in Section 4.2.8.7. Information pertaining to marine birds in US waters can be found in Section 4.2.8.8. A discussion of the potential effects of the increased Project-related marine vessel traffic and associated mitigation as well as a discussion of the spatial boundaries for marine birds are located in Section 4.3.8.

#### *4.2.8.1 Spatial Boundaries*

The existing environmental conditions for marine birds are described with regard to the Marine Birds LSA, which includes the inbound and outbound marine shipping lanes, the area between the shipping lanes where it exists and a 1 km buffer extending from the outermost edge of each shipping lane. The shipping lanes extend from the Westridge Marine Terminal in Burnaby, through Burrard Inlet, south through southern part of the Strait of Georgia, the Gulf Islands and Haro Strait, then westward past Victoria and though Juan de Fuca Strait out to the 12 nautical mile limit of Canada's territorial sea. The Marine Birds LSA is shown on Figure 4.2.2.

#### *4.2.8.2 General Information*

The Marine RSA falls within the Strait of Georgia, Haro Strait and Juan de Fuca Strait, all within the Salish Sea, an inland area of ocean that extends from Olympia, Washington northward to Campbell River, BC. The Salish Sea supports diverse populations of seasonally present birds, abundant marine bird breeding colonies, designated IBAs and Reserves, and seasonally important foraging areas, such as marine upwellings, shallow open water and the continental shelf. The Marine RSA encompasses large breeding colonies and other sensitive marine bird foraging and staging areas proximate to the shipping lanes.

There are an estimated 124 marine bird species (Campbell *et al.* 1990, Stevens 1995) using coastal terrestrial habitats (above the 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) of the Marine RSA. Some of these species may comprise populations of tens of thousands of breeding, migrant or wintering birds. Species of conservation concern found using marine habitats within the Marine RSA include short-tailed albatross, Brandt's cormorant, double-crested cormorant, western grebe, great blue heron, common murre, horned puffin, marbled murrelet, surf scoter, red knot, long-billed curlew and peregrine falcon (Badzinzki *et al.* 2008, BC CDC 2013). Breeding colonies of double-crested cormorants, pelagic cormorants, black oystercatchers, rhinoceros auklets, Cassin's auklets, tufted puffins, pigeon guillemots, great blue herons, fork-tailed and Leach's storm-petrels and glaucous-winged gulls are documented within the Salish Sea (Chatwin *et al.* 2002, Elliot *et al.* 2005, Vermeer 1983, Wahl *et al.* 1981). Substantial breeding areas in the Salish Sea are located on Protection Island, Tatoosh Island, Smith and Minor Islands in the US, and Mandarte Island and Race Rocks in Canada (Wahl *et al.* 1981). Multiple non-colonial species also breed in these areas (Wahl *et al.* 1981, Burton 2010).

In BC, marine habitats are adversely affected by recreational activities, commercial fishing, fish farms, industrial developments, timber harvesting and vessel operations, which have reduced important habitats for marine birds, with the exception of some designated conservation areas. Marine and coastal ecosystems are subject to large-scale changes and fluctuations in productivity.

#### 4.2.8.2.1 Conservation Areas

Provincially designated conservation areas include Wildlife Management Areas, MPAs, RCAs, Ecological Reserves, and Provincial Parks (Table 4.2.8.1, Figure 4.2.3). Both pelagic and coastal waters are used seasonally by a wide variety of breeding, foraging and over-wintering marine birds especially in extensive tidal mudflats, eelgrass beds, rocky offshore islets and old-growth forest (Parks Canada 2009b). Federal protection designations include Migratory Bird Sanctuaries (CWS), DFO MPAs, National Marine Conservation Areas (Parks Canada), National Parks of Canada (Parks Canada), National Wildlife Areas (CWS) and Critical Habitat (*SARA*) (Figure 4.2.26).

**TABLE 4.2.8.1**

**CONSERVATION AREAS WITHIN AND NEAR THE MARINE RSA**

| Conservation Area Type | Conservation Area Title |
|---|---|
| MPA | Race Rocks |
| Migratory Bird Sanctuary | George C. Reifel Migratory Bird Sanctuary |
| National Wildlife Area | Alaksen National Wildlife Area |
| RAMSAR | Fraser River Delta |
| National Marine Conservation Area Reserve | Southern Strait of Georgia National Marine Conservation Area Reserve (PROPOSED) |
| RCA | Mayne Island North |
| RCA | McCall Bank |
| RCA | Halibut Bank |

**TABLE 4.2.8.1**

**CONSERVATION AREAS WITHIN AND NEAR THE MARINE RSA (continued)**

| Conservation Area Type | Conservation Area Title |
|---|---|
| RCA | Valdes Island East |
| RCA | Galiano Island North |
| WMA | Roberts Bank WMA |
| WMA | Boundary Bay WMA |
| WMA | Sturgeon Bank WMA |
| WMA | South Arm Marshes WMA |
| Ecological Reserve | Oak Bay Islands Ecological Reserve |
| Ecological Reserve | Ten Mile Point Ecological Reserve |
| Ecological Reserve | Trial Islands Ecological Reserve |
| Ecological Reserve | Race Rocks Ecological Reserve |
| Ecological Reserve | Galiano Island Ecological Reserve |
| Ecological Reserve | Ballingall Islets Ecological Reserve |
| Ecological Reserve | Canoe Islets Ecological Reserve |
| Ecological Reserve | Rose Islets Ecological Reserve |
| Ecological Reserve | Hudson Rocks Ecological Reserve |
| Ecological Reserve | Satellite Channel Ecological Reserve |

#### 4.2.8.2.2 Important Bird Areas

There are 20 IBAs present within the Marine RSA (Table 4.2.8.2, Figure 4.2.2.6), which range in size from 140 ha to 153,717 ha. Detailed information on the importance of each of these IBAs was gathered from Bird Studies Canada and Nature Canada (2012) and BirdLife International (2012a).

**TABLE 4.2.8.2**

**IMPORTANT BIRD AREAS FOUND WITHIN AND NEAR THE MARINE RSA**

| IBA Name | Regulatory Prov/State | Central Coordinates | Size (ha) | Details | Bird Colonies | IBA Trigger Species | Globally Significant Species | Proximity to Marine Bird LSA and Marine RSA |
|---|---|---|---|---|---|---|---|---|
| Active Pass (BC015) | BC | 123° 18.06' W<br>48° 52.25' N | 1,700 (4.5 km long) | • Between Galiano and Mayne Islands in the southwest of the Strait of Georgia<br>• Approximately 40 km south of Vancouver and 50 km north of Victoria<br>• High intertidal and subtidal biodiversity<br>• Rich feeding ground for fish-eating avifauna during tidal ebbs in spring, fall and winter | • None | • 2,000 individual Pacific loons<br>• 4,000 individual Brandt's cormorants<br>• 10,000 individual Bonaparte's gulls | • Pacific loon<br>• Brandt's cormorant<br>• Bonaparte's gull | Within the Marine RSA, approximately 12 km northwest of the Marine Birds LSA |
| Boundary Bay and Roberts Bank (BC017) | BC | 123º 7.26' W<br>49º 9.05' N | 76,000 | • Encompasses Boundary Bay and the estuarine coastal wetland areas of Sturgeon Bank and Roberts Bank, the waters north and south of the south arm of the Fraser River and Point Roberts (US)<br>• Includes 3 separate areas (Boundary Bay, Roberts Sturgeon Banks) that many species move frequently between<br>• A variety of habitats include mudflats and intertidal marshes<br>• Low tides expose large mudflats and extensive eelgrass beds in bays | • Great blue heron | • 46,700 individual snow geese<br>• 4,751 individual Brants<br>• 526 individual Trumpeter swans<br>• 30,500 individual American wigeons<br>• 20,950 individual mallards<br>• 24,940 individual northern pintails<br>• 2,576 individual red-necked grebes<br>• 3,000 individual western grebes<br>• 1,600 individual grey plovers<br>• 500,000 individual western sandpipers<br>• 29,000 individual dunlins<br>• 19,000 individual glaucous-winged gulls | • N/A | Within the Marine RSA, adjacent (< 2 km) to the Marine Birds LSA |
| English Bay and Burrard Inlet (BC020) | BC | 123º 5.52' W<br>49º 17.87' N | 14,009 | • Burrard Inlet is a sheltered fjord of Strait of Georgia<br>• Includes False Creek and English Bay, Vancouver Harbour, Port Moody Arm and Indian Arm<br>• Most of shoreline is rocky or built up with port facilities and seawalls<br>• Extensive tidal sandflats, mudflats and saltwater marshes, inlets and coastal features | • Purple martin (nest boxes)<br>• Great blue heron | • 183 breeding pairs of great blue heron | • Western grebe<br>• Barrow's goldeneye<br>• Surf scoter | Within the Marine RSA and Marine Birds LSA near Westridge Marine Terminal |
| White Islets and Wilson Creek (BC025) | BC | 123° 42' 43.2" W<br>49° 25' 4.7994" N | 2,938 | • Located approximately 6 km southeast of Sechelt, where Wilson Creek discharges into the Strait of Georgia, the shoreline on both sides of Wilson Creek and approximately 2 km offshore in a 2 km radius around the islets<br>• White Islets are small and rocky with rock crevices<br>• Wilson Creek shoreline is composed of sand and gravel substrates<br>• Sub-tidal habitats are ideal feeding areas for surf scoters and harlequin ducks | • None | • 490 breeding pairs of glaucous-winged gulls<br>• 1,000 breeding pairs of surfbirds | • Surfbird | Within the Marine RSA, approximately 27 km northwest of the Marine Birds LSA |

**TABLE 4.2.8.2**

**IMPORTANT BIRD AREAS FOUND WITHIN AND NEAR THE MARINE RSA (continued)**

| IBA Name | Regulatory Prov/State | Central Coordinates | Size (ha) | Details | Bird Colonies | IBA Trigger Species | Globally Significant Species | Proximity to Marine Bird LSA and Marine RSA |
|---|---|---|---|---|---|---|---|---|
| Chain Islets and Great Chain Island (BC045) | BC | 123° 16.16' W<br>48° 25.22' N | 140 | • Located in Oak Bay in Juan de Fuca Strait, approximately 2 km from Victoria<br>• Encompasses a radius of approximately 700 $m^2$ of marine water<br>• 18 small islets and rocks clustered within Mayor Channel<br>• Shorelines comprise steep cliff faces, rocky outcrops, boulders, crevices and small gravel beaches<br>• Waters are shallow with emerging rocky reefs | • Pelagic cormorant | • 2,432 breeding pairs of glaucous-winged gulls<br>• 2,000 individual Brandt's cormorants<br>• 510 breeding pairs of double-crested cormorants | • Glaucous-winged gull<br>• Brandt's cormorant | Within the Marine RSA, adjacent (<2 km) to the Marine Birds LSA |
| Sidney Channel (BC047) | BC | 123º 21' 28.8'' W<br>48º 37' 33.59'' N | 8,710 | • Situated along the extreme southeast shore of Vancouver Island between James Island and Sidney Island<br>• 4 km wide channel that connects Haro Strait and the Strait of Georgia<br>• Lagoon present at the northwestern end of Sidney Island<br>• Supports large schools of sand lance in the marine substrate that provide food for marine birds in spring and summer | • None | • 3,000 individual Brants<br>• 20 breeding pairs of black oystercatchers<br>• 900 individual Brandt's cormorants<br>• 50 individual great blue herons<br>• 500 individual mew gulls<br>• 300 individual pigeon guillemots | • Brandt's cormorant<br>• Mew gull | Within the Marine RSA, approximately 5 km east of Marine Birds LSA |
| Cowichan Estuary (BC048) | BC | 123º 34.48' W<br>48º 44.35' N | 1,300 | • No site description | • None | • 216 individual Trumpeter swans<br>• 724 individual mew gulls<br>• 530 individual Thayer's gulls | • N/A | Within the Marine RSA, approximately 20 km northwest of the Marine Birds LSA |
| Porlier Pass (BC052) | BC | 123° 35' 27.59" W<br>49° 0' 43.2" N | 1,558<br><br>(2 km long) | • Situated in the Southern Gulf Islands between the south end of Valdes Island and the north end of Galiano Island<br>• 1.5 km radius<br>• Extends along the north shoreline of Galiano Island from Alcala Point to Dionisio Point, and from Shah Point to Cardale Point on the south end of Valdes Island<br>• Strong tidal currents surge through the pass each day causing strong upwellings in the narrow passage | • Glaucous-winged gull<br>• Black oystercatchers | • 1,000 individual mew gulls | • Mew gull | Within the Marine RSA, approximately 12 km east of the Marine Birds LSA |
| Snake Island (BC055) | BC | 123° 53' 27.6" W<br>49° 12' 57.6" N | 396 | • Approximately 3 km northwest of Gabriola Island in the Strait of Georgia on the approach to Nanaimo Harbour<br>• Encompasses a long, narrow sandstone island surrounded by the marine waters in a 1 km radius | • Glaucous-winged gull<br>• Pelagic cormorant | • 673 breeding pairs of glaucous-winged gulls<br>• 74 breeding pairs of pelagic cormorants | • N/A | Within the Marine RSA, approximately 35 km east of the Marine Birds LSA |

**TABLE 4.2.8.2**

**IMPORTANT BIRD AREAS FOUND WITHIN AND NEAR THE MARINE RSA (continued)**

| IBA Name | Regulatory Prov/State | Central Coordinates | Size (ha) | Details | Bird Colonies | IBA Trigger Species | Globally Significant Species | Proximity to Marine Bird LSA and Marine RSA |
|---|---|---|---|---|---|---|---|---|
| Little Qualicum Estuary to Nanoose Bay (BC056) | BC | 124º 12.86' W<br>49º 18.37' N | 17,000 | • Encompasses 30 km of Vancouver Island coastline from Little Qualicum River estuary to Nanoose Harbour, and extends a few km upriver in several estuaries and into the Strait of Georgia<br>• Includes some small islands off Nanoose Bay Peninsula<br>• Shoreline mostly comprised of rock and large tidal flats of sand, rock, pools, eelgrass beds and mud | • None | • 5,415 individual Brant geese<br>• 4,800 individual western grebes<br>• 960 individual Thayer's gulls | • Brant goose | Within the Marine RSA, approximately 55 km east of the Marine Birds LSA |
| Amphitrite and Swiftsure Banks (BC097) | BC | 125º 19.86' W<br>48º 43.25' N | 10,800 | • Two small areas of rich productive water off the West Coast of Vancouver Island<br>• Amphitrite Bank (approximately 90 km²) is about 6 km southwest of Ucluelet<br>• Swiftsure Bank (18 km²) is separate and further to the south, being about 15 km southwest of the western end of Nitinat Lake | • None | • 15,000 individual California gulls | • N/A | Within the Marine RSA, approximately 15 km north of the Marine Birds LSA |
| Western Strait of Juan de Fuca | Washington | 124º 5' 59.9'' W<br>48º 12' 0'' N | 153,717<br>(100 km long) | • Extends from Koitlah Point at the northwest corner of Neah Bay eastward to the mouth of Dry Creek, 3.5 km east of the mouth of the Elwha River<br>• The entire site is within the nearshore ecological zone (*i.e.*, < 30 m depth) except on the stretches of coast between Tongue Point and Observatory Point, and between Slip Point and Pillar Point | • None | • 1,116 individual marbled murrelets | • Marbled murrelet | Within the Marine RSA, approximately 5 km southeast of the Marine Birds LSA |
| Port Angeles MAMU | Washington | 123º 30' 43.2'' W<br>48º 9' 43.2'' N | 8,729 | • Located in the Puget Trough/Georgia Basin Marine Ecoregion<br>• Extensive estuary with a long narrow sands spit and a large deep-water harbor<br>• Olympic National Park has old-growth forests, breeding habitat for Marbled Murrelet | • None | • 870 breeding individual of marbled murrelets | • N/A | Within the Marine RSA, approximately 5 km south of the Marine Birds LSA |
| Port Angeles Harbor/<br>Ediz Hook | Washington | 123º 25' 58.8'' W<br>48º 7' 58.8'' N | 1,364 | • Includes Port Angeles Harbor, Ediz Hook, and shallow marine waters immediately north and west of Ediz Hook<br>• Port Angeles Harbor is the deepest harbor on the US West Coast, with depths up to 50 m<br>• Protected from the open marine waters by Ediz Hook, a 5 km-long spit comprising about 80 ha of sand/gravel beach and rocky breakwater<br>• Highly industrialized<br>• Contains large shipping facilities, a marina and commercial net pens | • None | • 400 individual Heermann's gulls | • N/A | Within the Marine RSA, approximately 5 km south of the Marine Birds LSA |

**TABLE 4.2.8.2**

**IMPORTANT BIRD AREAS FOUND WITHIN AND NEAR THE MARINE RSA (continued)**

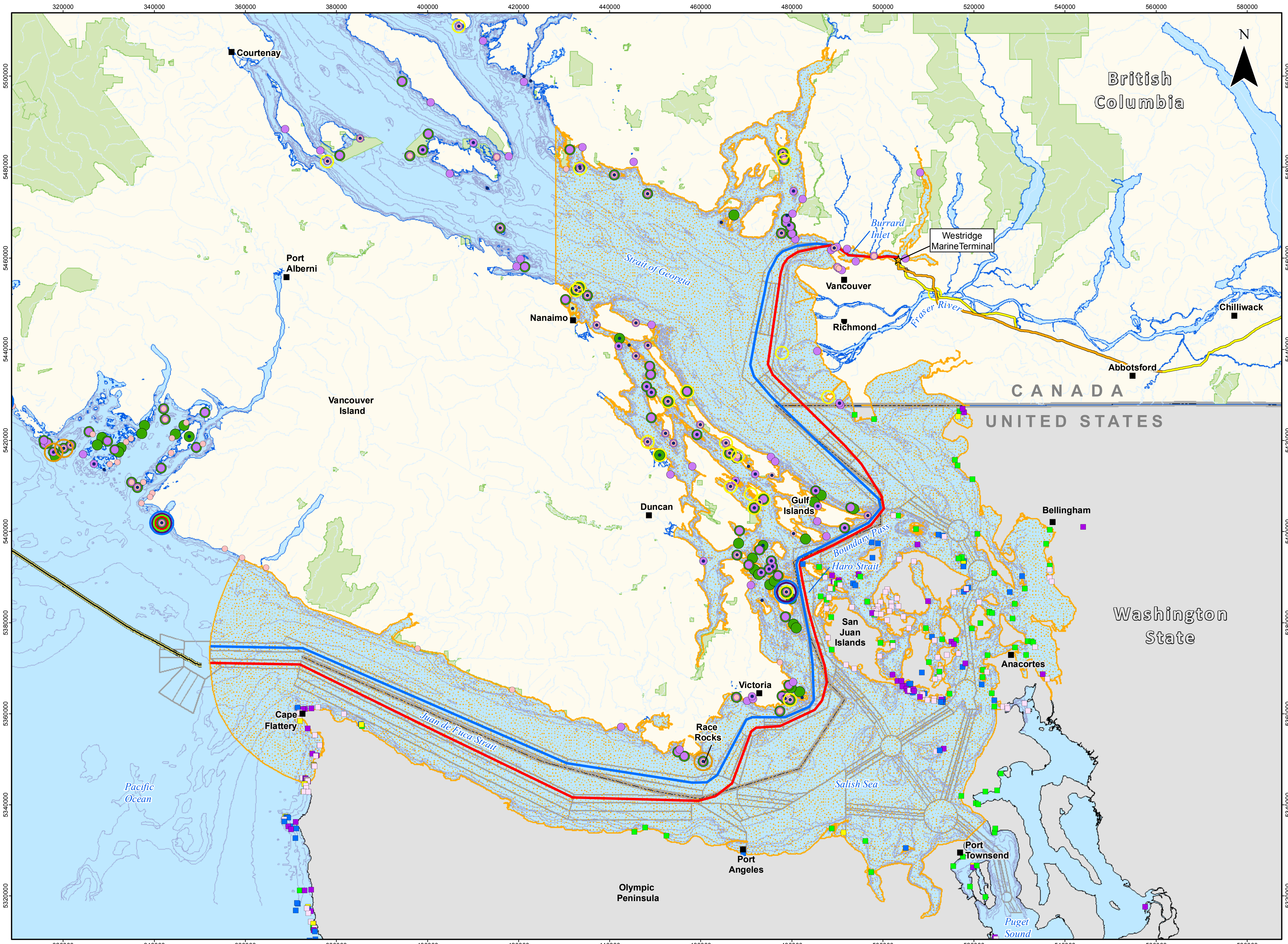
| IBA Name | Regulatory Prov/State | Central Coordinates | Size (ha) | Details | Bird Colonies | IBA Trigger Species | Globally Significant Species | Proximity to Marine Bird LSA and Marine RSA |
|---|---|---|---|---|---|---|---|---|
| Dungeness Bay | Washington | 123º 9' 0'' W<br>48º 10' 12'' N | 2,203 | • North shore of the Olympic Peninsula,<br>• includes intertidal and subtidal waters of Dungeness Bay, Dungeness Spit, the Dungeness River estuary and adjacent wetlands<br>• Comprises extensive sandflats and mudflats<br>• Adjacent coastal wetlands contain fresh water, estuarine marshes and ponds maintained by a seasonally high water table | • None | • 25 individual bald eagles<br>• 8,000 individual Brants<br>• 100 individual common loons<br>• 83 individual great blue herons<br>• 3 individual merlins<br>• 3 individual Peregrine falcons | • N/A | Within the Marine RSA, approximately 20 km southeast of the Marine Birds LSA |
| Sequim Bay | Washington | 123º 1' 11.9'' W<br>48º 4' 12'' N | 14,950 | • Includes open waters and intertidal zones of Sequim Bay, Washington Harbor, Travis Spit, Gibson Spit, the beaches and bluffs north of Gibson Spit as far north as Marlyn Nelson county park at Port Williams and the marine waters of Juan de Fuca Strait adjacent to the mouth of Sequim Bay | • None | • 215 individual black-bellied plovers<br>• 1,775 individual dunlins<br>• 260 individual Heermann's gulls | • N/A | Within the Marine RSA, approximately 35 km southeast of the Marine Birds LSA |
| Protection Island | Washington | 122º 54' 0'' W<br>48º 6' 0'' N | 275 | • No site description | • None | • 300 breeding pairs of double-crested cormorants<br>• Glaucous-winged gull<br>• Pelagic cormorant<br>• Pigeon guillemot<br>• Rhinoceros auklet<br>• Tufted puffin | • N/A | Within the Marine RSA, approximately 30 km southeast of the Marine Birds LSA |
| Deception Pass | Washington | 122º 35' 59.9'' W<br>48º 23' 59.9'' N | 300 | • Marine waters in Deception Pass State Park Deception Pass Bridge past West Point to Deception Island and past Lighthouse Point to Northwest Island<br>• Narrow and shallow<br>• Huge volumes of tidewater funnel through at speeds up to 8 knots<br>• Water speeds decrease rapidly within 0.8 km of the pass<br>• Bounded by rocky shores and cliffs with a few beaches | • None | • 17 individual black oystercatchers<br>• 378 individual pigeon guillemots<br>• 670 non-breeding individual red-throated loons | • N/A | Within the Marine RSA, approximately 35 km east of the Marine Birds LSA |
| Samish/Padilla Bays | Washington | 122º 30' 0'' W<br>48º 30' 0'' N | 59,000 | • Located near Anacortes<br>• Extensive shallow bays (Similk, Fidalgo, Padilla and Samish) and associated mudflats and sloughs<br>• Sheltered bays and sloughs provide critical wintering area for seabirds, ducks and geese<br>• Shelter and food for large concentrations of seabirds<br>• Some of the most extensive eelgrass beds on the West Coast | • None | • 60 non-breeding individual black oystercatchers<br>• 1,130 non-breeding individual Brants<br>• 11,456 non-breeding individual dunlins<br>• 1,105 breeding individual great blue herons<br>• 102 non-breeding individual marbled murrelets<br>• 89 non-breeding individual red-necked grebes<br>• 984 non-breeding individual trumpeter swans<br>• 520 non-breeding individual western grebes | • Brant<br>• Trumpeter swan | Within the Marine RSA, approximately 40 km east of the Marine Birds LSA |

TRANS MOUNTAIN

# FIGURE: 4.2-26

## BIRD BREEDING AREAS IN AND NEAR THE MARINE RSA

## TRANS MOUNTAIN EXPANSION PROJECT




- Westridge Marine Terminal
- Town / City
- Marine Vessel Inbound Shipping Lane
- Marine Vessel Outbound Shipping Lane
- International Border
- Canadian 12 Nautical Mile Territorial Boundary
- Bathymetry
- Watercourse
- Existing Trans Mountain Pipeline
- Trans Mountain Expansion Proposed Pipeline Corridor
- Waterbody
- Provincial Park
- Traffic Separation Scheme
- Land of British Columbia
- Land of Washington State
- Marine RSA (Transportation)

**BC Marine Bird Colonies**

- Pigeon Guillemot Colonies
- Pelagic Cormorant Colonies
- Glaucous-winged Gull Colonies
- Black Oystercatcher Breeding Areas
- Double-crested Cormorant Colonies
- Cassin's Auklet Colonies
- Brandt's Cormorant Colonies
- Rhinoceros Auklet Colonies
- Tufted Puffin Colonies
- Fork-tailed and Leach's Storm-petrels Colonies

**Washington Marine Bird Colonies**

- Alcids (Possibly Others)
- Commorants (Possibly Others)
- Alcids and Commorants (Possibly Others)
- Other Seabirds
- Unknown

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Projection: UTM Zone 10N; Marine Vessel Inbound Shipping Lane: Moffatt & Nichol, 2013a; Marine Vessel Outbound Shipping Lane: Moffatt & Nichol, 2013b; International Border: British Columbia Ministry of Energy and Mines, 2013; Canadian 12 Nautical Mile Territorial Boundary and Traffic Separation Scheme: Canadian Hydrographic Service, 2013; 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; Provincial Park: BC MFLNRO, 2008a; Land of British Columbia: National Topographic Data Base, 2007; Land of Washington State: Washington State Department of Ecology, 1994; Bird Colonies: Environment Canada, 2008; Coastal Resource Information Management System (CRIMS), 2011; Washington State DFW, 1989.

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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 SS | CHECKED SD | DESIGN SD |

SCALE: 1:800,000

0 5 10 15 20 km

ALL LOCATIONS APPROXIMATE

10494_ea_trans_mar_04_02_26_important_breeding_areas_in_and_near_rsa.mxd

#### *4.2.8.3 Field Data Collection*

The abundant literature and data resources currently available for marine ecological information within the Marine RSA is deemed sufficient for the assessment of potential effects of the increased Project-related marine traffic on indicator species. Studies to pursue the collection of additional marine bird biological field data were considered unnecessary.

#### *4.2.8.4 Database and Information Gathering*

The marine bird knowledge base is derived from a review of relevant literature and databases from peer-reviewed journals, government reports and other documents, local publications, technical reports, electronic resources including:

- BC Species and Ecosystems Explorer;
- COSEWIC assessments and status reports;
- Species at Risk Public Registry; and
- Washington State Coastal Atlas.

Local and regional data (Bird Studies Canada, BC Breeding Bird Atlas, BC Marine Bird Atlas, Project Feederwatch, Great Backyard Bird Count, eBird), the Marine Atlas of Pacific Canada and the Pacific North Coast Integrated Management Area, were also used to supplement the published reports. The information gathered was focused on marine bird ecology and life history, seasonal distribution and habitat use, abundance, and the effects of wake, visual disturbance, in-air and underwater noise, and avoidance of preferred foraging habitat.

Long-term data sets compiled by Naturecounts (Bird Studies Canada 2013a) have facilitated the characterization of marine bird distribution and abundance in the Marine RSA (Table 4.2.8.3) for species recorded between 1946 and 2012. These compiled data were derived from the following databases managed by Bird Studies Canada (2013):

- BC Breeding Bird Atlas (2008 to 2012);
- BC Coastal Waterbird Surveys (1999 to 2013);
- BC Marine Bird Atlas (2008 to 2009);
- Project Feederwatch (1988 to 2009);
- eBird (1946; 1967 to 1975; 1977 to 2013); and
- Great Backyard Bird Count (1998 to 2011).

## TABLE 4.2.8.3

## MARINE BIRDS OF THE MARINE RSA

| Species | Survey Type (No. Individuals Observed) | | | | | | Total Number of Individuals Observed | Per Cent of Overall Observations | BC List Status[1] | *SARA* Status[1] |
|---|---|---|---|---|---|---|---|---|---|---|
| | BC Coastal Waterbird Surveys | BC Marine Bird Atlas | BC Breeding Bird Atlas | Great Backyard Bird Count | Project Feederwatch | eBird | | | | |
| American Avocet | 5 | | | 34 | 2 | | 41 | 0.01 | Red | |
| American Bittern | 16 | | 6 | 331 | | | 353 | 0.11 | Blue | |
| American Black Duck | 1 | | | 7 | 1 | | 9 | 0.003 | Exotic | |
| American Coot | 240 | | 3 | 2,763 | 22 | | 3,028 | 0.93 | Yellow | |
| American Golden-Plover | 7 | | | 93 | | | 100 | 0.03 | Blue | |
| American White Pelican | | | | 8 | | | 8 | 0.002 | Red | |
| American Wigeon | 2,716 | 4 | 6 | 6,698 | 144 | | 9,568 | 2.92 | Yellow | |
| Ancient Murrelet | 60 | 63 | | 207 | | | 330 | 0.1 | Blue | Schedule 1 Special Concern (2006) |
| Arctic Loon | | | | 2 | | | 2 | 0.0006 | Not listed | |
| Arctic Tern | 1 | | | | | | 1 | 0.0003 | Yellow | |
| Baird's Sandpiper | 15 | | | 406 | | | 421 | 0.13 | Unknown | |
| Bald Eagle | 2,839 | 103 | 204 | 9,871 | 360 | 191 | 13,568 | 4.15 | Yellow | |
| Barrow's Goldeneye | 1,854 | 11 | | 746 | 91 | | 2,702 | 0.83 | Yellow | |
| Bar-tailed Godwit | | | | 40 | | | 40 | 0.01 | Accidental | |
| Belted Kingfisher | 1,391 | 1 | 88 | 3,039 | 52 | 8 | 4,579 | 1.4 | Yellow | |
| Black Brant | | | | 32 | | | 32 | 0.01 | | |
| Black Guillemot | 2 | | | | | | 2 | 0.001 | Not listed | |
| Black Oystercatcher | 1,401 | 63 | 72 | 3,048 | 59 | | 4,643 | 1.42 | Yellow | |
| Black Scoter | 444 | 2 | | 450 | 8 | | 904 | 0.28 | Yellow | |
| Black Swift | | | 4 | 109 | | | 113 | 0.03 | Yellow | |
| Black Turnstone | 824 | 20 | | 2,032 | 21 | | 2,897 | 0.89 | Yellow | |
| Black-bellied Plover | 433 | 2 | | 1,761 | 6 | | 2,202 | 0.67 | Yellow | |
| Black-crowned Night-Heron | 14 | | 1 | 1,121 | | | 1,136 | 0.35 | Red | |
| Black-footed Albatross | | | | 5 | | | 5 | 0.002 | Blue | Schedule 1 Special Concern (2009) |
| Black-headed Gull | | | | 5 | | | 5 | 0.002 | Accidental | |
| Black-legged Kittiwake | 1 | | | 22 | | | 23 | 0.01 | No Status | |
| Black-necked Stilt | | | 4 | 13 | | | 17 | 0.01 | No Status | |
| Blue-winged Teal | 8 | | 9 | 494 | | | 511 | 0.16 | Yellow | |
| Bonaparte's Gull | 483 | 59 | | 1,725 | 8 | | 2,275 | 0.7 | Yellow | |
| Brandt's Cormorant | 794 | 115 | 1 | 1,203 | 21 | | 2,134 | 0.65 | Red | |
| Brant | 320 | 8 | | 968 | 7 | | 1,303 | 0.4 | Blue | |
| Brown Pelican | 3 | | | 75 | | | 78 | 0.02 | No Status | |
| Buff-breasted Sandpiper | | | | 33 | | | 33 | 0.01 | No Status | |
| Bufflehead | 3,488 | 39 | 1 | 5,889 | 283 | | 9,700 | 2.97 | Yellow | |
| Buller's Shearwater | | | | 1 | | | 1 | 0.00 | Blue | |

## TABLE 4.2.8.3

## MARINE BIRDS OF THE MARINE RSA (continued)

| Species | Survey Type (No. Individuals Observed) | | | | | | Total Number of Individuals Observed | Per Cent of Overall Observations | BC List Status[1] | *SARA* Status[1] |
|---|---|---|---|---|---|---|---|---|---|---|
| | BC Coastal Waterbird Surveys | BC Marine Bird Atlas | BC Breeding Bird Atlas | Great Backyard Bird Count | Project Feederwatch | eBird | | | | |
| Cackling Goose | 14 | | | 318 | 1 | | 333 | 0.10 | Blue | |
| Small Cackling Goose | | | | 2 | | | 2 | 0.0006 | | |
| Taverner's Cackling Goose | | | | 1 | | | 1 | 0.0003 | | |
| California Gull | 691 | 109 | | 2,864 | 21 | | 3,685 | 1.13 | Blue | |
| Canada Goose | 2,095 | 54 | 156 | 6,904 | 210 | | 9,419 | 2.88 | Yellow | |
| Canvasback | 92 | | | 939 | 3 | | 1,034 | 0.32 | Yellow | |
| Caspian Tern | 127 | 2 | 2 | 1400 | | | 1,531 | 0.47 | Blue | |
| Cassin's Auklet | 4 | 1 | | 37 | | | 42 | 0.01 | Blue | |
| Cattle Egret | | | | 22 | | | 22 | 0.01 | No Status | |
| Cinnamon Teal | 13 | | 9 | 613 | | | 635 | 0.19 | Yellow | |
| Clark's Grebe | | 1 | | 12 | | | 13 | 0.004 | Red | |
| Cliff Swallow | | | 18 | 726 | | | 744 | 0.23 | Yellow | |
| Common Eider | | | | 2 | | | 2 | 0.001 | Accidental | |
| Common Goldeneye | 2,387 | 6 | | 2,594 | 123 | | 5,110 | 1.56 | Yellow | |
| Common Loon | 2,910 | 19 | 3 | 3,586 | 62 | | 6,580 | 2.01 | Yellow | |
| Common Merganser | 1,567 | 8 | 33 | 2,689 | 104 | | 4,401 | 1.35 | Yellow | |
| Common Murre | 511 | 205 | | 1,652 | 7 | | 2,375 | 0.73 | Red | |
| Common Raven | 425 | 1 | 162 | 3,691 | 206 | 200 | 4,685 | 1.43 | Yellow | |
| Common Snipe | | | | | 1 | | 1 | 0.0003 | Not listed | |
| Common Tern | 33 | | | 210 | | | 243 | 0.07 | Yellow | |
| Crested Auklet | | | | 3 | | | 3 | 0.0009 | Accidental | |
| Curlew Sandpiper | | | | 11 | | | 11 | 0.0034 | Accidental | |
| Double-crested Cormorant | 4,208 | 86 | 28 | 7,036 | 126 | | 11,484 | 3.51 | Blue | |
| Dunlin | 599 | 5 | | 2,604 | 19 | | 3,227 | 0.99 | Yellow | |
| Eared Grebe | 93 | 4 | | 235 | 3 | | 335 | 0.10 | Yellow | |
| Elegant Tern | | | | 11 | | | 11 | 0.0034 | Accidental | |
| Emperor Goose | | | | 11 | | | 11 | 0.0034 | Accidental | |
| Eurasian Wigeon | 462 | | | 1,193 | 38 | | 1,693 | 0.52 | No Status | |
| Far Eastern Curlew | | | | 1 | | | 1 | 0.0003 | Accidental | |
| Flesh-footed Shearwater | | | | 2 | | | 2 | 0.0006 | Blue | |
| Fork-tailed Storm-Petrel | | | | 9 | | | 9 | 0.0028 | Yellow | |
| Franklin's Gull | 4 | | | 53 | 1 | | 58 | 0.02 | Yellow | |
| Gadwall | 262 | | 17 | 3,363 | 5 | | 3,647 | 1.11 | Yellow | |
| Garganey | | | | 7 | | | 7 | 0.0021 | Accidental | |
| Glaucous Gull | 9 | | | 44 | 6 | | 59 | 0.02 | No Status | |
| Glaucous-winged Gull | 5,382 | 519 | 125 | 13,178 | 236 | 3 | 19,443 | 5.94 | Yellow | |

**TABLE 4.2.8.3**

**MARINE BIRDS OF THE MARINE RSA (continued)**

| Species | Survey Type (No. Individuals Observed) | | | | | | Total Number of Individuals Observed | Per Cent of Overall Observations | BC List Status[1] | *SARA* Status[1] |
|---|---|---|---|---|---|---|---|---|---|---|
| | BC Coastal Waterbird Surveys | BC Marine Bird Atlas | BC Breeding Bird Atlas | Great Backyard Bird Count | Project Feederwatch | eBird | | | | |
| Great Blue Heron | 2,659 | 27 | 88 | 10,054 | 162 | 11 | 13,001 | 3.97 | Blue | Schedule 1 |
| Great Egret | 3 | | | 20 | | | 23 | 0.01 | Accidental | |
| Greater Scaup | 705 | 3 | | 1,822 | 17 | | 2,547 | 0.78 | Yellow | |
| Greater White-fronted Goose | 30 | 4 | | 506 | | | 540 | 0.17 | Yellow | |
| Greater Yellowlegs | 473 | | | 2,690 | 9 | | 3,172 | 0.97 | Yellow | |
| Green Heron | 6 | | 2 | 50 | | | 58 | 0.02 | Blue | |
| Green-winged Teal | 957 | 1 | 7 | 4,393 | 23 | | 5,381 | 1.64 | Yellow | |
| Green-winged Teal (American) | | | | 300 | 14 | | 314 | 0.1 | | |
| Green-winged Teal (Eurasian) | 4 | | | 25 | | | 29 | 0.01 | | |
| Harlequin Duck | 2,354 | 51 | 2 | 2,646 | 73 | | 5,126 | 1.57 | Yellow | |
| Heermann's Gull | 186 | 24 | | 1,490 | | | 1,700 | 0.52 | Yellow | |
| Herring Gull | 312 | | | 538 | 53 | 1 | 904 | 0.28 | Yellow | |
| Hooded Merganser | 1,136 | 9 | 25 | 2,690 | 73 | | 3,933 | 1.20 | Yellow | |
| Horned Grebe | 2,213 | 14 | | 2,721 | 51 | | 4,999 | 1.53 | Yellow | |
| Hudsonian Godwit | 1 | | | 54 | | | 55 | 0.02 | Red | |
| Iceland Gull | 2 | | | 19 | | | 21 | 0.01 | Accidental | |
| Ivory Gull | | | | 11 | | | 11 | 0.003 | Accidental | |
| Killdeer | 620 | | 70 | 3,404 | 21 | | 4,115 | 1.26 | Yellow | |
| King Eider | 1 | | | 4 | | | 5 | 0.0015 | Accidental | |
| Kittlitz's Murrelet | | | | 3 | | | 3 | 0.0009 | Accidental | |
| Leach's Storm-Petrel | | | | 3 | | | 3 | 0.0009 | Yellow | |
| Least Bittern | | | | 1 | | | 1 | 0.0003 | Accidental | |
| Least Sandpiper | 60 | | | 1,647 | 1 | | 1,708 | 0.52 | Yellow | |
| Lesser Golden-Plover | 1 | | | | | | 1 | 0.00 | | |
| Lesser Sand-Plover | | | | 5 | | | 5 | 0.00 | Accidental | |
| Lesser Scaup | 355 | | | 1,940 | 19 | | 2,314 | 0.71 | Yellow | |
| Lesser Yellowlegs | 45 | | | 1,243 | 1 | | 1,289 | 0.39 | Yellow | |
| Little Gull | | | | 5 | | | 5 | 0.002 | Accidental | |
| Little Stint | | | | 6 | | | 6 | 0.002 | Accidental | |
| Long-billed Curlew | 41 | | | 256 | | | 297 | 0.09 | Blue | Schedule 1 |
| Long-billed Dowitcher | 88 | 1 | | 1,767 | 3 | | 1,859 | 0.57 | Yellow | |
| Long-tailed Duck | 855 | 29 | | 806 | 8 | | 1,698 | 0.52 | Blue | |
| Long-tailed Jaeger | 2 | | | 3 | | | 5 | 0.002 | No Status | |
| Mallard | 3,046 | 6 | 102 | 9,597 | 219 | 16 | 12,986 | 3.97 | Yellow | |
| Mallard x Northern Pintail | 1 | | | | | | 1 | 0.0003 | | |
| Mallard x Northern Pintail (hybrid) | | | | 36 | | | 36 | 0.01 | | |

## TABLE 4.2.8.3

## MARINE BIRDS OF THE MARINE RSA (continued)

| Species | Survey Type (No. Individuals Observed) | | | | | | Total Number of Individuals Observed | Per Cent of Overall Observations | BC List Status[1] | *SARA* Status[1] |
|---|---|---|---|---|---|---|---|---|---|---|
| | BC Coastal Waterbird Surveys | BC Marine Bird Atlas | BC Breeding Bird Atlas | Great Backyard Bird Count | Project Feederwatch | eBird | | | | |
| Mallard x Northern Shoveler (hybrid) | | | | 1 | | | 1 | 0.0003 | | |
| Mandarin Duck | | | | 1 | | | 1 | 0.0003 | Not listed | |
| Marbled Godwit | 52 | | | 382 | 1 | | 435 | 0.13 | Yellow | |
| Marbled Murrelet | 475 | 137 | 6 | 816 | 6 | | 1,440 | 0.44 | Blue | Schedule 1 |
| Mew Gull | 3,127 | 239 | 3 | 5,211 | 98 | | 8,678 | 2.65 | Yellow | |
| Mute Swan | 282 | 4 | 15 | 829 | 12 | | 1,142 | 0.35 | Exotic | |
| Northern Fulmar | | | | 20 | | | 20 | 0.01 | Red | |
| Northern Pintail | 932 | 1 | 2 | 5,016 | 33 | | 5,984 | 1.83 | Yellow | |
| Northern Shoveler | 255 | | 6 | 3,441 | 7 | | 3,709 | 1.13 | Yellow | |
| Northwestern Crow | 2,116 | | 197 | 12,411 | 347 | 344 | 15,415 | 4.71 | Yellow | |
| Osprey | 64 | | 41 | 650 | 2 | | 757 | 0.23 | Yellow | |
| Pacific Golden-Plover | 4 | | | 52 | | | 56 | 0.02 | No Status | |
| Pacific Loon | 1,138 | 47 | | 1,283 | 33 | | 2,501 | 0.76 | Yellow | |
| Parasitic Jaeger | 3 | 2 | | 121 | | | 126 | 0.04 | No Status | |
| Pectoral Sandpiper | 31 | | | 834 | | | 865 | 0.26 | Yellow | |
| Pelagic Cormorant | 3,055 | 400 | 46 | 3,241 | 79 | | 6,821 | 2.09 | Yellow | |
| Pied-billed Grebe | 227 | | 14 | 1,293 | 9 | | 1,543 | 0.47 | Yellow | |
| Pigeon Guillemot | 1,174 | 591 | 69 | 2,430 | 11 | | 4,275 | 1.31 | Yellow | |
| Pine Grosbeak | | | | | 1 | | 1 | 0.0003 | | |
| Pink-footed Shearwater | | | | 19 | | | 19 | 0.01 | Blue | Schedule 1 Threatened (2005) |
| Pomarine Jaeger | | | | 20 | | | 20 | 0.01 | No Status | |
| Purple Martin | 1 | | 66 | 601 | | | 668 | 0.20 | Blue | |
| Red Knot | 6 | | | 105 | | | 111 | 0.03 | Red | Schedule 1 Threatened (2007) |
| Red Phalarope | 1 | | | 20 | | | 21 | 0.01 | Unknown | |
| Red-breasted Merganser | 2,582 | 56 | 1 | 2,957 | 125 | | 5,721 | 1.75 | Yellow | |
| Redhead | 3 | | | 92 | | | 95 | 0.03 | Yellow | |
| Red-necked Grebe | 1,436 | 3 | | 1,443 | 10 | | 2,892 | 0.88 | Yellow | |
| Red-necked Phalarope | 9 | | | 426 | | | 435 | 0.13 | Blue | |
| Red-necked Stint | 1 | | | 9 | | | 10 | 0.0031 | Accidental | |
| Red-throated Loon | 791 | 3 | | 868 | 2 | | 1,664 | 0.51 | Yellow | |
| Rhinoceros Auklet | 451 | 244 | 9 | 1,958 | 1 | | 2,663 | 0.81 | Yellow | |
| Ring-billed Gull | 1,104 | 4 | | 2,572 | 7 | | 3,687 | 1.13 | Yellow | |
| Ring-necked Duck | 58 | | 2 | 1,206 | 18 | | 1,284 | 0.39 | Yellow | |
| Rock Sandpiper | 10 | | | 52 | | | 62 | 0.02 | Yellow | |
| Ross's Goose | | | | 4 | | | 4 | 0.001 | Accidental | |
| Ruddy Duck | 93 | | | 705 | 2 | | 800 | 0.24 | Yellow | |
| Ruddy Turnstone | 5 | | | 104 | | | 109 | 0.03 | Yellow | |
| Ruff | 1 | | | 44 | | | 45 | 0.01 | Accidental | |

## TABLE 4.2.8.3

## MARINE BIRDS OF THE MARINE RSA (continued)

| Species | Survey Type (No. Individuals Observed) | | | | | | Total Number of Individuals Observed | Per Cent of Overall Observations | BC List Status[1] | *SARA* Status[1] |
|---|---|---|---|---|---|---|---|---|---|---|
| | BC Coastal Waterbird Surveys | BC Marine Bird Atlas | BC Breeding Bird Atlas | Great Backyard Bird Count | Project Feederwatch | eBird | | | | |
| Sabine's Gull | 1 | | | 12 | | | 13 | 0.004 | No Status | |
| Sanderling | 277 | 3 | | 798 | 4 | | 1,082 | 0.33 | Yellow | |
| Sandhill Crane | 6 | | 5 | 1,449 | 1 | | 1,461 | 0.45 | Yellow | |
| Semipalmated Plover | 19 | | | 630 | | | 649 | 0.20 | Yellow | |
| Semipalmated Sandpiper | 8 | | | 488 | | | 496 | 0.15 | No Status | |
| Sharp-tailed Sandpiper | 2 | | | 117 | | | 119 | 0.04 | Yellow | |
| Short-billed Dowitcher | 38 | | | 600 | | | 638 | 0.20 | Blue | |
| Short-tailed Shearwater | | | | 13 | | | 13 | 0.004 | No Status | |
| Slaty-backed Gull | 2 | | | 1 | | | 3 | 0.001 | Accidental | |
| Smew | | | | 2 | | | 2 | 0.001 | Accidental | |
| Snow Goose | 152 | | | 2,031 | 1 | | 2,184 | 0.67 | Yellow | |
| Snowy Egret | | | | 1 | | | 1 | 0.0003 | Accidental | |
| Snowy Plover | | | | 1 | | | 1 | 0.0003 | Accidental | |
| Solitary Sandpiper | 2 | | | 87 | 1 | | 90 | 0.03 | Yellow | |
| Sooty Shearwater | | | | 87 | | | 87 | 0.03 | No Status | |
| Sora | | | 9 | 123 | | | 132 | 0.04 | Yellow | |
| South Polar Skua | | | | 1 | | | 1 | 0.0003 | No Status | |
| Spoon-billed Sandpiper | | | | 2 | | | 2 | 0.0006 | Accidental | |
| Spotted Redshank | | | | 3 | | | 3 | 0.0009 | Accidental | |
| Spotted Sandpiper | 128 | | 34 | 774 | 3 | | 939 | 0.29 | Yellow | |
| Stilt Sandpiper | 3 | | | 194 | | | 197 | 0.06 | No Status | |
| Surf Scoter | 3,170 | 55 | | 3,766 | 99 | | 7,090 | 2.17 | Blue | |
| Surfbird | 202 | 13 | | 456 | 6 | | 677 | 0.21 | Yellow | |
| Terek Sandpiper | | | | 2 | | | 2 | 0.0006 | Accidental | |
| Thayer's Gull | 697 | | | 1,022 | 20 | | 1,739 | 0.53 | Yellow | |
| Trumpeter Swan | 162 | | | 1,490 | 36 | 2 | 1,690 | 0.52 | Yellow | |
| Tufted Duck | | | | 19 | | | 19 | 0.01 | Accidental | |
| Tufted Puffin | | | | 21 | | | 21 | 0.01 | Blue | |
| Tundra Swan | 6 | | | 87 | | | 93 | 0.03 | Blue | |
| Virginia Rail | 17 | | 23 | 636 | 1 | | 677 | 0.21 | Yellow | |
| Wandering Tattler | 3 | 1 | | 68 | | | 72 | 0.02 | Blue | |
| Western Grebe | 988 | 7 | | 1,412 | 23 | | 2430 | 0.74 | Red | |
| Western Gull | 189 | | | 507 | 17 | | 713 | 0.22 | Yellow | |
| Western Sandpiper | 189 | | | 2,353 | 6 | | 2,548 | 0.78 | Yellow | |
| Whimbrel | 28 | | | 296 | | | 324 | 0.10 | Yellow | |
| White-rumped Sandpiper | | | | 12 | | | 12 | 0.004 | Accidental | |

**TABLE 4.2.8.3**

**MARINE BIRDS OF THE MARINE RSA (continued)**

| Species | Survey Type (No. Individuals Observed) | | | | | | Total Number of Individuals Observed | Per Cent of Overall Observations | BC List Status[1] | *SARA* Status[1] |
|---|---|---|---|---|---|---|---|---|---|---|
| | BC Coastal Waterbird Surveys | BC Marine Bird Atlas | BC Breeding Bird Atlas | Great Backyard Bird Count | Project Feederwatch | eBird | | | | |
| White-winged Scoter | 1,330 | 4 | | 1,490 | 21 | | 2,845 | 0.87 | Yellow | |
| Willet | 24 | | | 232 | 1 | | 257 | 0.08 | Accidental | |
| Wilson's Phalarope | | | 2 | 193 | | | 195 | 0.06 | Yellow | |
| Wilson's Snipe | 60 | | 7 | 661 | 1 | | 729 | 0.22 | Yellow | |
| Wood Duck | 50 | | 36 | 1,591 | 6 | | 1,683 | 0.51 | Yellow | |
| Wood Sandpiper | | | | 8 | | | 8 | 0.0024 | Accidental | |
| Yellow-billed Loon | 10 | | | 18 | | | 28 | 0.01 | Blue | |
| Accipiter species | 1 | | | | | | 1 | 0.00 | | |
| Alcid species | 148 | | | 14 | | | 162 | 0.05 | | |
| American Wigeon x Mallard | | | | 1 | | | 1 | 0.0003 | | |
| Common x Barrow's Goldeneye | | | | 1 | | | 1 | 0.0003 | | |
| Cormorant species | 912 | 44 | | 241 | | | 1,197 | 0.37 | | |
| Crow species | | | | 3 | | | 3 | 0.001 | | |
| Dabbler species | 41 | | | | | | 41 | 0.01 | | |
| Dowitcher species | 24 | | | 114 | | | 138 | 0.04 | | |
| Duck species | 341 | 5 | | 223 | 3 | | 572 | 0.17 | | |
| Eagle species | | | | 1 | | | 1 | 0.0003 | | |
| Eurasian x American Wigeon | 4 | | | 52 | | | 56 | 0.02 | | |
| Glaucous-winged x Glaucous Gull | | | | 1 | | | 1 | 0.00 | | |
| Glaucous-winged x Western Gull | 174 | | 4 | 1,017 | 6 | | 1,201 | 0.37 | | |
| Goldeneye species | 73 | | | 22 | | | 95 | 0.03 | | |
| Goose species | 26 | | | 20 | | | 46 | 0.01 | | |
| Grebe species | 107 | | | 4 | | | 111 | 0.03 | | |
| Gull species | 1,963 | 54 | | 1,604 | 9 | 12 | 3,642 | 1.11 | | |
| Herring x Glaucous-winged Gull | | | | 47 | | | 47 | 0.01 | | |
| Jaeger species | | | | 17 | | | 17 | 0.01 | | |
| Larus species | | | | 9 | | | 9 | 0.00 | | |
| Loon species | 303 | 6 | | 92 | | | 401 | 0.12 | | |
| Merganser species | 16 | | | 6 | | | 22 | 0.01 | | |
| Peep species | | | | 184 | | | 184 | 0.06 | | |
| Phalarope species | 3 | | | 12 | | | 15 | 0.005 | | |
| Plover species | 1 | | | 1 | | | 2 | 0.001 | | |
| Scaup species | 350 | | | 145 | | | 495 | 0.15 | | |
| Scoter species | 542 | 1 | | 45 | | | 588 | 0.18 | | |
| Shearwater species | | | | 2 | | | 2 | 0.001 | | |
| Shorebird species | 154 | | | 49 | | | 203 | 0.06 | | |

**TABLE 4.2.8.3**

**MARINE BIRDS OF THE MARINE RSA (continued)**

| Species | Survey Type (No. Individuals Observed) | | | | | | Total Number of Individuals Observed | Per Cent of Overall Observations | BC List Status[1] | *SARA* Status[1] |
|---|---|---|---|---|---|---|---|---|---|---|
| | BC Coastal Waterbird Surveys | BC Marine Bird Atlas | BC Breeding Bird Atlas | Great Backyard Bird Count | Project Feederwatch | eBird | | | | |
| Swan species | 9 | | | 31 | | | 40 | 0.01 | | |
| Teal species | | | | 4 | | | 4 | 0.0012 | | |
| Tern species | 3 | | | 1 | | | 4 | 0.0012 | | |
| Tringa species | | | | 1 | | | 1 | 0.0003 | | |
| Yellowlegs species | 12 | | | 3 | | | 15 | 0.0046 | | |
| **Total Numbers of Individuals** | **87,861** | **3,603** | **1,845** | **228,967** | **4,073** | **788** | **327,137** | **--** | **--** | **--** |
| **Total Number of Species** | **154** | **62** | **51** | **214** | **89** | **10** | **222** | **--** | **--** | **--** |
| **Indicator Species Per Cent** | **10.211** | **--** | **--** | **--** | **--** | **--** | **--** | **--** | **--** | **--** |

**Sources:** BC CDC 2013, Government of Canada 2013a,b.

**Note:** 1 See Section 4.2.1.3 for definitions of *SARA* and BC List status.

### *4.2.8.5 Conservation Status*

Based on a review of the COSEWIC, the federal *SARA* public registry list (Schedule 1) and the BC CDC Red and Blue lists, 19 species of waterfowl and coastal seabirds at risk have been identified as potentially occurring within the Marine RSA (Table 4.2.8.4). The Conservation Framework (CF), established by the BC government, guides efforts to conserve species and ecosystems by establishing priorities for action. Management action is based on five criteria (rated on a scale of 1 [highest] to 6 [lowest]): global and provincial status; trends; threats; stewardship responsibility; and feasibility of recovery. Of all the marine birds that use marine habitats along the south coast, and whose ranges overlap with the marine transportation route, eight are identified on Schedule 1 of the *SARA* (four are Threatened and four are of Special Concern). Several others are provincially Red- or Blue-listed species (Table 4.2.8.4).

**TABLE 4.2.8.4**

**MARINE BIRD SPECIES AT RISK POTENTIALLY OCCURRING WITHIN THE MARINE RSA**

| Common Name | Scientific Name | *SARA* (Schedule 1 Status)[1] | COSEWIC Status[1] | BC Status[1] | CF Priority[2] |
|---|---|---|---|---|---|
| Black-footed albatross | *Phoebastria nigripes* | Special Concern (2009) | Special Concern (2007) | Blue | 2 |
| Short-tailed albatross | *Phoebastria albatrus* | Threatened (2005) | Threatened (2003) | Red | 1 |
| Pink-footed shearwater | *Puffinus creatopus* | Threatened (2005) | Threatened (2004) | Blue | 2 |
| Brant | *Branta bernicla* | No status | No status | Blue | 2 |
| Northern fulmar | *Fulmarus glacialis* | No status | No status | Red | 2 |
| Great blue heron | *Ardea herodias fannini* | Special Concern (2010) | Special Concern (2008) | Blue | 1 |
| Double-crested cormorant | *Phalacrocorax auritus* | No status | Not at Risk (1978) | Blue | 1 |
| Brandt’s cormorant | *Phalacrocorax penicillatus* | No status | No status | Red | 1 |
| Pelagic cormorant | *Phalacrocorax pelagicus pelagicus* | No status | No status | Red | 2 |
| Caspian tern | *Hydroprogne caspia* | No status | Not at Risk (1999) | Blue | 2 |
| Long-billed curlew | *Numenius americanus* | Special Concern (2005) | Special Concern (2011) | Blue | 2 |
| Red knot | *Calidris canutus roselaari* | Threatened (2007) | Threatened (2007) | Red | 1 |
| Marbled murrelet | *Brachyramphus marmoratus* | Threatened (2003) | Threatened (2012) | Blue | 1 |
| Ancient murrelet | *Synthliboramphus antiquus* | Special Concern (2006) | Special Concern (2004) | Blue | 1 |
| Tufted puffin | *Fratercula cirrhata* | No status | No status | Blue | 2 |
| Horned puffin | *Fratercula corniculata* | No status | No status | Red | 2 |
| Cassin’s auklet | *Ptychoramphus aleuticus* | No status | Candidate (2011) | Blue | 2 |

**TABLE 4.2.8.4**

**MARINE BIRD SPECIES AT RISK POTENTIALLY OCCURRING WITHIN THE MARINE RSA (continued)**

| Common Name | Scientific Name | *SARA* (Schedule 1 Status)[1] | COSEWIC Status[1] | BC Status[1] | CF Priority[2] |
|---|---|---|---|---|---|
| Common murre | *Uria aalge* | No status | No status | Red | 2 |
| Thick-billed murre | *Uria lomvia* | No status | No status | Red | 2 |

**Sources:** BC CDC 2013, Government of Canada 2013a,b. List was updated on November 25, 2013.

**Notes:** 1 See Section 4.2.1.3 for definitions of COSEWIC, SARA and BC List status

2 CF Priority: Each species receives a rank of 1 (highest) through 6 (lowest) under each of the three goals: 1) contribute to global efforts for species and ecosystem conservation; 2) prevent species and ecosystems from becoming at risk; and 3) maintain the diversity of native species and ecosystems

Species not expected to be affected by the increased Project-related marine vessel traffic include albatrosses, shearwaters, fulmars, Brandt's cormorant, long-billed curlew and red knot due to their obligate pelagic nature and/or lack of breeding records and/or very low global population numbers. These criteria indicate their potential for occurrence within the Marine Birds LSA and Marine RSA will be rare.

### *4.2.8.6 Indicator Species*

Five indicator species were selected to represent potential Project-related effects on marine birds within the Marine Birds LSA and Marine RSA (see Table 4.2.8.5): the fork-tailed storm-petrel; Cassin's auklet; surf scoter; pelagic cormorant; and glaucous-winged gull. These species are intended to represent a set of foraging guilds in the overall diverse group of marine birds using the open water habitats present within the Marine Birds LSA and Marine RSA. All of these species are highly mobile and are, at times, widely distributed throughout the Marine RSA. See Section 4.3 for more information regarding indicators.

**TABLE 4.2.8.5**

**SUMMARY OF SELECTED MARINE BIRD INDICATORS**

| Common Name | Scientific Name | SARA (Schedule 1 Status)[1] | COSEWIC Status[1] | BC List Status[1] |
|---|---|---|---|---|
| Fork-tailed storm-petrel | *Oceanodroma furcata* | No status | No status | Yellow |
| Cassin's auklet | *Ptychoramphus aleuticus* | No status | Candidate (2011) | Blue |
| Surf scoter | *Melanitta perspicillata* | No status | No status | Blue |
| Pelagic cormorant | *Phalacrocorax pelagicus pelagicus* | No status | No status | Red |
| Glaucous-winged gull | *Larus glaucescens* | No status | No status | Yellow |

**Sources:** BC CDC 2013, Government of Canada 2013a,b

**Note:** 1 See Section 4.2.1.3 for definitions of COSEWIC, SARA and BC List status

#### 4.2.8.6.1 Fork-Tailed Storm-Petrel

The fork-tailed storm-petrel is found only in the North Pacific Ocean, is one of the most common marine birds breeding in Alaska, and the second most abundant and widespread of the storm-petrels (5 to 10 million individuals). It nests along the North American coast from northern California to Alaska. It appears to move offshore during the nonbreeding season and is associated with the continental-shelf break. In the breeding season, it feeds close to breeding colonies, in nearshore waters over the continental shelf.

The species is often seen foraging in small groups on the continental shelf or shelf break. It often follows ships during the day, and is often attracted by boat lights at night. It is mainly pelagic, spending up to eight months of the year at sea. Pairs generally nest in burrows or crevices in talus slopes, but also use burrows they excavate or side chambers of other burrowing seabirds.

The main diet is zooplankton, nekton and small fish, which are usually captured while hovering, pattering with wings partly spread, or dipping at the surface of the sea (Boersma and Silva 2000).

#### 4.2.8.6.2 Cassin's Auklet

The Cassin's auklet is found on islands from the Baja California Peninsula to the Aleutian Islands, Alaska. The center of population is BC, where an estimated 2 million birds were observed in the Scott Island group (1980) and 1.1 million on Triangle Island outside of the Marine RSA. Wintering populations move south, frequenting waters off the continental shelf edge.

Breeding primarily occurs along the coast of BC. This auklet nests in shallow burrows, which the birds excavate, and also in rock crevices or under trees or logs. During the non-breeding season, it spends most of its time at sea, with southern populations likely moving north and northern ones moving south to the central portion of its Pacific range. It is most abundant in waters of the continental shelf.

The preferred food includes small crustaceans, squid and larval/juvenile fish (Ainley *et al.* 2011).

#### 4.2.8.6.3 Pelagic Cormorant

The pelagic cormorant breeds along the Pacific Coast of North America from northern Alaska to Baja California (Hobson 1997, Campbell *et al.* 1990). It is present as both a resident and a migrant species in coastal areas of southwestern BC. There are two subspecies in BC: *P. pelagicus pelagicus* along the south coast in winter (provincially Blue-listed [BC CDC 2013]), and the resident *P. p. resplendens* which breeds from southern BC northwards (Campbell *et al.* 1990).

Pelagic cormorants prefer rocky coasts and sheltered habitat such as harbours and coves, and are rarely found far within inlets. Cliffs, reefs, unvegetated rocky islets and human-made structures, such as bridges and wharves, provide roosting habitat. Breeding colonies are located on rocky cliffs of islands or headlands, in caves, and on bridge pylons, towers, navigational beacons and other human-made structures (Campbell *et al.* 1990). Within Haro Strait, they have been recorded on Mandarte, Great Chain Islands, and to the north along Strait of Georgia at Five Fingers Island, Gabriola Island cliffs, Galiano Island cliffs, Hudson Rocks and Snake Island, North Pender Island cliffs, and Arbutus Island (Chatwin *et al.* 2002). Between 1955 and 2000, the number of pelagic cormorant nests within the Strait of Georgia declined by approximately 55 per cent (Chatwin *et al.* 2002). However, in recent years populations have been stable (Crewe *et al.* 2012).

Pelagic cormorants are divers that select prey from the littoral-benthic zone and are bottom feeders of solitary fish and invertebrates that live in rocky areas (Hobson 1997, Campbell *et al.* 1990, Ainley *et al.* 1981).

#### 4.2.8.6.4 Surf Scoter

Surf scoters are medium-distance migrants that are widely distributed along the entire BC coastline, especially during spring migration. The Strait of Georgia and Burrard Inlet are particularly important winter and spring staging grounds. Southward migration from inland breeding areas occurs from late August to October (BC CDC 2013), usually at night (Butler and Savard 1985). Large aggregations occur from a few hundred to several thousand individuals.

Wintering surf scoters usually forage within 1 km of the shore (Vermeer 1981). Non-breeding habitat includes sheltered freshwater and marine bays, harbours and lagoons. At these sites, birds prefer shallow marine waters, less than 10 m deep, with substrates of pebbles and sand (Goudie *et al.* 1994, Campbell *et al.* 1990). This species rarely uses estuaries, except during migration (Campbell *et al.* 1990, Savard *et al.*1998). Large numbers forage near steep shores of fjords where food resources (*e.g.*, mollusks) are abundant on submarine rocky walls (Vermeer 1981, Vermeer and Bourne 1984).

Surf scoters eat aquatic invertebrates on its breeding grounds and mollusks in spring, fall, and winter (Savard *et al.* 1998).

#### 4.2.8.6.5 Glaucous-Winged Gull

The glaucous-winged gull is an abundant resident along the northwest coast of North America, where its omnivorous food habits make it abundant in coastal cities and towns. It is present at coastal islands and cliffs from the north-central Bering Sea and Alaska, south to northwest Oregon. Relatively dense concentrations reside in all areas of the Salish Sea. Although generally an inshore species, it does venture from the coast where it is often seen around fishing vessels at sea.

In fresh water, in BC and Washington, it nests at high densities in large or small colonies on offshore islands, although it has recently begun nesting on roofs of waterfront buildings and pylons of bridges and other marine structures. Nests are typically on relatively treeless and small islands close to mainland where visibility is good. There were forty nests counted on support beams of the Ironworkers Memorial Second Narrows Crossing in 1980.

In BC, the gull feeds pelagically as far as the continental shelf (ca. within 100 km from shore), with a few individuals going as far as 300 km. It feeds in salt and brackish water (rarely freshwater) in bays, estuaries, harbors, city parks, beaches, mudflats, landfills and barren islands. A wide variety of fish, marine invertebrates, garbage, and carrion are consumed (Hayward and Verbeek 2008).

### *4.2.8.7 Aboriginal Traditional Knowledge*

Traditional harvesting of marine resources, including marine birds for food and other purposes, has historically been and remains important for coastal Aboriginal communities in the Marine RSA. Ducks hold cultural importance to coastal communities, and their feathers are used to insulate clothing (Canadian Environmental Assessment Agency 2006, Suttles 2006). Birds may be shot or snared, or hunted by net and spear. Common kinds of birds and eggs harvested in the Marine RSA include goldeneye, canvasback, ruddy duck, wood duck, American wigeon, northern pintail, mallard, northern shoveler, green-winged teal, grebe and murre (First Nations Health Council 2011a, Jacques Whitford Ltd. 2006, Simonsen *et al*. 1995). Extensive studies completed by Fediuk and Thom (2003) with the Elders from various Salish communities have identified 31 bird species as culturally relevant that have been traditionally harvested (*e.g.*, black scoter, white scoter, murre, bald eagle, golden eagle, ruffed grouse, blue grouse, mallard, trumpeter swan, western grebe).

#### *4.2.8.8 US Waters*

The WDFW has set aside certain areas of Puget Sound marine waters for the protection and preservation of marine species and/or habitats. These are generally known as MPAs and include 9 Conservation areas, 16 Marine Preserves and 2 Sea Cucumber and Sea Urchin Commercial Harvest Exclusion Zones. The greater San Juan Island archipelago holds the most MPAs. Many of these sites provide habitat for breeding colonies of several species of marine birds. The north coast of the state has the largest MPA, the Olympic Coast National Marine Sanctuary. Several state parks, IBAs, federal historical parks and federal marine sanctuaries are also present in Puget Sound (Van Cleve *et al.* 2009, WDFW 2013a) as well as MPAs administered by other agencies, such as the Department of Natural Resources, as mentioned above.

### ***4.2.9 Marine Species at Risk***

This subsection identifies the federally and provincially listed marine species at risk (fish, mammals and birds) that may occur within the Marine RSA (Table 4.2.9.1), including those whose potential occurrence would be considered rare or unlikely. More detailed technical information pertaining to marine species at risk and their potential occurrence in the Marine RSA is presented in the marine fish and fish habitat, marine mammals and marine birds sections (Section 4.2.6, 4.2.7 and 4.2.8 respectively).

A discussion of the potential effects of the increased Project-related marine vessel traffic for marine species at risk can be found in Section 4.3.9.

This list was developed through a review of the federal Species at Risk Public Registry, COSEWIC assessments and status reports, and the BC CDC Red and Blue lists.

A total of 53 marine species at risk have been identified as potentially occurring within the Marine RSA, including 19 marine fish and invertebrate species (or populations), 15 marine mammal species (or ecotypes) and 19 marine bird species (BC CDC 2013, Government of Canada 2013a,b).

## TABLE 4.2.9.1

## MARINE SPECIES AT RISK IN THE MARINE RSA

| Species Name (population[s]) | Taxon | *SARA* Status[1] | COSEWIC Status[1] | BC List Status[1] |
|---|---|---|---|---|
| Ancient murrelet *Synthliboramphus antiquus* | Marine bird | Special Concern Schedule 1 | Special Concern | Blue |
| Basking shark *Cetorhinus maximus* | Fish | Endangered Schedule 1 | Endangered | No Status |
| Black-footed albatross *Phoebastria nigripes* | Marine bird | Special Concern Schedule 1 | Special Concern | Blue |
| Blue whale *Balaenoptera musculus* | Marine mammal | Endangered Schedule 1 | Endangered | Red |
| Bluntnose sixgill *Shark Hexanchus griseus* | Fish | Special Concern Schedule 1 | Special Concern | No Status |
| Bocaccio Sebastes paucispinis | Fish | No Status | Threatened | No Status |
| Brandt's cormorant Phalacrocorax penicillatus | Marine bird | No Status | No Status | Red |
| Brant Branta bernicla | Marine bird | No Status | No Status | Blue |
| Canary rockfish Sebastes pinniger | Fish | No Status | Threatened | No Status |
| Caspian tern *Hydroprogne caspia* | Marine bird | No Status | Not at Risk | Blue |
| Cassin's auklet *Ptychoramphus aleuticus* | Marine bird | No Status | Candidate | Blue |
| Chinook salmon *Oncorhynchus tshawytscha* (Okanagan population) | Fish | No Status | Threatened | Yellow |
| Common murre *Uria aalge* | Marine bird | No Status | No Status | Red |
| Coho salmon *Oncorhynchus kisutch* (Interior Fraser population) | Fish | No Status | Endangered | No Status |
| Darkblotched rockfish *Sebastes crameri* | Fish | No Status | Special Concern | No Status |
| Double-crested cormorant *Phalacrocorax auritus* | Marine bird | No Status | Not at Risk | Blue |
| Eulachon *Thaleichthys pacificus* (Fraser River population) | Fish | No Status | Endangered | Blue |
| Fin whale *Balaenoptera physalus* | Marine mammal | Threatened Schedule 1 | Threatened | Red |
| Great blue heron *Ardea herodias fannini* | Marine bird | Special Concern Schedule 1 | Special Concern | Blue |

## TABLE 4.2.9.1

## MARINE SPECIES AT RISK IN THE MARINE REGIONAL STUDY AREA (continued)

| Species Name (population[s]) | Taxon | *SARA* Status[1] | COSEWIC Status[1] | BC List Status[1] |
|---|---|---|---|---|
| Grey whale<br>*Eschrichtius robustus* | Marine mammal | Special Concern Schedule 1 | Special Concern | Blue |
| Harbour porpoise<br>*Phocoena phocoena* | Marine mammal | Special Concern Schedule 1 | Special Concern | Blue |
| Horned puffin<br>*Fratercula corniculata* | Marine bird | No Status | No Status | Red |
| Humpback whale<br>*Megaptera novaeangliae* | Marine mammal | Threatened Schedule 1 | Special Concern | Blue |
| Killer whale<br>*Orcinus orca*<br>(Northeast Pacific southern resident population) | Marine mammal | Endangered Schedule 1 | Endangered | Red |
| Killer whale<br>*Orcinus orca*<br>(Northeast Pacific northern resident population) | Marine mammal | Threatened Schedule 1 | Threatened | Red |
| Killer whale<br>*Orcinus orca*<br>(Northeast Pacific transient [or Bigg's] population) | Marine mammal | Threatened Schedule 1 | Threatened | Red |
| Killer whale<br>*Orcinus orca*<br>(offshore population) | Marine mammal | Threatened Schedule 1 | Threatened | Red |
| Long-billed curlew<br>*Numenius americanus* | Marine bird | Special Concern Schedule 1 | Special Concern | Blue |
| Longspine thornyhead<br>*Sebastolobus altivelis* | Fish | Special Concern Schedule 1 | Special Concern | No Status |
| Marbled murrelet<br>*Brachyramphus marmoratus* | Marine bird | Threatened Schedule 1 | Threatened | Blue |
| North Pacific right whale<br>*Eubalaena japonica* | Marine mammal | Endangered Schedule 1 | Endangered | Red |
| North Pacific spiny dogfish<br>*Squalus suckleyi* | Fish | No Status | Special Concern | No Status |
| Northern abalone<br>*Haliotis kamtschatkana* | Mollusc | Endangered Schedule 1 | Endangered | Red |
| Northern fulmar<br>*Fulmarus glacialis* | Marine bird | No Status | No Status | Red |
| Northern fur seal<br>*Callorhinus ursinus* | Marine mammal | No Status | Threatened | Blue |
| Olympia oyster<br>*Ostrea lurida* | Mollusc | Special Concern Schedule 1 | Special Concern | Blue |

## TABLE 4.2.9.1

## MARINE SPECIES AT RISK IN THE MARINE REGIONAL STUDY AREA (continued)

| Species Name (population[s]) | Taxon | *SARA* Status[1] | COSEWIC Status[1] | BC List Status[1] |
|---|---|---|---|---|
| Pacific sardine *Sardinops sagax* | Fish | Special Concern Schedule 3 | Not at Risk | No Status |
| Pelagic cormorant *Phalacrocorax pelagicus pelagicus* | Marine bird | No Status | No Status | Red |
| Pink-footed shearwater *Puffinus creatopus* | Marine bird | Threatened Schedule 1 | Threatened | Blue |
| Quillback rockfish *Sebastes maliger* | Fish | No Status | Threatened | No Status |
| Red knot *Calidris canutus roselaari* | Marine bird | Threatened Schedule 1 | Threatened | Red |
| Rougheye rockfish type I *Sebastes* sp. *type I & II* | Fish | Special Concern Schedule 1 | Special Concern | No Status |
| Sea otter *Enhydra lutris* | Marine mammal | Special Concern Schedule 1 | Special Concern | Blue |
| Sei whale *Balaenoptera borealis* | Marine mammal | Endangered Schedule 1 | Endangered | Red |
| Short-tailed albatross *Phoebastria albatrus* | Marine bird | Threatened Schedule 1 | Threatened | Red |
| Sockeye salmon *Oncorhynchus nerka* (Cultus population, Sakinaw population) | Fish | No Status | Endangered | No Status |
| Sperm whale *Physeter macrocephalus* | Marine mammal | No Status | Not at Risk | Blue |
| Steller sea lion *Eumetopias jubatus* | Marine mammal | Special Concern Schedule 1 | Special Concern | Blue |
| Thick-billed murre *Uria lomvia* | Marine bird | No Status | No Status | Red |
| Tope *Galeorhinus galeus* | Fish | Special Concern Schedule 1 | Special Concern | No Status |
| Tufted puffin *Fratercula cirrhata* | Marine bird | No Status | No Status | Blue |
| Yelloweye rockfish *Sebastes ruberrimus* (Pacific Ocean outside waters population, inside waters population) | Fish | Special Concern Schedule 1 | Special Concern | No Status |
| Yellowmouth rockfish *Sebastes reedi* | Fish | No Status | Threatened | No Status |

**Sources:** BC CDC 2013, Government of Canada 2013a,b. List was last updated on November 25, 2013.

**Note:** 1 See Section 4.2.1.3 for definitions of COSEWIC, SARA and BC List status

#### *4.2.9.1 Aboriginal Traditional Knowledge*

A desktop review of Aboriginal traditional knowledge as it relates to species at risk is discussed under the marine fish and fish habitat, marine mammals, and marine birds sections (Sections 4.2.6, 4.2.7 and 4.2.8).

#### *4.2.9.2 US Waters*

A desktop review of marine species at risk in US waters is discussed under the marine fish and fish habitat, marine mammals, and marine birds sections (Sections 4.2.6, 4.2.7 and 4.2.8).

### *4.2.10 Traditional Marine Resource Use*

This subsection provides a broad description of the existing characteristics of traditional marine resource use from the Westridge Marine Terminal in Burnaby, BC to the 12 nautical mile limit of Canada's territorial sea. Of the 27 marine and inlet Aboriginal communities engaged on the Project with Trans Mountain, the following 21 communities have been identified as having an interest in the Project or having interests potentially affected by the increased Project-related marine vessel traffic.

- Esquimalt Nation;
- Cowichan Tribes;
- Halalt First Nation;
- Hwlitsum First Nation;
- Penelakut First Nation;
- Semiahmoo First Nation;
- Stz'uminus First Nation (Chemainus);
- Lyackson First Nation;
- Malahat First Nation;
- Pacheedaht First Nation;
- Pauquachin First Nation;
- Scia'new Indian Band (Beecher Bay);
- Tsawout First Nation;
- Tsawwassen First Nation;
- Tseycum First Nation;
- Katzie First Nation;
- Kwikwetlem First Nation;
- Musqueam Indian Band;
- Squamish Nation;
- Tsleil-Waututh Nation; and
- Tsartlip First Nation.

More detailed technical information pertaining to traditional marine resource use is presented in the Traditional Marine Resource Use - Marine Transportation Technical Report (Volume 8B, TR 8B-5).

Information pertaining to traditional marine resource use in US waters can be found in Section 4.2.10.4.

A discussion of the potential effects of the increased Project-related marine vessel traffic and associated mitigation as well as a discussion of the spatial boundaries for traditional marine resource use are located in Section 4.3.10.

#### *4.2.10.1 Traditional Marine Resource Use Indicators*

Two indicators were selected to represent potential effects from increased Project-related marine vessel traffic on traditional marine resource use: subsistence activities and sites, and cultural sites. Potential effect pathways and measurement endpoints for traditional marine resource use are described in detail in the Traditional Marine Resource Use - Marine Transportation Technical Report (Volume 8B, TR 8B-5), as well as rationale for selection of indicators. As part of the traditional marine resource use (TMRU) studies for the Project, each participating Aboriginal community is asked to identify potential subsistence activities and sites, including hunting, fishing, plant gathering, and travelways and cultural sites including gathering places and sacred areas.

Subsistence activities and sites represent the extensive land and water bases on which activities take place; a broad view of where and how people move in the landscape, how they use it and where they inhabit it. Cultural sites represent people's long-term connection to the land and water and includes the ability to participate in and continue practices and activities conducted by past generations, and the ability to pass on the collective knowledge and use of the environment according to tradition. Access to and continued use of cultural sites promotes cultural continuity. Gathering areas and sacred areas are collective terms used to incorporate all types of sites unrelated to the acquisition of environmental resources. See Section 4.3 for more information regarding indicators.

#### *4.2.10.2 Traditional Marine Resource Use Studies*

TMRU studies were initiated for the Project in 2013 and are ongoing. Participation in the TMRU studies, either as TERA-facilitated or community directed using a third-party consultant, was discussed with Aboriginal communities based on an indicated interest in participating in these studies. The Project scope, timetable and location were discussed. Project information packages, which included a Project description, facts on the nature, timing, scope and location of the Project, and relevant contact information for communication with Trans Mountain and TERA, were sent to each community and meetings were subsequently scheduled. Communities were also provided with copies of the proposed TMRU study methods and a draft outline of TERA's TMRU study work plan. Interpreters are made available at the request of the community.

On August 29, 2013, Esquimalt Nation elected to conduct a TERA-facilitated TMRU study. The TMRU study included a map review and community interviews that focused on the Crown lands and waters within the asserted traditional territory of Esquimalt Nation crossed by the Marine RSA. The results of Esquimalt Nation TMRU study completed to date for the Project are provided in the Traditional Marine Resource Use – Marine Transportation Technical Report (Volume 8B, TR 8B-5). Each phase of the TERA-facilitated TMRU study is described in further detail in the following subsections. TERA has implemented proper record keeping practices for information obtained during the TMRU study to ensure that study results are accessible for future reference and confidential information is protected.

Trans Mountain provided funding to assist Aboriginal communities that elected to conduct their own independent, community led TMRU studies (*i.e.*, third-party). These communities often engaged other consultants to provide technical support and assistance with their TMRU studies for the Project. The following communities have elected to conduct independent, community led TMRU studies:

- Cowichan Tribes;

- Halalt First Nation;
- Hwlitsum First Nation;
- Lyackson First Nation;
- Pacheedaht First Nation;
- Penelakut First Nation;
- Semiahmoo First Nation; and
- Stz'uminus First Nation.

To date, preliminary interests specific to the ESA have been identified to Trans Mountain by Esquimalt Nation, Semiahmoo First Nation and by Cowichan Nation Alliance on behalf of Penelakut First Nation, Halalt First Nation, Hwlitsum First Nation, Stz'uminus First Nation and Cowichan Tribes. These interests and the progress of each participating community's TMRU study at the time of application filing is described in detail in the Traditional Marine Resource Use - Marine Transportation Technical Report (Volume 8B, TR 8B-5). Additional TMRU study work with participating Aboriginal communities is scheduled for completion prior to the intiation of operations. Information gathered during ongoing TMRU studies will be considered for incorporation into Project planning under the guidance of existing marine transport regulations and mitigation recommendations made to date. The results of these ongoing engagement efforts will be provided to the NEB (see Section 4.5). Further details regarding additional studies are provided in Section 4.5 of Volume 8A.

Katzie First Nation, Kwikwetlem First Nation, Musqueam Indian Band, Malahat First Nation, Pauquachin First Nation, Scia'new Indian Band, Squamish Nation, Tsartlip First Nation, Tsawout First Nation, Tsawwassen First Nation, Tseycum First Nation and Tsleil Waututh Nation Katzie have also identified a potential interest in the Project. To date, Trans Mountain has shared Project information and invited each of these communities to participate in the development of a TMRU study and identification of interests. Trans Mountain will continue to support the participation of Katzie First Nation, Kwikwetlem First Nation, Musqueam Indian Band, Squamish Nation and Tsleil-Waututh Nation in Project activities and interest in a TMRU study will be determined by each individual community.

A detailed summary of Trans Mountain's engagement activities with each potentially affected Aboriginal community is provided in Volume 3B and Appendix A of Volume 3B.

#### *4.2.10.3 Existing Conditions*

Existing (baseline) conditions represent the current use of marine resources by Aboriginal communities for traditional purposes prior to the increased Project-related marine vessel traffic, and provides a reference point against which future conditions are compared to assess Project-specific and cumulative effects. Existing conditions of traditional marine resource use encountered within or in proximity to the Marine RSA were determined through a review of: publicly available harvest data, Aboriginal traditional knowledge and TMRU reports; the results of engagement with Aboriginal community representatives; and TMRU studies conducted with potentially affected Aboriginal communities for the Project.

Further detail on existing conditions for traditional marine resource use related to marine transportation can be found in the Traditional Marine Resource Use - Marine Transportation Technical Report (Volume 8B, TR 8B-5).

#### 4.2.10.3.1 Literature/Desktop Review

Much of the publicly available literature relevant to the Marine RSA consists of data compiled by representative organizations acting on behalf of one or more Aboriginal communities with shared areas of interest and use within their asserted traditional territories. Potential resource use issues within the Marine RSA and identification of historic and current use of areas within the RSA by potentially affected Aboriginal communities to maintain a traditional lifestyle are described in Table 4.2.10.1. The results of this literature/desktop review will be verified and augmented through field data collection by potentially affected communities.

**TABLE 4.2.10.1**

**RESULTS OF LITERATURE/DESKTOP REVIEW – TRADITIONAL MARINE RESOURCE USE WITHIN OR IN PROXIMITY TO THE MARINE RSA**

| Location | Activity/Site Type | Description | Location Relative to Marine RSA | Shipping Lanes Crossed to Access Activity/Site? |
|---|---|---|---|---|
| Beecher Bay | Marine resource harvesting and fishing | Species harvested by Scia'new First Nation include: salmon (Chinook, pink, coho, chum); cod (ling, pacific, black); halibut; trout (cutthroat); dogfish; shiners; herring; and sole. | Within RSA | No |
| Boatswain Bank | Marine resource harvesting and fishing | Species harvested by Pauquachin First Nation, Tsawout First Nation, Tsartlip First Nation and Semiahmoo First Nation include: barnacles; butter, cockle, manila, horse and littleneck clams; Dungeness and red rock crab; giant red chiton; green and red sea urchin; mussels; native and Pacific oysters; northern abalone; octopus; prawns; sea cucumber; herring roe; grey whales; killer whales; Steller sea lions; Pacific white-sided dolphins; harbor seals; porpoises; skate; octopus; waterfowl; seaweed; sea lettuce; kelp; red lavers; salmon (sockeye, Chinook, chum, coho, pink); steelhead; anchovies; bullhead; dogfish; sole; halibut; herring; cod (rock and ling); and red snapper. | Within RSA | No |
| Boundary Bay | Marine bird harvesting sites | Ducks, geese harvested by Tsawwassen First Nation. | Within RSA | No |
| Burrard Inlet | Fishing | Salmon fished by Tsleil-Waututh First Nation and Squamish Nation. | Within RSA | Yes |

**TABLE 4.2.10.1**

**RESULTS OF LITERATURE/DESKTOP REVIEW – TRADITIONAL MARINE RESOURCE USE WITHIN OR IN PROXIMITY TO THE MARINE REGIONAL STUDY AREA (continued)**

| Location | Activity/Site Type | Description | Relative to Marine RSA | Shipping Lanes Crossed to Access Activity/Site? |
|---|---|---|---|---|
| Cape Keppel | Marine resource harvesting and fishing | Species harvested by Pauquachin First Nation, Tsawout First Nation, Tsartlip First Nation and Semiahmoo First Nation include: barnacles; butter, cockle, manila, horse and littleneck clams; Dungeness and red rock crab; giant red chiton; green and red sea urchin; mussels; native and Pacific oysters; northern abalone; octopus; prawns; sea cucumber; herring roe; grey whales; killer whales; Steller sea lions; Pacific white-sided dolphins; harbour seals; porpoises; skate; octopus; waterfowl; seaweed; sea lettuce; kelp; red lavers; salmon (sockeye, Chinook, chum, coho, pink); steelhead; anchovies; bullhead; dogfish; sole; halibut; herring; cod (rock and ling); and red snapper. | Within RSA | No |
| Cannery Point | Marine resource harvesting | Species harvested by Tsawwassen First Nation include: clams; blue mussels, cockles and crabs. | Within RSA. Depending on the extent of fishing area, may enter US waters | Yes |
| | Fishing | Tsawwassen First Nation fishes salmon and sturgeon. | Within RSA. Depending on the extent of fishing area, may enter US waters | Yes |
| Chemainus Bay/ Chemainus River Estuary | Settlement area | Halalt First Nation, Hwlitsum First Nation, Lyackson First Nation, Penelakut First Nation, and Stz'uminus First Nation | Within RSA | No |
| | Harvesting of marine mammals | Seals, porpoises, and sea lions harvested by Halalt First Nation, Hwlitsum First Nation, Lyackson First Nation, Penelakut First Nation and Stz'uminus First Nation. | Within RSA | No |
| | Marine hunting of waterfowl | Ducks, geese hunted by Halalt First Nation, Hwlitsum First Nation, Lyackson First Nation, Penelakut First Nation and Stz'uminus First Nation. | Within RSA | No |
| Chemainus River Estuary | Ceremonial and cultural site | Halalt First Nation, Hwlitsum First Nation, Lyackson First Nation, Penelakut First Nation, and Stz'uminus First Nation | Within RSA | No |
| Cowichan and Koksilah rivers | Travelways | Cowichan Tribes | From Vancouver Island to within RSA | Yes |

## TABLE 4.2.10.1

## RESULTS OF LITERATURE/DESKTOP REVIEW – TRADITIONAL MARINE RESOURCE USE WITHIN OR IN PROXIMITY TO THE MARINE REGIONAL STUDY AREA (continued)

| Location | Activity/Site Type | Description | Relative to Marine RSA | Shipping Lanes Crossed to Access Activity/Site? |
|---|---|---|---|---|
| Craigflower Creek | Historically fished | Fished by Esquimalt Nation. | From Vancouver Island to within RSA | No |
| Fraser River | Settlement areas | Halalt First Nation, Hwlitsum First Nation, Lyackson First Nation, Penelakut First Nation, Kwikwetlum First Nation and Stz'uminus First Nation | From mainland to within RSA | No |
| | Fishing | Salmon and sturgeon fished by Tsawwassen First Nation, Musqueam Indian Band, Tsleil-Waututh First Nation and Tseycum First Nation. | From mainland to within RSA | No |
| | Historically fished | Kwikwetlum First Nation historically fished for salmon, sturgeon, euchalon, trout, catfish and carp | From mainland to within RSA | No |
| Fulford Harbour (Salt Spring Island) | Harvesting of marine mammals | Seals, porpoises, and sea lions harvested by Halalt First Nation, Hwlitsum First Nation, Lyackson First Nation, Penelakut First Nation, Stz'uminus First Nation, Pauquachin First Nation, Tsawout First Nation, Tsartlip First Nation and Semiahmoo First Nation. | Within RSA | Yes |
| | Marine fishing | Ling cod, halibut, salmon, herring spawn, and clams fished by Pauquachin First Nation, Tsawout First Nation, Tsartlip First Nation and Semiahmoo First Nation. | Within RSA | Yes |
| | Marine hunting of waterfowl | Ducks and geese hunted by Halalt First Nation, Hwlitsum First Nation, Lyackson First Nation, Penelakut First Nation and Stz'uminus First Nation. | Within RSA | No |
| Gabriola Passage | Harvesting of marine species | Species harvested by Halalt First Nation, Hwlitsum First Nation, Lyackson First Nation, Penelakut First Nation and Stz'uminus First Nation include: barnacles; butter, cockle, manila, horse and littleneck clams; Dungeness and red rock crab; giant red chiton; green and red sea urchin; mussels; native and Pacific oysters; northern abalone; octopus; prawns; sea cucumber; and herring roe. | Within RSA | No |
| Gorge Waterway | Marine resource harvesting and fishing site | Esquimalt Nation harvests: kelp, eelgrass, salmon (Chinook, pink, coho, chum, sockeye), cod (ling, pacific, black), sturgeon, halibut, trout, dogfish, shiners, herring and sole; hunts: whales, seals, ducks and geese. | Within RSA. Depending on the extent of harvesting area, may enter US waters | No |

## TABLE 4.2.10.1

## RESULTS OF LITERATURE/DESKTOP REVIEW – TRADITIONAL MARINE RESOURCE USE WITHIN OR IN PROXIMITY TO THE MARINE REGIONAL STUDY AREA (continued)

| Location | Activity/Site Type | Description | Relative to Marine RSA | Shipping Lanes Crossed to Access Activity/Site? |
|---|---|---|---|---|
| Gorge Rapids near Admirals Street Bridge | Sacred site | Esquimalt Nation | Within RSA | No |
| Gulf Islands | Marine harvesting | Species harvested by Halalt First Nation, Hwlitsum First Nation, Lyackson First Nation, Penelakut First Nation, Stz'uminus First Nation, Pauquachin First Nation, Tsawout First Nation, Tsartlip First Nation and Semiahmoo First Nation include: barnacles; butter, cockle, manila, horse and littleneck clams; Dungeness and red rock crab; giant red chiton; green and red sea urchin; mussels; native and Pacific oysters; northern abalone; octopus; prawns; sea cucumber; and herring roe. | Within RSA | Yes |
| | Summer camps | Pauquachin First Nation, Tsawout First Nation, Tsartlip First Nation and Semiahmoo First Nation | Within RSA | Yes |
| | Fishing | Salmon fished by Tsawwassen First Nation, Pauquachin First Nation, Tsawout First Nation, Tsartlip First Nation and Semiahmoo First Nation. | Within RSA. Depending on the extent of fishing area, may enter US waters | Yes |
| Kulleet Bay | Settlement area | Halalt First Nation, Hwlitsum First Nation, Lyackson First Nation, Penelakut First Nation, and Stz'uminus First Nation | Within RSA | No |
| | Marine harvesting | Species harvested by Halalt First Nation, Hwlitsum First Nation, Lyackson First Nation, Penelakut First Nation, and Stz'uminus First Nation include: barnacles; butter, cockle, manila, horse and littleneck clams; Dungeness and red rock crab; giant red chiton; green and red sea urchin; mussels; native and Pacific oysters; northern abalone; octopus; prawns; sea cucumber; and herring roe. | Within RSA | No |
| Penelakut Island | Settlement area | Halalt First Nation, Hwlitsum First Nation, Lyackson First Nation, Penelakut First Nation, and Stz'uminus First Nation | Within RSA | No |

**TABLE 4.2.10.1**

**RESULTS OF LITERATURE/DESKTOP REVIEW – TRADITIONAL MARINE RESOURCE USE WITHIN OR IN PROXIMITY TO THE MARINE REGIONAL STUDY AREA (continued)**

| Location | Activity/Site Type | Description | Relative to Marine RSA | Shipping Lanes Crossed to Access Activity/Site? |
|---|---|---|---|---|
| | Marine harvesting | Species harvested by Halalt First Nation, Hwlitsum First Nation, Lyackson First Nation, Penelakut First Nation, and Stz'uminus First Nation include: barnacles; butter, cockle, manila, horse and littleneck clams; Dungeness and red rock crab; giant red chiton; green and red sea urchin; mussels; native and Pacific oysters; northern abalone; octopus; prawns; sea cucumber; and herring roe. | Within RSA | No |
| Lighthouse Point | Marine harvesting | Tsawwassen First Nation harvests clams, blue mussels, cockles and crabs. | Within RSA | No |
| Lulu Island | Summer base camp | Cowichan Tribes | From mainland to within RSA | Extent of fishing area is unknown |
| | Marine fishing | Tsawwassen First Nation fishes sturgeon. | Within RSA | No |
| Macaulay Point | Marine fishing | Esquimalt Nation fishes salmon (Chinook, pink, coho, chum, sockeye), cod (ling, pacific, black), sturgeon, halibut, trout, dogfish, shiners, herring and sole. | Within RSA | No |
| Mayne Island | Marine harvesting and fishing | Species harvested and fished by Pauquachin First Nation, Tsawout First Nation, Tsartlip First Nation and Semiahmoo First Nation include: barnacles; butter, cockle, manila, horse and littleneck clams; Dungeness and red rock crab; giant red chiton; green and red sea urchin; mussels; native and Pacific oysters; northern abalone; octopus; prawns; sea cucumber; herring roe; grey whales; killer whales; Steller sea lions; Pacific white-sided dolphins; harbour seals; porpoises; skate; octopus; and waterfowl; seaweed; sea lettuce; kelp; red lavers; salmon (sockeye, Chinook, chum, coho, pink); steelhead; anchovies; bullhead; dogfish; sole; halibut; herring; cod (rock and ling); and red snapper. | Within RSA. Depending on the extent of fishing area, may enter US waters | Yes by Semiahmoo First Nation |
| Mill Bay Marina | Burial site | Malahat First Nation | Within RSA | No |
| Mount Prevost | Sacred site | Cowichan Tribes | From Vancouver Island to within RSA | No |
| Montague Harbour on Galiano Island | Marine harvesting | Species harvested by by Halalt First Nation, Hwlitsum First Nation, Lyackson First Nation, Penelakut First Nation, and Stz'uminus First Nation include clams, sea urchins, and seaweed. | Within RSA | Yes |

**TABLE 4.2.10.1**

**RESULTS OF LITERATURE/DESKTOP REVIEW – TRADITIONAL MARINE RESOURCE USE WITHIN OR IN PROXIMITY TO THE MARINE REGIONAL STUDY AREA (continued)**

| Location | Activity/Site Type | Description | Relative to Marine RSA | Shipping Lanes Crossed to Access Activity/Site? |
|---|---|---|---|---|
| | Fishing | Species fished by Halalt First Nation, Hwlitsum First Nation, Lyackson First Nation, Penelakut First Nation, and Stz'uminus First Nation include salmon, herring, cod, flounder and halibut. | Within RSA. Depending on the extent of fishing area, may enter US waters | Extent of fishing area is unknown |
| | Fishing camps | Halalt First Nation, Hwlitsum First Nation, Lyackson First Nation, Penelakut First Nation, and Stz'uminus First Nation. | Within RSA | No |
| Oyster Bay | Settlement | Halalt First Nation, Hwlitsum First Nation, Lyackson First Nation, Penelakut First Nation and Stz'uminus First Nation | Within RSA | No |
| | Marine harvesting | Species harvested by by Halalt First Nation, Hwlitsum First Nation, Lyackson First Nation, Penelakut First Nation, and Stz'uminus First Nation include: grey whales; Steller sea lions; Fraser River Pacific white-sided dolphins; killer whales; harbour seals; and porpoises. | Within RSA | No |
| Pender Island | Marine harvesting and fishing | Species harvested and fished by Pauquachin First Nation, Tsawout First Nation, Tsartlip First Nation and Semiahmoo First Nation include: barnacles; butter, cockle, manila, horse and littleneck clams; Dungeness and red rock crab; giant red chiton; green and red sea urchin; mussels; native and Pacific oysters; northern abalone; octopus; prawns; sea cucumber; herring roe; grey whales; killer whales; Steller sea lions; Pacific white-sided dolphins; harbour seals; porpoises; skate; octopus; waterfowl; seaweed; sea lettuce; kelp; red lavers; salmon (sockeye, Chinook, chum, coho, pink); steelhead; anchovies; bullhead; dogfish; sole; halibut; herring; cod (rock and ling); and red snapper. | Within RSA | Yes by Semiahmoo First Nation |
| Roberts Bank | Fishing site | Tsawwassen First Nation fishes sturgeon and salmon. | Within RSA | Extent of fishing area is unknown |
| | Marine harvesting | Tsawwassen First Nation harvests clams, blue mussels, cockles and crabs. | Within RSA | No |
| Saanich Inlet | Fishing site | Species fished by Pauquachin First Nation, Tsawout First Nation, Tsartlip First Nation and Semiahmoo First Nation and Tseycum First Nation include fish rock and ling cod, salmon, herring fish and roe. | Within RSA | No |

## TABLE 4.2.10.1

## RESULTS OF LITERATURE/DESKTOP REVIEW – TRADITIONAL MARINE RESOURCE USE WITHIN OR IN PROXIMITY TO THE MARINE REGIONAL STUDY AREA (continued)

| Location | Activity/Site Type | Description | Relative to Marine RSA | Shipping Lanes Crossed to Access Activity/Site? |
|---|---|---|---|---|
| | Marine harvesting | Species harvested by Pauquachin First Nation, Tsawout First Nation, Tsartlip First Nation and Semiahmoo First Nation and Tseycum First Nation include: clams, oysters, mussels, eelgrass, and crabs. | Within RSA | No |
| | Sacred area | Pauquachin First Nation, Tsawout First Nation, Tsartlip First Nation and Semiahmoo First Nation. | Within RSA | Yes by Semiahmoo First Nation |
| Salt Spring Island | Marine harvesting and fishing | Species harvested and fished by Pauquachin First Nation, Tsawout First Nation, Tsartlip First Nation and Semiahmoo First Nation, Halalt First Nation, Hwlitsum First Nation, Lyackson First Nation, Penelakut First Nation, and Stz'uminus First Nation include: clams, herring, herring spawn, crabs and seaweed. | Within RSA | Yes by Semiahmoo First Nation |
| | Marine bird hunting | Ducks hunted by Halalt First Nation, Hwlitsum First Nation, Lyackson First Nation, Penelakut First Nation and Stz'uminus First Nation. | Within RSA | No |
| | Fishing site | Species fished by Halalt First Nation, Hwlitsum First Nation, Lyackson First Nation, Penelakut First Nation, and Stz'uminus First Nation include salmon cod, rock-cod, groundfish and octopus. | Within RSA | Extent of fishing area is unknown |
| San Juan Islands | Fishing, marine resource harvesting and settlement site | Pauquachin First Nation, Tsartlip First Nation, Tsawout First Nation | Within RSA, within US waters | Yes |
| Saturna Island | Marine harvesting and fishing | Species harvested and fished by Pauquachin First Nation, Tsawout First Nation, Tsartlip First Nation and Semiahmoo First Nation include: barnacles; butter, cockle, manila, horse and littleneck clams; Dungeness and red rock crab; giant red chiton; green and red sea urchin; mussels; native and Pacific oysters; northern abalone; octopus; prawns; sea cucumber; herring roe; grey whales; killer whales; Steller sea lions; Pacific white-sided dolphins; harbour seals; porpoises; skate; octopus; waterfowl; seaweed; sea lettuce; kelp; red lavers; salmon (sockeye, Chinook, chum, coho, pink); steelhead; anchovies; bullhead; dogfish; sole; halibut; herring; cod (rock and ling); and red snapper. | Within RSA | Yes by Semiahmoo First Nation |

## TABLE 4.2.10.1

## RESULTS OF LITERATURE/DESKTOP REVIEW – TRADITIONAL MARINE RESOURCE USE WITHIN OR IN PROXIMITY TO THE MARINE REGIONAL STUDY AREA (continued)

| Location | Activity/Site Type | Description | Relative to Marine RSA | Shipping Lanes Crossed to Access Activity/Site? |
|---|---|---|---|---|
| Shawnigan Creek | Historical settlement | Malahat First Nation | Within RSA | No |
| | Fishing site | Malahat First Nation | Within RSA | No |
| Sidney Island | Marine harvesting | Species harvested by Pauquachin First Nation, Tsawout First Nation, Tsartlip First Nation and Semiahmoo First Nation include: barnacles; butter, cockle, manila, horse and littleneck clams; Dungeness and red rock crab; giant red chiton; green and red sea urchin; mussels; native and Pacific oysters; northern abalone; octopus; prawns; sea cucumber; herring roe; grey whales; killer whales; Steller sea lions; Pacific white-sided dolphins; harbour seals; porpoises; skate; octopus; waterfowl; seaweed; sea lettuce; kelp; red lavers; salmon (sockeye, Chinook, chum, coho, pink); steelhead; anchovies; bullhead; dogfish; sole; halibut; herring; cod (rock and ling); and red snapper. | Within RSA | Yes by Semiahmoo First Nation |
| Strait of Georgia | Fishing site | Species fished by Cowichan Tribes, Halalt First Nation, Hwlitsum First Nation, Lyackson First Nation, Penelakut First Nation, Stz'uminus First Nation, Tsawwassen First Nation and Squamish Nation include: herring, cod, flounder and halibut. | Within RSA | Yes |
| | Marine harvesting | Species harvested by Halalt First Nation, Hwlitsum First Nation, Lyackson First Nation, Penelakut First Nation, Stz'uminus First Nation, Esquimalt First Nation and Squamish Nation include: littleneck clams; butterclams; horse clams; geoduck clams; basket cockles; oysters; scallops; mussels; chiton; crabs; sea cucumber; octopus; red and green sea urchins; kelp; rockweed; sea lettuce; ducks; barnacles; Dungeness crab; giant red chiton; manila clam; northern abalone; prawn; and red rock crab. | Within RSA | Yes |
| | Marine mammal and bird hunting | Species hunted by Halalt First Nation, Hwlitsum First Nation, Lyackson First Nation, Penelakut First Nation, Stz'uminus First Nation, Esquimalt Nation and Squamish Nation include seals, sea lions, porpoises, whales, dolphins, ducks and geese. | Within RSA | Yes |

**TABLE 4.2.10.1**

**RESULTS OF LITERATURE/DESKTOP REVIEW – TRADITIONAL MARINE RESOURCE USE WITHIN OR IN PROXIMITY TO THE MARINE REGIONAL STUDY AREA (continued)**

| Location | Activity/Site Type | Description | Relative to Marine RSA | Shipping Lanes Crossed to Access Activity/Site? |
|---|---|---|---|---|
| Thetis Island | Marine mammal and bird hunting | Species hunted by Halalt First Nation, Hwlitsum First Nation, Lyackson First Nation, Penelakut First Nation and Stz'uminus First Nation include: seals, sea lions, porpoises, whales, dolphins, ducks and geese. | Within RSA | No |
| Valdes Island | Settlement | Halalt First Nation, Hwlitsum First Nation, Lyackson First Nation, Penelakut First Nation, and Stz'uminus First Nation | Within RSA | No |
| Vesuvius Bay | Marine mammal and bird hunting | Species hunted by Halalt First Nation, Hwlitsum First Nation, Lyackson First Nation, Penelakut First Nation and Stz'uminus First Nation include seals, sea lions, porpoises, whales, dolphins, ducks and geese. | Within RSA | No |
| Westham Island | Marine bird hunting | Tsawwassen First Nation hunts ducks, mallards and loons. | Within RSA | No |
| Willy Island | Marine mammal and bird hunting | Species hunted by Halalt First Nation, Hwlitsum First Nation, Lyackson First Nation, Penelakut First Nation and Stz'uminus First Nation include seals, sea lions, porpoises, whales, dolphins, ducks and geese. | Within RSA | No |

**Sources:** BC Ministry of Environment Lands and Parks 1996, BC Ministry of Environment Lands and Parks 1997, Squamish Nation, Land and Resources Committee 2001, Rose and Corbet 2004, Hul'qumi'num Treaty Group 2005, Jacques Whitford Ltd 2006, Musqueam Indian Band 2009, Esquimalt Nation 2010a, Esquimalt Nation 2010b, Port Renfrew Online 2011, Metro Vancouver 2012, Simpson and Bainas 2012, Cowichan Tribes 2013, Royal BC Museum 2013.

### 4.2.10.3.2 Traditional Marine Resource Use Studies

Engagement with potentially affected Aboriginal communities is ongoing. Trans Mountain continues to engage potentially affected Aboriginal communities and will continue to facilitate TMRU studies with interested communities. The results from ongoing TMRU studies will be provided to the NEB. Table 4.2.10.2 provides the results to date of the Esquimalt Nation TMRU study for the Project, as well as the preliminary interests identified by participating Aboriginal communities that may be affected by the increased Project-related marine vessel traffic. Further details regarding the status of TMRU studies and the preliminary interests received to date can be found in the Traditional Marine Resource Use – Marine Transportation Technical Report (Volume 8B, TR 8B-5).

## TABLE 4.2.10.2

## TRADITIONAL MARINE RESOURCE USE IDENTIFIED TO DATE BY PARTICIPATING ABORIGINAL COMMUNITIES WITHIN OR IN PROXIMITY TO THE MARINE RSA

| Location | Activity/Site Type | Description | Relative to Shipping Lanes | Relative to Marine RSA | Shipping Lanes Crossed to Access Activity/Site? |
|---|---|---|---|---|---|
| **Esquilmalt Nation** | | | | | |
| Bear Mountain | Hunting | Ducks in the past | 14 km northwest | Northwest of RSA | No |
| Sooke Inlet | Hunting | Ducks in the past | 8 km north | Within RSA | No |
| East Sooke Park | Hunting | Ducks and deer in the past | 10 km north | North of RSA | No |
| Albert head | Fishing | Ling Cod | 4 km west | Within RSA | No |
| Beacon Hill | Fishing | Sea Urchins | 2 km north | North of RSA | No |
| Ross Bay | Fishing | Sea Urchins | 2 km north | Within RSA | No |
| Dallas Road | Fishing | Salmon in the past | 2 km off coast at Dallas Road | Within RSA | No |
| Brother Island | Fishing | Scrooge Rocks, which are used to collect ling cod eggs | 3 km north | Within RSA | No |
| Race Rocks | Fishing | Ling cod | 3 km north | Within RSA | No |
| Salish Sea | Fishing | Halibut | Encompasses portions of the outbound shipping lane | Within RSA | Yes |
| Sidney Channel | Fishing | Salmon year round | 10 km west | Within RSA | No |
| Port Hardy | Fishing | Clam digging from Esquimalt to Port Hardy in the past. | 3 km west | From Vancouver Island to within RSA | No |
| Goldstream | Hunting<br>Fishing<br>Plant gathering | Deer and elk in the past.<br>Chum, coho, during low tides it is good for sole harvesting. Site shared by many bands.<br>Clam digging.<br>Salmon berry harvest | 25 km north | North of RSA | No |
| Discovery Island | Fishing | Crabbing in the past | 1 km west | Within RSA | No |
| Catham Island | Fishing | Crabbing in the past | 1 km west | Within RSA | No |
| Saanich | Fishing | Clam digging at very low tide | 11 km west | West of RSA | No |

## TABLE 4.2.10.2

## TRADITIONAL MARINE RESOURCE USE IDENTIFIED TO DATE BY PARTICIPATING ABORIGINAL COMMUNITIES WITHIN OR IN PROXIMITY TO THE MARINE REGIONAL STUDY AREA (continued)

| Location | Activity/Site Type | Description | Relative to Shipping Lanes | Relative to Marine RSA | Shipping Lanes Crossed to Access Activity/Site? |
|---|---|---|---|---|---|
| **Esquilmalt Nation** | | | | | |
| Inskip Island | Fishing | Clam digging and rock sticker digging at very low tide | 6 km north | Within RSA | No |
| Beecher Bay | Fishing | Crabbing, clam digging, and octopus harvest, salmon, halibut, ling cod | 5 km north | Within RSA | No |
| Esquimalt Lagoon | Hunting Fishing | Ducks in the past. Clam digging and crabbing at Cooper's Cove in the past | 7.5 km northwest | Northwest of RSA | No |
| Orveas Bay | Fishing | Collecting clams, mussels, oysters, and urchins | 7.5 km north | Within RSA | No |
| Sooke Basin | Fishing | Clam digging at every point on basin beaches | 10 km north | Within RSA | No |
| Fisgard Lighthouse | Fishing | Clams and rock stickers in the past | 7.5 km northwest | Northwest of RSA | No |
| Esquimalt Harbour | Fishing | Clams in the past | 8 km northwest | Within RSA | No |
| Victoria Harbour | Gathering place | Historic Village | 3 km north | North of the RSA | No |
| Portage Inlet | Gathering place | Historic Village | 6 km northwest | Northwest of the RSA | No |
| Esquimalt | Gathering place | Current Village | 4.5 km northwest | Northwest of the RSA | No |
| Small Pox Island | Sacred area | Burial site in the past, now a naval base | 6.5 km north | North of the RSA | No |
| Leprosy Island | Sacred area | Burial site, also called D'Arcy Island | 3 km west | West of the RSA | No |
| Beecher Bay | Sacred area | Rock Art site | 5 km north | On land, adjacent RSA | No |
| Large Bedford Island | Sacred area | Rock Art site | 5 km north | On land, adjacent RSA | No |
| **Cowichan Tribes** | | | | | |
| Salish Sea | Subsistence activities | No details provided | Unknown | Within RSA | Unknown |

**TABLE 4.2.10.2**

**TRADITIONAL MARINE RESOURCE USE IDENTIFIED TO DATE BY PARTICIPATING ABORIGINAL COMMUNITIES WITHIN OR IN PROXIMITY TO THE MARINE REGIONAL STUDY AREA (continued)**

| Location | Activity/Site Type | Description | Relative to Shipping Lanes | Relative to Marine RSA | Shipping Lanes Crossed to Access Activity/Site? |
|---|---|---|---|---|---|
| Unspecified | Cultural sites | No details provided | Unknown | Unknown | Unknown |
| **Halalt First Nation** | | | | | |
| Salish Sea | Subsistence activities | No details provided | Unknown | Within RSA | Unknown |
| Unspecified | Cultural sites | No details provided | Unknown | Unknown | Unknown |
| **Hwlitsum First Nation** | | | | | |
| Salish Sea | Subsistence activities | No details provided | Unknown | Within RSA | Unknown |
| Unspecified | Cultural sites | No details provided | Unknown | Unknown | Unknown |
| **Penelakut Tribe** | | | | | |
| Salish Sea | Subsistence activities | No details provided | Unknown | Within RSA | Unknown |
| Unspecified | Cultural sites | No details provided | Unknown | Unknown | Unknown |
| **Semiahmoo First Nation** | | | | | |
| Semiahmoo Bay | Subsistence activities and sites | Traditional fishing area | Unknown | Within RSA | Unknown |
| Boundary Bay | Subsistence activities and sites | Traditional fishing area | Unknown | Within RSA | Unknown |
| Mud Bay | Subsistence activities and sites | Traditional fishing area | Unknown | Within RSA | Unknown |
| Strait of Georgia | Subsistence activities and sites | Traditional fishing area | Unknown | Within RSA | Unknown |
| Unspecified | Subsistence activities and sites | Traditional fishing and shellfish gathering sites | Unknown | Unknown | Unknown |
| Unspecified | Cultural sites | Traditional practices and culture | Unknown | Unknown | Unknown |

#### *4.2.10.4 US Waters*

The shipping lanes are partially located in US waters, and the Marine RSA extends into US waters in the following areas:

- Strait of Georgia, near Point Roberts, Washington;

- Haro Strait, near San Juan Islands, Washington; and
- Juan de Fuca Strait, near the Olympic Peninsula, Clallam County, Washington.

Traditional marine resource use is expected to be similar in US and Canadian waters, given the similar types of marine environments in Washington and BC and, where available, descriptions of existing conditions related to traditional marine resource use within US waters are included in Tables 4.2.10.1 and 4.2.10.2.

### *4.2.11 Marine Commercial, Recreational and Tourism Use*

This subsection describes existing conditions related to MCRTU in order to provide a context for understanding potential Project-related effects associated with marine vessel traffic from the Westridge Marine Terminal to the 12 nautical mile limit of Canada's territorial sea (shown in Figure 4.2.1).

Further detail on existing conditions for MCRTU can be found in the Marine Commercial, Recreational and Tourism Use – Marine Transportation Technical Report (Volume 8B, TR 8B-6).

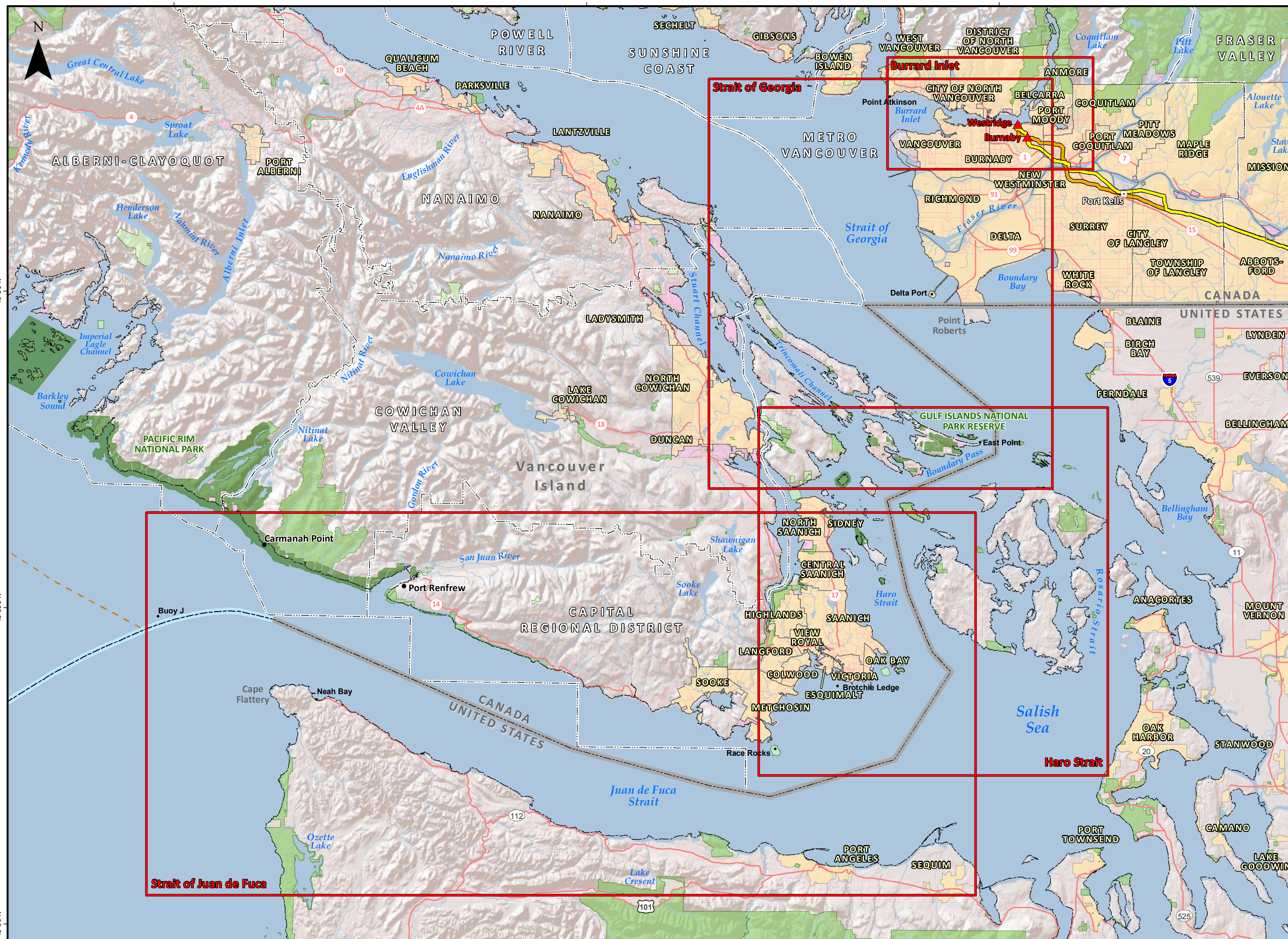
It is recognized that marine commercial, recreational and tourism users are both Aboriginal and non-Aboriginal. While the setting pertaining to traditional marine resource use is discussed in Section 4.2.10, the following should be read with the understanding that many commercial fishers and recreational marine users are Aboriginal.

Information pertaining to MCRTU in US waters can be found in Section 4.2.11.7.5. A discussion of the potential effects of the increased Project-related marine vessel traffic and associated mitigation as well as a discussion of the spatial boundaries for MCRTU are located in Section 4.3.11.

#### *4.2.11.1 Marine Commercial Recreational and Tourism Use Regions*

In order to examine nuances in marine use patterns for MCRTU, the Marine LSA is divided into four study regions in the following areas.

- Region 1: Burrard Inlet – west from the marine area around the Westridge Marine Terminal to the entrance to Vancouver's Outer Harbour.
- Region 2: Strait of Georgia – southwest from the entrance to Vancouver Outer Harbour in the Strait of Georgia to Boundary Pass (near East Point on Saturna Island).
- Region 3: Haro Strait – south from Boundary Pass through Haro Strait, past Turn Point on Stuart Island and continuing past Victoria to the Victoria Pilot Boarding Station.
- Region 4: Juan de Fuca Strait – southwest from the Pilot Boarding Station at Brotchie Ledge near Victoria, then west through Juan de Fuca Strait, with the western boundary being the 12 nautical mile limit northwest of Cape Flattery, Washington.
- Figures 4.2.27 to 4.2.31 provide an overview map of the existing conditions within the Marine RSA and maps of each MCRTU region.




TRANS MOUNTAIN

**FIGURE 4.2-27**

**MARINE COMMERCIAL, RECREATIONAL AND TOURISM USE (MCRTU) REGIONS**

**TRANS MOUNTAIN EXPANSION PROJECT**

- Terminal
- Existing Pump Station
- Trans Mountain Pipeline (TMPL)
- Trans Mountain Expansion Project Proposed Pipeline Corridor
- Highway
- Road
- 12 Nautical Mile Limit (Territorial Sea)
- Limit of Exclusive Economic Zone (EEZ)
- International Boundary
- Marine Region
- City / Town / District Municipality
- Indian Reserve / Métis Settlement
- National Park
- Provincial / State Park
- Protected Area/Natural Area/ Provincial Recreation Area/Wilderness Provincial Park/Conservancy Area
- Regional District Boundary

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Projection: UTM Zone 10N.
Routing: Baseline TMPL & Facilities: provided by KMC 2012; Proposed Pipeline Corridor V6: provided by UPI Aug. 23, 2013; Transportation: BC Forests, Lands and Natural Resource Operations, 2012 & ESRI, 2005; Geopolitical Boundaries: IHS Inc., 2011, BC FLNRO, 2007 & ESRI, 2005; First Nation Lands: Government of Canada, 2013 & IHS Inc., 2011; Hydrology: IHS Inc., 2004, United States National Imagery and Mapping Agency, 2000, Natural Resouces Canada, 2010; Parks and Protected Areas: Natural Resources Canada, 2013, BC FLNRO, 2008 & ESRI, 2005; Territorial Sea Boundary: Extrapolated from shoreline data (IHS Inc., 2011 & ESRI, 2005); Hillshade: Service Layer Credits: Copyright:© 2009 ESRI

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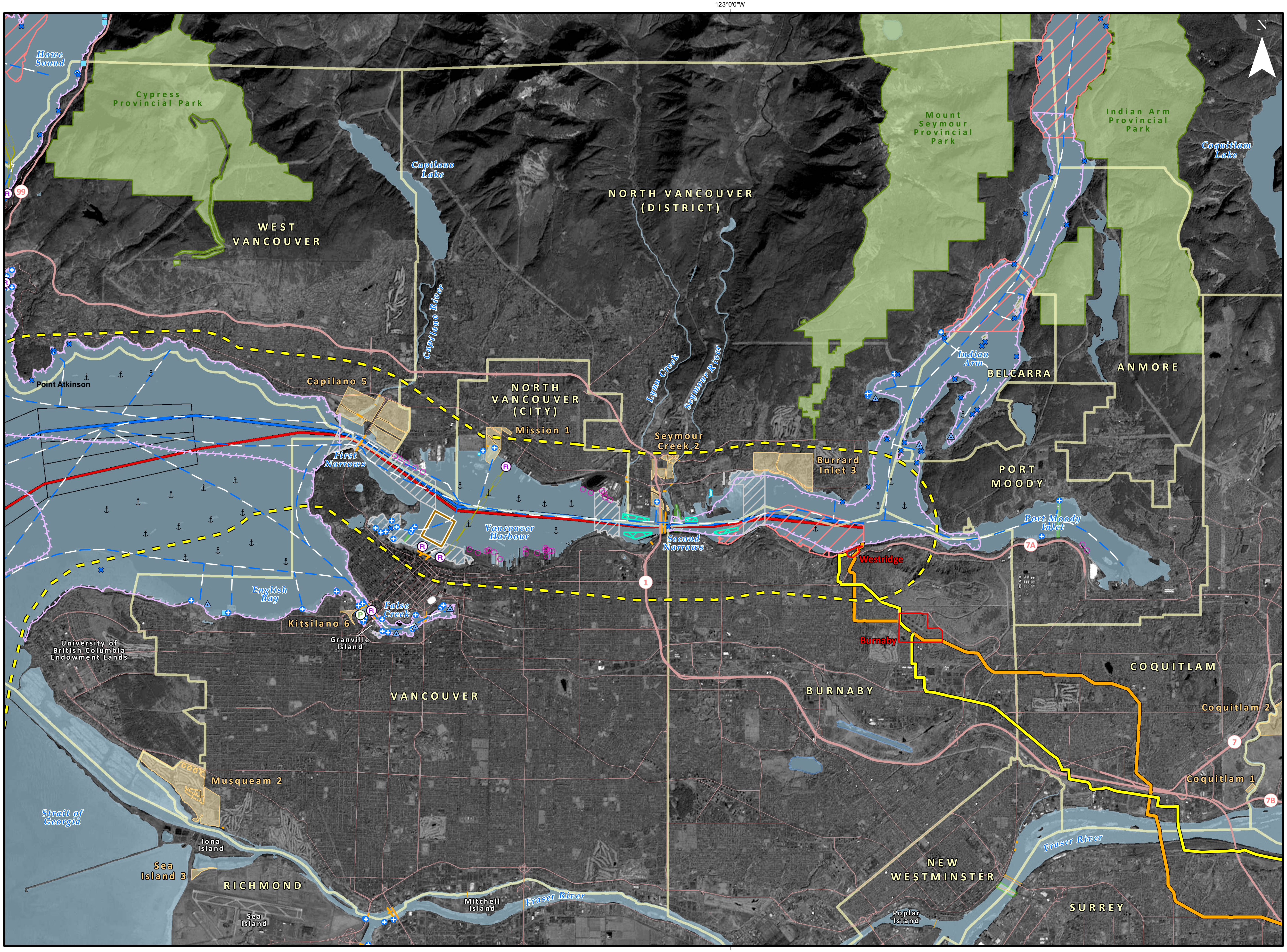


TRANS MOUNTAIN

**FIGURE 4.2-28**

**MCRTU REGION 1: BURRARD INLET**

**TRANS MOUNTAIN EXPANSION PROJECT**

- Trans Mountain Pipeline (TMPL)
- Trans Mountain Expansion Project Proposed Pipeline Corridor
- Terminal Facility Footprint
- Approximate LSA for Marine Shipping Lanes
- Anchorage Area / Anchor Berth
- Berth
- Coastal Anchorage
- Coastal Diving Site
- Marina/Yacht Club/Public Dock/Other Berth
- Private Moorage
- Ferry Terminal
- Public Wharf
- Highway
- Road
- Bridge
- Ferry Route
- Coastal Recreational Craft Cruising Route
- Coastal Kayak Route
- Marine Vessel Outbound Lane
- Marine Vessel Inbound Lane
- Municipality
- Indian Reserve
- Cable / Pipeline Area
- Sea Plane Landing Area
- Holding Area
- Log Pond
- Provincial Park
- Sport Fishing Area
- Rockfish Conservation Area
- Marine Restricted Area
- Traffic Separation Scheme



Projection: NAD 1983 UTM Zone 10N. Routing: Baseline TMPL and Facilities provided by KMC, 2012; Proposed Pipeline Corridor V6: provided by UPI Aug. 23, 2013; Roads: BC FLNRO, 2012; Populated Places: BC FLNRO, 2007; Hydrology: BC FLNRO 2008, IHS 2004; First Nation Lands: Geobase, 2013; Parks and Protected Areas: BC FLNRO, 2008, Natural Resources Canada, 2013, ESRI 2005; US State Boundary: ESRI, 2005; Marine Vessel Traffic Lanes: Moffat and Nichol, 2013; Coastal Kayak Destinations, Campsites: BC FLNRO, 1998; Anchorages, Moorages, Marinas and Facilities, Recreational Craft Cruising Routes, Kayak Routes, and Dive Sites: BCMCA, 2011; Crown Land Tenures: BC FLRNO, 2008; Sport Fishing Areas: BCMCA, 2011. Rockfish Conservation Areas: Department of Fisheries and Oceans Canada, 2012; CHS Berth/anchorage points, pilot boarding points, marine facility area features, regulated zones, marine navigation area features, ferry routes and utility area features provided by KMC, 2013. Additional ferry routes: BCMCA, 2013; Ferry Terminals: BC FLNRO, 1998; B/W Imagery: Landsat7 NASA Geospatial Interoperability Program. 2005.

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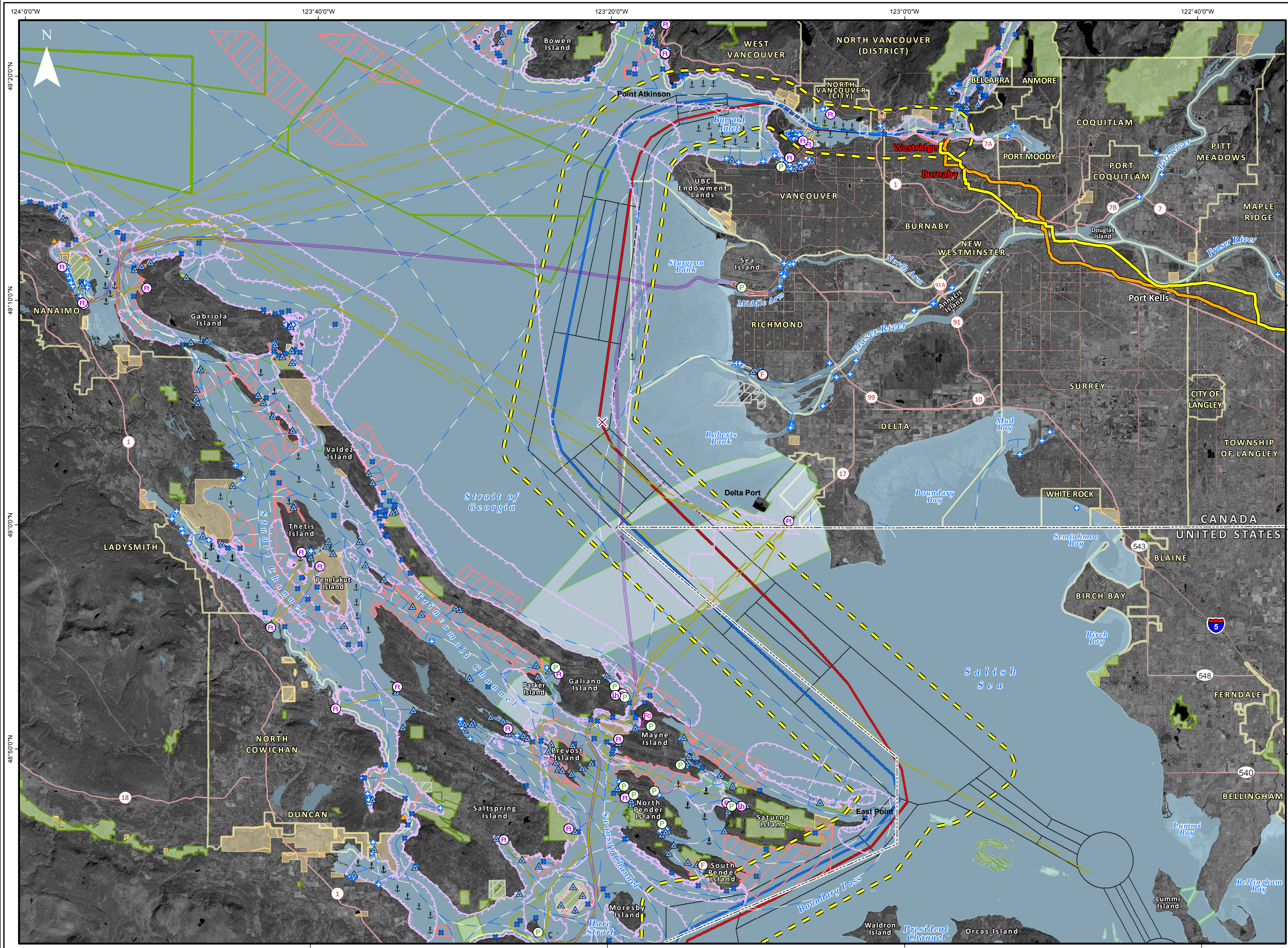


TRANS MOUNTAIN

**FIGURE 4.2.29**

**MCRTU REGION 2: STRAIT OF GEORGIA**

**TRANS MOUNTAIN EXPANSION PROJECT**

- Terminal
- Existing Pump Station
- Trans Mountain Pipeline (TMPL)
- Trans Mountain Expansion Project Proposed Pipeline Corridor
- Approximate LSA for Marine Shipping Lanes
- Anchorage Area / Anchor Berth
- Coastal Anchorage
- Coastal Campsite
- Coastal Diving Site
- Marina/Yacht Club/Public Dock/Other Berth
- Pilot Boarding Station
- Fishery Facility
- Floating Cabin
- Log Handling/Storage
- Ferry Terminal
- Public Wharf
- Highway
- Road
- Ferry Route
- Freight Route
- Coastal Recreational Craft Cruising Route
- Coastal Kayak Route
- Marine Vessel Outbound Lane
- Marine Vessel Inbound Lane
- Municipality
- Indian Reserve
- National/Provincial/State Park
- International Border
- Cable / Pipeline Area
- Sea Plane Landing Area
- Military Practice Area
- Sport Fishing Area
- Rockfish Conservation Area
- Marine Restricted Area
- Traffic Separation Scheme



Projection: NAD 1983 UTM Zone 10N. Routing: Baseline TMPL and Facilities provided by KMC, 2012; Proposed Pipeline Corridor V6: provided by UPI Aug. 23, 2013; Roads: BC FLNRO, 2012; Populated Places: BC FLNRO, 2007; Hydrology: BC FLNRO 2008, IHS 2004; First Nation Lands: Geobase, 2013; Parks and Protected Areas: BC FLNRO, 2008, Natural Resources Canada, 2013, ESRI 2005; US State Boundary: ESRI, 2005; Marine Vessel Traffic Lanes: Moffat and Nichol, 2013; Coastal Kayak Destinations, Select Coastal Campsites: BC FLNRO, 1998; Anchorages, Moorages, Marinas and Facilities, Recreational Craft Cruising Routes, Kayak Routes, and Dive Sites: BCMCA, 2011; Crown Land Tenures: BC FLRNO, 2008; Sport Fishing Areas: BCMCA, 2011; Rockfish Conservation Areas: Department of Fisheries and Oceans Canada, 2012; CHS Berth/anchorage points, pilot boarding points, marine facility area features, regulated zones, marine navigation area features, ferry routes and utility area features provided by KMC, 2013. Additional ferry routes: BCMCA, 2013; Ferry Terminals: BC FLNRO, 1998; B/W Imagery: Landsat7 NASA Geospatial Interoperability Program. 2005.

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0 2 4 6 8 10 km

ALL LOCATIONS APPROXIMATE

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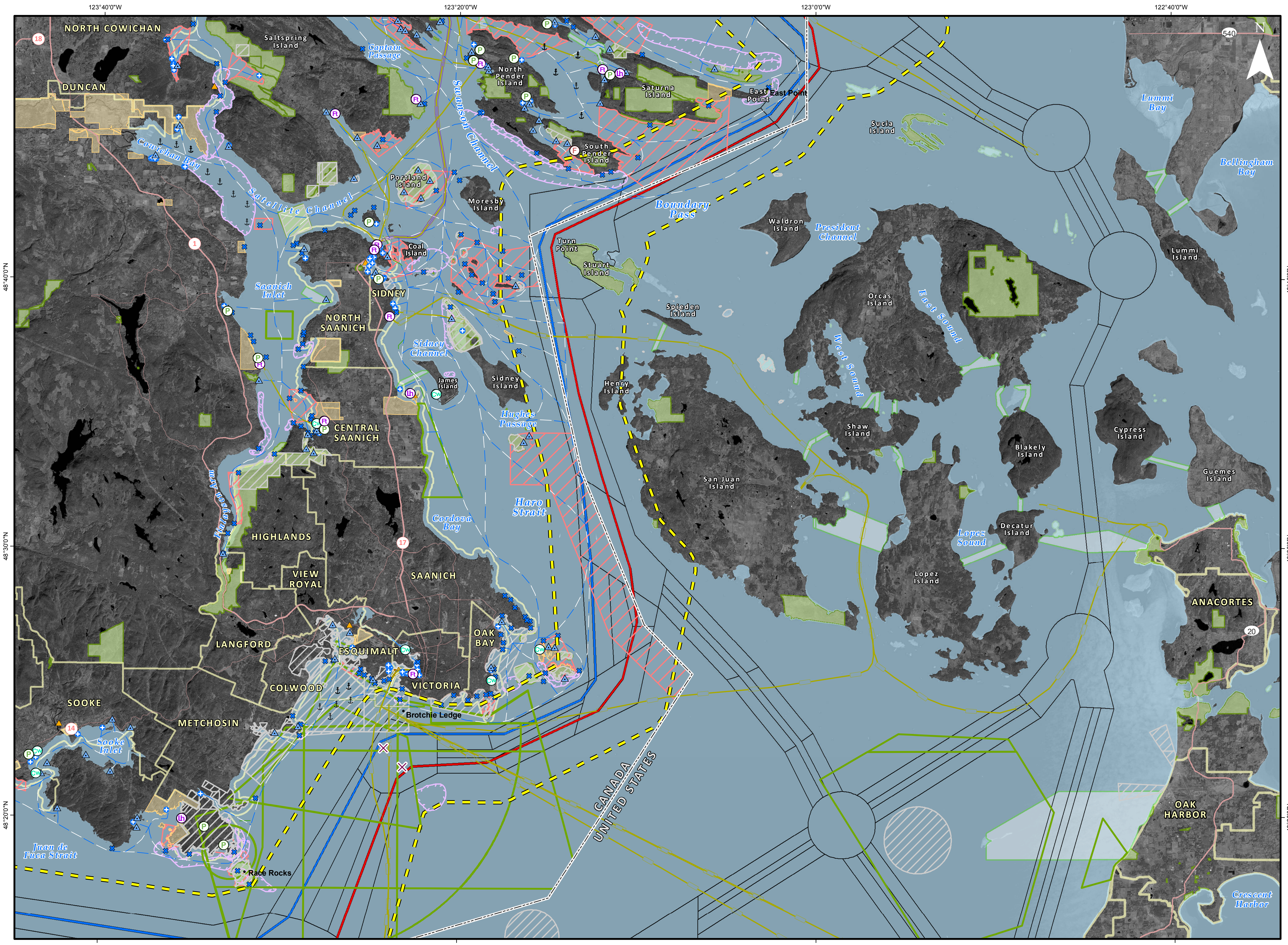
**TRANS MOUNTAIN**

**FIGURE 4.2-30**

**MCRTU REGION 3:**
**HARO STRAIT**

**TRANS MOUNTAIN**
**EXPANSION PROJECT**




- Anchorage Area / Anchor Berth
- Coastal Anchorage
- Coastal Campsite
- Coastal Diving Site
- Marina/Yacht Club/Public Dock/Other Berth
- Pilot Boarding Station
- Commercial Wharf
- Fishery Facility
- Floating Cabin
- Log Handling/Storage
- Ferry Terminal
- Public Wharf
- Highway
- Road
- Ferry Route
- Freight Route
- Coastal Recreational Craft Cruising Route
- Coastal Kayak Route
- Marine Vessel Outbound Lane
- Marine Vessel Inbound Lane
- Approximate LSA for Marine Shipping Lanes
- Municipality
- Indian Reserve
- National/Provincial/State Park
- International Border
- Cable / Pipeline Area
- Sea Plane Landing Area
- Military Practice Area
- Sport Fishing Area
- Rockfish Conservation Area
- Marine Restricted Area
- Traffic Separation Zone



Projection: NAD 1983 UTM Zone 10N. Routing: Baseline TMPL and Facilities provided by KMC, 2012; Proposed Pipeline Corridor V6: provided by UPI Aug. 23, 2013; Roads: BC FLNRO, 2012; Populated Places: BC FLNRO, 2007; Hydrology: BC FLNRO 2008, IHS 2004; First Nation Lands: Geobase, 2013; Parks and Protected Areas: BC FLNRO, 2008, Natural Resources Canada, 2013, ESRI 2005; US State Boundary: ESRI, 2005; Marine Vessel Traffic Lanes: Moffat and Nichol, 2013; Coastal Kayak Destinations, Select Coastal Campsites: BC FLNRO, 1998; Anchorages, Moorages, Marinas and Facilities, Recreational Craft Cruising Routes, Kayak Routes, and Dive Sites: BCMCA, 2011; Crown Land Tenures: BC FLRNO, 2008; Sport Fishing Area: BCMCA, 2011; Rockfish Conservation Areas: Department of Fisheries and Oceans Canada, 2012; CHS Berth/anchorage points, pilot boarding points, marine facility area features, regulated zones, marine navigation area features, ferry routes and utility area features provided by KMC, 2013. Additional ferry routes: BCMCA, 2013; Ferry Terminals: BC FLNRO, 1998; B/W Imagery: Landsat7 NASA Geospatial Interoperability Program. 2005.

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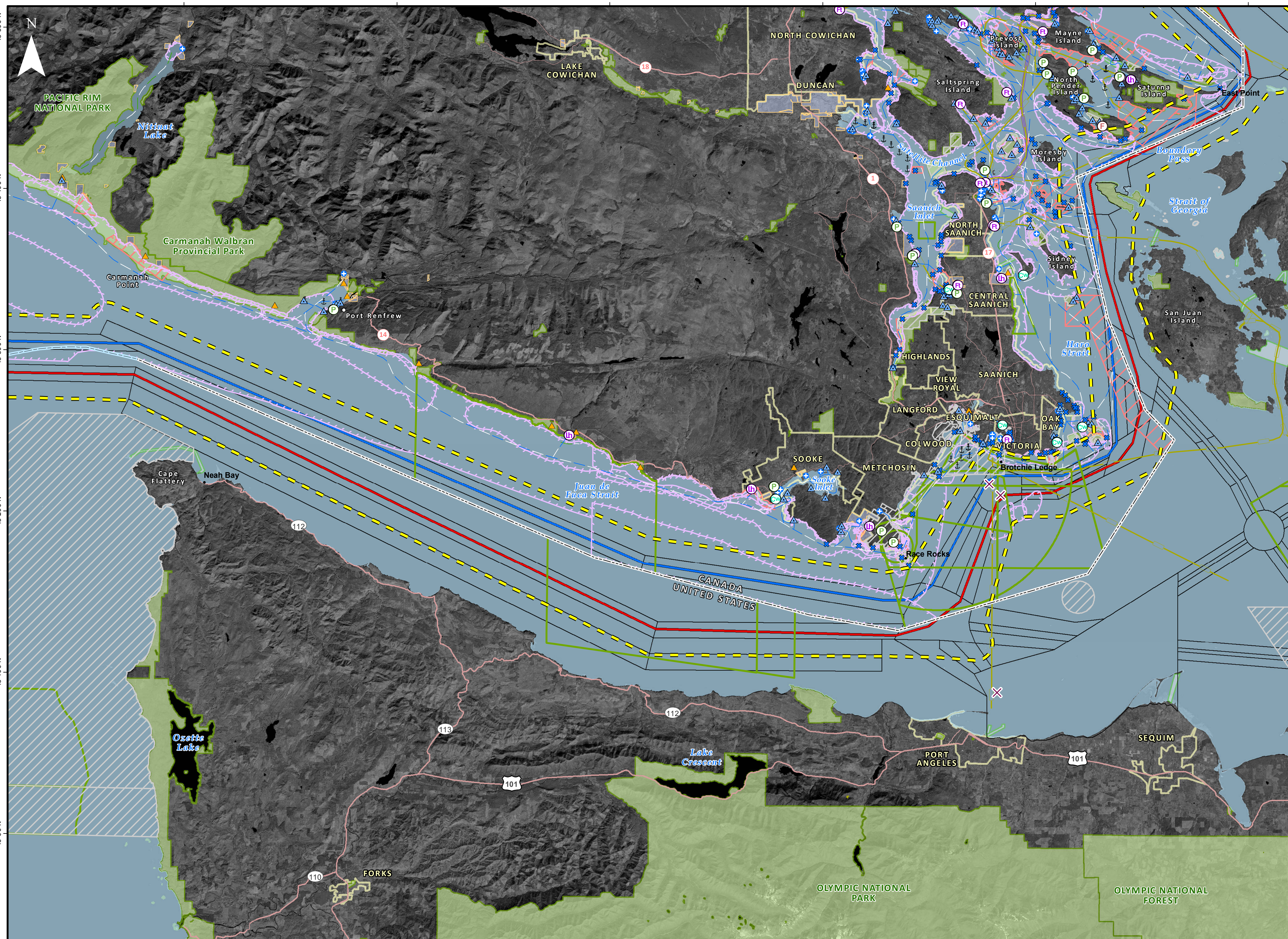


TRANS MOUNTAIN

**FIGURE 4.2-31**

**MCRTU REGION 4: JUAN DE FUCA STRAIT**

**TRANS MOUNTAIN EXPANSION PROJECT**

- Anchorage Area / Anchor Berth
- Coastal Anchorage
- Coastal Campsite
- Coastal Diving Site
- Marina/Yacht Club/Public Dock/Other Berth
- Pilot Boarding Station
- Commercial Wharf
- Fishery Facility
- Floating Cabin
- Log Handling/Storage
- Ferry Terminal
- Public Wharf
- Highway
- Road
- 12 Nautical Mile Limit (Territorial Sea)
- Limit of Exclusive Economic Zone (EEZ)
- International Boundary
- Ferry Route
- Freight Route
- Coastal Recreational Craft Cruising Route
- Coastal Kayak Route
- Marine Vessel Outbound Lane
- Marine Vessel Inbound Lane
- Approximate LSA for Marine Shipping Lanes
- Municipality
- Indian Reserve
- National/Provincial/State Park
- Cable / Pipeline Area
- Sea Plane Landing Area
- Military Practice Area
- Sport Fishing Area
- Rockfish Conservation Area
- Marine Restricted Area
- Traffic Separation Scheme



Projection: NAD 1983 UTM Zone 10N. Routing: Baseline TMPL & Facilities provided by KMC, 2012; Proposed Pipeline Corridor V6: provided by UPI Aug. 23, 2013; Roads: BC FLNRO, 2012; Populated Places: BC FLNRO, 2007; Hydrology: BC FLNRO 2008, IHS 2004; First Nation Lands: Geobase, 2013; Parks and Protected Areas: BC FLNRO, 2008, Natural Resources Canada, 2013, ESRI 2005; US State Boundary: ESRI, 2005; Marine Vessel Traffic Lanes: Moffat and Nichol, 2013; Coastal Kayak Destinations, Select Coastal Campsites: BC FLNRO, 1998; Anchorages, Moorages, Marinas and Facilities, Recreational Craft Cruising Routes, Kayak Routes, and Dive Sites: BCMCA, 2011; Crown Land Tenures: BC FLRNO, 2008; Sport Fishing Area: BCMCA, 2011; Rockfish Conservation Areas: Department of Fisheries and Oceans Canada, 2012; CHS Berth/anchorage points, pilot boarding points, marine facility area features, regulated zones, marine navigation area features, ferry routes and utility area features provided by KMC, 2013. Additional ferry routes: BCMCA, 2013; Ferry Terminals: BC FLNRO, 1998; Territorial Sea Boundary: Extrapolated from shoreline data (IHS Inc., 2011 & ESRI, 2005); B/W Imagery: Landsat7 NASA Geospatial Interoperability Program. 2005.

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0 5 10 15 km

ALL LOCATIONS APPROXIMATE

*4.2.11.2 Indicators*

Four indicators were selected to represent potential effects from Project-related marine vessel traffic on MCRTU:

- commercial fisheries and aquaculture;
- marine transportation;
- marine recreational use; and
- marine tourism use.

The MCRTU indicators broadly represent the categories of users that may be affected by the increased Project-related marine vessel traffic. See Section 4.3 for more information regarding indicators.

*4.2.11.3 Region 1: Burrard Inlet*

**4.2.11.3.1 Overview**

Burrard Inlet is a tidal salt-water inlet of approximately 11.3 $km^2$ located in the Metro Vancouver Area (BIEAP 2011). Burrard Inlet is comprised of several distinct marine sections, including the Outer Harbour, the Inner Harbour bounded by the First and Second Narrows, the Central Harbour, Port Moody Inlet and Indian Arm. The First Narrows is between the Outer Harbour and the Inner Harbour and is crossed by a vehicle bridge. The Second Narrows is between the Inner Harbour and the Central Harbour and is crossed by a vehicle bridge and a rail bridge. The Second Narrows rail bridge can be raised to accommodate large marine vessels (PMV 2010).

The City of Vancouver, which bounds most of the southern shore of Burrard Inlet, is Canada's third-largest city and its busiest port (PMV 2013a). Over 2 million people live in the Lower Mainland in the 8 municipalities surrounding the inlet, namely: the cities of Vancouver, Burnaby and Port Moody on the south shore; the villages of Belcarra and Anmore on the east shore of Indian Arm and Port Moody Inlet; and the City of North Vancouver; the District of North Vancouver; and the District of West Vancouver on the north shore (BIEAP 2011). See Section 4.2.10 for information regarding traditional territories and First Nations.

**4.2.11.3.2 Commercial Fishing and Aquaculture**

Commercial fishers in Burrard Inlet mainly harvest Dungeness crab, prawn and shrimp. Commercial fishing for crab (Dungeness crab and red rock crab) in Burrard Inlet takes place primarily in the Outer Harbour. A fishing presence (*i.e.*, less than three boats) is noted in the eastern portions of the harbour and in Indian Arm (DFO 2013i). Dungeness crabs are fished by a trap fishery, where fishing vessels set single or multiple crab traps on a line. The traps are left to "soak" for a specified time period and then hauled in (DFO 2013i). In Burrard Inlet the fishery is typically open from early summer to November or December (DFO 2013i). Live crabs are destined for Asian and local markets (BC Ministry of Agriculture 2011).

Shrimp are fished commercially by trap and trawl fisheries. Spot prawns are the largest species of shrimp in BC waters, and are targeted by a commercial trap fishery (DFO 2013j). The prawn trap fishery is usually active over a short period from late spring to early summer, subject to fishery openings that area based on evaluation of the stock status by DFO (DFO 2013j). The commercial prawn trap fishery has a low level of fishing effort in the approach to the Outer

Harbour, and a small portion of Indian Arm. Prawn traps are typically set in depths of between 40 to 100 m (DFO 2013j). Other species of shrimp are caught by the shrimp trawl fishery, which consists of two types of trawl vessels, namely: otter trawlers; and beam trawlers. Both types of trawlers tow large, conical nets along the sea floor, although beam trawlers tend to be smaller vessels that fish closer to shore (DFO 2013k). The shrimp trawl fishery opens in mid to late-summer and often extends into the winter months. Shrimp beam trawlers are active in the approach to Vancouver Outer Harbour (DFO 2013k).

A small commercial fishery for surf smelt is present in Burrard Inlet, mainly near spawning beaches in English Bay. Surf smelt are an important prey item for many marine species. The fishery is closed from June 15 to August 15, to protect spawning populations (DFO 2012c).

Permanent navigational closures for all fishing activities are in place in the Inner Harbour between the First and Second Narrows, and in part of English Bay near False Creek. Navigational closures are in place to allow for the safe passage of marine vessels. A small marine reserve closed to all fishing is located on the north shore of Burrard Inlet in West Vancouver, around Lighthouse Park and Point Atkinson (DFO 2013i). The entire area of Burrard Inlet is subject to a permanent sanitary closure for shore-based bivalve shellfish harvesting (DFO 2013l). The Eastern Burrard Inlet RCA is located around the Westridge Marine Terminal in the east of Vancouver harbour, and another RCA is designated in Indian Arm. RCAs permit certain types of fishing that are unlikely to harm rockfish populations. Permitted fishing activities include: fishing by seine or gillnet; trap fisheries for prawn or crab; diving for or hand-picking of invertebrates; and mid-water trawl fisheries (DFO 2013l).

Further details on commercial fishing, including fisheries maps, are presented in the Marine Commercial, Recreational and Tourism Use – Marine Transportation Technical Report of (Volume 8B, TR 8B-6).

#### 4.2.11.3.3 Marine Transportation

PMV is the port authority mandated under the *Canada Marine Act* to be responsible for the safe and efficient movement of marine vessel traffic in Burrard Inlet (PMV 2013a). PMV is responsible for oversight of all marine traffic within Burrard Inlet and operates harbour patrol vessels and services including emergency response, harbour monitoring, and support services (PMV 2013a). The port authority provides oversight for operations of 28 cargo and container terminals, 23 of which are in Burrard Inlet (PMV 2013a).

In 2012, PMV activities for terminals in Burrard Inlet, the lower Fraser River and Delta included:

- handling of approximately 123 million tonnes of cargo;
- handling over 3,000 calls by foreign vessels; and
- facilitating the movements of a total of 191 cruise ship voyages, with over 600,000 passengers (PMV 2012a).

Marine vessels in Burrard Inlet must comply with localized regulations dictated by PMV, pursuant to Section 56 of the *Canada Marine Act* (PMV 2010). Vessel movements and related communications are monitored by the CCG MCTS. Most marine vessels over 20 m in length are required to request clearance from MCTS, and PMV recommends that all vessels register with MCTS within Burrard Inlet (CCG 2013a, PMV 2010). Most vessels over 350 gross tonnes, including tankers, cargo ships, cruise ships and container ships, are required to be under the conduct of at least one marine pilot when transiting through BC coastal waters, including in Burrard Inlet (PMV 2010).

The Outer Harbour and the eastern portions of the harbour contain multiple commercial anchorages for large deep draft marine vessels. Designated inbound and outbound shipping lanes start in the Outer Harbour and continue into the Strait of Georgia. The purpose of the traffic separation scheme is to mitigate the possibility of collisions between inbound and outbound vessels (CCG 2013b).

The Inner Harbour is heavily industrialized, containing several major marine cargo, container and cruise ship terminals. The Second Narrows is crossed by a vehicle bridge and a rail bridge, the latter of which is operated by CN railway. Depending on the size of the marine vessel, the rail bridge may be raised to allow passage of marine vessels. The coordination of operations of the CN Rail Bridge at the Second Narrows is essential for all vessel movements, with the exception of small boats and harbour craft, between the terminals and docks east of the Second Narrows and the Inner Harbour. Bridge operations are the responsibility of the CN railway Bridge operator. Vessels requiring a bridge opening must contact the bridge operator. Safe passage is indicated by the bridge operator with navigational lights displayed on the lift span (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 2013).

A seaplane base is located in the Inner Harbour. The area has a high level of seaplane activity 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 marine area used by seaplanes in the Inner Harbour is a restricted area that does not intersect with marine shipping lanes.

The Inner Harbour between the First Narrows and Second Narrows is subject to the Second Narrows MRA Regulations. The area around the Second Narrows is relatively shallow, and is a natural bottleneck area with strong currents (CCG 2013b). In the MRA, marine vessels are not permitted to meet or overtake each other, and must be in communication with MCTS at all times. MRA procedures stipulate that all piloted vessels must transit only at high slack tide to ensure adequate bottom clearance and minimal stress from tidal currents (PMV 2010).

Specific regulations apply to the passage of tankers in Burrard Inlet. For example, laden tankers (*i.e.*, tankers carrying product) are required under PMV regulations to transit through Burrard Inlet in daylight hours (PMV 2010). Tankers which are over 40,000 DWT, such as Aframax tankers that berth at the Westridge Marine Terminal, require an escort of a minimum of two tugs when inward or outward bound (PMV 2010). All vessels with a total length greater than 265 m are required to have two pilots aboard (PMV 2010).

Piloted vessels require a “Clear Narrows” authorization to transit the First and Second Narrows. A Clear Narrows clearance ensures that large vessels will be able to transit the Narrows without being overtaken or crossed ahead by any other vessel (*i.e.*, all other vessels must keep clear when piloted vessels are transiting through the MRA) (PMV 2010). No unpowered sailboats, personal watercraft or fishing activities are allowed in the MRA (PMV 2010).

The Central Harbour continues east of the Second Narrows and contains marine terminals including the Westridge Marine Terminal, as well as the Chevron oil refinery (PMV 2013a). Marine terminals are also present in Port Moody Inlet, east of the Westridge Marine Terminal.

A fleet of harbour tugs assist other vessels with shipberthing in Burrard Inlet. There are approximately 4,500 instances annually in Burrard Inlet when a tug assists another vessel (Eckford pers. comm.). Harbour assist tugs are differentiated from ocean or coastal tugs, the latter of which are used in the transportation of barges (Seaspan Marine 2013). Tug traffic, including harbour assist tugs and tugs engaged in towing activities, comprise a significant portion of total vessel traffic in Burrard Inlet (see the TMEP TERMPOL 3.2 Application, Volume 8C, TR 8C-2). 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. Anchorages designated as short-term require that a pilot remain on board (PMV 2012b).

#### 4.2.11.3.4 Marine Recreational Use

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, which is accessed through Burrard Inlet and has provincial and regional parks along much of the shoreline.

Fishing is popular in many areas of Burrard Inlet. Fishing opportunities are available for salmon, halibut, rockfish, crab and other shellfish in close proximity to major population centres (Destination BC 2013). Fishers target salmon at the mouth of the Capilano River and nearshore areas around Stanley Park in the vicinity of First Narrows, and recreational fishing for crab, prawn and shrimp is popular in the Outer Harbour and English Bay (Bird pers. comm.). A large run of pink salmon migrates every two years through Indian Arm in the fall, and a run of chum salmon migrates into the Inlet in late summer (BC Parks 2013a). The recreational fishery for surf smelt in Burrard Inlet is active in the summer months and is expanding, raising concerns that the fishery may not be sustainable (DFO 2012c).

Recreational fisheries in BC tidal waters are regulated by DFO, and regulations include area closures, minimum size restrictions and possession limits (DFO 2013i). Recreational fishing areas cover most of Burrard Inlet, extending from the southern portion of Indian Arm and the entrance to Port Moody Inlet west, excluding the Inner Harbour between the First and Second Narrows. The recreational fishing areas do not have a regulatory element; however, they do indicate use by recreational fishers. Burrard Inlet is designated as a sport fishery area for groundfish species by DFO, and commercial fishing for groundfish is prohibited (DFO 2013m). No fishing is permitted between the First and Second Narrows for navigation and safety reasons (PMV 2010).

Recreational boating (*i.e.*, power boats and sail boats) takes place throughout Burrard Inlet. Sailing is permitted in English Bay and the Outer Harbour, west of the First Narrows, in part of the Inner Harbour and east of the Second Narrows (PMV 2010). No sailing or channel crossing is permitted in the First and Second Narrows (PMV 2010). The Coal Harbour area is restricted to sea cadet sail training. Several yacht clubs are active in Burrard Inlet, with races, individual sailing and lessons taking place in English Bay, when wind conditions are favourable (City of Vancouver 2013). Marinas are concentrated in False Creek and Coal Harbour, and are also present in Indian Arm, Port Moody Inlet, at the Second Narrows and on the north shore of the Inner Harbour.

Windsurfing is a popular activity in English Bay (City of Vancouver 2013). Paddle boarders use Deep Cove in Indian Arm, English Bay and False Creek. Sea kayakers tend to use more sheltered areas such as False Creek and nearshore areas of North Vancouver, into Indian Arm (Greater Vancouver Visitors and Convention Bureau 2013a). Kite boarders are also present in English Bay but are not permitted in the summer months (City of Vancouver 2013).

Parks around the shoreline of Burrard Inlet are used for swimming, fishing from piers, kayaking, boating and scuba diving. Swimming is popular at beaches in Stanley Park in Vancouver, and scuba diving is a popular activity at Lighthouse Park in West Vancouver, and at Cates Park in North Vancouver. Specific information on marine use of parks around Burrard Inlet can be found in the Marine Commercial, Recreational and Tourism Use – Marine Transportation Technical Report (Volume 8B, TR 8B-6).

#### 4.2.11.3.5 Marine Tourism Use

Tourism is a large contributor to the provincial economy. In 2011, the BC tourism sector generated $13.4 billion in total revenue and contributed $6.5 billion to the economy, measured in Gross Domestic Product (BC Ministry of Jobs, Tourism and Skills Training 2012). Approximately 75,000 people or nearly 80 per cent of the provincial total number of tourism workers were employed in tourism-related businesses in the Vancouver, Coast and Mountains Region in 2011, which includes Metro Vancouver, Whistler and Hope (BC Ministry of Jobs, Tourism and Skills Training 2012). Marine tourism is an important part of the tourism industry in the Lower Mainland. Marine tourism activities in the Vancouver area include cruise ships, boat charters, sportfishing, kayak tours and whale-watching tours.

Vancouver is the homeport for the Vancouver-Alaska cruise ship industry, with two cruise ship terminals in the Inner Harbour. A total of 199 sailings from 14 cruise line companies called at PMV in 2011 (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). Smaller day cruise operators based in the Vancouver area offer boat tours and corporate and private cruises in Vancouver Harbour, the Inner Harbour and Indian Arm (Destination BC 2013, Harbour Cruises 2013). Most sportfishing charter operators are based in marinas in Coal Harbour and Granville Island. A small number of commercial sportfishing guides are based in Steveston and Richmond (Bird pers. comm.). The sportfishing season for various salmon species generally runs from January until the end of October, when most runs have returned to natal rivers for spawning. Fishing charter operators often employ traps for crabs or prawns as well as offering fishing for salmon and other finfish (Ocean Adventure Centre 2013).

Sea kayaks can be rented for day trips at locations in Deep Cove in Indian Arm, Port Moody Inlet, Coal Harbour and Spanish Banks in Vancouver, and near Ambleside Park in North Vancouver. Many operators also offer guided tours locally or into Howe Sound and other areas (Kayak Rental Vancouver 2013). For local scuba diving, dive centres in Vancouver and Burnaby offer courses and trips and arrange dive charters into Howe Sound and other areas around the Marine RSA and beyond (Destination BC 2013). Charter companies in the Vancouver area also offer boat rentals for sail and power boat cruising (Destination BC 2013).

Whale-watching tour operators in Burrard Inlet are based at Granville Island in False Creek and in Coal Harbour in Vancouver Inner Harbour. The whale-watching season generally begins in April and finishes in October, in order to view killer whales in areas of the Strait of Georgia. Grey whales, humpback whales and other marine mammals and birds are also viewed on whale-watching tours (Greater Vancouver Visitors and Convention Bureau 2013a).

### *4.2.11.4 Region 2: Strait of Georgia*

#### 4.2.11.4.1 Overview

The Strait of Georgia is a navigable channel about 220 km long, varying in width from 18.5 to 55 km and with a total area of approximately 6,800 $km^2$ (Gustafson *et al.* 2000). The strait is situated between Vancouver Island and the mainland coast of BC, bounded at both ends by narrow passages and a large number of islands. Discovery Passage in the north connects the Strait of Georgia with Johnstone Strait. In the south, Haro Strait and Rosario Strait connect the Strait of Georgia with Juan de Fuca Strait.

The Fraser River drains into the Strait of Georgia, depositing sediments into intertidal marshes and mudflats including Roberts Bank, Sturgeon Bank and Boundary Bay (Harrison *et al.* 1999). The Fraser River estuary is the largest estuary and the largest producer of salmon along the Pacific coast of North America (Harrison *et al.* 1999). The area is also highly important for migratory waterfowl and provides essential habitat for fish, invertebrates and many other species (BC Waterfowl Society 2012, Harrison *et al.* 1999).

In the Strait of Georgia, the shipping lanes pass near the cities of Richmond and Delta. As of 2011, Richmond and Delta had residential populations of 190,473 and 99,863 respectively (Statistics Canada 2012). See Section 4.2.10 for information regarding traditional territories and First Nations.

#### 4.2.11.4.2 Commercial Fishing and Aquaculture

The commercial fishing season is active from approximately June to November in the Strait of Georgia for most fisheries. Many commercial fishing vessels are based marinas in the Lower Mainland and southern Vancouver Island. The strait is used for fishing activities as well as access to other areas. Participants at the Victoria ESA Workshop commented that vessels cross the shipping lanes in the Strait of Georgia to access fishing grounds in other areas as well as accessing processing facilities along the Fraser River.

During active fishing seasons, commercial fishers are permitted to cross and fish within shipping lanes if the area is clear; however, fishers are not permitted to impede the passage of other vessels (CCG 2013b). Other marine vessels are advised to exercise caution in areas where large concentrations of fishing vessels may operate, including the area around Roberts Bank (CCG 2013c). Fishing vessels are advised to monitor the VTS channel for the area where they are transiting, and other vessels are advised to monitor VTS and VHF channel 78A when transiting through open fishing grounds (CCG 2013c).

Salmon are fished by troll, seine and gillnet in many areas of the Strait of Georgia. Between July and November, gillnet fishers may be present through the day and night near the approaches to the Fraser River. Gillnets can be up to 375 m long, with one end attached to the vessel and the other attached to a lighted buoy. Gillnets can be difficult to see in the water and incidents of gear entanglement with other marine vessels have been reported (CCG 2013c).

Pacific herring are fished by seine and gillnet in the Strait of Georgia (DFO 2012d). Precise opening times for herring seiners and gillnetters are determined by fishery managers and announced as they are determined (DFO 2012d). The roe herring fishery is managed by dockside landings of herring catch; therefore, spatial data on areas of fishing activity is not available. Previous fishing years show commercial activity in the Strait of Georgia to be concentrated north of the Marine LSA around the Nanaimo area. Metro Vancouver is one of the designated landing stations for roe herring dockside validation (DFO 2012d).

Groundfish is a collective term that describes fish that live on or near the sea floor and in mid-water. Groundfish are fished by trawlers, which drag large nets along the sea floor, as well as by hook and line fisheries (DFO 2013m). The Strait of Georgia is open year-round for the commercial groundfish fisheries with the exception of the halibut hook and line fishery which typically opens in mid-spring and closes in late fall. A small fleet of about 10 vessels bottom trawl for groundfish exclusively in the Strait of Georgia. The vessels are typically much smaller than trawl vessels, which fish in outside waters with only one or two crew. The total catch of the Strait of Georgia groundfish trawl fleet is less than 0.5 per cent of the coastwide groundfish trawl catch in BC (G S Gislason and Associates *et al.* 2010).

The rockfish by hook and line fishery also occurs in the study area. The fishery is open year-round in most areas, excluding RCAs (DFO 2013m).

Shrimp beam trawlers fish in the Strait of Georgia near the shipping lanes west of Roberts Bank, off Richmond and Delta (DFO 2013k). The area is one of the highest activity areas for the fishery in the Marine RSA. In general, shrimp are fished in sandy and muddy nearshore areas (DFO 2013k).

Moderate fishing effort occurs along Roberts Bank for Dungeness crab, according to the data provided by DFO. The marine area around the terminal and extending east to Roberts Bank is a navigational closure for crab fishing. However, fishing occurs near the closure (CCG 2013b). The entire area around the mouth of the Fraser River is highly productive fish habitat (BC Waterfowl Society 2012). Fishing vessels may be present in the shipping lanes during fishery openings for salmon, crab or other species (CCG 2013c).

Most active shellfish aquaculture operations for Pacific oyster, Manila clam and other species in the southern Strait of Georgia are located north and west of the Marine RSA, such as in protected inshore waters along the east coast of Vancouver Island, near Ladysmith, on Gabriola Island, and in Nanoose (BCMCA 2013, DFO 2013o). Aquaculture operations in Baynes Sound near Comox produce about half of the oysters in BC (DFO 2013m).

Further details on commercial fisheries, including fisheries maps, are presented in the Marine Commercial, Recreational and Tourism Use – Marine Transportation Technical Report (Volume 8B, TR 8B-6).

#### 4.2.11.4.3 Marine Transportation

The Strait of Georgia is a busy and regionally important shipping route. Most commercial vessels use the shipping lanes, with the exceptions of passenger ferries and tugs and barges. Cargo ships use the Strait of Georgia to access the 23 active marine terminals in Burrard Inlet, the 2 automobile terminals and a cargo and container terminal along the Fraser River, and the Roberts Bank Superport Terminal in Delta. Roberts Bank Superport is a twin-terminal port facility in Delta, BC that contains a coal terminal and a container terminal. The coal terminal exported 27.3 million tonnes of coal and coke in 2011 (Westshore Terminals 2013). The container terminal at Roberts Bank is Canada's largest container terminal (PMV 2013a).

Towing and barging services in the Strait of Georgia are provided by companies such as Seaspan Coastal Intermodal Company and Island Tug and Barge. Truck trailers, rail cars and bulk cargo are barged frequently across the shipping lanes between terminals on the Fraser River and Nanaimo and Swartz Bay, north of Victoria, as well as smaller coastal ports north of the Marine RSA (Transport Canada 2006). In 2012, tug transits (*i.e.*, all tug and barge traffic) made up approximately 29 per cent of the total sailed nautical miles in the southern Strait of Georgia from Sturgeon Bank near the Middle Arm of the Fraser River to East Point on Saturna Island. Ferry and cargo traffic make up a further 26 per cent and 24 per cent, respectively (see TMEP TERMPOL 3.2 Application, Volume 8C, TR 8C-2).

A marine traffic separation scheme is in place for vessels approaching Vancouver Harbour from the Strait of Georgia (CCG 2013b). Traffic separation schemes separate opposing streams of traffic by establishing inbound and outbound shipping lanes and associated navigational aids, as well as a separation zone between lanes in some areas (IMO 2013a). Marine vessels including cargo ships, cruise ships and oil tankers are required to use established shipping lanes through the Strait of Georgia for navigational and safety purposes (CCG 2013a). The *Canada Shipping Act, Collision Regulations* apply in all BC coastal waters including the Strait of Georgia, Haro Strait and Juan de Fuca Strait (Transport Canada 2013i). These regulations set out navigation rules to be followed by marine vessels in order to prevent collisions (US Office of Coast Survey 2013).

Passenger ferries operated by BC Ferry Services use the Strait of Georgia for passenger ferry service between ports on the Lower Mainland, Vancouver Island, and the Southern Gulf Islands. Ferries transit frequently between:

- Horseshoe Bay (West Vancouver) and Departure Bay (Nanaimo area);
- Tsawwassen (Delta) and Duke Point (Nanaimo area);
- Tsawwassen and Swartz Bay (Victoria area); and
- Tsawwassen, Swartz Bay and the Southern Gulf Islands (Salt Spring, Pender, Mayne, Galiano, and Saturna Islands) (BC Ferry Services 2013a).

BC Ferries is one of the largest ferry operators in the world, carrying 20.2 million people in 2012 between 47 ports (BC Ferry Services 2012). Passenger ferry routes cross the shipping lanes in the Strait of Georgia at multiple locations, between Tsawwassen Terminal in Delta and terminals on Vancouver Island and the Gulf Islands. All passenger ferries are exempted from using marine pilots and instead rely upon the local knowledge of the captains and crew (CCG 2013b).

The Alaska Marine Highway System includes, as part of its transportation network, the Alaska ferry from Bellingham via Prince Rupert, BC into Alaska. The ferry route is in the shipping lanes through the Strait of Georgia, continuing north through Johnstone and Hecate Strait. The fleet includes 11 vessels and there are weekly, regularly scheduled departures with service to 33 communities. The service receives US federal highway funding, since it is the sole means of transport for people, goods and services to several communities in Alaska (State of Alaska 2013).

Special Operations Areas are marine areas that have been reserved for military use or exploration activities. Mariners are cautioned to remain clear of these areas when activities are taking place. Areas used for military exercises in the Marine RSA are located west of Point Grey in the Strait of Georgia, in Haro Strait north of Cordova Bay, south of Victoria in Juan de Fuca Strait, and in large areas of Juan de Fuca Strait west of Sooke (see the TMEP TERMPOL 3.2 Application, Volume 8C, TR 8C-2).

Disposal at Sea ocean dump sites are located at various locations in the Marine RSA. Disposal at sea is permitted under CEPA, 1999 for approved material from ships, aircraft or marine structures. In BC materials disposed of at sea are primarily comprised of dredged sediments from rivers or marine sources. Active disposal at sea sites in or near the Marine RSA in the Strait of Georgia include: a site in the Strait of Georgia off Point Grey, near the approach to Vancouver Harbour; a site at Sand Heads, near the Fraser River Estuary; and a site in Porlier Pass between Valdez and Galiano Island (Environment Canada 2013c).

#### 4.2.11.4.4 Marine Recreational Use

The Strait of Georgia is a major route for recreational users accessing areas in the Southern Gulf Islands, Vancouver Island, the US San Juan Islands and many other destinations. Commonly used boating routes cross the shipping lanes north of Roberts Bank off Delta and at several other points from the east, to access Porlier Pass between Valdes Island and Galiano Island and Active Pass between Mayne Island and Galiano Island.

The southern Strait of Georgia around the mouth of the Fraser River is a key fishing area for both recreational and commercial fishers. Recreational fishing for crabs and prawns is popular in the Strait of Georgia off Tsawwassen and Delta. Recreational fishing areas are identified in areas of Vancouver's Outer Harbour across the shipping lanes, continuing south in the Strait of Georgia adjacent to the eastern edge of shipping lanes around Roberts Bank. The marine area around Roberts Bank is a popular recreational fishing area for salmon returning to the Fraser River as well as for halibut and other groundfish species. At the entrance to Boundary Pass, a second recreational fishing area is identified along the north shores of Saturna Island and Tumbo Island, west of the shipping lanes. Shellfish sanitary closures are in effect in throughout the balance of the southern Strait of Georgia (DFO 2013l).

Windsurfing is popular off Spanish Banks, west of Vancouver in the Strait of Georgia, as well as south of Vancouver in Delta near Boundary Bay Regional Park, and off the BC Ferries causeway at the Tsawwassen Terminal (BC Lodging and Campground Association 2013, Greater Vancouver Visitors and Convention Bureau 2013a, Shangaan Webservices 2013). The BC Ferries causeway is also popular with anglers and bird watchers (BC Lodging and Campground Association 2013).

Yacht racing occurs in areas of the Strait of Georgia. The Southern Straits Race takes place annually in the spring, with yachts racing from West Vancouver Yacht Club in Vancouver Harbour west across the strait as far as Lasqueti Island, and south to Gabriola Island (West Vancouver Yacht Club 2013).

#### 4.2.11.4.5 Marine Tourism Use

Marine tourism in the Strait of Georgia includes sportfishing, whale-watching tours and cruise ships.

Commercial sportfishing guides operate out of Richmond and Vancouver, with charters targeting salmon year-round around Vancouver, the Gulf Islands and Vancouver Harbour. Several marine tour operators based in Steveston offer whale-watching, cruising, fishing and wildlife-viewing tours, in the Fraser River estuary, Steveston Harbour and the Gulf Islands (Worldweb 2013). A number of sports fishing guides are active exclusively on the Fraser River for sturgeon and salmon, while other guides take clients out into the Strait of Georgia for salmon and halibut (Bird pers. comm.).

Whale-watching operators use the Strait of Georgia for accessing areas where whales are typically present, such as the Southern Gulf Islands and the US San Juan Islands. However, whales can be present throughout the Strait of Georgia from spring to fall (Towers pers. comm.). Whale-watching tours in the Strait of Georgia typically target resident killer whales, between March and October, when whales are feeding on migrating salmon. Sea lions, seals, porpoises and marine birds are also targeted for wildlife viewing (Greater Vancouver Visitors and Convention Bureau 2013a). Most of the Strait of Georgia is designated as critical habitat for southern resident killer whales (DFO 2011a).

Cruise ships call at the BC ports of Vancouver, Victoria, Nanaimo, Port Alberni and Prince Rupert. Vancouver and Victoria are the first and second-largest cruise ports in Canada, respectively (Cruise BC 2013). Cruise ships are required to transit through the Strait of Georgia using the shipping lanes (CCG 2013a). Cruise ships in the Strait of Georgia are bound for ports in Alaska, through the Inside Passage between Vancouver Island and the mainland coast, and other US and international ports (PMV 2013a).

#### *4.2.11.5 Region 3: Haro Strait*

##### 4.2.11.5.1 Overview

Haro Strait is the main navigable channel in Canadian waters that connects the Strait of Georgia to Juan de Fuca Strait. Haro Strait also defines part of the international boundary between Canada and the US, dividing the Southern Gulf Islands from the US San Juan Islands. The strait is approached from the Strait of Georgia through Boundary Pass near East Point on Saturna Island.

Haro Strait is approximately 50 km long, including Boundary Pass. The shipping lanes are situated on or near the international boundary for most of the strait. The strait is narrow throughout much of its length and is known for navigational hazards and strong tidal currents (CCG 2013a). See Section 4.2.10 for information regarding traditional territories and First Nations.

The Southern Gulf Islands are on the west side of Haro Strait. Saturna Island, South Pender Island, Sidney Island and a number of smaller islands are adjacent to the shipping lanes and fall within the Marine LSA. As of 2011, the islands of Saturna and South Pender had year-round populations of 335 and 201, respectively (Statistics Canada 2012). The Town of Sidney, the city of Victoria and the Greater Victoria municipalities of North Saanich, Central Saanich, Saanich and Oak Bay are along the shoreline of Vancouver Island adjacent to Haro Strait. Collectively, the Greater Victoria area had a population of 316,327 in 2011 (Statistics Canada 2012).

##### 4.2.11.5.2 Commercial Fishing and Aquaculture

Participants at the Victoria ESA Workshop indicated that commercial and recreational fishing are very active along the shipping lanes in Haro Strait and Juan de Fuca strait. The crab trap fishery occurs year-round in nearshore areas of Haro Strait, north of Victoria. The shrimp beam trawl fishery occurs in the strait from summer to late fall, with areas of higher activity in the strait northeast of Victoria.

Prawn trap fishers are active during a brief fishing season that typically occurs from late-spring to early-summer in Haro Strait. Key fishing areas include south of Pender Island and west of Stuart Island, and east of the Saanich Peninsula. The prawn trap fishery was the third most valuable wild capture fishery after halibut and geoduck clam in 2011 (BC Stats 2013). More than

60 per cent of commercial landings of prawns originate from fishing grounds in inside waters, especially along the east coast of Vancouver Island (DFO 2013j).

Salmon are commercially fished in Haro Strait, with trollers concentrated around Boundary Pass and the north end of the strait in late summer and early fall (DFO 2013b). Opportunities for commercial seiners to fish Fraser River sockeye in areas of Haro Strait typically occur in late July; however, decisions about whether to open the fishery are typically made close to the start of the fishing season (DFO 2013b).

An experimental dive fishery for giant pacific octopus was in place from 2007 to mid-2013 (DFO 2013l). Octopuses were harvested primarily in nearshore areas along the east coast of Vancouver Island. Commercial dive fisheries currently take place in areas of Boundary Pass and Haro Strait for red and green urchin and geoduck clam (DFO 2013l). Bivalve shellfish harvesting is permitted along some shoreline areas in Haro Strait and Boundary Pass, subject to temporal and area closures (DFO 2013m).

Aquaculture operations for shellfish and finfish are present in nearshore areas in Haro Strait. Active licences for shellfish aquaculture operations for mussels, Manila clams, Pacific oysters and other shellfish are present in the Southern Gulf Islands, in sheltered areas near Saturna Island and Saltspring Island (DFO 2013n). The aquaculture operations identified with active licences are not proximal to the shipping lanes. Most aquaculture operations are located in sheltered areas, away from shipping channels. A finfish aquaculture operation for Atlantic salmon is present on the east side of Saltspring Island in Captain Passage (DFO 2013o).

Further details on commercial fishing, including fisheries maps, are presented in the Marine Commercial, Recreational and Tourism Use – Marine Transportation Technical Report (Volume 8B, TR 8B-6).

#### 4.2.11.5.3 Marine Transportation

Tanker and cargo traffic from terminals in Vancouver use Haro Strait to access international waters via Juan de Fuca Strait. Most commercial marine vessels are required to follow the shipping lanes and the traffic separation schemes in Haro Strait and Boundary Pass to mitigate the possibility of collisions (CCG 2013b). In 2012, passenger ferry transits made up approximately 38 per cent of the total sailed nautical miles in Haro Strait, with cargo traffic making up a further 21 per cent (see the TMEP TERMPOL 3.2 Application, Volume 8C, TR 8C-2). The Turn Point Special Operating Area is the transboundary area around Turn Point on Stuart Island in Haro Strait. Operating rules prohibit vessels of 100 m or more in length from entering the area when another vessel of 100 m or more in length is already in the area. The regulations are in place to prevent more than one single deep draft vessel occupying the area at a given time (USCG 2013).

Outbound tankers (*i.e.*, carrying product) are required to have a tethered escort tug while in transit through Haro Strait. The escort tug meets the tanker just north of East Point on Saturna Island and remains tethered until reaching the pilot boarding station south of Victoria in Juan de Fuca Strait. From the pilot station, the tug disconnects and remains with the tanker until the vessels reach Race Rocks. In Haro Strait, two pilots are also required to be present on board outbound tankers. Inbound, ballasted tankers require a single pilot to be on board due to the decreased risk. Tankers are also required to travel at speeds of less than 10 knots in Boundary Pass and Haro Strait (PPA 2013).

Various ferry services transport passengers and some cargo between ports in BC and Washington, and all services follow routes that are for the most part outside of the shipping lanes. Ferries cross the shipping lanes at various locations. Washington State Ferries transiting between Sidney and Anacortes in Washington cross the shipping lanes in Haro Strait daily in both directions, transiting east to west near Sidney Spit Marine Park on Sidney Island (Washington State Department of Transportation 2013a). From Victoria, Black Ball Ferry Line runs regular trips between Victoria and Port Angeles in Washington, with between four and eight sailings daily depending on the season (Black Ball Ferry Line 2013). The Victoria Clipper is a passenger-only ferry service that runs high-speed catamarans daily between Victoria, BC and Seattle, Washington, crossing the shipping lanes south of Race Rocks Ecological Reserve off Victoria (Clipper Navigations 2013).

#### 4.2.11.5.4 Marine Recreational Use

Marine traffic in Haro Strait increases by about 60 per cent in the summer months, due to increased pleasure craft and ferry traffic. Commercial marine traffic is constant for much of the year (TMEP TERMPOL 3.2 Application, Volume 8C, TR 8C-2). The Southern Gulf Islands and the inshore areas of southeast Vancouver Island are popular recreational areas in the summer months for residents and tourists.

Together, Boundary Pass and Haro Strait form the eastern boundary of the Gulf Islands National Park Reserve, which protects terrestrial and marine areas on many of the islands in the Gulf Islands archipelago. The park reserve is a destination for activities such as kayaking, canoeing, boating, scuba diving, coastal camping, whale-watching and wildlife viewing. The marine area within the reserve has been proposed as the Southern Strait of Georgia National Marine Conservation Area, which would be created under the *Canada Oceans Act*, to protect a representative area of the Strait of Georgia marine region. The proposed area would encompass the current boundaries of the Gulf Islands National Park Reserve with substantial marine additions, including the southwest Strait of Georgia and the area around the Southern Gulf Islands reaching to Cordova Bay north of Victoria (Parks Canada 2013b). Final boundaries of the Southern Strait of Georgia National Marine Conservation Area are subject to ongoing consultation with stakeholders (Parks Canada 2013b). The designated shipping lanes are within the area boundaries, as are key fishing grounds for several commercial and recreational fisheries, log handling areas, ocean dumping sites and commercial anchorages.

Recreational fishing in Haro Strait takes place in many areas around the Gulf Islands and off the City of Victoria. Fishing activity is highest from May through November, and includes fishing for Dungeness crab, shrimp and spot prawn as well as salmon, halibut, lingcod and rockfish. Fishing for salmon begins in early summer and peaks in late summer, while halibut are usually fished in winter and spring (Island Angler 2013). Recreational fishers are commonly around Discovery Island and many other areas off Victoria and can be present in the shipping lanes, which are close to shore in this area (Juandesooka Enterprises 2013).

Scuba diving in the Haro Strait region of the Marine RSA includes locations in nearshore areas of Saturna Island, South Pender Island, Prevost Passage and Sidney Island. Dive sites are also present around the Brethour, Domville, Forrest, Gooch Islands RCA north of Sidney Island. Dive sites around the Victoria area include Ten Mile Point, Plumper Passage and Mouat Channel off the Oak Bay area of Victoria (Shangaan Webservices 2013).

An extensive marine trail network of paddling routes, access points and coastal campsites throughout coastal BC provides detailed information for trip planning for kayakers, canoeists and other small craft (BC Marine Trails Association 2013). Many accessible routes for sea kayaying are located in the Gulf Islands (Gulf Islands Tourism 2013). Coastal campsites are present on South Pender, Sidney and D'Arcy Islands, in marine parks that are also part of the National Park Reserve. In the Victoria area, Discovery Island Marine Park off Oak Bay in Victoria is popular for kayaking. Kayakers use the coastal campsites on the south side of the islands in Rudlin Bay, as well as other campsites in the Chatham Islands to the north in Haro Strait. The shipping lanes are directly offshore from the Discovery Islands (BC Parks 2013b).

#### 4.2.11.5.5 Marine Tourism Use

Marine tourism use in the Haro Strait area includes: whale-watching; charters for sportfishing, scuba diving and boating; and sea kayak tours.

Provincially, upwards of half a million passengers per year are carried by about 80 whale-watching boats. The major attractions for tourists in the summer and early fall months are killer whales (DFO 2011a). Whale-watching and wildlife viewing tour companies are based in Vancouver, Victoria and other parts of the Marine RSA. Although whales can be spotted in many areas of the Marine RSA, whale-watching operators are often in Haro Strait where killer whales are often present. Haro Strait is a major destination for whale-watching tours from Victoria, Vancouver and the US San Juan Islands (Towers pers. comm.). Whale-watching tours also frequently sight other whale species, as well as porpoises, sea lions and seals, and marine birds (Prince of Whales Whale Watching 2013).

In recent years, an average of 19 to 22 whale-watching boats have been observed daily near southern resident killer whales in Haro Strait throughout the summer months, including privately owned vessels (DFO 2011a). The Gulf Islands National Park Reserve in Haro Strait is a major destination for whale-watching tours from Victoria and Vancouver due to the presence of a wide variety of marine wildlife and marine birds (Parks Canada 2013a).

Companies specializing in sportfishing, scuba diving, whale-watching, sea kayaking and wildlife tours are based in Sidney and Victoria. Charters offer fishing trips to areas near Victoria and in the Gulf Islands for Chinook salmon, halibut and other fish, primarily in the summer months (Sport Fishing Institute of BC 2013, Tourism Victoria 2013). Dive charter companies operate year round (dive.bc.ca 2013). Sea kayak tours are offered through companies operating out of the Greater Victoria area, other communities on southern Vancouver Island, and the Gulf Islands (BC Marine Trails Association 2013).

### *4.2.11.6 Region 4: Juan de Fuca Strait*

#### 4.2.11.6.1 Overview

The Juan de Fuca Strait is a wide channel about 160 km long separating southeast Vancouver Island from the north coast of the Washington. The strait connects the Pacific Ocean with the Strait of Georgia and Puget Sound (US Office of Coast Survey 2013). The eastern entrance is marked by Race Rocks Ecological Reserve, south of Metchosin on Vancouver Island. The western boundary of the strait is generally defined by a north-south line between Cape Flattery, on the northeast edge of the Olympic Peninsula, to Carmanah Point on Vancouver Island. The international boundary runs along the centre of the strait. The Marine RSA extends another 12 nautical miles (about 22 km) east of this point into the Pacific Ocean. The 12 nautical mile limit also defines the extent of Canada's territorial sea (DFO 2013l).

The city of Victoria and the Greater Victoria municipalities of View Royal, Colwood, Metchosin and Sooke are along the shoreline of Vancouver Island adjacent to Haro Strait. The CRD provides services and regional governance to Greater Victoria and unincorporated areas west of

Sooke, including the community of Port Renfrew which is located about 2 hours west of Victoria (CRD 2013). See Section 4.2.10 for information regarding traditional territories and First Nations.

#### 4.2.11.6.2 Commercial Fishing and Aquaculture

Commercial fishing activity in Juan de Fuca Strait includes fishing for salmon, groundfish and crab. Factory ships operate in Juan de Fuca Strait near Cape Flattery between June and November, as well as salmon fishers using seine nets (CCG 2013c, DFO 2013b). Gillnet vessels typically fish for salmon in late fall in nearshore areas west of Port Renfrew, while seiners are more widely distributed throughout the strait in the fall and winter (DFO 2013b).

Salmon trollers and other fishing vessels may congregate in the approaches to Juan de Fuca Strait between April and September, subject to fishery opening dates (CCG 2013b, DFO 2013b). The MCTS centre in Tofino, BC provides radar-derived information on the locations of concentrations of fishing vessels in the strait (CCG 2013b).

The groundfish trawl fishery operates throughout Juan de Fuca Strait, with effort concentrated in western parts of the Strait near Port Renfrew and Swiftsure Bank, and west of Sooke. Groundfish and rockfish are also caught by hook and line fisheries in the strait near Sooke (DFO 2013m).

The crab trap fishery is active throughout most of the year in nearshore areas around Victoria, Sooke and Port Renfrew (DFO 2013i).

Constance Bank is a highly productive fishing area south of Victoria harbour in the strait near the shipping lanes. Fishing vessels deploying hook and line gear or traps are often in the area during fishing season, either in or adjacent to the shipping lanes. Participants at the Victoria ESA Workshop commented that vessels in the shipping lanes have had close interactions with small fishing vessels on a number of occasions, although no reported incidents have been identified.

Further out to sea near Port Renfrew, Swiftsure Bank at the approach to the Strait is a highly productive area for many fisheries, and fishing vessels can be numerous during the fishing season in this region. It was noted during the Victoria ESA Workshop that both commercial and recreational fishing vessels tend to transit through the strait in nearshore areas outside of the shipping lanes, when feasible.

In Sooke harbour west of Victoria, small commercial and recreational trap fisheries for coonstripe shrimp (or dock shrimp) and other incidentally caught shrimp species take place in the winter months (DFO 2013j). Active aquaculture licenses for Atlantic salmon, Manila clams and Pacific oysters are also present in Sooke harbour (DFO 2013n,o).

Further details on commercial fishing, including fisheries maps, are presented in the Marine Commercial, Recreational and Tourism Use – Marine Transportation Technical Report (Volume 8B, TR 8B-6).

#### 4.2.11.6.3 Marine Transportation

Juan de Fuca Strait is a major shipping route for marine traffic accessing ports on Vancouver Island, Metro Vancouver and US ports in Puget Sound. Traffic Separation Schemes are in place and are mandatory for all large marine vessels in Juan de Fuca Strait. The separation scheme consists of inbound and outbound traffic lanes with separation zones, as well as two precautionary areas. The precautionary areas are marked by lighted buoys. The purpose of the separation scheme and precautionary areas is to mitigate safety issues associated with cross traffic in the area (CCG 2013b, US Office of Coast Survey 2013). In addition to the main inbound and outbound shipping lanes, additional routes for smaller vessels are located south of the main shipping lanes in the strait (US Office of Coast Survey 2013).

Aside from commercial fishing traffic, the shipping lanes are used by vessels including cargo and container ships, tankers bound for the Westridge Marine Terminal and other Canadian and US terminals, cruise ships bound for Vancouver, tugs and barges, and Canadian and US naval vessels. In 2012, cargo traffic made up the largest proportion of the total marine traffic (TMEP TERMPOL 3.2 Application, Volume 8C, TR 8C-2). Navigation through the strait is described as relatively simple in clear weather due to the navigation aids throughout the strait; however, gales are common. Winds are strongest from October through March. Dense sea fog is common in the summer months and early fall, particularly in the western areas of the strait. In poor weather, strong irregular currents also contribute to hazardous conditions (US Office of Coast Survey 2013).

A voluntary Tanker Exclusion Zone (TEZ) has been established off the Pacific Coast of Canada, with the purpose of keeping laden tankers farther out to sea in order to protect the shoreline and coastal waters from the potential risk of oil pollution. The TEZ defines an area where a disabled tanker would be likely to drift ashore, prior to the arrival of salvage tugs (Chamber of Shipping 2011). The TEZ is comprised of the Coastal Waters of BC to about 100 km offshore, from the Alaska border to a point just off Cape Flattery (CCG 2013b).

#### 4.2.11.6.4 Marine Recreational Use

Marine recreational use in Juan de Fuca Strait includes sailing, boating, fishing, surfing, kayaking and scuba diving. Yacht racing takes place annually in Juan de Fuca Strait, notably the Swiftsure International Yacht Race. The Swiftsure Race is a long distance race with challenging conditions which takes place at the end of May between Victoria Harbour and Swiftsure Bank, northwest of Cape Flattery and west of the entrance to Juan de Fuca Strait. Yachts must cross the shipping lanes to complete the race course (Royal Victoria Yacht Club 2013). Sailing is a popular recreational activity around the Victoria area with races occurring frequently in Esquimalt and Victoria harbours. Coastal boating routes are close to the shoreline along much of the strait, accessing recreational fishing areas along the coastline of Vancouver Island and destinations further north. Marinas are present in the Sooke area and in Port Renfrew.

Recreational fishers access areas throughout the strait. Swiftsure Bank located in the western Juan de Fuca Strait near Port Renfrew is an important nursery area for many marine species and is known for its rich and diverse marine life. The area itself is closed to recreational fishing to protect fish stocks; however, fishing is popular for Chinook salmon, halibut and other species just outside the closed area. Recreational fishing for halibut and rockfish also takes place around Race Rocks Ecological Reserve at the southern tip of Vancouver Island, where currents are strong and fast and the shipping lanes are near the shore (Juandesooka Enterprises 2013).

Dive sites in Juan de Fuca Strait include the area around the Race Rocks Ecological Reserve, which is considered to be the best dive site in the area, as well as wreck diving further out in Race Passage (Pinnacle Scuba Adventures 2013). Kayaking and surfing are popular in nearshore areas from Sooke to Port Renfrew, on the southwest side of Vancouver Island. Windsurfers and kite boarders also use the area in windy conditions (Port Renfrew

Accommodations 2013). Juan de Fuca Provincial Park is located along much of the coastline in the area and is used by experienced kayakers, surfers and windsurfers (BC Parks 2013c).

#### 4.2.11.6.5 Marine Tourism Use

Marine tourism in Juan de Fuca Strait includes sportfishing charters, kayak tours and whale-watching tours.

Commercial sportfishing charters operate out of Victoria and Sooke, targeting Chinook, pink and coho salmon, halibut and other species around Swiftsure Bank, Race Rocks off Metchosin, and other areas open to recreational fishing (Juandesooka Enterprises 2013).

Sea kayak tour companies based out of Victoria and Sooke offer kayak tours along the coastline between Sooke and Port Renfrew (Discover Sooke 2008).

### *4.2.11.7 Region 5: US Waters*

#### 4.2.11.7.1 Overview

The Marine LSA consists of the shipping lanes, the area between the shipping lanes and a buffer area of 2 km on each side, which extends into US waters in many areas. Incoming marine vessel traffic bound for the Westridge Marine Terminal in Burrard Inlet travels through US waters because the shipping lanes loosely follow the international boundary throughout much of the area.

The Marine RSA encompasses a large portion of the Salish Sea, including the coastal waterways between BC and Washington, namely: the southern Strait of Georgia; Haro Strait; Juan de Fuca Strait; and the northern limit of Puget Sound. Puget Sound is a major inlet of the Pacific Ocean that extends about 130 km into Washington from eastern Juan de Fuca Strait. Most of Puget Sound is excluded from the Marine RSA.

#### 4.2.11.7.2 Commercial Fisheries and Aquaculture

The commercial fishing industry in Washington includes major fisheries for halibut and other groundfish, salmon, albacore tuna and shellfish (including Dungeness crab, shrimp, and clams) (WDFW 2008). Seattle, Bellingham and Blaine are the main fishing ports in Puget Sound, and Port Angeles, Port Townsend, Sequim and Neah Bay are the main fishing ports along Juan de Fuca Strait (WDFW 2008). Commercial fishing is an important contributor to the economy of Washington. In 2006, the statewide commercial catch excluding tribal fisheries totaled approximately $65 million in ex-vessel value, which is the price received by fish harvesters (WDFW 2008).

The groundfish fishery is the largest fishery in Washington, accounting for over half of the total commercial catch; however, the groundfish trawl fishery occurs outside the Marine RSA. Statewide, shellfish fisheries generate the highest overall value, accounting for over 60 per cent of the total value of capture fisheries in 2006 (WDFW 2008). In the northern portion of Puget Sound, which includes the shipping lanes in the southern Strait of Georgia and the San Juan Islands, the total catch from all commercial fisheries in 2006 was about half shellfish and half salmon. Fishers in Juan de Fuca Strait primarily catch shellfish (83 per cent of the total catch in 2006), with groundfish making up most of the remainder (WDFW 2008). Most of the commercial catch for Dungeness crab in Puget Sound occurs in nearshore areas of the Strait of Georgia near Point Roberts and Blaine (WDFW 2013b).

Commercial gillnet vessels fishing for salmon are most commonly present in the fall months in US waters in the Strait of Georgia and Haro Strait. Treaty fishing with all gear types often occurs around Neah Bay and off the Olympic Peninsula throughout the year (USCG 2013). Fishing vessels transit throughout the Marine RSA, and fishing vessels are permitted to engage in fishing activity within traffic separation zones in the shipping lanes as they are in Canadian waters (USCG 2013). In Juan de Fuca Strait, most US fishing vessels use the small vessel shipping lanes when in transit, which are south of the main shipping lanes (USCG 2013).

Aquaculture operations generated approximately $81 million state-wide in 2006 (WDFW 2008). Aquaculture operations are managed by the Washington Department of Natural Resources, which leases state-owned tidal lands for cultivation of oysters, clams, mussels, and other shellfish. Most shellfish aquaculture operations in state waters are for oysters. The state also leases sites for finfish aquaculture pens for salmon and herring. Salmon aquaculture operations are scattered throughout Puget Sound (Washington Department of Natural Resources 2013).

In the San Juan Islands, harvesting sea cucumbers and urchins is prohibited in the Haro Strait Special Management Fishery Area in the area southwest of San Juan Island to the international boundary (MPAtlas 2013). Areas throughout the San Juan Islands are voluntary no-take areas for rockfish, to allow these species to recover.

#### 4.2.11.7.3 Marine Transportation

Washington has 11 ports that can accept deep draft marine vessels. Seattle and Tacoma are the largest ports, together comprising the second largest load centre in the US, after Los Angeles (Washington State Department of Transportation 2013b). Shipping lanes in Juan de Fuca Strait, the Strait of Georgia and other areas of Puget Sound are heavily used by US bound commercial marine vessels, including tankers, bulk carriers, container ships, vehicle carriers, cruise ships, navy and coast guard vessels, tugs and barges, and passenger ferries (van Dorp 2008, Washington State Department of Transportation 2013b).

Regulations in US waters include designated shipping lanes with traffic separation schemes. All vessels over 40 m in length, vessels engaged in towing activities, and all commercial vessels must report to VTS (USCG 2013). Transboundary marine areas in the eastern Juan de Fuca Strait, Haro Strait and Strait of Georgia are designated as Cooperative Vessel Traffic Service Areas with information shared between the CCG and USCG. The arrangement is designed to protect the common shared marine environment (USCG 2013). With respect to the eastern Juan de Fuca Strait, the area has strong tidal currents and often has very high concentrations of marine vessels, including seasonal fleets of fishing vessels, whale-watching vessels, military and coast guard ships, tugs and barges, and cargo ships and tankers. The area is also not subject to pilotage, since pilots embark near Victoria in Canadian waters and near Port Angeles in US waters (USCG 2013).

Approximately 1,300 oil tankers call at terminals in Puget Sound annually (van Dorp 2008), including tankers carrying crude oil or petroleum products to Cherry Point Refinery, which is located near Bellingham on the US mainland in the Strait of Georgia. Tankers also carry refined products away from the Cherry Point refinery. In 2008, about 10 tankers a month called at Cherry Point (van Dorp 2008).

Laden tankers which are travelling through Juan de Fuca Strait must have an escort tug in attendance between Port Angeles and their destination anchorage or terminal (van Dorp 2008). An emergency tug service is located at Neah Bay, near the western end of Juan de Fuca Strait. The tug is funded by companies in the US petroleum industry and is on 24-hour standby to assist any vessels in range near Cape Flattery (van Dorp 2008). Tankers are obliged to avoid transiting within 25 miles of the Pacific coast of Washington, which includes the area around Cape Flattery south of the shipping lanes (USCG 2013).

Bulk carriers, container ships and vehicle carriers transit through Juan de Fuca Strait, then north to PMV or south to terminals in Puget Sound (van Dorp 2008). Chemical carriers transit to terminals in Vancouver. Tugs and log tows frequently transit through Puget Sound, mainly through smaller channels in the San Juan Islands (WDFW 2013c). Approximately 2000 monthly tug transits were made in Puget Sound between 1996 and 2006 (van Dorp 2008).

Passenger ferries make up the bulk of transits in US waters in the Marine RSA. The Washington State Ferry Service is the largest ferry service in the US, averaging about 15,000 transits monthly between 1996 and 2006 (van Dorp 2008). Ferries transiting between Sidney, BC and Anacortes on Fidalgo Island cross the shipping lanes in Haro Strait daily in both directions, north of Sidney Spit Marine Park on Sidney Island (Washington State Department of Transportation 2013a).

In Juan de Fuca Strait, private ferries companies travel between Vancouver Island and Washington ports (see Section 4.2.11.6 for details).

The Port of Bellingham on the US mainland is the southern terminus for the Alaska Marine Highway System. The Alaska ferries transit through the Strait of Georgia en route to Prince Rupert, BC and ports in Alaska (Port of Bellingham 2013).

#### 4.2.11.7.4 Marine Recreational Use

Marine recreational use in US areas of the Marine RSA includes boating, paddling, diving, fishing and whale-watching. Recreational users use shorelines and nearshore areas throughout the Marine RSA including marine parks, beaches and recreational fishing areas.

Point Roberts is located adjacent to the Marine RSA on the southernmost tip of the Tsawwassen Peninsula, south of Delta, BC. There is no ferry service to the community, but marine users berth at the Point Roberts Marina, located at the southern end of the peninsula (Point Roberts Chamber of Commerce 2010). Local marine parks include Lighthouse Marine Park, located at the southwest corner of Point Roberts. Marine uses of the park include wildlife viewing and whale-watching, fishing, shellfish gathering, kayaking and boating. Lily Point Marine Reserve is also used by kayakers and is located at the southeast corner of Point Roberts (WDFW 2013c, Whatcom County 2007).

Transboundary yacht races are held in the Marine RSA, including the Patos Island Race which takes place annually in March between Sidney on Vancouver Island and Patos Island, north of the main San Juan Islands in the Strait of Georgia (Sidney North Saanich Yacht Club 2010). The Point Roberts Yacht Club, based at the Point Roberts Marina, hosts sailing races throughout the year. Race courses extend out into Boundary Bay and the Strait of Georgia (Point Roberts Yacht Club 2013). Washington has more than 40 marine state parks, most of which offer moorage at docks, floats or buoys (Washington State Parks 2013). Marine state parks in the Marine RSA are located on Stuart Island and Posey Island in Haro Strait (Washington State Parks 2013). Stuart Island State Park is part of the Cascadia Marine Trail, providing part of a network of coastal camping sites for kayakers and other boaters throughout Puget Sound (American Trails 2012). Lime Kiln Point State Park on the west side of San Juan Island is described locally as one of the best places in the world for land-based whale-watching (San Juan Islands Visitors Bureau 2011). East of Haro Strait, San Juan Island and Henry Island are known as advanced areas for experienced paddlers, and kayak outfitters are recommended for these "outer islands" (GoNorthwest 2013). Kayak outfitters are also active in Juan de Fuca Strait, operating out of Port Angeles and other communities on the Olympic Peninsula for destinations including Freshwater Bay (west of Port Angeles), Dungeness Spit National Wildlife Refuge (east of Port Angeles), and Neah Bay near Cape Flattery (Adventures Through Kayaking 2009).

Scuba diving occurs at sites in the San Juan Islands and along the Olympic Peninsula. Access to dive sites from shore is limited, and many divers use dive charter services based in Friday Harbour and other local communities. Dive sites in the Marine RSA include Turn Point Wall on Stuart Island, Kellett Wall on Henry Island, and Deadman Cove, on the West Coast of San Juan Island near Lime Kiln Point (Clements 2008). Dives along the outside perimeter of the San Juan Islands are known for excellent visibility, but are rated for advanced divers due to strong currents. Along the Olympic Peninsula, dive sites are clustered around the Cape Flattery area near Neah Bay. The area is known for high quality diving due to its rich and diverse marine life, but conditions are considered to be highly challenging due to the exposure to the Pacific Ocean (Clements 2008).

Commercial and recreational fishing in Washington is regulated by the WDFW. Recreational fishers in the Marine RSA target species such as Chinook and pink salmon, halibut, lingcod, Dungeness crab and prawn. In the San Juan Islands and along the Olympic Peninsula, Chinook salmon are typically caught in the spring and late summer, and pink and coho salmon can be caught in late summer to early fall (WDFW 2013b). Halibut and lingcod are mostly caught in late spring (WDFW 2013b). Recreational fisheries for salmon, halibut and lingcod are managed for short seasonal openings or until the set recreational quotas are reached (WDFW 2013b). Recreational fishing hotspots occur in Haro Strait, such as near Lime Kiln Point on San Juan Island and south of San Juan Island along Salmon Bank (Salmon University 2013). In Juan de Fuca Strait, hotspots include areas around the western Juan de Fuca Strait and bays and inlets around the Port Angeles area (USCG 2013).

Recreational crabbing is highly popular throughout Puget Sound, with Dungeness crab making up most of the catch. Sportfishers catch more than a million pounds of Dungeness crabs annually in Washington. In 2013, most areas are open for recreational crabbing from mid to late summer to the end of September. Northern Puget Sound crab fisheries are open in season for four days a week, and other restrictions apply depending on area (WDFW 2013b).

#### 4.2.11.7.5 Marine Tourism Use

Marine tourism in US waters within the Marine RSA includes whale-watching, commercial sportfishing, cruise ships, yacht charters, kayak outfitters and dive charters.

Whale-watching operators from Washington and BC track the pods of southern resident killer whales in the San Juan Islands, Southern Gulf Islands and other areas of Puget Sound and Juan de Fuca Strait (Towers pers. comm.). US whale-watching operations are based in ports around Puget Sound, including Friday Harbour, Anacortes, Bellingham and Port Townsend (GoNorthwest 2013, Port of Bellingham 2013). Due in part to its popularity for whale-watching, San Juan Island was voted as the best island for visitors in the US in 2013 (TripAdvisor 2013). The San Juan Islands overall were rated as the No. 3 US travel destination in 2013 (Lonely Planet 2013). In 2010, the annual economic activity in Washington from wildlife viewing was estimated at $1.5 billion, with an associated 26,000 jobs (WDFW 2008).

Fishing charter services are based in the San Juan Islands and other areas of Puget Sound, and in communities on the Olympic Peninsula including Port Angeles (Olympic Peninsula Tourism Commission 2012, San Juan Islands Visitors Bureau 2011). Fishing charter services primarily target salmon, lingcod, and halibut. In the Marine RSA, charter operators are present in popular recreational fishing areas ranging from Boundary Bay near Point Roberts to the San Juan Islands and Juan de Fuca Strait. In 2010, the annual economic activity in Washington from sportfishing was estimated at $1.1 billion, with an associated 14,655 jobs (WDFW 2008).

The Port of Seattle operates two cruise ship terminals with seven cruise lines that offer cruises to Alaska. Approximately 188 cruise ships with 850,000 passengers are expected to visit Seattle in 2013. The cruise industry in Seattle operates between May and September (Port of Seattle 2013). The cruise terminal operated by the Port of Bellingham is home port to charter vessels and foot ferries, including a number of businesses that offer boat trips to the San Juan Islands for whale-watching and wildlife viewing in the summer months (Port of Bellingham 2013). Alaska cruise ships bound for Washington tend to use the shipping lanes in Rosario Strait, east of Haro Strait between the San Juan Islands and the US mainland.

Kayaking outfitters operate in the San Juan Islands in Friday Harbour and other communities, from May through September. Whale-watching tours by kayak are offered by many companies (San Juan Islands Visitors Bureau 2011).

Yacht charters and dive charters are available at ports around Puget Sound. Charter services for yachts generally operate from May through October. Anacortes is a common departure point for charter destinations in the San Juan Islands, such as marine state parks (Yacht Charters.com 2013). Dive charters operate out of the San Juan Islands, Port Townsend, Port Angeles and other locations around Puget Sound and Juan de Fuca Strait (Washington Scuba Alliance 2011).

### *4.2.12 Human Health Risk Assessment*

This subsection summarizes the spatial boundaries used for the assessment of the potential effects of chemical emissions on human health associated with the increased Project-related marine vessel traffic. It includes a description of the people whose health might be adversely affected by the emissions from the increased Project-related marine vessel traffic through the marine shipping lanes from the Westridge Marine Terminal in Burnaby, BC to the 12 nautical mile limit of Canada's territorial sea. This subsection also outlines the current health status of people residing along the shipping lanes, with specific reference to those health parameters that are most commonly identified as being of concern in the region and are among the most relevant parameters for assessing the potential health effects of exposures to chemical emissions.

Details specific to the design of the assessment for marine transportation, as well as the results that emerged and the conclusions reached can be found in the Screening Level Human Health Risk Assessment of Marine Transportation in Volume 8B.

#### *4.2.12.1 Spatial Boundaries*

Spatial boundaries used for the assessment of potential effects of increased Project-related marine vessel traffic on human health are defined as follows, and shown on Figure 4.2.32:

- HHRA LSA: includes the inbound and outbound marine shipping lanes, the area between the shipping lanes, where it exists, and a 5 km buffer extending from the outermost edge of each shipping lane. The shipping lanes extend from the Westridge Marine Terminal in Burnaby, through Burrard Inlet, south through the southern part of the Strait of Georgia, the Gulf Islands and Haro Strait, then westward past Victoria and through Juan de Fuca Strait out to the 12 nautical mile limit of Canada's territorial sea. The HHRA LSA represents the predicted spatial extent of the chemical emissions from the Project-related marine vessel traffic to which people along the shipping lanes might be exposed.

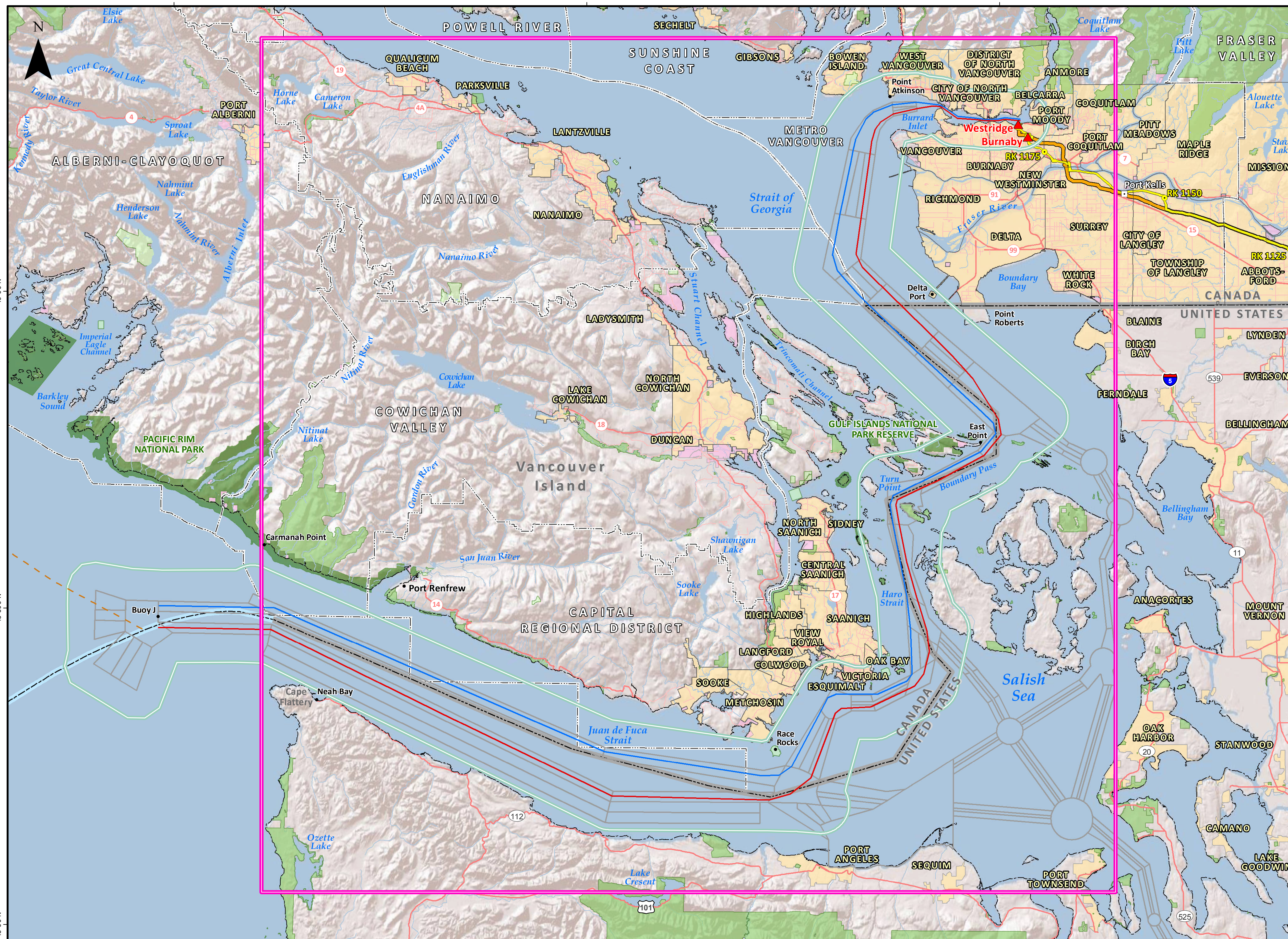
- Marine Air Quality RSA: a 150 km × 150 km area, generally centered on the marine shipping lanes, which extend from the Westridge Marine Terminal through Burrard Inlet, south through the southern part of the Strait of Georgia, the Gulf Islands and Haro Strait, westward past Victoria and Juan de Fuca Strait out to the 12 nautical mile limit of Canada's territorial sea. The Marine Air Quality RSA was used for the purposes of assessing the cumulative health effects associated with the chemical emissions from the increased Project-related marine vessel traffic.

TRANS MOUNTAIN

FIGURE 4.2.32

HUMAN HEALTH
STUDY AREA BOUNDARIES
FOR MARINE TRANSPORTATION

TRANS MOUNTAIN
EXPANSION PROJECT




| Legend | |
|---|---|
| | Reference Kilometre Post (RK) |
| | Trans Mountain Pipeline (TMPL) |
| | Trans Mountain Expansion Project Proposed Pipeline Corridor |
| | Terminal |
| | Existing Pump Station |
| | Highway |
| | Road |
| | 12 Nautical Mile Limit (Territorial Sea) |
| | Limit of Exclusive Economic Zone (EEZ) |
| | International Boundary |
| | Marine Vessel Outbound Shipping Lane |
| | Marine Vessel Inbound Shipping Lane |
| | Marine Air Quality RSA |
| | Marine SLHHRA LSA (5 km Buffer) |
| | Traffic Separation Scheme |
| | City / Town / District Municipality |
| | Indian Reserve / Métis Settlement |
| | National Park |
| | Provincial / State Park |
| | Protected Area/Natural Area/ Provincial Recreation Area/Wilderness Provincial Park/Conservancy Area |
| | Regional District Boundary |

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Projection: UTM Zone 10N.
Routing: Baseline TMPL & Facilities: provided by KMC, 2012; Proposed Pipeline Corridor V6: provided by UPI, Aug. 23, 2013; Transportation: BC Forests, Lands and Natural Resource Operations, 2012 & ESRI, 2005; Geopolitical Boundaries: IHS Inc., 2011, BC FLNRO, 2007 & ESRI, 2005, Natural Resources Canada, 2012; First Nation Lands: Government of Canada, 2013 & IHS Inc., 2011; Hydrology: IHS Inc., 2004, United States National Imagery and Mapping Agency, 2000, Natural Resouces Canada, 2010; Parks and Protected Areas: Natural Resources Canada, 2013, BC FLNRO, 2008 & ESRI, 2005; CHS Marine Navigation Area Features: Provided by KMC, 2013; Marine Vessel Inbound/Outbound Shipping Lanes: Moffat and Nichol, 2013; Territorial Sea Boundary: CHS, 2013; Hillshade: Copyright:© 2009 ESRI.

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_HEA_00435_REV0 | | SHEET 1 OF 1 |
| DATE: December 2013 | TERA REF.: 7894 | REVISION: 0 |
| SCALE: 1:650,000 | PAGE SIZE: 11x17 | DISCIPLINE: MR |
| DRAWN: AJS | CHECKED: TGG | DESIGN: TGG |

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ALL LOCATIONS APPROXIMATE

201310_MAP_TERA_HEA_00435_Rev0.mxd

#### *4.2.12.2 Assessment Indicators*

For the purposes of the HHRA, the assessment indicators are people whose health might be adversely affected as a result of exposures to the chemical emissions originating from increased Project-related marine vessel traffic through the marine shipping lanes. The assessment indicators included both permanent residents living within the HHRA LSA, as well as area users who might frequent the area for recreation or other purposes. The permanent residents were separated into Aboriginal peoples and non-Aboriginal people, with the latter residents further separated into urban and non-urban dwellers. Additional details are available in Section 4.3.

#### *4.2.12.3 Framework*

The HHRA for the Project was performed step-wise following a conventional risk assessment paradigm that is recognized world-wide. Its use has been endorsed by a number of leading federal, provincial and regional regulatory health authorities, including Health Canada, Environment Canada, the Canadian Council of Ministers of the Environment, BC MOE, and the US Environmental Protection Agency. The paradigm consists of several steps, highlights of which are outlined below.

- Problem Formulation – This step is concerned with defining the scope and nature of the assessment, and setting practical boundaries on the work such that it is directed at the principal areas of concern. The step focuses on five major areas.
  - Identification of the Project components that potentially could release chemicals of potential concern (COPCs) into the environment in a manner that provides some opportunity for exposure of people to the chemicals.
  - Identification of the area potentially impacted by the chemical releases from the Project components or sources of interest.
  - Identification of the specific COPCs released from the Project that might contribute to potential health risks.
  - Characterization of the people who might be exposed to the COPC, particularily sensitive or susceptible individuals (*e.g.*, young children, the elderly, and individuals with compromised health).
  - Identification of all potential exposure pathways by which the people might be exposed to the COPC.
- Exposure Assessment - This step is concerned with estimating the level of exposure to the COPC that might be received via the various exposure pathways. The step often relies on one or more forms of predictive modeling to arrive at the exposure estimates, with specific reliance on air dispersion modeling in the case of COPC emissions to air. Distinction is made between exposures of a short-term (or acute) nature extending over a few minutes to several hours and long-term (or chronic) exposures lasting for several months or years, possibly up to a lifetime. Note that the definition of short-term and long-term for the purposes of the HHRA is different than that used for significance evaluation (refer to Table 4.3.1.2).

- Toxicity Assessment – This step is concerned with identifying and understanding the potential health effects that can be caused by each of the COPC (acting either singly or in combination), and the conditions under which the effects can occur. A principal outcome of this step is the determination of exposure limits for the COPC, which refer to the levels of exposure that would not be expected to cause harm. The limits are typically based on guidelines, objectives or standards established by reputable regulatory authorities responsible for the protection of public health, and incorporate a high degree of protection to accommodate even vulnerable members of the population.
- Risk Characterization – This step is concerned with quantifying the potential health risks that could be presented to the local residents or general public by comparing the exposure estimates determined as part of the exposure assessment to the corresponding exposure limits determined as part of the toxicity assessment.

When interpreting the results of any health risk assessment, it is important to understand the uncertainty that is intrinsic to the prediction of health risks. By convention, the HHRA accommodated this uncertainty, in part, through the use of assumptions that embrace a high degree of conservatism and are often intentionally selected to represent worst-case conditions. Using this approach, any health risks identified by the assessment are unlikely to be understated, but may be considerably overstated. As a result, where the potential health risks are determined as part of the HHRA to be negligible or low, it can be concluded with confidence that adverse health effects would not be expected; conversely, where the screening level assessment suggests that potential health risks are elevated, this does not necessarily mean that health effects are certain or imminent. It does; however, indicate that further assessment is necessary in order to determine the actual extent of the human health risks. The increased detail and complexity of the comprehensive assessment that will be submitted in early 2014 will serve to reduce the uncertainty associated with the more simplistic HHRA, and provide for more realistic and reliable estimates of the potential human health risks.

#### *4.2.12.4 Existing Conditions*

This subsection outlines the current health status of people residing in the Marine Air Quality RSA, with the information consisting of population-based health statistics compiled by several Canadian and US-based health agencies from healthcare data collected by health authorities in BC and Washington. The information served as a benchmark for assessing the potential health impacts that might occur among people in the area from exposure to the chemical emissions associated with the marine transportation component of the Project. It represents one of several benchmarks that were examined as part of the HHRA. The baseline health status is described principally in terms of two parameters, namely cancer and respiratory health, since these indices have been identified as two of the more commonly-cited health concerns and they are among the most relevant parameters for assessing the potential effects of exposures to emissions of the COPC from marine vessels. The information presents an overall picture of the general health of the population residing in the Marine Air Quality RSA in relation to the two parameters of interest.

##### 4.2.12.4.1 Coastal British Columbia

The Marine Air Quality RSA includes areas covered by three regional Health Authorities, specifically the Fraser Health Authority (FHA), the Vancouver Coastal Health Authority (VCHA) and the Vancouver Island Health Authority (VIHA). The FHA extends south to BC’s border with the US, north across the Fraser River to the municipalities of Mission, Maple Ridge, Pitt Meadows, Port Coquitlam, Coquitlam, Port Moody and Burnaby, west to the municipality of Delta, and east to Hope. The VCHA includes two distinct areas along the southern and central mainland coast of BC. The first of these areas spans the southern BC coastline from Delta in the south through the Sunshine Coast to the Village of Lund in the north, and extends inland to the community of D'Arcy in the west. The second area includes the mainland communities of Bella Bella and Bella Coola and the surrounding areas of BC's central mainland coast. The VIHA includes all of Vancouver Island as well as the mainland communities bound by the southern and central areas of the VCHA. A limitation of using the population-based health statistics compiled by these Health Authorities is that the geographical coverage provided extends well beyond the Marine Air Quality RSA. However, the information obtained from these Health Authorities is still considered to be representative of the health status of people residing within the Marine Air Quality RSA since many of the communities that fall inside the three regional Health Authorities are comparable to those located along the marine shipping lanes to be used by marine vessel traffic. When available, sub-regional data that better represent the Marine Air Quality RSA were obtained and described.

For the sub-regional data, reliance was placed on the Health Service Delivery Areas (HSDAs) that operate under the auspices of the regional Health Authorities. These HSDAs include the Fraser East and Fraser North HDSAs, the North Shore/Coast Garibaldi and Vancouver HSDAs, and the Central Vancouver Island and South Vancouver Island HSDAs that serve as part of the FHA, VCHA and VIHA, respectively.

Table 4.2.12.1 presents region-specific health statistics for health parameters considered to be particularly relevant for assessing the potential health impacts that can result from chemical exposures associated with marine vessel traffic. These parameters include certain cancers and other chronic conditions, notably chronic respiratory illnesses. It is important to note that all these conditions arise from a complex combination of genetics, lifestyle, ethnicity, environment and other factors such as age and gender.

**TABLE 4.2.12.1**

**RATES OF SELECT HEALTH CONDITIONS**

| **Health Authorities** | **Fraser[1]** | | **Vancouver Coastal** | | **Vancouver Island** | | **British Columbia** |
|---|---|---|---|---|---|---|---|
| **Health Service Delivery Areas** | **Fraser East** | **Fraser North** | **North Shore/Coast Garibaldi** | **Vancouver** | **Central Vancouver Island** | **South Vancouver Island** | |
| **Population Profile[1]** | | | | | | | |
| Population | 286,758 | 616,412 | 287,432 | 668,690 | 265,979 | 374,674 | 4,573,321 |
| **Health Conditions[2,3]** | | | | | | | |
| Bladder cancer incidence (A-S per 100,000) | 17.5 | | 14.1 | | 22.2 | | 18.7 |
| Bladder cancer mortality (A-S per 100,000) | 4.7 | | 3.6 | | 5.4 | | 4.6 |
| Lung cancer incidence[4] (A-S per 100,000) | 49.0 | 53.8 | 47.5 | 46.0 | 50.3 | 47.5 | 48.8 |

**TABLE 4.2.12.1**

**RATES OF SELECT HEALTH CONDITIONS (continued)**

| Health Authorities | Fraser[1] | | Vancouver Coastal | | Vancouver Island | | British Columbia |
|---|---|---|---|---|---|---|---|
| Health Service Delivery Areas | Fraser East | Fraser North | North Shore/Coast Garibaldi | Vancouver | Central Vancouver Island | South Vancouver Island | |
| Lung cancer mortality (A-S per 100,000) | 37.1 | | 28.1 | | 38.7 | | 37.5 |
| Liver cancer incidence (A-S per 100,000) | 4.1 | | 6.8 | | 5.1 | | 4.8 |
| Liver cancer mortality (A-S per 100,000) | 1.9 | | 3.9 | | 1.7 | | 2.2 |
| Leukemia incidence (A-S per 100,000) | 12.3 | | 11.2 | | 9.5 | | 11.6 |
| Leukemia mortality (A-S per 100,000) | 4.4 | | 4.6 | | 4.4 | | 4.7 |
| Ischemic heart disease death rate[5] (A-S per 100,000) | M 105.4 F 63.2 | M 110.7 F 65.9 | M 94.7 F 48.6 | M 76.6 F 38.4 | M 97.7 F 52.4 | M 92.1 F 41.0 | M 99.7 F 51.0 |
| Asthma[6] (%) | 9.4 | 6.5 | 7.6 | 7.9 | 7.5 | 7.8 | 7.5 |
| Bronchitis, emphysema and asthma deaths[5] (A-S per 100,000) | 3.2 | 2.4 | 1.7 | 2.0 | 4.9 | 3.7 | 2.8 |
| Chronic Obstructive Pulmonary Disorder[6] (%) | 6.6 | 2.4 | -- | 2.1 | 5.6 | 2.8 | 3.8 |

**Sources:** BC Cancer Agency 2011, Statistics Canada 2013

**Notes:**
1 Data were available for year 2011
2 M = male, F = female
3 Data were available for year 2009, unless otherwise noted
4 Data were available for years 2007 to 2009
5 Data were available for years 2005 to 2007
6 Data were available for year 2009 to 2010

### *4.2.12.5 Aboriginal Traditional Knowledge*

Hunting, fishing and plant gathering are important activities for Aboriginal Peoples and are undertaken for both subsistence and traditional purposes. These activities allow for connection to the land and water and facilitate cultural continuity, including the ability to participate in, and continue practices and activities passed down by previous generations. The practice of these activities enables the ability to pass on collective knowledge and use of the environment according to tradition to members of the youth. Members of coastal Aboriginal communities in southern BC have traditionally harvested marine fish, birds, mammals, invertebrates and seaweed throughout the Marine Air Quality RSA. These harvesting activities are important for food and other resources.

The consumption of these traditional marine foodstuffs by the coastal Aboriginal Peoples living along the marine shipping lanes was examined as part of the HHRA.

*4.2.12.6 US Waters*

The Marine Air Quality RSA captures portions of Washington, including the counties of Whatcom, Jefferson, San Juan Islands, and Clallam. Consistent with the approach taken for coastal BC, Table 4.2.12.2 presents region-specific health statistics for health endpoints considered to be particularly relevant for assessing the potential health impacts that can result from COPC associated with marine vessel traffic. The health parameters include certain cancers and other chronic conditions, notably chronic respiratory illnesses.

**TABLE 4.2.12.2**

**RATES OF SELECT CHRONIC CONDITIONS**

| Counties | Whatcom | Jefferson | San Juan Islands | Clallam | Washington State Department of Health |
|---|---|---|---|---|---|
| **Population Profile**[1] | | | | | |
| Population | 200,434 | 29,676 | 15,484 | 71,413 | 6,664,195 |
| **Health Conditions**[2,3] | | | | | |
| Bladder cancer incidence (A-S per 100,000) | 24.8 | 29.2 | -- | 23.9 | 22.2 |
| Bladder cancer mortality (A-S per 100,000) | 4.3[4] | -- | -- | -- | 4.7 |
| Lung and bronchus cancer incidence (A-S per 100,000) | 62.2 | 61.7 | -- | 74.6 | 63.4 |
| Lung and bronchus cancer mortality (A-S per 100,000) | 39.7 | 54.1 | -- | 49.6 | 47.7 |
| Liver and intrahepatic bile duct cancer incidence[5] (A-S per 100,000) 2006 to 2010 | 7.4 | -- | -- | -- | 7.4 |
| Liver and intrahepatic bile duct cancer mortality[5] (A-S per 100,000) | 6.2 | -- | -- | -- | 6.0 |
| Leukemia incidence (A-S per 100,000) | 15.7 | -- | -- | 13.2 | 14.1 |
| Leukemia mortality (A-S per 100,000) | 8.0 | -- | -- | -- | 7.3 |
| Ischemic heart disease death rate (A-S per 100,000) | 96.5 | 88.5 | 48.4 | 97.9 | 105.8 |
| Asthma [4] (%) | -- | -- | -- | -- | 9.6 |
| Pneumonia and influenza, death rate[6] (per 100,000) | 12.5 | 13.4 | 13.0 | 14.3 | 10.1 |

**Sources:** Washington State Cancer Registry 2013, National Center for Health Studies 2013

**Notes:** 1 Data were available for year 2009

2 Rates for relevant diseases were searched; however, data was not available for the following diseases: cerebrovascular diseases death rate, bronchitis, emphysema and asthma deaths, and COPD

3 Data were available for years 2008 to 2010, unless otherwise noted

4 Data were available for years 2010

5 Data were available for years 2006 to 2010

6 Data were available for years 2004 to 2010

## 4.3 Effects Assessment – Marine Vessel Traffic Operations

The description of the environmental and socio-economic setting (current state of the environment) within the Project area (Section 4.2), is compared against the description of activities (Section 2.0) to assess potential environmental and socio-economic effects that might be caused by the Project. Since oil is currently transported by tanker from the Westridge Marine Terminal, the assessment focuses on the increased Project-related marine transportation, to assess the change the Project could potentially produce in the environment.

The environmental and socio-economic effects assessment (ESA) uses the information provided in the environmental and socio-economic setting and description of activities to:

- evaluate the environmental and socio-economic elements of importance in the Project area;
- identify relevant industry standards and legislation that reduce the magnitude of the potential effects and develop appropriate technically and economically feasible mitigation;
- identify and evaluate potential Project effects associated with each environmental and socio-economic element of importance; and
- identify the potential effects of the environment on the Project.

In addition, the ESA determines the significance of potential residual effects resulting from the increased Project-related marine vessel traffic after taking into consideration proposed mitigation.

### *4.3.1 Methodology*

The assessment evaluates the environmental and socio-economic effects of the increased marine vessel traffic associated with the Project. The assessment method includes the following steps:

- describe the environmental setting;
- identify key environmental elements that could be affected;
- define the indicators and measurement endpoints to be used to assess each element;
- determine spatial and temporal boundaries for each element;
- identify potential environmental effects for each indicator;
- develop appropriate technically and economically feasible site-specific mitigation and, where warranted, restitution measures that are technically and economically feasible;
- predict anticipated residual effects; and
- determine the significance of residual effects.

Each of the above steps is described below in the applicable Methodology subsection. This environmental and socio-economic effects assessment methodology is based on the following:

- 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 CEA Agency Cumulative Effects Assessment Practitioners Guide (Hegmann *et al.* 1999).
- The CEA Agency's Incorporating Climate Change Considerations in Environmental Assessment (CEA Agency 2012).
- The CEA Agency's Addressing Cumulative Environmental Effects under the *Canadian Environmental Assessment Act*, 2012 (CEA Agency 2013).
- The *CEA Act, 2012*.
- The NEB Filing Manual (NEB 2013c).
- NEB Issues List released July 2013 (NEB 2013a).
- Filing Requirements Related to the Potential Environmental and Socio-Economic Effects of Marine Shipping Activities, Trans Mountain Expansion Project (NEB 2013b).

An ESA Approach Summary document was released in March 2013. 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. More detail on the ESA Approach Summary document is found in Volume 3A. The methods, indicators and spatial boundaries for the environmental and socio-economic elements were reviewed based on feedback received on the ESA Approach Summary document from participants of the ESA Workshops, consultation with government agencies and engagement with Aboriginal communities.

The ESA of the Project is a collaborative effort of several qualified professionals with element-specific expertise, under the guidance of representatives of TERA. Table 4.3.1.1 acknowledges the contribution of these experts and professionals by environmental and socio-economic element.

**TABLE 4.3.1.1**

**ENVIRONMENTAL AND SOCIO-ECONOMIC EFFECTS ASSESSMENT TEAM**

| Environmental/Socio-Economic Element | Assessor |
|---|---|
| Marine Sediment and Water Quality | Stantec |
| Marine Air Emissions | RWDI |
| Marine Greenhouse Gas (GHG) Emissions | RWDI |
| Marine Acoustic Environment | RWDI |
| Marine Fish and Fish Habitat | Stantec |
| Marine Mammals | Stantec |
| Marine Birds | Stantec |
| Marine Species at Risk | Stantec |
| Traditional Marine Resource Use (TMRU) | TERA |
| Marine Commercial, Recreational and Tourism Use (MCRTU) | Vista Strategy and TERA |
| Human Health Risk Assessment (normal operations) | Intrinsik |
| Accidents and Malfunctions | Stantec and TERA |
| Credible Worst Case and Smaller Marine Spill Scenarios (Sections 5.6 and 5.7) | Stantec, Intrinsik, and TERA |
| Changes to the Project Caused by the Environment | Stantec and TERA |

#### *4.3.1.1 Environmental and Socio-Economic Elements*

The potential environmental (*i.e.,* biophysical) and socio-economic elements interacting with the Project are identified through: engagement with Aboriginal communities, regulatory authorities, stakeholders and the general public; experience gained from operation of marine tankers from the existing Trans Mountain system; available research literature; and the professional judgment of the assessment team. Issues noted during engagement with Aboriginal communities, federal regulatory authorities, stakeholders and the general public were essential in the determination of element interactions with the Project (Section 3.0).

Environmental and socio-economic elements potentially interacting with the Project include:

- physical elements such as marine sediment and water quality, marine air emissions, marine GHG emissions, and marine acoustic environment;
- biological elements such as marine fish and fish habitat, marine mammals, marine birds, and marine species at risk; and
- socio-economic elements such as TMRU and MCRTU.

Effects arising from potential accidents and malfunctions, and changes to the Project caused by the environment are also considered. The assessment of various marine spill scenarios on the environment, including an HHRA and an Ecological Risk Assessment (ERA), is provided in Section 5.0.

#### *4.3.1.2 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 regulatory authorities, the public, Aboriginal communities and other interested groups.

The indicators for each element have been identified based on: the NEB Filing Manual (2013c) and other regulatory guidelines; experience gained during current operations of the Westridge Marine Terminal; feedback from Aboriginal communities, regulatory authorities, stakeholders and the general public; public issues raised through media; available research literature; and the professional judgment of the assessment team.

Quantitative or qualitative measurement of potential Project effects was completed using one or more 'measurement endpoint' (measurable parameter) identified for each indicator. The degree of change in these measurable endpoints 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.

#### *4.3.1.3 Spatial and Temporal Boundaries*

The environmental and socio-economic 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 natural variation of a population or environmental or socio-economic indicator;
- the timing of sensitive life cycle phases in relation to the scheduling of the proposed physical activities;
- the time required for an effect to become evident;
- the time required for a population or environmental or socio-economic indicator to recover from an effect and return to a natural condition;
- the area directly affected by proposed physical activities; and
- the area in which a population or environmental or socio-economic indicator functions and within which a Project effect may be experienced.

##### 4.3.1.3.1 Temporal Boundaries

The time frame of the assessment of the increased Project-related marine vessel traffic includes the operation phase, (*i.e.*, the time during which increased marine vessel traffic operations are expected to occur, or more than 50 years).

Since the assumed pipeline in-service date is December 2017, the assumed start date of the increased marine tanker traffic is also December 2017. The increased marine vessel traffic associated with the Project is estimated to extend for a term exceeding 50 years. A detailed schedule for the construction of the various Project components, including the Westridge Marine Terminal, is provided in Volume 5A, Section 2.0.

#### 4.3.1.3.2 Spatial Boundaries

The spatial boundaries of the assessment of the Project consider the element-specific LSA or the RSA. The LSAs and RSAs were developed on an element-specific basis and, therefore, may vary between environmental and socio-economic elements. The definitions for each spatial boundary are provided in Table 4.3.1.2.

Individually established ecological boundaries are described within the discussions in Section 4.0 for each applicable biological or socio-economic element.

### *4.3.1.4 Potential Environmental and Socio-Economic Effects*

The potential environmental and socio-economic effects resulting from the Project are identified through: consultation and engagement with Aboriginal communities, government agencies, stakeholders and the general public; experience gained from operation of marine tankers from the existing Trans Mountain system; scientific studies; and the professional judgment of the assessment team.

The potential environmental and socio-economic effects arising from the increased Project-related marine vessel traffic are identified in Section 4.3.2.

**TABLE 4.3.1.2**

**EVALUATION OF THE SIGNIFICANCE OF RESIDUAL EFFECTS - ESA CRITERIA[1]**

| Assessment Criteria | Definition |
|---|---|
| **IMPACT BALANCE – of the Residual Effect** | |
| Positive | Residual effect is considered to have a net benefit to the environmental or socio-economic indicator. |
| Neutral | Residual effect is considered to have no net benefit or loss to the environmental or socio-economic indicator. |
| Negative | Residual effect is considered to be a net loss or a detriment to the environmental or socio-economic 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 rights-of-way, pump stations, tanks, Westridge Marine Terminal, temporary construction workspace, dredging, filling, temporary stockpile sites, temporary staging sites, construction camps, access routes and 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 operation. This generally represents a buffer from the centre of the proposed pipeline corridor or marine shipping lanes. |

**TABLE 4.3.1.2**

## EVALUATION OF THE SIGNIFICANCE OF RESIDUAL EFFECTS - ESA CRITERIA (continued)

| Assessment Criteria | | Definition |
|---|---|---|
| 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 or socio-economic indicator. This varies for each element. For the marine transportation component, the RSA extends from the Westridge Marine Terminal to the 12 nautical mile limit and is of variable width extending from the marine shipping lanes, depending on the indicator. |
| Provincial | | The area extending beyond regional or administrative boundaries but confined to Alberta and BC (*e.g.,* provincial permitting boundaries). |
| National | | The area extending beyond Alberta 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 one 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 – Environmental (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 one year to reverse residual effect. |
| | Medium-term | Greater than one 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. |
| Reversibility – Socio-economic (period of time over which the residual effect extends) | Short-term | Residual effect limited to the construction phase or to less than any one year during operations phase. |
| | Medium-term | Residual effect extends more than one year but less than or equal to 10 years into the operations phase. |
| | Long-term | Residual effect extends beyond the first 10 years of the operations phase. |
| | 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; however, are well within environmental and/or regulatory standards. |
| Medium | | Residual effects are detectable and may approach; however, are still within the environmental and/or regulatory standards. |
| High | | Residual effects are beyond environmental and/or regulatory standards. |

**TABLE 4.3.1.2**

**EVALUATION OF THE SIGNIFICANCE OF RESIDUAL EFFECTS - ESA CRITERIA (continued)**

| Assessment Criteria | Definition |
|---|---|
| **MAGNITUDE[3] - of the Residual Socio-Economic Effect** | |
| Negligible | No detectable change from existing (baseline) conditions. |
| Low | Change is detectable; however, has no effect on the socio-economic environment beyond that of an inconvenience or nuisance value. |
| Medium | Change is detectable and results in moderate modification in the socio-economic environment. |
| High | Change is detectable and is large enough to result in a severe modification in the socio-economic environment. |
| **PROBABILITY OF OCCURRENCE - Likelihood of Residual Effect** | |
| High | Likely. |
| 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.

**Significant Residual Socio-economic Effect:** A residual socio-economic effect is considered significant if the effect is predicted to be:

- high magnitude, high probability, short to medium-term reversibility and regional, provincial or national in extent that cannot be technically or economically mitigated; or
- high magnitude, high probability, long-term or permanent reversibility and any spatial boundary that cannot be technically or economically mitigated.

2 The assessment period for the effects assessment includes the lifetime of increased marine transportation activities while the assessment period for the cumulative effects assessment includes the above interval as well as the development, construction and operation 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 marine transportation 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 regulatory 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.

The assessment of the increased Project-related marine vessel traffic is based on conservative assumptions. If there are substantive changes from the assumptions used in the ESA resulting from changes in Project design, additional assessment and regulatory consultation may be warranted.

#### *4.3.1.5 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 severity of potential adverse environmental and socio-economic effects is reduced, mitigation measures are recommended in this ESA based upon current industry accepted standards, consultation with government agencies, interested groups and individuals, engagement with Aboriginal communities, and the professional judgment of the assessment team.

Many of the mitigation measures presented in this ESA are to be/have been discussed with Aboriginal leaders or others that have been involved in specific supporting environmental and socio-economic studies. A comprehensive review of all the issues that have been raised by each community and the mitigation measures proposed are to be or have already been conducted (Section 3.0). Meetings will be held to confirm additional issues of concern identified through ongoing engagement with potentially affected Aboriginal communities. Additional issues of concern will be considered for incorporation into Project planning under the guidance of existing marine transport legislation and mitigation recommendations made to date and will be reported in the TMRU supplemental studies and submitted to the NEB (Section 4.5).

Mitigation measures are outlined in the Project effects assessment. Mitigation measures recommended or detailed in element-specific technical reports are incorporated into the assessment. Various international and federal regulatory authorities, and industry-accepted standards and guidelines are considered in the ESA, and are referenced for each element.

It is expected that through the engagement program, additional issues related to the Project may be identified and further mitigation measures may be determined. Any additional mitigation measures developed as a result, if any are deemed necessary, will be included in supplemental information submitted to the NEB (Section 4.5).

For the purposes of the marine transportation assessment, since Trans Mountain has little direct control over the actions of vessel owners and operators, mitigation is considered to include existing regulations and shipping standards that are monitored by several federal and international authorities (*e.g.*, PMV, the PPA, the CCG, Transport Canada, and the IMO).Trans Mountain expects that through its tanker acceptance process the calling vessels are maintained and operated to high industry standards. See Section 1.4.1 for a description of relevant regulatory authorities.

Since Project activities for marine transportation are limited to designated shipping lanes, regional planning documents are assumed not to be directly relevant. However, planning documents for marine environments under federal and provincial jurisdiction within the Marine RSA considered relevant to the Project include the following.

- BIEAP Annual Report (2012);
- BIEAP's Consolidated Environmental Management Plan (2011);
- BIEAP's Fraser River Estuary Management Plan (2003);

- Canadian Parks and Wilderness Society's First Nations and Marine Protected Areas (2009);
- Parks Canada's Feasibility Study for the Proposed Southern Strait of Georgia National Marine Conservation Area Reserve (ongoing);
- DFO's Integrated Fisheries Management Plans (various);
- DFO's Aboriginal Fisheries Strategy;
- DFO's Aboriginal Aquatic Resource and Oceans Management Program;
- Government of British Columbia plans, including Provincial Marine Protected Areas in British Columbia (2001); and
- British Columbia Ministry of Sustainable Resource Management's Provincial Marine Protected Areas in British Columbia.

#### *4.3.1.6 Residual Effects*

As defined in the NEB Filing Manual (NEB 2013c), residual effects are the environmental and socio-economic effects that are present after mitigation and enhancement measures are applied. Mitigation measures may be predicted to mitigate the potential adverse effect or the mitigation measures may lessen, but not entirely eliminate the effects. Elements for which no residual effects are predicted require no further analysis.

#### *4.3.1.7 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 4.3.1. The agencies identify several possible methods for the determination of whether residual environmental or socio-economic effects are significant. These include:

- the use of regulatory environmental standards, guidelines or objectives in relation to potential residual effects;
- the use of quantitative risk assessment;
- quantitative assessment of residual effects; and
- qualitative assessment of the residual effects.

Some elements can be assessed using the standards and guidelines method. However, 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 research literature is considered to be the appropriate method for determining the significance of the potential residual effects,. Consequently, the determination of 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 4.3.1.2.

- Spatial boundary (*i.e.,* the geographic extent in the element-specific LSA or RSA).

- Temporal context (*i.e.,* duration and frequency of the event causing the residual effect, reversibility of the residual effect). Note that the reversibility criteria for potential socio-economic effects have been modified subsequent to the release of the ESA Summary Approach document in March 2013.

- Magnitude (*i.e.,* severity of the residual effect in relation to environmental and/or regulatory standards or modification to the socio-economic environment).

- 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).

Ecological context (*e.g.,* levels of existing disturbance; resilience of the receiving environment) is not included in Table 4.3.1.2. However, ecological context is provided in Section 4.3.3 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.

For socio-economic elements, a residual effect is considered significant if the effect is predicted to be:

- high magnitude, high probability, short to medium-term reversibility and regional, provincial or national in extent and cannot be technically or economically mitigated; or

- high magnitude, high probability, long-term or permanent reversibility, within any spatial boundary 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 and socio-economic residual effect. A positive effect balance is considered to have a net benefit to the environment or socio-economic indicator. A neutral balance is defined as no net benefit or loss to the environment or socio-economic indicator, while a negative balance is considered to be a net loss or detriment to the environment or socio-economic indicator.

All significance assessment criteria (*e.g.,* temporal context and magnitude) are considered by the assessment team for each residual environmental or socio-economic effect. Where appropriate, the key or most influential assessment criteria used to determine the significance of each residual effect are identified. It should be noted that the determination of a “not significant residual effect” is based on a pre-defined approach that incorporates magnitude, probability, reversibility and extent. However a “not significant residual effect” determination does not mean that the potential residual effect is not important to one or more Aboriginal communities, government agencies or stakeholders.

For the Project effects assessment, an evaluation of combined adverse 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 the combined effects is included in each subsection, where relevant. 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 and government policies.

The extent to which professional judgment of the assessment team is used in the evaluation of significance of potential environmental and socio-economic residual effects is provided for each element. For this Project, the assessment team consisted of discipline experts, the TERA Project Manager, experienced assessment practitioners and senior reviewers.

A summary of the significance evaluation for residual environmental and socio-economic effects arising from the increased Project-related marine vessel traffic is provided in Section 4.3.3. It should be noted that the significance evaluation focuses on the potential residual effects resulting from the increased Project-related marine vessel traffic, recognizing that oil is currently transported by tanker from the Westridge Marine Terminal.

Using the assessment methodology described in Section 4.3.1, the following subsections evaluate the potential environmental and socio-economic effects associated with the increased Project-related marine vessel traffic.

Environmental and socio-economic elements potentially interacting with the increased Project-related marine vessel traffic are identified in Table 4.3.1.3. This table also indicates where elements listed in the NEB Filing Manual (2013c) are considered in the elements assessed for the increased Project-related marine vessel traffic. Since this assessment is of a different nature than projects that generally fall under the NEB Filing Manual (2013c), not all elements are considered (*i.e.*, physical and meteorological environment, soils, wetlands and heritage resources). This is consistent with direction given in the NEB's Filing Requirements Related to the Potential Environmental and Socio-Economic Effects of Marine Shipping Activities, Trans Mountain Expansion Project (NEB 2013b).

**TABLE 4.3.1.3**

**ELEMENT INTERACTION WITH THE PROPOSED MARINE TRANSPORTATION COMPONENT**

| Element | Interaction with Marine Transportation | NEB Element(s) Considered |
|---|---|---|
| Marine Sediment and Water Quality | Yes | Water quality and quantity |
| Marine Air Emissions | Yes | Air emissions |
| Marine GHG Emissions | Yes | GHG emissions |
| Marine Acoustic Environment | Yes | Acoustic environment |
| Marine Fish and Fish Habitat | Yes | Fish and fish habitat; vegetation |
| Marine Mammals | Yes | Wildlife and wildlife habitat |
| Marine Birds | Yes | Wildlife and wildlife habitat |
| Marine Species at Risk | Yes | Wildlife and wildlife habitat; species at risk |
| TMRU | Yes | Vegetation; wildlife and wildlife habitat; traditional land and resource use |

**TABLE 4.3.1.3**

**ELEMENT INTERACTION WITH THE PROPOSED MARINE TRANSPORTATION COMPONENT (continued)**

| Element | Interaction with Marine Transportation | NEB Element(s) Considered |
|---|---|---|
| MCRTU | Yes | Human occupancy and resource use; social and cultural well-being; human health and aesthetics; infrastructure and services; employment and economy, navigation and navigation safety |

The potential environmental and socio-economic effects associated with the increased marine vessel traffic, as well as the proposed mitigation measures and resulting residual effects on the environmental and/or socio-economic indicator, are presented in the following subsections for each environmental and socio-economic element as well as for accidents and malfunctions. In addition, the evaluation of significance using the criteria presented in Table 4.3.1.2 for the potential residual effects associated with the applicable environmental and socio-economic elements is also provided. A description of the potential effects of credible worst case and smaller marine spill scenarios, including an HHRA and an ERA, is provided in Section 5.0.

#### 4.3.1.7.1 Transboundary Effects

Potential effects of the increased Project-related marine vessel traffic in the US are discussed under each element subsection. Where the effects are considered to be similar in Canadian and US waters for a particular element, the discussion of US waters refers back to the discussion of potential effects in Canadian waters. See Section 4.2 for environmental and socio-economic setting information for the US.

#### 4.3.1.7.2 Environmental Conditions Not Considered

Based on the NEB Filing Manual (2013c) and preliminary discussions of potential effects, underwater noise was initially considered for inclusion in the marine transportation assessment as a stand-alone element as a counterpart to atmospheric noise. Since the potential effects of underwater noise are discussed under the marine fish and fish habitat and marine mammals elements, underwater noise was not included as a stand-alone element in the marine transportation assessment. Underwater noise related to marine birds was included in the assessment of sensory disturbance (Section 4.3.8.4).

### *4.3.2 Marine Sediment and Water Quality*

Marine water and sediment quality are important components of the marine environment, since they provide the physical elements that support aquatic life. Contaminants that are introduced from human activities, such as releases from vessels and discharges from land-based activities (*e.g.*, industrial, municipal waste water, runoff from urban and agricultural areas), can alter water or sediment quality and present an increased risk of toxicity to marine organisms. For normal marine transportation operations, the assessment focuses on the potential for introduction of contaminants from vessels travelling to and from the Westridge Marine Terminal. Release of bilge water and erosion of marine paints from marine vessels are potential contaminant sources associated with routine shipping activities. Any release of bilge water containing fuels, oils and/or lubricants from vessels would be accidental, and is addressed in Section 4.3.13.

Potential concerns with ballast water are related to introduction of non-native invasive species, not contaminants, and are addressed in Section 7.6 of Volume 5A.

Bilge water and marine paints were well-known historical sources of contaminants and their presence is reflected in baseline conditions. These marine contaminants are now governed through legislation, as discussed in Section 4.2.2 and summarized here.

- Release of bilge water is regulated through the *Canada Shipping Act,* 2001 *(Vessel Pollution and Dangerous Chemicals Regulations)*. Bilge water must be treated prior to release to remove hydrocarbons (oils, grease, fuel).
- Use of marine anti-fouling paints is regulated through the IMO and through the *Canada Shipping Act,* 2001 *(Vessel Pollution and Dangerous Chemicals Regulations)*.

The *Canada Shipping Act,* 2001 (*Vessel Pollution and Dangerous Chemicals Regulations*) applies to Canadian vessels operating in all waters and to all vessels operating within Canadian waters. Bilge water must be treated by filtration or oily water separating equipment prior to release to remove hydrocarbons (oils, grease, fuel) to not more than 15 mg/L (applicable to discharges into waters other than inland waters). Release of oily water containing more than 15 mg/L of oil (total oil and grease) would be treated as accidental (see Section 4.3.13). Anti-fouling systems, mainly anti-fouling paints, are used in the marine transportation industry to control growth of aquatic organisms (*e.g.*, algae, mussels, barnacles and other invertebrates) on vessel hulls. They are used to avoid introduction of alien invasive species into foreign waters and to improve transportation efficiencies (heavy growth of organisms increases the surface drag, which increases fuel consumption and increases air emissions [Taylan 2010]). The paint is effective in two ways: a toxicological effect associated with a biocide (fungicide, bactericide, insecticide) such as the organotin compound tributyl tin (TBT); and the physical effect related to mechanical wearing away of the paint (making it difficult for organisms to remain attached to the hull).

Environmental concerns identified with use of TBT led to its prohibition in 2008 (IMO 2013b). The TBT is an effective biocide, released continuously from the paint to ensure its efficacy (US EPA 2003), but it is also released when paint sloughs off the hull. This has led to concerns, particularly in harbours, where many vessels are present year round, as the paint is deposited on sediment and TBT continues to leach into the water, affecting marine organisms. Butyltins can adversely affect development and growth of many species through exposure in the water column or sediment and through ingestion of contaminated organisms in the food chain (Leung *et al*. 2006, Morton 2009, Oehlmann *et al*. 1996). Marine birds with elevated TBT in their tissue have been shown to have reduced body condition, which may prevent them from migrating and breeding, leading to reduced population size (Elliott *et al*. 2007).

The IMO developed an *International Convention on the Control of Harmful Anti-Fouling Systems on Ships*, prohibiting the application or reapplication of anti-fouling systems acting as biocides as of January 1, 2008. Since then, all vessels over 400 GT-bearing organotin anti-fouling systems have had the organotin paint removed or coated to create a barrier preventing leaching (IMO 2013b). Canadian legislation regulates the use of organotins through the *Vessel Pollution and Dangerous Chemicals Regulations (SOR/2012-69)*, within the *Canada Shipping Act, 2001*. The *Regulations* mirror the IMO *Convention* (Transport Canada 2010). Since the ban of organotin as an active ingredient in anti-fouling paints in 2008, numerous studies have confirmed the effectiveness of the ban (Choi *et al*. 2013, Law *et al*. 2012, Morton 2009, Verhaegen *et al*. 2011). Within Canada, historical use has left measurable concentrations in some harbours; however, levels decrease over time, through physical (photolysis) and biological pathways (Hoch 2001). Effects of Project-related marine vessel traffic on marine water and sediment quality are not assessed further in this subsection since the activities that can be potential sources of contaminants are highly regulated; if present, the contaminants would occur at levels below a regulated threshold that would not create a concern. In Canadian and international waters, Project-related marine vessels are governed by MARPOL (IMO 2013c), to which Canada is a signatory. MARPOL has been in force since 1983, and is aimed at preventing and minimizing pollution from accidents and routine operations. MARPOL annexes cover oil, noxious liquid substances in bulk, harmful substances in packaged form, sewage, garbage, and air emissions.

Strict compliance with pollution prevention provisions of the *Canada Shipping Act,* 2001 and MARPOL by Project-related marine vessels will restrict harmful effects of marine water and sediment quality by these vessels during marine transportation operations. While KMC can actively enforce vessels docked at the Westridge Marine Terminal to comply with KMC operating practices and standards, once the vessel departs from the Westridge Marine Terminal, KMC has no authority over the operating practices of the vessel. Marine transportation in Canadian waters is authorized and regulated through the *Canada Shipping Act,* 2001 and related legislation and regulations administered by Transport Canada (TC) and the CCG. Consequently, mitigation to reduce the potential effects of the increased Project-related marine vessel traffic is the primary responsibility of regulatory authorities charged with administration of various marine regulations and laws on the west coast of Canada. Trans Mountain will encourage awareness and information sharing about Project-related shipping with other marine commercial, recreational and tourism users through the Chamber of Shipping of British Columbia's website.

#### *4.3.2.1 United States Waters*

Contaminant sources and concentrations are expected to be similar in US and Canadian waters, given the similar types of activities in the transboundary waters of Juan de Fuca Strait. Potential effects related to marine sediment and water quality are not expected to differ between Canada and the US. Potential concerns with ballast water are addressed in Section 7.6 of Volume 5A and potential concerns associated with the accidental release of bilge water are addressed in Section 4.3.13 of this volume.

### *4.3.3 Marine Air Emissions*

Activities that occur during the marine operations phase have the potential to affect air quality, therefore, Project interactions with air quality were assessed. The Project will result in the following marine air emissions:

- Criteria air contaminants (CACs), a group of commonly found contaminants typically formed from combustion for which there are ambient air quality criteria, including particulate matter (PM), carbon monoxide (CO), nitrogen dioxide ($NO_2$), and sulfur dioxide ($SO_2$); and
- volatile organic compounds (VOCs), 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.

Combustion of fuel in the tanker engines and boilers will create CAC emissions. VOCs are released to atmosphere from evaporative losses of product from tanker holds and incomplete combustion of fuel. Ambient air quality objectives have been created for the CACs and VOCs of interest which are based on the potential for environmental and/or human health effect. Emissions were estimated based on a reasonable maximum operating scenario and concentrations were predicted using a dispersion model for operations only. This subsection considers the potential for marine air emissions to the atmospheric environment to change ambient air quality concentrations due to the increased Project-related marine vessel traffic.

#### *4.3.3.1 Assessment Indicators and Measurement Endpoints*

The assessment indicators and measurement endpoints used for the marine air quality assessment are summarized in Table 4.3.3.1.

The main air emissions associated with increased marine tanker traffic due to the Project are CACs and VOCs. Combustion of fossil fuels in main and auxiliary engines onboard tankers and tugboats are a source of CACs, including PM, CO, $NO_2$, and $SO_2$ and VOCs, including benzene, toluene, ethyl benzene, and xylene, known collectively as BTEX. In addition, fugitive emissions of VOCs are associated with tanker holds during transit.

In addition to these direct emissions from the Project, secondary pollutants will be formed from reactions between these primary pollutants in the atmosphere. In the presence of sunlight, pre-cursors such as nitrogen oxides ($NO_X$) and VOCs undergo a complex sequence of reactions to form ozone. Secondary PM can be formed from reactions between $NO_X$, sulfur oxides ($SO_X$) and ammonia. Primary and secondary PM can absorb and scatter sunlight, causing haze and obscuring visibility.

**TABLE 4.3.3.1**

**ASSESSMENT INDICATORS AND MEASUREMENT ENDPOINTS FOR MARINE AIR EMISSIONS**

| Marine Air Emissions Indicator | Measurement Endpoint | Rationale for Indicator Selection |
|---|---|---|
| Primary emissions of criteria air contaminants | • Emissions from increased Project-related marine vessel traffic and comparison to emissions from existing marine traffic<br>• 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 under the air emissions element in Table A-2, addressed concerns of participants of the ESA Workshops and was informed by government agencies (*i.e.*, Environment Canada, BC MOE, Metro Vancouver, Fraser Valley Regional District, PMV). |
| Primary emissions of volatile organic compounds | • Emissions from increased Project-related marine vessel traffic and comparison to emissions from existing marine traffic<br>• Predicted levels of ground-level concentrations and comparison to ambient air quality criteria and odour thresholds | |
| Formation of secondary particulate and ozone | • Predicted levels of ambient ground-level concentrations and comparison to ambient air quality criteria | |
| Visibility | • Predicted change in light extinction | |

#### *4.3.3.2 Spatial Boundaries*

Spatial boundaries for the assessment of potential Project effects on marine air emissions are as defined in Section 4.2.3.1, and as illustrated on Figure 4.2.4.

- **Marine Air Quality RSA** - a 150 km × 150 km area. The Marine Air Quality RSA is generally centered on the marine shipping lanes, which extend from the Westridge Marine Terminal through Burrard Inlet, south through the southern part of the Strait of Georgia, the Gulf Islands and Haro Strait, westward past Victoria and Juan de Fuca Strait out to the 12 nautical mile limit of Canada's territorial sea.
- **LFV** - a 412 km × 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 × 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 × 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 will be implemented over the inner 4 km resolution domain, with the boundary condition determined from baseline 36 km and 12 km model results.

The Marine Air Quality RSA includes the entire area in which shipping lanes are relatively defined, marine emissions will occur and can be reasonably represented in dispersion modelling. Beyond this point, shipping lanes will diverge into international waters depending on the destination. The RSA was specified based on discussions with PMV and has been approved as part of the detailed model plan for BC regulatory authorities (*i.e.*, Metro Vancouver and the BC MOE). The Marine Air RSA also follows guidance indicated by the NEB in the letter titled Filing Requirements Related to the Potential Environmental and Socio-Economic Effects of Increased Marine Shipping Activities, received by Trans Mountain on September 10, 2013. The letter indicates that the marine transportation assessment should extend to the 12 nautical mile limit of Canada's territorial seas.

For the photochemical modelling and CALPUFF modelling of formation of $PM_{2.5}$ and ozone, a larger modelling domain was created that includes the LFV as defined above. This larger domain was selected to account for a broader set of emissions from residential, transportation, and industrial sources, changes in land use and terrain, and varying meteorological conditions. In addition, the larger domain allows adequate time for atmospheric chemical reactions and allows for predictions at locations well outside the Marine Air Quality RSA. The LFV spatial boundary takes into account the results of consultation conducted to date with the Fraser Valley Regional District as well as BC MOE and Environment Canada. This regional model domain (LFV) is also consistent with an earlier study conducted by UBC (Steyn *et al.* 2011).

#### *4.3.3.3 Marine Air Emissions Context*

The shipping lanes to be used for the Project are well travelled routes that channel marine vessel traffic from open ocean through Juan de Fuca Strait to the BC Lower Mainland. The 2005 Corbett inventory provides an estimate of existing emissions from marine vessel traffic in the Marine Air Quality RSA and is modelled to provide context for increased emissions from the Project-related marine vessel traffic.

In addition to other existing marine traffic along the shipping lanes, there are other anthroprogenic and natural sources of CAC and VOC emissions in the Marine Air Quality RSA, primarily concentrated in the populated areas of Vancouver, Victoria, Duncan and Nanaimo. The man-made types of emissions are related to vehicle transportation, residential emissions like lawn mowers, small commercial facilities like restaurants, and dry cleaning and larger industrial plants (*i.e.*, cement, asphalt, etc).

Existing air quality conditions can be defined by ambient measurements from several stations that have been operating for a number of years. Ambient monitoring data of CACs are available from a number of stations operated by Metro Vancouver and the BC MOE. These stations are centered in urban areas and, therefore, it was deemed impractical to use these data to determine a single background concentration for the entire Marine Air Quality RSA which encompasses a wide range of land uses including water, urban and agricultural areas. The stations selected to represent the air quality setting at urban areas within the Marine Air Quality RSA were Vancouver-Kitsilano, Victoria Topaz, Duncan-Cairnsmore and Nanaimo Labieux.

#### *4.3.3.4 Potential Effects and Mitigation Measures*

Potential effects associated with increased Project-related marine vessel traffic on marine air emissions indicators are listed in Table 4.3.3.2. These interactions are based on the results of the literature review, desktop analysis, modelling, engagement with Aboriginal communities, government agencies, and other stakeholders (Section 3.0), and the professional experience of the assessment team. Dispersion modelling results indicate that ambient concentrations of hydrogen sulphide ($H_2S$), mercaptans, and other odorous VOC species are well below odour thresholds. Therefore, an air emissions indicator for nuisance odours was not assessed.

No mitigation measures were considered warranted other than emission limits mandated on marine vessels as part of the North American Emissions Control Area.

**TABLE 4.3.3.2**

**POTENTIAL EFFECTS, MITIGATION MEASURES AND RESIDUAL EFFECTS OF INCREASED PROJECT-RELATED MARINE VESSEL TRAFFIC ON MARINE AIR EMISSIONS**

| Potential Effect | Spatial Boundary[1] | Key Mitigation Measures in Place/Additional Recommendations | Potential Residual Effect(s) |
|---|---|---|---|
| **1. Marine Air Emissions Indicator – Primary Emissions of Criteria Air Contaminants** | | | |
| 1.1 Increase in CAC emissions | RSA | • All Project-related tankers are required to adhere to federal standards that may reduce air emissions, including standards for bunker fuel. | • Increase in ambient ground-level concentrations of CACs. |
| **2. Marine Air Emissions Indicator – Primary Emissions of Volatile Organic Compounds** | | | |
| 2.1 Increase in VOC emissions | RSA | • All Project-related tankers are required to adhere to federal standards that may reduce air emissions, including standards for bunker fuel. | • Increase in ambient ground-level concentrations of VOCs. |

**TABLE 4.3.3.2**

**POTENTIAL EFFECTS, MITIGATION MEASURES AND RESIDUAL EFFECTS OF INCREASED PROJECT-RELATED MARINE VESSEL TRAFFIC ON MARINE AIR EMISSIONS (continued)**

| Potential Effect | Spatial Boundary[1] | Key Mitigation Measures in Place/Additional Recommendations | Potential Residual Effect(s) |
|---|---|---|---|
| **3. Marine Air Emissions Indicator – Formation of Secondary Particulate Matter and Ozone** | | | |
| 3.1 Increased formation of secondary PM and ozone due to increased ambient concentrations of CACs and VOCs | LFV | • All Project-related tankers are required to adhere to federal standards that may reduce air emissions, including standards for bunker fuel. | • Increase in ambient ground-level concentrations of secondary PM.<br>• Increase in ambient ground-level concentrations of ozone. |
| **4. Marine Air Emissions Indicator – Visibility** | | | |
| 4.1 Increased light extinction | LFV | • All Project-related tankers are required to adhere to federal standards that may reduce air emissions, including standards for bunker fuel. | • Reduced visibility. |

**Note:** 1 RSA = Marine Air Quality RSA; LFV = Lower Fraser Valley Photochemical Model Domain.

### *4.3.3.5 Potential Residual Effects*

The potential residual environmental effects on marine air emission indicators associated with increased Project-related marine vessel traffic are:

- increase in ambient ground-level concentrations of CACs;
- increase in ambient ground-level concentrations of VOCs;
- increase in ambient ground-level concentrations of secondary PM;
- increase in ambient ground-level concentrations of ozone; and
- reduced visibility.

### *4.3.3.6 Significance Evaluation of Potential Residual Effects*

A quantitative assessment of marine air emissions using dispersion modelling (for CACs and VOCs) and photochemical modelling (for secondary PM, ozone and visibility) was determined to be the most appropriate approach to evaluate the significance of potential residual environmental effects, based on discussions with federal, provincial and local regulatory authorities. Details on the model approach and results are summarized in the Marine Air Quality and Greenhouse Gas – Marine Transportation Technical Report (Volume 8B, TR 8B-3).

After initiation of the marine air emissions modelling, and as a result of the quantitative risk assessment, Trans Mountain decided to consider the use of additional tug escort as a navigational safety measure to reduce the risk of an accidental spill from a laden Project-related tanker. Tug escort would be added for the entire route between the Westridge Marine Terminal and Buoy J where tugs are not currently used, as identified in Figure 5.3.2 and discussed in more detail in Section 5.3.2.1. Marine air emissions modelling numbers will be updated based on extended escort tug usage. Based on the professional judgment of the assessment team, the addition of the escort tug is not likely to change any of the significance conclusions presented for marine air emissions. Modeling results will be provided to the NEB in a supplemental filing in Q2 2014.

Table 4.3.3.3 presents the dispersion modelling results of increases in ambient concentrations of CACs and VOCs from increased Project-related marine vessel traffic. Values are shown separately for receptors over land and water. Note that the land-based receptors in this table are not the same as in the terrestrial assessment in Section 7 of Volume 5A, since the two RSAs and the Project-related emission sources are not identical. Regulatory standards are shown to facilitate the evaluation of the magnitude of the first two potential residual effects listed above: increases in ambient ground-level concentrations of CACs and of VOCs. Dependent on the location of the receptors with the maximum concentration shown in the table, the applicable regulatory authority is Metro Vancouver, the provincial government (BC), or the federal government. Therefore, standards for all three regulatory bodies are shown. Note that none of the three jurisdictions has regulatory standards for BTEX. Increases of CAC concentrations are mostly very small and none approach applicable regulatory standards. Therefore, the magnitude for these contaminants is evaluated as low. In the absence of regulatory standards for BTEX, a conservatively high assessment of medium magnitude was chosen.

**TABLE 4.3.3.3**

**DISPERSION MODELLING RESULTS OF AMBIENT CAC AND VOC CONCENTRATIONS FROM EMISSIONS FROM INCREASED PROJECT-RELATED MARINE VESSEL TRAFFIC (EXPRESSED AS NET CHANGE FROM EXISTING CONDITIONS) AND COMPARISON WITH APPLICABLE REGULATORY STANDARDS (IN µG/M$^3$)**

| Pollutant | Averaging Period | Project, Over Land | Project, Over Water | MV Objective | BC Objective | National Objective[1] |
|---|---|---|---|---|---|---|
| Total Suspended Particulate (TSP) | 24-hour | 0.92 | 0.45 | - | 120 | 120 |
| | Annual | 0.20 | 0.08 | - | 60 | 60 |
| Respirable Particulate Matter ($PM_{10}$) | 24-hour | 0.90 | 0.44 | 50 | 50 | - |
| | Annual | 0.19 | 0.08 | 20 | - | - |
| Inhalable Particulate Matter ($PM_{2.5}$) | 24-hour | 0.85 | 0.42 | 25 | 25 | 30, 28, and 27[2] |
| | Annual | 0.18 | 0.07 | 8 | 8 | 10 and 8.8[3] |
| Carbon Monoxide (CO) | 1-hour | 16.2 | 21.8 | 30,000 | 14,300 | 15,000 |
| | 8-hour | 18.6 | 8.3 | 10,000 | 5,500 | 6,000 |
| Nitrogen dioxide ($NO_2$) | 1-hour | 80.3 | 82.7 | 200 | - | 400 |
| | 24-hour | 50.8 | 27.5 | - | - | 200 |
| | Annual | 8.9 | 3.3 | 40 | - | 100 |
| Sulphur Dioxide ($SO_2$) | 1-hour | 6.5 | 8.8 | 450 | 450 | 450 |
| | 24-hour | 1.3 | 0.82 | 125 | 160 | 150 |
| | Annual | 0.27 | 0.10 | 30 | 25 | 30 |

## TABLE 4.3.3.3

## DISPERSION MODELLING RESULTS OF AMBIENT CAC AND VOC CONCENTRATIONS FROM EMISSIONS FROM INCREASED PROJECT-RELATED MARINE VESSEL TRAFFIC (EXPRESSED AS NET CHANGE FROM EXISTING CONDITIONS) AND COMPARISON WITH APPLICABLE REGULATORY STANDARDS (IN µG/M$^3$) (continued)

| Pollutant | Averaging Period | Project, Over Land | Project, Over Water | MV Objective | BC Objective | National Objective[1] |
|---|---|---|---|---|---|---|
| Benzene | 1-hour | 1.0 | 1.1 | - | - | - |
| | Annual | 0.008 | 0.04 | - | - | - |
| Ethylbenzene | 1-hour | 0.03 | 0.03 | - | - | - |
| Toluene | 1-hour | 0.72 | 0.79 | - | - | - |
| | 24-hour | 0.12 | 0.44 | - | - | - |
| Xylenes | 1-hour | 0.25 | 0.27 | - | - | - |
| | 24-hour | 0.04 | 0.15 | - | - | - |

**Notes:** 1 National objectives are NAAQO, with the exception of notes 2 and 3 below.

2 Values are the CWS effective since 2010 (30 µg/m3) and the CAAQS effective in 2015 (28 µg/m3) and 2020 (27 µg/m3). Metric is the 3-year average of the annual 98th percentile of the daily 24-hour average concentrations.

3 Values are the CAAQS effective in 2015 (10 µg/m3) and 2020 (8.8 µg/m3). Metric is the 3-year average of the annual average concentrations.

Table 4.3.3.4 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 water-based receptors. The LFV and the Project-related emission sources are the same in the marine and terrestrial assessments. The assessment for land-based receptors is covered in the terrestrial assessment in Section 7 of Volume 5A and not repeated here. 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 2.6 dv in Table 4.3.3.4 is likely noticeable in the LFV, and a conservatively high assessment of medium magnitude was chosen.

### TABLE 4.3.3.4

### PHOTOCHEMICAL MODELLING RESULTS OVER WATER 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

| Indicator | Predicted[1] | CWS (2010) | CAAQS (2015) | CAAQS (2020) |
|---|---|---|---|---|
| Ozone (maximum rolling 8-hour average in ppb)[2] | 0.2 | 65 | 63 | 62 |
| $PM_{2.5}$ (maximum 24-hour average in $\mu g/m^3$)[3] | 0.1 | 30 | 28 | 27 |
| Visibility (maximum 1-hour in dv)[4] | 2.6 | N/A | N/A | N/A |

**Notes:** 1 Maximum increase over water in the LFV predicted from 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 CWS and CAAQS is the 3-year average of the annual 4th highest daily maximum 8-hour average concentrations.

**3** Metric in CWS and CAAQS is the 3-year average of the annual 98th percentile of the daily 24-hour average concentrations.

4 The dv is unitless. The dv 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.

Table 4.3.3.5 provides a summary of the significance evaluation of the potential residual environmental effects of the increase in Project-related marine vessel traffic on air emissions. The rationale used to evaluate the significance of each of the residual environmental effects is provided below.

### TABLE 4.3.3.5

### SIGNIFICANCE EVALUATION OF POTENTIAL RESIDUAL EFFECTS OF INCREASED PROJECT-RELATED MARINE VESSEL TRAFFIC ON MARINE AIR EMISSIONS

| Potential Residual Effects | Impact Bal | Spatial Boundary[1] | Temporal Context | | | Magnitude | Probability | Confidence | Significance[2] |
|---|---|---|---|---|---|---|---|---|---|
| | | | Duration | Frequency | Reversibility | | | | |
| **1. Marine Air Emissions Indicator – Primary Emissions of Criteria Air Contaminants** | | | | | | | | | |
| 1(a) Increase in ambient ground-level concentrations of CACs. | Negative | RSA | Long-term | Periodic | Short-term | Low | High | Moderate | Not significant |
| **Marine Air Emissions Indicator – Primary Emissions of Volatile Organic Compounds** | | | | | | | | | |
| 2(a) Increase in ambient ground-level concentrations of VOCs. | Negative | RSA | Long-term | Periodic | Short-term | Medium | High | Moderate | Not significant |
| **Marine Air Emissions Indicator – Formation of Secondary Particulate Matter and Ozone** | | | | | | | | | |
| 3(a) Increase in ambient ground-level concentrations of secondary PM. | Negative | LFV | Long-term | Periodic | Short-term | Low | High | Moderate | Not significant |

**TABLE 4.3.3.5**

**SIGNIFICANCE EVALUATION OF POTENTIAL RESIDUAL EFFECTS OF INCREASED PROJECT-RELATED MARINE VESSEL TRAFFIC ON MARINE AIR EMISSIONS (continued)**

| Potential Residual Effects | Impact Bal | Spatial Boundary[1] | Temporal Context | | | Magnitude | Probability | Confidence | Significance[2] |
|---|---|---|---|---|---|---|---|---|---|
| | | | Duration | Frequency | Reversibility | | | | |
| 3(b) Increase in ambient ground-level concentrations of ozone. | Negative | LFV | Long-term | Periodic | Short-term | Low | High | Moderate | Not significant |
| 3(c) Combined effects of increased Project-related marine vessel traffic on the formation of secondary particulate matter and ozone indicator (3[a] and 3[b]). | Negative | LFV | Long-term | Periodic | Short-term | Low | High | Moderate | Not significant |
| **4. Marine Air Emissions Indicator – Visibility** | | | | | | | | | |
| 4(a) Reduced visibility. | Negative | LFV | Long-term | Periodic | Short-term | Medium | High | Moderate | Not significant |
| **5. Combined Effects of Increased Project-Related Marine Vessel Traffic on Marine Air Emissions** | | | | | | | | | |
| 5(a) Combined effects of increased Project-related marine vessel traffic on the marine air emissions indicators(1[a], 2[a], 3[c] and 4[a]). | Negative | LFV | Long-term | Periodic | Short-term | Medium | High | Moderate | Not significant |

**Notes:** 1 RSA = Marine Air Quality RSA; LFV = Lower Fraser Valley photochemical model domain

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.

#### 4.3.3.6.1 Marine Air Emissions Indicator - Primary Emissions of Criteria Air Contaminants

The increase in ambient ground-level concentrations of CACs is considered to have a negative impact balance. As shown in Table 4.3.3.5 point 1(a), the increase in ambient ground-level concentrations of CACs is confined to the Marine Air Quality RSA. Marine emissions are expected to change ambient concentrations of CACs periodically (*i.e.*, approximately twice daily) when Project-related marine vessel traffic enters and travels through the Marine Air Quality RSA. The change will be long-term in duration, reversible in the short-term as the marine vessel traffic leaves the Marine Air Quality RSA, and the magnitude is expected to be low. The probability of this occurring is high, and confidence in the residual effects assessment is moderate. A summary of the rationale for all of the significance criteria is provided below.

- **Spatial Boundary** - Marine Air Quality RSA – changes to ambient ground-level concentrations of CACs resulting from Project-related marine vessels are expected to occur within the Marine Air Quality RSA.
- **Duration** - long-term – emissions of CACs 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** - periodic – emissions of CACs will occur from Project-related marine vessels transiting through the Marine Air Quality RSA, which is expected to occur intermittently with approximately two vessel transits per day.
- **Reversibility** - short-term – emissions of CACs will cease and increases in ambient ground-level concentrations will reverse shortly after Project-related marine vessels exit the Marine Air Quality RSA.
- **Magnitude** - low – the increase in ambient ground-level concentrations of CACs is expected to be small relative to existing conditions and within regulatory limits; therefore, the magnitude of effect is rated as being low.
- **Probability** - high – an increase in Project-related marine vessel traffic will result in emissions of CACs.
- **Confidence** - moderate – residual effects assessment is based on a good understanding of cause-effect relationships between the Project and air emissions; however, vessel-specific data are limited.

#### 4.3.3.6.2 Marine Air Emissions Indicator - Primary Emissions of Volatile Organic Compounds

The increase in ambient ground-level concentrations of VOCs is considered to have a negative impact balance. As shown in Table 4.3.3.5 point 2(a), the increase in ambient ground-level concentrations of VOCs is confined to the Marine Air Quality RSA. Marine emissions are expected to change ambient VOC concentrations periodically when Project-related marine vessel traffic travels through the Marine Air Quality RSA. The change will be long-term in duration, reversible in the short-term as the Project-related marine vessel traffic leaves the Marine Air Quality RSA, and the magnitude is expected to be medium. The probability of this occurring is high, and confidence in the residual effects assessment is moderate. A summary of the rationale for all of the significance criteria is provided below.

- **Spatial Boundary** - Marine Air Quality RSA – changes to ambient ground-level concentrations of VOCs resulting from Project-related marine vessels are expected to occur within the Marine Air Quality RSA.
- **Duration** - long-term – emissions of VOCs 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** - periodic – emissions of VOCs will occur from Project-related marine vessels transiting through the Marine Air Quality RSA, which is expected to occur intermittently with approximately two vessel transits per day.
- **Reversibility** - short-term – emissions of VOCs will cease and increases in ambient ground-level concentrations will reverse shortly after Project-related marine vessels exit the Marine Air Quality RSA.
- **Magnitude** - medium – the increase in ambient ground-level concentrations of VOCs is expected to be small relative to existing conditions; in the absence of regulatory standards to compare with, the magnitude of effect is rated conservatively as medium.

- **Probability** - high – an increase in Project-related marine vessel traffic will result in emissions of VOCs.
- **Confidence** - moderate – residual effects assessment is based on a good understanding of cause-effect relationships between the Project and air emissions; however, vessel-specific data are limited.

#### 4.3.3.6.3 Marine Air Emissions Indicator - Formation of Secondary Particulate Matter and Ozone

The following subsections provide the evaluation of significance of the potential residual effects on the formation of secondary particulate matter and ozone indicator.

**Increase in Ambient Ground-Level Concentrations of Secondary Particulate Matter**

The increase in ambient ground-level concentrations of secondary PM is considered to have a negative impact balance. As shown in Table 4.3.3.5 point 3(a), the increase in ambient ground-level concentrations of secondary PM is confined to the photochemical model domain or LFV. Some of the marine emissions will contribute chemical pre-cursors for secondary pollutants periodically when Project-related marine vessel traffic travels through the Marine Air Quality RSA. The change will be long-term in duration, reversible in the short-term as the Project-related marine vessel traffic leaves the Marine Air Quality RSA, and the magnitude is expected to be low. The probability of this occurring is high, and confidence in the residual effects assessment is moderate. 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 PM resulting from Project-related marine vessels are expected to occur within the LFV.
- **Duration** - long-term – emissions of pre-cursors from Project-related marine vessels and subsequent changes to ambient ground-level concentrations of secondary PM are expected to occur for the life of the Project and, therefore, are considered to be long-term.
- **Frequency** - periodic – formation of secondary PM resulting from the intermittent release of pre-cursor emissions associated with Project-related marine vessels with approximately two vessel transits per day.
- **Reversibility** - short-term – emissions of pre-cursors will cease and any increases in ambient ground-level concentrations of secondary PM will reverse shortly after Project-related marine vessels exit the Marine Air Quality RSA.
- **Magnitude** - low – the increase in ambient ground-level concentrations of secondary PM is expected to be small relative to existing PM concentrations and within regulatory limits; therefore, the magnitude of effect is rated as being low.
- **Probability** - high – an increase in Project-related marine vessel traffic will result in pre-cursor emissions, which will react to form secondary PM.

- **Confidence** - moderate – residual effects assessment is based on a good understanding of cause-effect relationships between Project pre-cursor emissions and resultant ambient PM concentrations via atmospheric reactions; however, vessel-specific data are limited.

**Increase in Ambient Ground-Level Concentrations of Ozone**

The increase in ambient ground-level concentrations of ozone is considered to have a negative impact balance. As shown in Table 4.3.3.5 point 3(b), the increase in ambient ground-level concentrations of 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 Project-related marine vessel traffic travels through the Marine Air Quality RSA. The change will be long-term in duration, reversible in the short-term as the marine vessel traffic leaves the Marine Air Quality RSA, and the magnitude is expected to be low. The probability of this occurring is high, and confidence in the residual effects assessment is moderate. 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 resulting from Project-related marine vessels are expected to occur within the LFV.
- **Duration** - long-term – emissions of pre-cursors and subsequent changes to ambient ground-level concentrations of ozone are expected to occur for the life of the Project and, therefore, are considered long-term.
- **Frequency** - periodic – formation of ozone due to intermittent release of pre-cursor emissions from Project-related marine vessel traffic will occur intermittently with approximately two vessel transits per day.
- **Reversibility** - short-term – emissions of pre-cursors will cease and increases in ambient ground-level concentrations of ozone will reverse shortly after Project-related marine vessel traffic exit the Marine Air Quality RSA.
- **Magnitude** - low – the increase in ambient ground-level concentrations of ozone is expected to be small relative to existing conditions and well below regulatory limits; therefore, the magnitude of effect is rated as being low.
- **Probability** - high – an increase in Project-related marine vessel traffic will result in an increase of pre-cursor emissions, which will react to form ozone.
- **Confidence** - moderate – residual effects assessment is based on a good understanding of cause-effect relationships between Project pre-cursor emissions and resultant ambient PM concentrations via atmospheric reactions; however, vessel-specific data are limited.

**Combined Effects on Formation of Secondary Particulate Matter and Ozone Indicator**

The combined effects of marine air emissions on the indicator of formation of secondary particulate matter and ozone indicator are considered to have a negative impact balance. As shown in Table 4.3.3.5 point 3(c), the increase in ambient ground-level concentrations of secondary PM 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 Project-related marine vessel traffic travels through the Marine Air Quality RSA. The change will be long-term in duration, reversible in the short-term as the marine vessel traffic leaves the Marine Air Quality RSA, and the magnitude is expected to be low. The probability of this occurring is high, and confidence in the residual effects assessment is moderate. 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 PM and ozone resulting from Project-related marine vessels are expected to occur within the LFV.
- **Duration** - long-term – emissions of pre-cursors and subsequent changes to ambient ground-level concentrations of secondary PM and ozone are expected to occur for the life of the Project and, therefore, are considered long-term.
- **Frequency** - periodic – formation of secondary PM and ozone due to intermittent release of pre-cursor emissions from Project-related marine vessel traffic will occur intermittently with approximately two vessel transits per day.
- **Reversibility** - short-term – emissions of pre-cursors will cease and increases in ambient ground-level concentrations of secondary PM and ozone will reverse shortly after Project-related marine vessels exit the Marine Air Quality RSA.
- **Magnitude** - low – the increase in ambient ground-level concentrations of secondary PM and ozone is expected to be small relative to existing conditions and well below regulatory limits; therefore, the magnitude of effect is rated as being low.
- **Probability** - high – an increase in Project-related marine vessel traffic will result in an increase of pre-cursor emissions, which will react to form secondary PM and ozone.
- **Confidence** - moderate – residual effects assessment is based on a good understanding of cause-effect relationships between Project pre-cursor emissions and resultant ambient PM concentrations via atmospheric reactions; however, vessel-specific data are limited.

#### 4.3.3.6.4 Marine Air Emissions Indicator - Visibility

Reduced visibility is considered to have a negative impact balance. As shown in Table 4.3.3.3 point 4(a), the increase in reduced visibility is confined to the LFV. Some of the marine emissions will contribute chemical pre-cursors that could lead to the formation of aerosols periodically when Project-related marine vessel traffic travels through the Marine Air Quality RSA. The change will be long-term in duration, reversible short-term as the marine vessel traffic leaves the Marine Air Quality RSA, and the magnitude is expected to be medium. The probability of this occurring is high and confidence in the residual effects assessment is moderate. As shown in Table 4.3.3.5 point 4(a), the reduced visibility is confined to the LFV. A summary of the rationale for all of the significance criteria is provided below.

- **Spatial Boundary** - LFV – changes to visibility from Project-related marine vessel traffic are expected to occur within the LFV.

- **Duration** - long-term – emissions of pre-cursors causing light absorption are expected to occur for the life of the Project and, therefore, the duration of effect is considered long-term.
- **Frequency** - periodic – light absorption and reduced visibility due to intermittent release of pre-cursor emissions from Project-related marine vessels will occur intermittently with approximately two vessel transits per day.
- **Reversibility** - short-term – emissions of pre-cursors will cease and reduced visibility will reverse shortly after Project-related marine vessels exit the Marine Air Quality RSA.
- **Magnitude** - medium – the change in light extinction and visibility is expected to be small relative to existing conditions, and in the absence of regulatory limits, the magnitude of effect is rated conservatively as being medium.
- **Probability** - high – an increase in Project-related marine vessel traffic will result in an increase of pre-cursor emissions and secondary species, which will scatter light and reduce visibility.
- **Confidence** - moderate – residual effects assessment is based on a good understanding of cause-effect relationships between Project pre-cursor emissions and light absorption; however, vessel-specific data are limited.

#### 4.3.3.6.5 Combined Effects on Marine Air Emissions

The combined effects on the marine air emissions indicators is considered to have a negative impact balance. Effects are assessed with a setting of high volume vessel activity within the Marine Air Quality RSA and with the standards set by the existing regulatory framework. The results of the marine air emissions assessment does not contradict any management objectives of established regional marine conservation plans. As shown in Table 4.3.3.5 point 5(a), the combined effects on the marine air emissions indicators are confined to the LFV for the photochemical products (visibility, ozone and $PM_{2.5}$), which includes the Marine Air Quality RSA. Marine emissions are expected to change ambient concentrations intermittently when tanker traffic travels through the Marine Air Quality RSA. The change will be long-term in duration, reversible short-term as the Project-related marine vessel traffic leaves the Marine Air Quality RSA, and the magnitude is expected to be medium. The probability of this occurring is high, and confidence in the residual effects assessment is moderate. A summary of the rationale for all of the significance criteria is provided below.

- **Spatial Boundary** - LFV – changes to ambient concentrations associated with Project-related marine vessel traffic are expected to occur within the LFV, which includes the Marine Air Quality RSA.
- **Duration** - long-term – chemical emissions are expected to occur for the life of the Project; therefore, the duration of effect considered long-term.
- **Frequency** - periodic – Project effects on air emission concentrations due to release of emissions from Project-related marine vessel traffic will occur intermittently with approximately two tanker transits per day.

- **Reversibility** - short-term – emissions will cease and the effect on ambient concentrations will reverse shortly after the Project-related marine vessels exit the Marine Air Quality RSA.
- **Magnitude** - medium – the changes in ambient concentrations are expected to be small relative to existing conditions; no applicable regulatory limits are approached; for some residual effects, no regulatory standards are applicable, and, therefore, the magnitude of effect is rated conservatively as being medium.
- **Probability** - high – an increase in Project-related marine vessel traffic will result in an increase of emissions, and ambient concentrations will likely change.
- **Confidence** - moderate – residual effects assessment is based on a good understanding of cause-effect relationships between Project air emissions and ambient concentrations of primary and secondary pollutants and associated reductions in visibility; however, vessel-specific data are limited.

##### *4.3.3.7 Potential United States Effects*

Project effects on air emissions in US waters are expected to be similar to Canadian waters. The same vessels will travel through both Canadian and US waters and will emit the same emissions along the shipping lanes. Residual effects on land (*i.e.,* the Olympic Peninsula) may be similar to residual effects at the coastline along shipping lanes in Canadian waters. The dispersion climate and important factors such as wind direction will materially affect the extent and magnitude of the predicted impacts and effects.

##### *4.3.3.8 Summary*

As identified in Table 4.3.3.5, there are no situations where there is a high probability of occurrence of a permanent or long-term residual environmental effect on marine air emissions of high magnitude that cannot be technically or economically mitigated. Consequently, it is concluded that the residual environmental effects of increased Project-related marine vessel traffic on marine air emissions will be not significant.

#### ***4.3.4 Marine GHG Emissions***

Activities that occur during the marine operations phase have the potential to affect GHG levels. Therefore, Project interactions with GHGs were assessed. The Project will result in combustion of fuel in the tanker engines. Boilers will create GHG emissions and GHGs are also released to atmosphere from evaporative losses of product from tanker holds. Emissions are estimated based on a reasonable maximum operating scenario. This subsection considers the potential for marine GHG emissions to the atmospheric environment to change ambient concentrations due to the increased Project-related marine vessel traffic.

GHGs are a group of gases that build up in concentration in the atmosphere and have the potential to contribute incrementally to climate change. Individual GHGs are typically aggregated into "$CO_2$ equivalents" ($CO_2e$) which represent an equivalent quantity of $CO_2$ that would have the same global warming potential as the combined gases.

#### *4.3.4.1 Assessment Indicators and Measurement Endpoints*

The assessment indicators and measurement endpoints used for the marine GHG assessment are summarized in Table 4.3.4.1.

**TABLE 4.3.4.1**

**ASSESSMENT INDICATORS AND MEASUREMENT ENDPOINTS FOR GHG EMISSIONS**

| Marine GHG Indicator | Measurement Endpoint | Rationale for Indicator Selection |
|---|---|---|
| Emissions of $CO_2$, $CH_4$ and $N_2O$ | • Emissions of $CO_2e$ from Project-related marine vessel traffic; comparison to emissions from existing marine traffic and to federal totals | The selection of indicators and measurement endpoints considered NEB Filing Manual requirements for the GHG emissions element under Table A2, addressed concerns by participants of the ESA Workshops and was informed by government agencies (*i.e.*, Environment Canada, BC MOE, Metro Vancouver, Fraser Valley Regional District, PMV). |
| Effect on overall climate change | • Effects of $CO_2e$ emissions from Project-related marine vessel traffic on change in environmental parameters. such as global average temperatures | |

#### *4.3.4.2 Spatial Boundaries*

The spatial boundary of the potential effects of GHG emissions is international. All GHG are long lived gases that are dispersed globally over the course of years and alter the world's climate by increasing the fraction of outgoing long wave radiation that is absorbed by the atmosphere and emitted back towards the ground.

#### *4.3.4.3 Marine Greenhouse Gas Context*

The atmospheric lifetime (half-life) of the three GHG that are explicitly considered in the GHG emission indicators ranges from 12 years for $CH_4$ to 114 years for $N_2O$ (Technical Summary, Table TS.2 in IPCC 2007). GHG emissions from Project-related marine vessel traffic will be dispersed globally over a few years. They accumulate in the atmosphere and have the potential to contribute incrementally to climate change on a global scale. Therefore, the marine effects assessment of GHG emissions is based on total annual Project-related marine vessel traffic.

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 2013). 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 2013). 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 regulations 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, 6.0 Mt was estimated to be from domestic marine traffic. In BC alone, the total GHG emissions in 2011 were estimated to be 59.1 Mt, with 2.4 Mt generated from domestic marine traffic (Part 3, Tables A11-20 and A12-3 in Environment Canada 2013). The 2005 Corbett inventory (Wang *et al.* 2008) estimates a total of 35,872 tonnes (or 0.04 Mt) of $CO_2$ emissions from existing marine traffic in the Marine Air Quality RSA. Note; however, that a rough estimate of 2012 marine traffic suggests 15,000 to 20,000 tanker, cargo-ship, and ferry transits within the RSA. The associated GHG emissions would be roughly one to two orders of magnitude greater than the estimates in Wang *et al*. (2008). This would also be more consistent with total BC marine emissions, because emissions within the RSA should be a substantial percentage of the BC total.

#### *4.3.4.4 Potential Effects and Mitigation Measures*

Potential effects associated with increased Project-related marine vessel traffic on marine GHG indicators are listed in Table 4.3.4.2. These potential effects are based on the results of the literature review, desktop analysis, engagement with Aboriginal communities, government agencies, and other stakeholders (Section 3.0), and the professional experience of the assessment team.

No mitigation measures were considered in the marine GHG assessment. It is recognized; however, that new energy efficiency standards were adopted by the IMO in July 2011 and that these standards may improve GHG emissions from new vessels in the future.

**TABLE 4.3.4.2**

**POTENTIAL EFFECTS, MITIGATION MEASURES AND RESIDUAL EFFECTS OF INCREASED PROJECT-RELATED MARINE VESSEL TRAFFIC ON MARINE GHG EMISSIONS**

| Potential Effect | Spatial Boundary | Key Mitigation Measures in Place/Additional Recommendations | Potential Residual Effect(s) |
|---|---|---|---|
| **1. Marine GHG Indicator –Emissions of $CO_2$, $CH_4$, and $N_2O$** | | | |
| 1.1 Increase in $CO_2$e emissions | International | • All Project-related tankers are required to adhere to federal standards that may reduce GHG emissions, including standards for bunker fuel. | • Increase in $CO_2$e emissions. |
| **2. Marine GHG Indicator – Effect on Overall Climate Change** | | | |
| 2.1 Changes in environmental parameters | International | • All Project-related tankers are required to adhere to federal standards that may reduce GHG emissions, including standards for bunker fuel. | • Changes in environmental parameters (global average temperature increase, precipitation events, heavy rainfall, crop yield, etc.). |

#### *4.3.4.5 Potential Residual Effects*

The potential residual environmental effects on marine GHG indicators associated with the increase in Project-related marine vessel traffic are:

- increase in $CO_2$e emissions; and

- changes in environmental parameters such as global average temperature increase; change in precipitation, increase in heavy rainfall, yield reduction in a number of crops, changes in stream flow, and decreases in the extent of annually averaged and September Arctic sea ice.

#### *4.3.4.6 Significance Evaluation of Potential Residual Effects*

A quantitative assessment of marine GHG emissions was determined to be the most appropriate approach to evaluate the significance of potential residual environmental effects, based on discussions with federal, provincial and local government agencies. Details on the GHG emission calculations for increased Project-related marine vessel traffic are summarized in the Marine Air Quality and Greenhouse Gas – Marine Transportation Technical Report (Volume 8B, TR 8B-3).

Table 4.3.4.3 summarises the marine GHG emissions that were calculated for the Project. Specifically, the vessel type, number of transits per month and year, and GHG emissions by component are provided.

**TABLE 4.3.4.3**

**SUMMARY OF ANNUAL PROJECT-RELATED MARINE VESSEL TRANSITS AND ASSOCIATED GHG EMISSIONS (EXPRESSED AS NET CHANGE FROM EXISTING CONDITIONS) (GHG EMISSIONS IN TONNES)**

| Vessel Type | Number of Transits Per Month | Number of Transits Per Year | $CO_2$ | $CH_4$ | $N_20$ | $CO2_e$ |
|---|---|---|---|---|---|---|
| Panamax tanker (including tug escorts)[1] | 0 | 0 | -99.0 | -0.005 | -0.003 | -100.0 |
| Aframax tanker (including tug escorts)[2] | 29 | 348 | 71,500 | 1.3 | 1.9 | 72,200 |
| Total | 29 | 348 | 71,400 | 1.3 | 1.9 | 72,100 |

**Notes:**
1 GHG emission were calculated with tug escorts in two areas of the voyage. The first tug escort (three tugs) is in the Vancouver harbour, from Berry Point just east of Second Narrows to English Bay west of First Narrows. The second tug escort area is in Boundary Passage and Haro Strait. After initiation of GHG modeling, KMC added the safety mitigation measure of an escort tug for assistance in Georgia Strait and Juan de Fuca Strait. GHG emissions will be recalculated with the extra tug in 2014 and submitted to the NEB.
2 No Panamax tankers are added by the Project. Emissions by current Panamax activities are expected to drop slightly during Project operations because of decreases berth time at the Westridge Marine Terminal.

To put Project-related marine vessel traffic GHG emissions into context, Table 4.3.4.4 shows comparisons with various inventories. Project-related marine emissions are less than one percent of total annual Canadian and BC emissions and on the order of a few percent of Canadian and BC marine emissions. Compared to the last available inventory for total annual GHG emissions in the marine RSA, the expected Project-related emissions are twice as large. The marine RSA inventory is likely a substantial underestimation and the relative size of the Project emissions a conservatively high estimate. Given that this is a substantial contribution but that there is currently no regulatory limit for GHG emissions in the RSA, the magnitude is rated as medium.

### TABLE 4.3.4.4

### COMPARISON OF PROJECT-RELATED MARINE VESSEL TRAFFIC GHG EMISSIONS (EXPRESSED AS NET CHANGE FROM EXISTING CONDITIONS) WITH AVAILABLE INVENTORIES

| GHG Inventory | GHG Emissions (kt $CO_2e$) | Relative Size of Project Emissions (%) |
|---|---|---|
| Canadian Total (2011) | 702,000 | 0.01 |
| Canadian Marine (2011) | 6,000 | 1.4 |
| BC Total (2011) | 59,100 | 0.14 |
| BC Marine (2011) | 2,400 | 3.5 |
| Marine RSA (2005)[1] | 35.9 | 235 |

**Note:** 1 This is most likely an underestimate of one to two orders of magnitude.

Table 4.3.4.5 shows best estimates of changes in environmental parameters caused by 50-year total GHG emissions from project-related marine vessel traffic. These estimates are based on numerical modelling results with Earth-systems models of medium complexity with integrated carbon cycle (NRC 2010). The model runs show that the changes are equivalent to total GHG emissions and do not reverse for hundreds to thousands of years, therefore are practically permanent. The predicted changes are too small to be measureable; therefore, the magnitude of the residual effect is negligible.

### TABLE 4.3.4.5

### BEST ESTIMATES OF CHANGES IN ENVIRONMENTAL PARAMETERS CAUSED BY 50-YEAR TOTAL PROJECT-RELATED MARINE VESSEL TRAFFIC GHG EMISSIONS

| Change in Environmental Parameter[1] | Best Estimate |
|---|---|
| Global warming (°C) | $1.7 \times 10^{-6}$ |
| Precipitation changes (%) | ±0.000015 |
| Increase in heavy rainfall (%) | 0.000014 |
| Yield reduction in a number of crops (%) | 0.000021 |
| Changes in streamflows (%) | ±0.000015 |
| Decrease in the extent of annually averaged Arctic sea ice (%) | 0.000038 |
| Decrease in the extent of September Arctic sea ice (%) | 0.000038 |

**Note:** 1 Calculated for 50 years of estimated annual GHG emissions provided in Table 4.3.4.3.

After initiation of the marine GHG emissions modelling, and as a result of the quantitative risk assessment, Trans Mountain decided to consider the use of additional tug escort as a navigational safety measure to reduce the risk of an accidental spill from a laden Project-related tanker. Tug escort would be added for the entire route between the Westridge Marine Terminal and Buoy J where tugs are currently not in use, as identified in Figure 5.3.2 and discussed in more detail in Section 5.3.2.1. Marine GHG emissions modelling numbers will be updated based on extended escort tug usage. Based on the professional judgment of the assessment team, the addition of the escort tug is not likely to change any of the significance conclusions presented for marine GHG emissions. Modeling results will be provided to the NEB in a supplemental filing in Q2 2014.

Table 4.3.4.6 provides a summary of the significance evaluation of the potential residual environmental effects increased Project-related marine vessel traffic on GHG emissions. The rationale used to evaluate the significance of each of the residual environmental effects is provided below.

**TABLE 4.3.4.6**

**SIGNIFICANCE EVALUATION OF POTENTIAL RESIDUAL EFFECTS OF INCREASED PROJECT-RELATED MARINE VESSELTRAFFIC ON MARINE GHG EMISSIONS**

| Potential Residual Effects | Impact Balance | Spatial Boundary | Temporal Context | | | Magnitude | Probability | Confidence | Significance[1] |
|---|---|---|---|---|---|---|---|---|---|
| | | | Duration | Frequency | Reversibility | | | | |
| **1. Marine GHG Indicator – Emissions of $CO_2$, $CH_4$, and $N_2O$** | | | | | | | | | |
| 1(a) Increase in $CO_2$e emissions. | Negative | International | Long-term | Periodic | Immediate | Medium | High | Moderate | Not significant |
| **2. Marine GHG Indicator – Effect on Overall Climate Change** | | | | | | | | | |
| 2(a) Changes in environmental parameters. | Negative | International | Long-term | Periodic | Permanent | Negligible | High | Moderate | Not significant |
| **3. Combined Effects of Increased Project-Related Marine Vessel Traffic on Marine Greenhouse Gas Emissions** | | | | | | | | | |
| 3(a) Combined effects of increased Project-related marine vessel traffic on the marine GHG indicators (1[a] and 2[a]). | Negative | International | Long-term | Periodic | Immediate to permanent | Medium | 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.

### 4.3.4.6.1 Marine Greenhouse Gas Emissions Indicator - Emissions of $CO_2$, $CH_4$, and $N_2O$

The increase in $CO_2$e emissions related to Project marine vessel traffic is considered to have a negative impact balance. Marine GHG emissions are expected to increase when Project-related marine vessel traffic travels through the Marine Air Quality RSA. As shown in Table 4.3.4.6 point 1(a), the increase in $CO_{2e}$ emissions has an international spatial boundary. The change will be long-term in duration, reversible immediately as the Project-related marine vessel traffic leaves the Marine Air Quality RSA, and the magnitude is expected to be low. The probability of this occurring is high, and confidence in the residual effects assessment is moderate. A summary of the rationale for all of the significance criteria is provided below.

- **Spatial Boundary** - international – emissions of GHG associated with Project-related marine vessel traffic disperse globally and overlap with global GHG emissions to cause potential effects.

- **Duration** - long-term – emissions of GHG are expected to occur for the life of the Project and, therefore, are considered long-term.

- **Frequency** - periodic – emissions of GHG will occur upon Project-related marine vessels transiting through the Marine Air Quality RSA, which is expected to occur intermittently with one to two vessels per day.

- **Reversibility** - immediate – emissions of GHG within the Marine Air Quality RSA will cease immediately when vessels exit the Marine Air Quality RSA.

- **Magnitude**:- medium – the increase in GHG emissions is quantifiable and more than twice that of current marine-related GHG emissions in the Marine Air Quality RSA, but in the absence of regulatory GHG emissions limits, the magnitude is rated as being medium.

- **Probability** - high – an increase in Project-related marine vessel traffic 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, vessel-specific data are limited.

#### 4.3.4.6.2 Marine Greenhouse Gas Emissions Indicator - Effect on Overall Climate Change

Project-related 50-year total GHG emissions are predicted to cause changes in environmental parameters that are considered to have mostly a negative impact balance. Examples for changes in environmental parameters are shown in Table 4.3.4.5. As shown in Table 4.3.4.6 point 2(a), the changes in environmental parameters have an international spatial boundary. The events causing these changes (Project-related marine vessels travelling through the Marine Air Quality RSA) will occur periodically (typically one to two vessels per day) and long-term over the duration of the Project. As pointed out in the discussion of Table 4.3.4.5, the changes in environmental parameters caused by Projected-related GHG emissions are predicted to last for centuries to millennia and, therefore, are practically permanent. The table also demonstrates that the changes are not measureable; therefore the magnitude is negligible. The probability of this occurring is high. Confidence in the residual effects assessment is moderate, because the residual effects assessment is based on a good understanding of cause-effect relationships between the Project-related marine GHG emissions and changes in environmental parameters, but vessel-specific data are limited. A summary of the rationale for all of the significance criteria is provided below.

- **Spatial Boundary** - international – global changes in environmental parameters are expected from GHG emissions associated with Project-related marine vessel traffic.

- **Duration** - long-term – the events (Project-related marine vessel transiting) that will likely change environmental parameters are expected to occur for the life of the Project and, therefore, are considered long-term.

- **Frequency** - periodic – changes in environmental parameters will likely result from GHG emissions from Project-related marine vessels transiting through the Marine Air Quality RSA, which is expected to occur intermittently but repeatedly with one to two vessels per day.

- **Reversibility** - permanent – permanent – changes in environmental parameters are proportional to total GHG emissions and predicted to last for centuries to millennia and are, therefore, effectively permanent.
- **Magnitude** - negligible – changes in environmental parameters likely resulting from the Project's vessels transiting are not detectable from existing (baseline) climate variability.
- **Probability**- high – an increase in Project-related marine vessel traffic will increase GHG emissions, which is extremely likely to change environmental parameters.
- **Confidence** - high – determination of significance is based on a good understanding of cause-effect relationships between Project-related GHG emissions from marine vessel traffic and overall climate change. Observational and numerical modelling data also support the significance determination.

#### 4.3.4.6.3 Combined Effects on Marine Greenhouse Gas Emissions

The combined effects on the marine GHG indicators are considered to have a negative impact balance. Effects are assessed with a setting of high volume vessel activity within the Marine Air Quality RSA and with the standards set by the existing regulatory framework. The results of the marine GHG assessment do not contradict any management objectives of established regional marine conservation plans. As shown in Table 4.3.4.6 point 3(a), the combined effects on marine GHG emissions have an international spatial boundary. Marine GHG emissions are expected to increase when Project-related marine vessel traffic travels through the Marine Air Quality RSA, and they will contribute to global GHG levels and likely change environmental parameters. Project-related marine vessel traffic will occur periodically and long-term over the duration of the Project. The reversibility of changes in environmental parameters caused by Project-related marine GHG emissions is permanent. Estimated annual Project-related marine GHG emissions are more than twice the current emissions in the marine RSA, but there are no regulatory limits for GHG emissions in the RSA; therefore, the magnitude is rated as medium. The probability of this occurring is high, and confidence in the residual effects assessment is moderate. A summary of the rationale for all of the significance criteria is provided below.

- **Spatial Boundary** - International – marine GHG emissions disperse globally and the associated changes in environmental parameters are global in nature.
- **Duration** - long-term – the events (Project-related marine vessel transiting) that will emit GHG and likely change environmental parameters are expected to occur for the life of the Project and, therefore, are considered long-term.
- **Frequency** - periodic – the events emitting GHG and likely changing environmental parameters will occur from Project-related marine vessels transiting through the Marine Air Quality RSA, which is expected to occur intermittently with one to two vessels per day.
- **Reversibility** - permanent – likely changes in environmental parameters will last past the life of the Project for hundreds to thousands of years, and, therefore, are effectively permanent.

- **Magnitude** - medium – Project-related emissions of GHG from marine traffic are expected to be more than twice that of current marine-related GHG emissions in the RSA, but in the absence of regulatory GHG emissions limits, the magnitude is rated as being medium.
- **Probability** - high – an increase in Project-related marine vessel traffic will increase GHG emissions and is extremely likely to contribute to changes in environmental parameters.
- **Confidence** - moderate – determination of significance is based on a good understanding of cause-effect relationships between Project-related GHG emissions from marine vessel traffic and changes in environmental parameters. Observational and numerical modelling data also support the significance determination; however, vessel-specific data are limited.

#### *4.3.4.7 Potential United States Effects*

As noted in the previous section, GHG emissions and their effect on overall global climate change are international in nature, the effects described are expected to be similar for US lands and waterways.

#### *4.3.4.8 Summary*

As identified in Table 4.3.4.6 there are no situations where there is a high probability of occurrence of a permanent or long-term residual environmental effect on marine GHG emissions of high magnitude. Consequently, it is concluded that the residual environmental effects of increased Project-related marine vessel traffic on marine GHG emissions will be not significant.

### *4.3.5 Marine Acoustic Environment*

Atmospheric sound is considered to be an issue due to the potential to affect people and wildlife. Changes in sound levels can result in annoyance and sleep disturbance for people, and in changes in behaviour for wildlife.

Changes in sound levels can be noticed at specific thresholds by humans. Project-related sounds contribute to the local environment and are viewed as potentially affecting the nature of the acoustic environment in a community or the environmental aesthetic for recreational marine users. Noise events during mooring or departure currently noticed by people in some onshore areas have the potential to increase in the frequency of occurrence. This subsection of the assessment considers the potential for sound levels in the atmospheric acoustic environment to change due to increased Project-related marine vessel traffic.

#### *4.3.5.1 Assessment Indicators and Measurement Endpoints*

The key issue anticipated in the marine acoustic environment as a result of the Project is the potential for increased atmospheric sound levels as a result of increased Project-related marine vessel traffic along the marine shipping lanes. The indicator for this element is atmospheric sound levels. Ambient sound levels (ASLs) and permissible sound levels (PSLs) will be used in comparison against the predicted noise from the increased Project-related marine vessel traffic to determine its potential impact. The rationale for the selection of this indicator is provided in Table 4.3.5.1.

The measurement endpoints for marine acoustic environment include quantitative measurement of potential Project effects. As environmental noise varies over time, a single number descriptor known as the energy equivalent sound level ($L_{eq}$) is used to quantify noise. The $L_{eq}$ value, expressed in A-weighted decibels (dBA), is the energy-averaged A-weighted sound level for a specified time period. It is defined as the steady, continuous sound level over a specified time period that has the same acoustic energy as the actual varying sound levels occurring over the same time period. The A-weightings are assigned to account for the frequency response of the human ear, which is most sensitive to mid-frequency sounds. Table 4.3.5.1 provides a summary of the measurement endpoints considered for the marine acoustic environment indicator.

**TABLE 4.3.5.1**

**ASSESSMENT INDICATOR AND MEASUREMENT ENDPOINTS FOR MARINE ACOUSTIC ENVIRONMENT**

| Marine Acoustic Environment Indicator | Measurement Endpoints | Rationale for Indicator Selection |
|---|---|---|
| Atmospheric sound levels | • Ambient atmospheric sound levels in dBA<br>• Permissible atmospheric sound levels ($L_{eqNight}$ and $L_{eqDay}$) in dBA | • Represents potential increased atmospheric noise associated with increased marine vessel traffic and can be used to determine potential impacts to receptors |

The BC Oil and Gas Commission (BC OGC) Noise Control Guideline (BC OGC 2009) is receptor based guidance, such that noise is assessed to meet PSLs at the point of the receptor. Where a receptor (dwelling) is not present, the PSL should be met at 1.5 km from the facility under assessment. A receptor is defined as any permanent or seasonally occupied dwelling. As such, the assessment for the Marine Acoustic Environment is focussed on human receptors. The potential effects of atmospheric sound on marine mammals and marine birds are discussed under Section 4.3.7 and Section 4.3.8, respectively.

The BC OGC Guideline has different allowable noise levels for daytime, which it defines as the hours of 07:00 to 22:00, and nighttime, defined as 22:00 to 07:00. The $L_{eq}$ for daytime is the 15-hour A-weighted $L_{eq}$. Similarly, the $L_{eq}$ during nighttime periods is a 9-hour A-weighted $L_{eq}$. PSLs are set based on dwelling density and proximity to heavily travelled, road, rail or aircraft routes (BC OGC 2009).

#### *4.3.5.2 Spatial Boundaries*

Spatial boundaries for the assessment of potential Project effects on the acoustic environment are as defined in Section 4.2.5.1:

- **Marine LSA** - includes the inbound and outbound marine shipping lanes, the area between the shipping lanes, where it exists, and a 2 km buffer extending from the outermost edge of each shipping lane. The shipping lanes extend from the Westridge Marine Terminal in Burnaby, through Burrard Inlet, south through the southern part of the Strait of Georgia, the Gulf Islands and Haro Strait, then westward past Victoria and through the Juan de Fuca Strait out to the 12 nautical mile limit of Canada's territorial sea, corresponding to the line of longitude of Buoy J.

- **Marine RSA** - comprised of a large portion of the Salish Sea, including the inland marine waters of the southern Strait of Georgia and the Juan de Fuca Strait and their connecting channels, passes and straits. The Marine RSA is generally centred on the marine shipping lanes, which extend from the Westridge Marine Terminal through Burrard Inlet, south through the southern part of the Strait of Georgia, the Gulf Islands and Haro Strait, westward past Victoria and through Juan de Fuca Strait out to the 12 nautical mile limit of Canada's territorial sea. The western boundary of the Marine RSA extends further out to sea than the western boundary of the Salish Sea and the northern boundary of the Marine RSA is limited to the southern portion of the Strait of Georgia. Puget Sound is excluded from the Marine RSA.

#### *4.3.5.3 Marine Acoustic Environment Context*

The shipping lanes to be used by the increased Project-related marine vessel traffic are well-travelled routes that channel thousands of ships from the open ocean through Juan de Fuca Strait to the BC lower mainland each year. Existing atmospheric sound in the vicinity of the marine shipping lanes is a combination of natural and man-made sound. The dominance of man-made sound varies along the shipping lanes based on the proximity to land and the density of shoreline developments.

Tankers travel at various speeds and with or without tug escorts and tethered tugs throughout the shipping lanes at various points of travel. Sounds occur as individual events for each tanker or tanker/tug combination that passes by a specific location. All vessel activity in the Marine RSA is a source of sound, and the existing Trans Mountain related shipping forms part of the existing acoustic environment.

No changes to the types of sound generated or the intensity of the individual vessels is expected. The only change in sound level that is expected to occur due to the Project is the number of pass-by occurrences due to the increase in tanker traffic, which is expected to be on average one laden tanker and one empty tanker daily. This increase in events could increase day and night average sound levels, which forms the basis for the assessment.

#### *4.3.5.4 Potential Effects and Mitigation Measures*

The potential effects to the marine acoustic environment along the shipping lanes are considered on the basis of the numbered segments within the Marine LSA, as defined in Section 4.2.5 and on the type of activity within each segment. Specifically, Segments 1, 2, 5 and 6 (Figure 4.2.17) have shoreline areas that may be affected by changes in noise level.

Marine transportation for the Project within Segments 1 and 2 (First and Second Narrows of the Burrard Inlet) will consist of tankers idling at anchor or moving with engine load of approximately 25 per cent, and escorted by up to three tugboats depending on the actual location within the segments. Ships can be stopped and anchored in Burrard Inlet or at the Westridge Marine Terminal. Sound emissions related to the engine noises of Project-related marine vessel traffic do not change from existing conditions so are pre-dominated by the tugboats used for these areas, as shown in Section 4.2.5. The type of engine sound generated is steady when the ship transits occur or when generators are operating while the vessel is not moving. Transits occur intermittently. Singular noise events can occur when a tanker is anchored in Burrard Inlet. Ship horns can be used in specific weather conditions or as part of normal navigation.

For Segment 5 (Haro Strait and along southeastern Vancouver Island), the tankers are held at approximately 40 per cent engine power and, when laden, are escorted by one tugboat. Therefore, sound levels in this segment are a combination of both tanker and tugboat. Along Segment 6 (between Port Angeles and Victoria in the Juan de Fuca Strait), the tankers travel under their own power, at between an engine load of 70 to 80 per cent. The type of engine sound generated is steady when the ship transits occur. Transits will occur intermittently (approximately twice daily). Singular, impulsive noise events can occur when ship horns are used in specific weather conditions or as part of normal navigation, for safety purposes.

The Project-related tankers and tugboats will be fitted with exhaust silencers similar to those already in place, so all sound emitted by all vessels passing through the Marine RSA calling at the Westridge Marine Terminal is equivalent. Singular events cannot be predicted and depend on the shipping schedules, weather conditions and type of vessel, therefore, mitigation is limited to best practices that consider nuisance effects from activities. The potential effects and mitigation measures are summarized in Table 4.3.5.2.

**TABLE 4.3.5.2**

**POTENTIAL EFFECTS, MITIGATION MEASURES AND RESIDUAL EFFECTS OF INCREASED PROJECT-RELATED MARINE VESSEL TRAFFIC ON MARINE ACOUSTIC ENVIRONMENT**

| Potential Effect | Spatial Boundary[1] | Key Mitigation Measures in Place/Additional Recommendations | Potential Residual Effect(s) |
|---|---|---|---|
| **1. Marine Acoustic Environment Indicator – Atmospheric Sound Levels** | | | |
| 1.1 Consistent increase in average daytime or nighttime atmospheric sound level | LSA | • All Project-related marine vessels will be fitted with exhaust silencers similar to those already in use through industry standards. | • Increase in average daytime or night time sound levels for human receptors in the Marine LSA. |
| 1.2 Singular sound level events | LSA | • No mitigation measures recommended for effects of singular sound level events. | • Annoyance of human receptors by singular sound level events. |

**Note:** 1 LSA = Marine LSA

### *4.3.5.5 Potential Residual Effects*

The potential residual effects on the marine acoustic environment indicator associated with an increase in Project-related marine vessel traffic are:

- increase in average daytime or nighttime sound levels for human receptors in the Marine LSA; and
- annoyance of human receptors by singular sound level events.

### *4.3.5.6 Significance Evaluation of Potential Residual Effects*

The measurement endpoints for the marine acoustic environment include both quantitative and qualitative evaluation of potential Project effects. Quantitative assessment examines potential for changes in day and night sound levels based on proposed changes in ship traffic. Regarding singular, or impulsive sound level events, there is a lack of regulatory thresholds and data regarding these events for all marine activity within the Marine LSA. Consequently, a qualitative discussion of the potential for increase in these events based on changes in ship traffic is provided, which relies on the professional judgment of the assessment team.

The approach to the assessment of average daytime and nighttime sound levels was to compare existing and future daily average ship traffic levels with the ship traffic levels including the increased Project-related marine vessel traffic in each relevant segment to evaluate changes over time. In addition, the potential effects for increases in singular noise events are discussed on the basis of the increase in ship traffic as a proportional indicator of the increase in events.

After initiation of the marine acoustic environment assessment, and as a result of the quantitative risk assessment, Trans Mountain decided to consider the use of additional tug escort as a navigational safety measure to reduce the risk of an accidental spill from a laden Project-related tanker. Tug escort would be added for the entire route between the Westridge Marine Terminal and Buoy J where tugs are not currently in use, as identified in Figure 5.3.2 and discussed in more detail in Section 5.3.2.1. The marine acoustic environment assessment will be updated based on extended escort tug usage. Based on the professional judgment of the assessment team, the addition of the escort tug is not likely to change any of the significance conclusions presented for marine acoustic environment. Results will be provided to the NEB in a supplemental filing in Q2 2014.

The significance evaluation of these results is summarized in Table 4.3.5.3 and further described below.

**TABLE 4.3.5.3**

**SIGNIFICANCE EVALUATION OF POTENTIAL RESIDUAL EFFECTS OF INCREASED PROJECT-RELATED MARINE VESSEL TRAFFIC ON MARINE ACOUSTIC ENVIRONMENT**

| Potential Residual Effects | Impact Balance | Spatial Boundary[1] | Temporal Context | | | Magnitude | Probability | Confidence | Significance[2] |
|---|---|---|---|---|---|---|---|---|---|
| | | | Duration | Frequency | Reversibility | | | | |
| **1. Marine Acoustic Environment Indicator – Atmospheric Sound Levels** | | | | | | | | | |
| 1(a) Increase in average daytime or nighttime sound levels for human receptors in the Marine LSA. | Negative | LSA | Long-term | Periodic | Immediate | Low | High | Moderate | Not significant |
| 1(b) Annoyance of human receptors by singular sound level events. | Negative | LSA | Long-term | Periodic | Immediate | Low to medium | High | Moderate | Not significant |
| 1(c) Combined effects on the atmospheric sound levels indicator (1[a] and 1[b]). | Negative | LSA | Long-term | Periodic | Immediate | Low to medium | High | Moderate | Not significant |

**Note:** 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.

#### 4.3.5.6.1 Marine Acoustic Environment Indicator – Atmospheric Sound Levels

The following subsection provides the evaluation of significance of the potential residual effect on the atmospheric sound levels indicator.

**Increase in Atmospheric Sound Levels for Human Receptors in the Marine LSA**

Significance of an increase in sound levels is primarily defined by the magnitude of the change. To establish magnitude ratings, PSL threshold limits from the BC OGC Noise Control Guideline (BC OGC 2009) combined with the "just noticeable difference" of 3 dBA (Crocker 2007) were used. A change in ambient conditions of less than 3 dBA along with compliance with the BC OGC PSL was considered low magnitude. Project noise predictions that result in a more than 3 dBA change from ambient sound levels; however, still comply with BC OGC guidance were considered to be of medium magnitude and non-compliance with BC OGC guidance was considered high magnitude regardless of the amount of change in sound level.

The Project will add approximately 29 to 30 tankers per month to the shipping lanes. This changes the number of Project-related round trips made by a tanker from about two per week to one, occasionally two, per 24 hour period. The typical case was defined as one round trip taken within a 24 hour period for the assessment. On this basis, the number of individual events that occur within a 24 hour period is expected to remain relatively constant once the operation of Project-related marine vessel traffic begins.

The change in total traffic on a daily basis for Segments 1, 2 5 and 6 are provided in Table 4.3.5.4. This table shows that a change in atmospheric sound levels due to increased Project-related marine vessel traffic is expected in the Second Narrows segment near the Westridge Marine Terminal; however, will remain within the BC OGC PSL values.

**TABLE 4.3.5.4**

**POTENTIAL CHANGE IN ATMOSPHERIC SOUND LEVEL BASED ON INCREASED PROJECT-RELATED MARINE VESSEL TRAFFIC FOR MARINE ACOUSTIC ENVIRONMENT**

| Shipping Lane Segment | Existing Vessel Transits per 24-hr period (average)[1] | Project Vessels per 24-hr period (average) | % Increase in Vessel Traffic | Day/Night Ambient Sound Level (dBA) | Project Day/Night Sound Level[2] (dBA) | Day/Night PSL (dBA) |
|---|---|---|---|---|---|---|
| 1. Second Narrows | 20 | 2 | 10% | 56/46 | 56/46 | 61/51 |
| 2. First Narrows | 51 | 2 | 4% | 56/46 | 56/46 | 61/51 |
| 5. Haro Strait to Boundary Pass | 24 | 2 | 8% | 45/35 | 45/35 | 50/40 |
| 6. Victoria to Race Rocks | 26 | 2 | 8% | 45/35 | 45/35 | 50/40 |

Notes: 1 Includes existing Westridge Marine Terminal traffic

2 Project Day/Night Sound Level is the logarithmic increase of the ambient sound level based on the percent increase in vessel traffic.

The analysis above is a high level overview of potential changes in sound levels due to tanker movements. Sound will also attenuate with distance from the tankers and tug boats, and will occur only for short periods (less than ½ hour) at a particular point of reception. These events occur as variations in sound during the day and night. There would be occasional 24-hour periods (about four times per month) where the number of events within the defined day and nighttime periods may increase from two (one in/ from? each direction) to four (two in/from? each direction).

In reviewing the existing atmospheric sound level contributions for the three tanker pass-by configurations (Figure 4.2.18), the amount of variability in sound levels would depend on the proximity of the receiver to the shipping lanes. The nearest shoreline receptors are located within Burrard Inlet, past the Second Narrows. Vessel/tug configurations would be within 400 m of homes, where, based on Figure 4.2.18, atmospheric sound level as the tanker plus three tugs pass-by would momentarily be 39 dBA. When compared with the Westridge Marine Terminal ambient monitoring data (Section 6.0 of Volume 5A), this degree of variation is within the normal range of values that occur during the day or night. Marine users may be present at a variety of distances from the shipping lanes; however, the occurrences of atmospheric sound events for marine users are at most a 12 per cent increase in the number of events based on average daily total vessel traffic along the shipping lanes (Table 4.3.5.4).

Details on the calculation and analysis supporting these results are provided in the Marine Noise (Atmospheric) – Marine Transportation Technical Report (Volume 8B, TR 8B-4). The potential for the increase in daytime or nighttime atmospheric sound levels for human receptors associated with increased Project-related marine vessel traffic is considered to have a negative impact balance. The results in Table 4.3.5.4 show the potential change in atmospheric sound levels due to the increased number of events over a 24-hour period compared to the BC OGC PSL for all shipping lane segments is less than 3 dBA and, consequently, of low magnitude. The effect of sound from vessel traffic is periodic, occurring approximately twice per day for any given receptor, and the change in atmospheric sound levels is completely reversible, with sound from Project–related marine vessel traffic pass-bys ending as soon as the Project ends. As shown in Table 4.3.5.3 point 1(a), the increase in atmospheric sound levels is confined to the Marine LSA. A summary of the rationale for all of the significance criteria is provided below.

- **Spatial Boundary** - Marine LSA – changes to atmospheric sound levels are expected to occur only within the Marine LSA.
- **Duration** - long-term – the sound emissions from Project-related marine vessels will occur for the life of the Project.
- **Frequency** - periodic – sound level increases from Project-related marine vessel pass-bys will occur intermittently but repeatedly for the life of the Project due to the regularity of vessel transits (approximately twice daily).
- **Reversibility** - immediate – Project-related marine vessel sound emissions will cease when the Project is no longer in operation, so sound level increases from Project vessel pass-bys will last less than two days.
- **Magnitude** - low – the increases in atmospheric sound level are within the BC OGC Guideline PSL values and show a degree of variability consistent with existing conditions.

- **Probability** - high – the Project vessels will generate sound and more trips will occur.
- **Confidence** - moderate – the confidence in the evaluation is based on data relevant to the Project area as well as good understanding of noise propagation.

**Annoyance of Human Receptors by Singular Sound Level Events**

Singular noise events, such as the movement of anchor chains, audible ship signals or ship horns, are considered to have a negative impact balance. These events can be sources of annoyance and have been noted by community stakeholders during the Vancouver ESA Workshop, and a qualitative assessment was conducted of the potential effect. The significance of sudden changes in noise level is usually addressed through quantitative means that establish the number of events that result in a greater than 10 dBA change indoors. Effects of noise events can result in sleep disturbance if more than 10 of these events occur within the nighttime period (WHO 1999).

Sound level or event count data that defines discrete noise events from all shipping in Burrard Inlet is not available. Therefore, the significance of changes in noise events is based on the change in Project-related marine vessel traffic, using the assumption that any existing noise events associated with the ships would increase at the same rate.

The type of singular sound level events from vessels that currently exist in Burrard Inlet would not change due to the Project. However, the frequency of occurrences will change proportionally to the total ship traffic in an area, which is estimated at 12 per cent (Table 4.3.5.4). Events are not expected to change for anchorages outside Burrard Inlet.

The number of singular sound level events occurring at night is expected to increase from tankers in the vicinity of the Westridge Marine Terminal. Project-related singular sound level events are anticipated to occur on occasion due to ship anchors or ship horns being used. These events are expected to be mostly during daylight hours, as Aframax tankers are not able to transit Second Narrows at night and will anchor off English Bay if they arrive at night. Even if two Project-related events took place on the same night and resulted in a 10 dBA indoor change in sound levels, inside a home, the number of events would still be less than the level where sleep disturbance occurs (WHO 1999). The change from existing conditions increases the potential of noise events occurring up to twice per day.

The changes in atmospheric sound level from singular sound level events are not expected to change within a day or night period when Project-related marine vessels are active; however, the number of days or nights on which they occur does increase, which is considered to be a low to medium magnitude consequence. The frequency of occurrence is periodic, as use of anchors and horns are operational safety requirements for normal ship movements. The magnitude identified in Table 4.3.5.3 point 1(b) for this change is considered low to medium.

- **Spatial Boundary** - Marine LSA – changes to atmospheric sound levels are expected to occur only within the Marine LSA.
- **Duration** - long-term – the sound emissions from Project-related marine vessels will occur for the life of the Project.

- **Frequency** - periodic – sound level increases from Project-related marine vessel anchors or horns will occur intermittently; however, repeatedly over the assessment period. Anchors are generally raised or lowered twice per day for only a few minutes, and ship horns are used only when signalling required or weather conditions dictate safety requirements.
- **Reversibility** - immediate – sound level increases from Project-related singular sound level events will cease when the Project is no longer in operation, so sound level increases will last less than two days.
- **Magnitude** - low to medium – changes in atmospheric sound level from singular sound level events are not expected to change within a day or night period when Project-related marine vessels are active; however, the number of days or nights on which they occur does increase.
- **Probability** - high – the Project-related marine vessels will generate sound and more trips will occur.
- **Confidence** - moderate – no numerical data for singular sound level events from ships in Burrard Inlet are available; however, the evaluation is based on a good understanding of operational conditions.

**Combined Effects on Atmospheric Sound Levels**

The evaluation of the combined effects of increased Project-related marine vessel traffic on marine acoustic environment considers collectively the assessment of the likely potential residual effects on the atmospheric sound levels indicator. Effects are assessed with a setting of high volume vessel activity within the Marine RSA and with the standards set by the existing regulatory framework. The results of the marine acoustic environment assessment do not contradict any management objectives of established regional marine conservation plans. The effects of singular sound level events on human receptors are considered more sensitive than the effects on average daytime or nighttime sound levels due to the increased uncertainty of when singular sound levels will occur and the low level of the effect on average day-time and nighttime sound levels. Both potential effects are considered to have a negative impact balance. Each potential effect of noise is an assessment of a different time period as well as a distinct type of sound. Therefore, the combined effects on marine acoustic environment in Table 4.3.5.3 point 1(c) represent the worst case effect for each evaluation criteria between the two residual effects.

- **Spatial Boundary** - Marine LSA – changes to sound levels are expected to occur only within the Marine LSA.
- **Duration** - long-term – the sound emissions and singular sound level events from Project-related marine vessels will occur for the life of the Project.
- **Frequency** - periodic – sound level increases from Project-related marine vessel pass-bys, anchors or horns will occur infrequently but at intervals. Typically, two ships per day will travel the shipping route. Anchors are generally raised or lowered twice per day for only a few minutes, and ship horns are used only when signalling required or weather conditions dictate safety requirements.

- **Reversibility** - immediate – Project-related marine vessel sound emissions will cease when the Project is no longer in operation.
- **Magnitude** - low to medium – changes in atmospheric sound level from vessel pass-bys are within the BC OGC Guideline PSL values and show a degree of variability consistent with existing conditions. Atmospheric sound levels from singular sound level events are not expected to change within a day or night period when Project-related marine vessels are active, but the number of days or nights on which they occur does increase.
- **Probability** - high – the Project vessels will generate sound and more trips will occur.
- **Confidence** - moderate – the confidence in the evaluation of the combined effects is based on data relevant to the Project area as well as good understanding of noise propagation.

##### *4.3.5.7 Potential United States Effects*

Project sound levels in US waters, specifically the various shoreline areas in US waters are expected to be similar to those in Canadian waters at the same distances from the shipping lanes. No differences in acoustic environment conditions in the US and Canadian portions of the Marine RSA were identified that would change the nature of the effects assessment. The same types of effects assessed as key issues in Canadian waters are expected to be present in US waters since the acoustic environment conditions are expected to be similar.

##### *4.3.5.8 Summary*

As identified in Table 4.3.5.4, 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 marine acoustic environment indicators. Consequently, it is concluded that the residual environmental effects of operation activities associated with increased Project-related marine vessel traffic on marine acoustic environment will be not significant.

#### ***4.3.6 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 of the ESA considers the potential effects of the increased Project-related marine vessel traffic on marine fish and their habitats. Key issues for marine fish and fish habitat were identified through discussions with federal government agencies, including DFO, Environment Canada (EC) 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 based on extensive experience working on marine transportation projects in BC. Key issues for marine fish and fish habitat are listed below.

- potential effects of vessel wake on shoreline habitats and associated biota; and
- potential introduction of invasive species during discharge of ballast water.

This subsection of the ESA considers only those effects that could arise during routine operations of Project-related marine vessels (*i.e.,* tankers and tugs) and is, therefore, limited to the assessment of wake effects on marine fish and fish habitat. Bilge and ballast water releases in Canadian waters are strictly regulated by Transport Canada under the *Canada Shipping Act,* 2001 in order to prevent the release of contaminated substances and/or invasive species. Since tankers typically release their ballast water while berthed at the Westridge Marine Terminal, the potential introduction of invasive species from Project-related tankers is discussed in the marine fish and fish habitat assessment for the Westridge Marine Terminal (Volume 5A, Section 7.6). The release of contaminated bilge water is illegal in Canadian waters and would therefore occur only as a result of an accident or malfunction. The potential effects of a contaminated bilge water release are discussed in Section 4.3.13.3.

#### *4.3.6.1 Assessment Indicators and Measurement Endpoints*

Indicators for the assessment of marine fish and fish habitat have been identified through consideration of marine fish species and habitats that occur in the Marine RSA and that could be affected by the increased Project-related marine vessel traffic. The list of candidate species and habitats was refined by focusing on those that support commercial, recreational and/or Aboriginal FSC fisheries. For the species-based indicators, marine fish and invertebrates representative of broader taxonomic groups were considered. Preference was given to species that are: 1) likely to occur seasonally or year-round in the Marine RSA; 2) sensitive to Project-related marine vessel traffic; and 3) considered to be of conservation concern. For the habitat-based indicators, all marine habitat types potentially affected by Project-related marine vessel traffic were considered. Preference was given to habitat types that could be sensitive to Project-related marine vessel traffic. The final selection of indicators took into consideration: experience gained during previous projects with similar ecological conditions and potential issues; feedback from regulatory authorities, Aboriginal communities and stakeholders; and the professional judgment of the assessment team.

The assessment indicators selected for marine fish and fish habitat are: intertidal habitat; Pacific herring (*Clupea pallasii*); and Pacific salmon (*Oncorhynchus* spp.). The rationale for the selection of each of these indicators is provided in Table 4.3.6.1.

The measurement endpoints for marine fish and fish habitat include both quantitative and qualitative measurement of potential Project effects. For the assessment of intertidal habitat, the measurement endpoints are: predicted wake wave heights at the shoreline; length of shoreline potentially affected by vessel wake; and length of shore types potentially affected by vessel wake. Supported by findings from previous vessel wake studies, the predicted wake wave heights at the shoreline resulting from the increased Project-related marine vessel traffic were calculated using established methods. The length of the shoreline and the length of shore types potentially affected by vessel wake were calculated using geospatial information from previous coastal resource studies and GIS analysis.

For the assessment of Pacific herring and Pacific salmon, the measurement endpoint is the likelihood of injury or mortality due to vessel wake. The likelihood of injury or mortality was qualitatively assessed based on the known or inferred spatial and temporal distribution of Pacific herring and Pacific salmon and their sensitivity to vessel wake in the marine environment. Table 4.3.6.1 provides a summary of the measurement endpoints considered for each indicator.

**TABLE 4.3.6.1**

**ASSESSMENT INDICATORS AND MEASUREMENT ENDPOINTS FOR MARINE FISH AND FISH HABITAT**

| Marine Fish and Fish Habitat Indicator | Measurement Endpoints | Rationale for Indicator Selection |
|---|---|---|
| Intertidal habitat | • Predicted wake wave height at the shoreline<br>• Length (km) of shoreline potentially affected by vessel wake<br>• Length (km) of shore types potentially affected by vessel wake | • Present along all shorelines within the Marine LSA and Marine RSA<br>• Ecologically important for sustaining marine biological communities<br>• Provides spawning and migration habitat for commercial, recreational and Aboriginal fish stocks including Pacific herring and Pacific salmon |
| Pacific herring | • Likelihood of injury or mortality | • Representative small pelagic forage fish<br>• Spawning areas include intertidal and shallow subtidal habitats in the Marine LSA and Marine RSA<br>• DFO Important Areas for Pacific herring overlap with the Marine LSA and Marine RSA<br>• Important forage fish for marine fish, marine birds, and marine mammals<br>• Supports commercial, recreational and Aboriginal fisheries |
| Pacific salmon | • Likelihood of injury or mortality | • Representative large pelagic fish<br>• Migration route includes nearshore areas in the Marine RSA<br>• DFO Important Areas for Pacific salmon overlap with the Marine LSA and Marine RSA<br>• Preyed upon by marine fish, marine birds, and marine mammals<br>• Supports commercial, recreational and Aboriginal fisheries |

#### *4.3.6.2 Spatial Boundaries*

Spatial boundaries for the assessment of potential Project effects on marine fish and fish habitat are defined as follows:

- **Marine LSA** - includes the inbound and outbound marine shipping lanes, the area between the shipping lanes, where it exists, and a 2 km buffer extending from the outermost edge of each shipping lane. The shipping lanes extend from the Westridge Marine Terminal in Burnaby, through Burrard Inlet, south through the southern part of the Strait of Georgia, the Gulf Islands and Haro Strait, then westward past Victoria and through Juan de Fuca Strait out to the 12 nautical mile limit of Canada’s territorial sea.

- **Marine RSA** - comprised of a large portion of the Salish Sea, including the inland marine waters of the southern Strait of Georgia and Juan de Fuca Strait and their connecting channels, passes and straits. The Marine RSA is generally centred on the marine shipping lanes, which extend from the Westridge Marine Terminal through Burrard Inlet, south through the southern part of the Strait of Georgia, the Gulf Islands and Haro Strait, westward past

Victoria and through Juan de Fuca Strait out to the 12 nautical mile limit of Canada's territorial sea. The western boundary of the Marine RSA extends further out to sea than the western boundary of the Salish Sea and the northern boundary of the Marine RSA is limited to the southern portion of the Strait of Georgia. Puget Sound is excluded from the Marine RSA.

The boundaries of the Marine LSA are selected to encompass the area along the shipping lanes within which vessel wake from a tanker or escort tug would be expected to reach adjacent shorelines at a magnitude that could potentially affect marine fish and fish habitat. The 2 km buffer around the shipping lanes was selected based on a literature review of previous studies on wake from tankers including Moffatt and Nichol (2010, 2011) and Force Technology and Danish Hydraulic Institute (DHI) (2012). Based on the findings of these studies, the 2 km buffer was determined to be appropriate for the assessment because the predicted height of wake waves outside of this buffer (≤ 0.1 m) are well within the range of natural wave conditions (see Section 4.2.1.4).

The boundaries of the Marine RSA are selected to encompass the diversity of intertidal habitat types found along the shipping lanes and the regional distribution of resident and seasonally-present marine fish species. The Marine RSA encompasses over 3,800 km of shoreline habitat representing 15 shore types, seasonally important foraging areas and migration routes for Pacific salmon and Pacific herring, and spawning habitats for Pacific herring.

The marine fish and fish habitat study areas also follow guidance indicated by the NEB in the letter titled Filing Requirements Related to the Potential Environmental and Socio-Economic Effects of Increased Marine Shipping Activities (NEB 2013b), received by Trans Mountain on September 10, 2013. The letter indicates that the marine transportation assessment should take place out to the 12 nautical mile limit of Canada's territorial seas.

Study area boundaries for marine fish and fish habitat are shown in Figure 4.2.2.

#### *4.3.6.3 Marine Fish and Fish Habitat Context*

The shipping lanes extend from the Westridge Marine Terminal through Burrard Inlet, south through the southern part of the Strait of Georgia, the Gulf Islands and Haro Strait, westward past Victoria and Juan de Fuca Strait out to the 12 nautical mile limit of Canada's territorial sea. The shipping lanes are an established route for all types of vessels and are among the busiest shipping lanes in BC (see Volume 8C TERMPOL Studies, BC MCA 2010). These waterways are all within the Salish Sea, an inland area of ocean that extends from Olympia, Washington northward to Campbell River, BC. The total length of Canadian shoreline adjacent to the shipping lanes is approximately 2,315 km. The average channel width in the Strait of Georgia and Juan de Fuca Strait is approximately 22–28 km (Thompson 1981). Maximum significant wave heights in the Strait of Georgia and Juan de Fuca Strait are typically less than 5 m and the average significant wave heights range from approximately 0.1 to 0.3 m (DFO 2013).

A total of 409 species of marine fish have been reported in Canadian Pacific waters (Peden 2013). Shoreline habitats adjacent to the shipping lanes are used for spawning, rearing, migration and foraging by many species of marine fish and invertebrates. For example, Pacific herring use intertidal substrates, seagrass and algae as spawning substrate for their eggs (Humphreys and Hourston 1978, Levings and Thom 1994, Taylor 1964), and Pacific salmon use nearshore habitat and estuaries for rearing and migration (Healey 1980, Levings and Jamieson 2001, Levings and Thom 1994).

Typically, five partially-laden tankers per month are currently loaded with heavy crude oil or diluted bitumen at the Westridge Marine Terminal. The expanded system will be capable of serving 34 partially-laden Aframax vessels per month, with actual seasonal and annual demand driven by market conditions (see Section 2.2). The maximum size of vessels served at the terminal is not forecast to change as part of the Project.

In addition to tanker traffic, the Westridge Marine Terminal also currently loads about two barges with crude oil per month. Westridge Marine Terminal also operates a system to receive about one barge of jet fuel per month using a separate pipeline system that serves YVR. Barge activity is not expected to change as a result of the Project.

#### *4.3.6.4 Potential Effects and Mitigation Measures*

##### 4.3.6.4.1 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, government agencies 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.

**Behavioural Disturbance to Marine Fish and Invertebrates Due to Underwater 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 sound from vessel traffic (Popper and Hastings 2009b).

Several reviews on the effects of anthropogenic sounds on fish and invertebrates have concluded that there is a lack of empirical data and knowledge about the effects of underwater noise on marine fish and invertebrates (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). At present there are no standard criteria or thresholds for the effects of underwater noise from vessel traffic on marine fish or invertebrates. Existing information indicates that noise levels from vessel traffic are not likely to cause physical injury or mortality to marine fish (Popper and Hastings 2009b), therefore, physical injury and mortality were not considered further in this assessment. Underwater noise from vessel traffic could; however, potentially trigger behavioural responses by marine fish. Consequently, this potential effect was considered for inclusion in the assessment.

The effects of short-term and long-term exposure to underwater noise from vessel traffic 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 impulsive sources such as 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 necessarily provide accurate insight as to how animals will behave in their natural habitat (Popper and Hastings 2009a,b). Popper and Hastings (2009b) also 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 range from: 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 long-term survival.

Scientific literature is sparse regarding behavioural responses of marine fish and invertebrate species found in the Marine RSA to noise from vessel traffic. A single study on the behavioural responses of Pacific herring to noise from fishing vessels was identified. Schwarz and Greer (1984) studied behavioural responses of net-penned Pacific herring to a variety of tape-recorded underwater sounds. They found that the fish exhibited a mildly negative response to the sound of large fishing vessels approaching by slowly moving away from the sound source.

Marine fish and invertebrates located near berthed or transiting tankers and escort tugs may respond to the underwater noise by moving away from the sound source for the duration of the disturbance; however, there is no evidence in the literature that vessel traffic will result in the large-scale displacement of fish or invertebrate populations from foraging, spawning, rearing or migration areas or will otherwise affect their distribution or abundance. This conclusion is supported by the existing overlap of areas of high shipping activity and Pacific herring and Pacific salmon migration areas, such as the Haro Strait and the Fraser and Columbia rivers.

For the reasons discussed above and according to the judgment of the assessment team, behavioural disturbance to marine fish and invertebrates due to underwater noise from vessel traffic was not considered further in this assessment.

#### 4.3.6.4.2 Identified Potential Effects

Vessel wake associated with the transit of Project-related tankers and tugs has the potential to affect marine fish and fish habitat. The severity of this effect depends on a number of factors including: the height of the wake when it reaches the shoreline; the natural wave environment; and the type of habitat affected. Potential effects associated with vessel wake include: 1) the physical disturbance of fish habitat due to increased erosion of sediments or dislodging of structure-forming organisms along the shoreline (*e.g.*, algae, sessile invertebrates); and 2) injury or mortality of marine fish due to the dislodging of fish eggs (roe) from shoreline substrates and/or the stranding of fish migrating or foraging along the shoreline.

Table 4.3.6.2 shows the identified potential effects associated with Project-related marine vessel traffic on marine fish and fish habitat indicators as well as mitigation measures and potential residual effects. The potential effects listed in Table 4.3.6.2 are based on the results of literature reviews, desktop analyses, consultation/engagement with government agencies, Aboriginal communities and other stakeholders (Section 3.0), and the experience of the assessment team.

Based on a review of federal regulatory guidelines, industry best management practices and the experience of the assessment team, it was determined that no measures are necessary to mitigate the effects of vessel wake on marine fish and fish habitat (Table 4.3.6.2).

**TABLE 4.3.6.2**

**POTENTIAL EFFECTS, MITIGATION MEASURES AND RESIDUAL EFFECTS OF INCREASED PROJECT-RELATED MARINE VESSEL TRAFFIC ON MARINE FISH AND FISH HABITAT**

| Potential Effect | Spatial Boundary[1] | Key Mitigation Measures in Place/Additional Recommendations | Potential Residual Effect(s) |
|---|---|---|---|
| **1. Marine Fish and Fish Habitat Indicator – Intertidal Habitat** | | | |
| 1.1 Disturbance to intertidal habitat | LSA | No mitigation measures recommended for effects of vessel wake. | Disturbance to intertidal habitat due to vessel wake. |
| **2. Marine Fish and Fish Habitat Indicator – Pacific Herring** | | | |
| 2.1 Injury or mortality to Pacific herring | LSA | No mitigation measures recommended for effects of vessel wake. | Injury or mortality to Pacific herring due to vessel wake. |
| **3. Fish and Fish Habitat Indicator – Pacific Salmon** | | | |
| 3.1 Injury or mortality to Pacific salmon | LSA | No mitigation measures recommended for effects of vessel wake. | Injury or mortality to Pacific salmon due to vessel wake. |

**Note:** 1 LSA = Marine LSA

### *4.3.6.5 Potential Residual Effects*

The potential residual environmental effects on marine fish and fish habitat indicators associated with an increased Project-related marine vessel traffic are:

- disturbance to intertidal habitat due to vessel wake;
- injury or mortality to Pacific herring due to vessel wake; and
- injury or mortality to Pacific salmon due to vessel wake.

### *4.3.6.6 Significance Evaluation of Potential Residual Effects*

The measurement endpoints for marine fish and fish habitat include both quantitative and qualitative measurement of potential Project effects. There is a lack of regulatory thresholds, standards or guidelines for evaluating potential residual effects from vessel wake on marine fish and fish habitat. Consequently, the findings of the quantitative analyses were considered in concert with the professional judgment of the assessment team.

Predicted wake wave heights at the shoreline were estimated using methods established in previous vessel wake studies. The length of the shoreline and the length of shore types potentially affected by vessel wake were calculated using geospatial information from previous coastal resources studies and GIS analysis. The likelihood of injury or mortality to Pacific herring and Pacific salmon was evaluated qualitatively based on a thorough review of relevant scientific literature.

Table 4.3.6.3 provides a summary of the significance evaluation of the potential residual environmental effects of Project-related increases in marine vessel traffic on marine fish and fish habitat. The rationale used to evaluate the significance of each of the residual environmental effects is provided below.

**TABLE 4.3.6.3**

**SIGNIFICANCE EVALUATION OF POTENTIAL RESIDUAL EFFECTS FROM INCREASED PROJECT-RELATED MARINE VESSEL TRAFFIC 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 – Intertidal Habitat** | | | | | | | | | |
| 1(a) Disturbance to intertidal habitat. | Negative | LSA | Long-term | Periodic | Immediate | Negligible | High | High | Not significant |
| **2. Marine Fish and Fish Habitat Indicator – Pacific Herring** | | | | | | | | | |
| 2(a) Injury or mortality to Pacific herring. | Negative | LSA | Long-term | Periodic | Medium-term | Negligible | Low | High | Not significant |
| **3. Fish and Fish Habitat Indicator – Pacific Salmon** | | | | | | | | | |
| 3(a) Injury or mortality to Pacific salmon. | Negative | LSA | Long-term | Periodic | Medium-term | Negligible | Low | High | Not significant |
| **4. Combined Effects of Increased Project-Related Marine Vessel Traffic on Marine Fish and Fish Habitat** | | | | | | | | | |
| 4(a) Combined effects of increased Project-related marine vessel traffic on the marine fish and fish habitat indicators (1[a], 2[a] and 3[a]). | Negative | LSA | Long-term | Periodic | Immediate | Negligible | 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.

#### 4.3.6.6.1 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.

**Disturbance to Intertidal Habitat Due to Vessel Wake**

Several recent studies have focused on the predicted wake wave heights from tankers and associated escort tugs in confined channels in BC. Moffatt and Nichol (2010, 2011) conducted studies on vessel wake from very large crude carriers (VLCC), liquefied natural gas (LNG) carriers, and escort tugs in Douglas Channel, BC where depths ranged up to 365 m. Key points and findings from these studies includes the following.

- Moving vessels generate two types of waves: primary (drawdown waves) and secondary waves. The height of drawdown waves generated by ships depend on vessel speed, vessel cross-sectional area, channel depth and channel cross-sectional area. Drawdown waves do not break at the shoreline; however, instead cause the water level to slowly rise and fall as the vessel passes. The height of secondary waves generated by ships depend on vessel speed, channel depth and vessel type. Like normal ocean waves, secondary waves break at the shoreline.

- Drawdown wave heights generated by tankers are very low (*i.e.*, 0.015 to 0.025 m) due to the relative size of the channel cross-sectional area compared to the ship cross-sectional area.
- At a distance of 10 m from the VLCC (this is a larger vessel than the Aframax tankers currently used at Westridge Marine Terminal) and LNG carrier hull, and at a speed of 16 knots, the secondary wave height is approximately 0.3 m, decreasing to a height of approximately 0.1 m at distances of 1,000 to 1,500 m from the vessel.
- At a distance of 10 m from the escort tug hull and at a speed of 16 knots, the secondary wave height is approximately 0.4 m, decreasing to a height of approximately 0.1 m at distances of 1,000 to 1,500 m from the vessel.

A supplemental study by Force and DHI (2012) modelled vessel wake from a loaded VLCC moving at a speed of 16 knots, a loaded Aframax tanker at a speed of 12 knots, and an escort tug at speed of 12 knots in Douglas Channel and in Principe Channel where channel depths are 250 m and 90 m respectively. Wave heights of wind-generated waves were also modelled at these locations. Key points and findings from this study are as follows.

- Waves generated by the Aframax tanker moving at a speed of 12 knots with an escort tug 60 m behind was of the same magnitude as the VLCC moving at 16 knots.
- Results from the models show maximum wave heights of 0.05 – 0.10 m at Kikiata Inlet in the Douglas Channel from a loaded VLCC at a speed of 16 knots and an escort tug at a speed of 12 knots; and a maximum wave height of 0.15 m at the outer islands in Principe Channel from a loaded VLCC at a speed of 16 knots; with wave periods in the range of 3.0–4.5 seconds at both locations.
- Results from the models support the findings of Moffatt and Nichol (2010).
- Assuming 500 vessel transits per year, vessel generated waves would occur less than 0.14 per cent of the year at Kikiata Inlet in the Douglas Channel.
- Wind-waves of similar height to the vessel-generated waves occur approximately 10 times more frequently than the vessel-generated waves at Kikiata Inlet in the Douglas Channel and Dixon Island in Principe Channel.

The height of secondary waves generated by ships depends on vessel speed, channel depth, and vessel type, therefore, the findings of the vessel wake studies described above do not necessarily apply to Project-related marine vessel traffic due to potential differences in these three parameters. The applicability of the parameters used in Moffatt and Nichol (2010, 2011) to the proposed Project-related marine vessel traffic is evaluated here.

- **Vessel speed** - Vessel speeds of Trans Mountain tankers along the shipping lanes will range from 6.0–14.5 knots. These speeds, although lower, are comparable for purpose of the ESA to the speeds used in Moffatt and Nichol (2010, 2011) and Force and DHI (2012) (*i.e.*, 8–16 knots).

- **Channel depth** - Average depths in the Douglas Channel are considerably greater than those in the Strait of Georgia or Juan de Fuca Strait. Moffatt and Nichol (2010, 2011) and Force and DHI (2012) used average depths of 250–365 m in their studies of vessel wake in the Douglas Channel. However, average depths in the Strait of Georgia are approximately 155 m, and depth ranges from 55–250 m in Juan de Fuca Strait (Thompson 1981).

- **Vessel type** - Calculations of secondary wave height used by Moffatt and Nichol (2010, 2011) used a coefficient $\alpha^1$, which varies depending on vessel type. In those studies, a $\alpha^1$ value of 0.7 was chosen for VLCCs and LNG carriers based on recommendations from laboratory and field tests. Given that VLCCs are much larger than the Aframax tankers proposed for use in the TMEP, and Force and DHI (2012) found that waves generated by an Aframax tanker are of the same magnitude as the VLCC, a $\alpha^1$ value of 0.7 seems conservative for calculating secondary wave heights generated by Aframax tankers.

Average channel depth in the Douglas Channel is substantially greater than average channel depths in the Strait of Georgia and Juan de Fuca Strait, and the shallower depths may result in larger secondary wave heights from Project-related marine vessel traffic along the shoreline of the Marine RSA, which may be somewhat mitigated by the lesser draft and speeds of the Aframax tankers that transit to the Westridge Marine Terminal employed for the Project. Therefore, in summary, the vessel speeds and vessel types used in the vessel wake studies are broadly comparable to those proposed for the Project.

Using the methods outlined in Moffatt and Nichol (2010, 2011), the secondary wave heights at various distances generated by Aframax tankers and escort tugs moving at various speeds can be calculated for channel depths along the shipping lanes in the Strait of Georgia and Juan de Fuca Strait. Distances used in the calculations range from 10 to 2,000 m, corresponding to the outer limit of the 2 km buffer on either side of the shipping lanes that defines the boundaries of the Marine LSA. Secondary wave height is calculated from the following formula:

- $H = h\alpha^1(S/h)^{-0.33}(F_h^4)$; and
- where $F_h$ = Froude number, $F_h = V_s/(\sqrt{gh})$:
  - $S$ = distance from vessel's side and a point of interest;
  - $\alpha^1$ = coefficient depending on vessel type (0.7 for tankers, 1.0 for escort tugs);
  - $h$ = channel depth; and
  - $V_s$ = vessel speed.

The predicted wave heights from tankers traveling at various speeds in channel depths of 55 m and 155 m are shown in Table 4.3.6.4. In channel depths of 55 m, at a distance of 10 m from the tanker hull, and at a speed of 14 knots, the secondary wave height is approximately 0.6 m, decreasing to a height of approximately 0.1 m at a distance of 2,000 m from the vessel. In channel depths of 155 m, at a distance of 10 m from the tanker hull, and at a speed of 14 knots, the secondary wave height is approximately 0.3 m decreasing to a height of approximately 0.05 m at a distance of 2,000 m from the vessel.

**TABLE 4.3.6.4**

**PREDICTED WAVE HEIGHTS FROM TANKERS BY VESSEL SPEED AND CHANNEL DEPTH IN MARINE LSA**

| Vessel Speed (knots) | Predicted Wave Height at Distance from Tanker Traveling in Channel Depth of 55 m | | | | | |
|---|---|---|---|---|---|---|
| | 10 m | 100 m | 500 m | 1,000 m | 1,500 m | 2,000 m |
| 16 | 1.07 | 0.50 | 0.29 | 0.23 | 0.20 | 0.19 |
| 14 | 0.63 | 0.29 | 0.17 | 0.14 | 0.12 | 0.11 |
| 12 | 0.34 | 0.16 | 0.09 | 0.07 | 0.06 | 0.06 |
| 10 | 0.16 | 0.08 | 0.04 | 0.04 | 0.03 | 0.03 |
| 8 | 0.07 | 0.03 | 0.02 | 0.01 | 0.01 | 0.01 |
| **Vessel Speed (knots)** | **Predicted Wave Height at Distance from Tanker Traveling in Channel Depth of 155 m** | | | | | |
| | **10 m** | **100 m** | **500 m** | **1,000 m** | **1,500 m** | **2,000 m** |
| 16 | 0.53 | 0.25 | 0.15 | 0.12 | 0.10 | 0.09 |
| 14 | 0.31 | 0.15 | 0.09 | 0.07 | 0.06 | 0.05 |
| 12 | 0.17 | 0.08 | 0.05 | 0.04 | 0.03 | 0.03 |
| 10 | 0.08 | 0.04 | 0.02 | 0.02 | 0.02 | 0.01 |
| 8 | 0.03 | 0.02 | 0.01 | 0.01 | 0.01 | 0.01 |

The predicted wave heights from escort tugs traveling at various speeds in channel depths of 55 m and 155 m are shown in Table 4.3.6.5. In channel depths of 55 m, at a distance of 10 m from the tug hull, and at a speed of 14 knots, the secondary wave height is approximately 0.9 m decreasing to a height of approximately 0.16 m at a distance of 2,000 m from the vessel. In channel depths of 155 m, at a distance of 10 m from the tug hull, and at a speed of 14 knots, the secondary wave height is approximately 0.5 m decreasing to a height of approximately 0.1 m at a distance of 2,000 m from the vessel.

**TABLE 4.3.6.5**

**PREDICTED WAVE HEIGHTS FROM ESCORT TUGS BY VESSEL SPEED AND WATER DEPTH**

| Vessel Speed (knots) | Predicted Wave Height at Distance from Escort Tug Traveling in Channel Depth of 55 m | | | | | |
|---|---|---|---|---|---|---|
| | 10 m | 100 m | 500 m | 1,000 m | 1,500 m | 2,000 m |
| 16 | 1.53 | 0.71 | 0.42 | 0.33 | 0.29 | 0.27 |
| 14 | 0.89 | 0.42 | 0.25 | 0.20 | 0.17 | 0.16 |
| 12 | 0.48 | 0.23 | 0.13 | 0.11 | 0.09 | 0.08 |
| 10 | 0.23 | 0.11 | 0.06 | 0.05 | 0.04 | 0.04 |
| 8 | 0.10 | 0.04 | 0.03 | 0.02 | 0.02 | 0.02 |
| **Vessel Speed (knots)** | **Predicted Wave Height at Distance from Tanker Traveling in Channel Depth of 155 m** | | | | | |
| | **10 m** | **100 m** | **500 m** | **1,000 m** | **1,500 m** | **2,000 m** |
| 16 | 0.76 | 0.36 | 0.21 | 0.17 | 0.15 | 0.13 |
| 14 | 0.45 | 0.21 | 0.12 | 0.10 | 0.09 | 0.08 |
| 12 | 0.24 | 0.11 | 0.07 | 0.05 | 0.05 | 0.04 |
| 10 | 0.12 | 0.05 | 0.03 | 0.03 | 0.02 | 0.02 |
| 8 | 0.05 | 0.02 | 0.01 | 0.01 | 0.01 | 0.01 |

Due to the average channel width of 22–28 km in the Strait of Georgia and Juan de Fuca Strait (Thompson 1981) and the relatively rapid rate at which wake waves decrease in height away from the transiting tankers and escort tugs (Tables 4.3.6.4 and 4.3.6.5), vessel wake is not expected to be detectable from existing wave conditions along most of the shoreline in the Marine RSA.

Approximately 109 km of shoreline representing only 5 per cent of the total length of shoreline in the Canadian portion of the Marine RSA is located within 2,000 m of the shipping lanes (see Figure 4.2.2). These areas include shoreline in Burrard Inlet, Haro Strait and the area around Victoria on Vancouver Island. Within Burrard Inlet, Project-related tankers and tugs travel at speeds of 8 knots or less (typically around 6 knots), resulting in maximum predicted wave heights of 0.03 m at a distance of 500 m and 0.02 m at a distance of 1,000 m (Tables 4.3.6.4 and 4.3.6.5). Outbound tankers transiting between East Point on Saturna Island and Race Rocks on southern Vancouver Island are accompanied by an escort tug and are restricted to a maximum speed of 10 knots. Inbound tankers do not require an escort tug outside of Burrard Inlet and, typically, transit Haro Strait and Boundary Pass at around 12 knots. At these speeds, the maximum predicted wave heights generated by Project-related marine vessels are 0.09 m at a distance of 500 m, 0.07 m at a distance of 1,000 m and 0.06 m at a distance of 2,000 m (Tables 4.3.6.4 and 4.3.6.5).

Intertidal habitats located within the Marine LSA may be subject to increased wave action due to vessel wake resulting in temporary disturbance to intertidal sediment and vegetation, which is considered to have a negative impact balance. Habitat types most susceptible to disturbance are those dominated by fine-grained sediments (*e.g.*, sand and mud). Of the 109 km of shoreline in the Marine LSA, only 3.8 per cent are soft sediment ('sand beach' – 0.4 per cent; 'sand flat' – 1.0 per cent, 'mud flat' - 1.6 per cent, 'estuary, marsh or lagoon' – 0.8 per cent) (Figure 4.2.19a-d) (BC MFLNRO 2005). Dominant habitat types in the Marine LSA are 'man made' (44.7 per cent), 'sand and gravel flat' (11.2 per cent), 'rock cliff' (10.2 per cent), 'sand and gravel beach' (9.1 per cent), 'rock, sand and gravel beach' (7.8 per cent), and 'rock with gravel beach' (7.6 per cent) (Figure 4.2.19a-d) (BC MFLNRO 2005). These coarser substrates are more resistant to the physical forces imparted by waves and are often located in areas subject to higher wave exposure.

Shoreline erosion from vessel wake may result from high-speed vessels, such as high-speed passenger ferries, or deep-draft vessels operating in sheltered to semi-sheltered estuaries and river environments (Garel *et al*. 2008, Soomere *et al*. 2009, Velegrakis *et al*. 2007). However, these effects are unlikely from vessels moving at conventional speeds (*e.g.*, 12 to 15 knots) in the marine environment. Shoreline erosion from vessel wake typically only occurs in cases where the heights of vessel wake waves are different from those of natural waves (Velegrakis *et al*. 2007).

Although information on natural wave conditions within the Marine LSA and Marine RSA is limited, long-term data from three ocean buoys located in the Marine RSA suggest that wave conditions vary considerably with location and time of year (DFO 2013a). At the Patricia Bay buoy located in Saanich Inlet, significant wave heights, defined as the average height of the highest third of waves observed, range from 0 to 4.33 m, with an average of 0.06 m (DFO 2013a). At the La Perouse Bank buoy located off the west coast of Vancouver Island, significant wave heights range from 0 to 19.51 m, with an average of 2.23 m (DFO 2013a). Although neither of these buoys are positioned directly along the shipping route, they are representative of sheltered inshore waters (Patricia Bay) and exposed offshore waters (La Perouse Bank), and therefore encompass much of the variability in regional marine conditions. Within the Marine

LSA, wave heights likely vary depending on water depth, fetch, and local topography; however, the available data suggest that the predicted tanker and tug wake wave heights at the shoreline (*i.e.*, < 0.1 m) are well within the range of natural wave conditions. Therefore, any disturbance to intertidal habitat due to vessel wake will not be detectable from existing conditions and, consequently, is considered to be of negligible magnitude (Table 4.3.6.3, point 1[a]). A summary of the rationale for all of the significance criteria is provided below.

- **Spatial Boundary** - Marine LSA – residual effects on intertidal habitat will be limited to the area of overlap between intertidal habitat and the Marine LSA due to the low height of wake waves outside of the Marine LSA.
- **Duration** - long-term – vessel transits along the shipping lanes will be initiated during the operations phase and will extend for the life of the Project.
- **Frequency** - periodic – the event causing vessel wake is the transit of Project-related tankers and tugs, which will occur, on average, two times per day (one inbound and one outbound) for the operational life of the Project.
- **Reversibility** - immediate – residual effects on intertidal habitat will be limited to the period during which wake waves are interacting with the shoreline.
- **Magnitude** - negligible – residual effects of vessel wake on intertidal habitat will not be detectable from existing conditions.
- **Probability** - high – Project-related marine vessel traffic is likely to generate wake waves and these waves will interact with intertidal habitat.
- **Confidence** - high – based on a good understanding by the assessment team of the cause-effect relationships between vessel wake and the disturbance to intertidal habitat.

#### 4.3.6.6.2 Marine Fish and Fish Habitat Indicator - Pacific Herring

The following subsection provides the evaluation of significance of the potential residual effect on the Pacific herring indicator.

**Injury or Mortality to Pacific Herring Due to Vessel Wake**

In the Strait of Georgia, Pacific herring spawn in late-winter between January and June, with the peak spawning period occurring in March (DFO 2013f, Hart 1973, Hay 1985, Hay and McCarter 2012). Spawning occurs along the shoreline in the intertidal to shallow subtidal zones between high tide and depths of 11 m (Hart 1973, Rooper *et al*. 1999). The eggs are very sticky and once deposited, they adhere in large masses to a variety of substrates (Hart 1973, Taylor 1964). The eggs sometimes adhere to rocks, pilings, and debris; but primarily adhere to marine vegetation (Hart 1973, Taylor 1964). The dominant substrate in sheltered bays and along sandy beaches is eelgrass (*Zostera marina*) and surfgrass (*Phyllospadix scoulerii*), along rocky shores it is rockweed (*Fucus gardneri*), and in shallow subtidal areas it is kelp (*Laminaria* sp.) (Hart 1973, Taylor 1964). The dominant substrates available for herring spawn in the Strait of Georgia are eelgrass, surfgrass, Japanese wireweed, and rockweed; while the dominant substrates available for herring spawn on the west coast of Vancouver Island are eelgrass and surfgrass (Taylor 1964).

Pacific herring will spawn every year and each female may deposit as many as 20,000 eggs (Hay 1985, DFO 2013f). However, the rate of spawn mortality is high, with estimates ranging from 56 to 100 per cent depending on the spawning location (Rooper *et al*. 1999, Taylor 1964). Major causes of spawn mortality are predation by birds, disruption from wave action (depending on the degree of exposure), and desiccation from exposure to air (Taylor 1964). The mortality rate attributed to predation by birds is estimated to be 30 to 55 per cent (Taylor 1964). When spawning is followed by poor weather and increased wave action, eelgrass can become dislodged or the eggs themselves can break loose and wash up on shore (Hart 1973).

Studies on spawn mortality due to wave action during storm events have estimated resulting mortality rates of 26 to 74 per cent (Hart and Tester 1934, Hay and Miller 1982, Rooper 1996). Rooper *et al*. (1999) studied a variety of habitat factors controlling egg loss in Prince William Sound, Alaska including depth of spawn, wave exposure, substrate type and vegetation type, among others. They found that depth of spawn was the primary factor determining egg loss. Analysis of wave exposure at spawning sites found that egg loss was consistently higher in protected areas than in exposed areas, but the factors driving this trend were not known. Substrate type and vegetation type were not found to be predominate factors in rates of egg loss. Taylor (1955) notes that spawn survival is highest near zero tide level and in locations partially protected from wave action and least in both exposed and well protected localities. This suggests that a moderate amount of wave action may improve hatching success (Gustafson *et al*. 2006). According to Hay and Miller (1982), most of the herring spawn in BC is deposited in the subtidal zone and, therefore, is relatively protected from wave action.

Historic data on herring spawning areas in BC from 1941 to 2002 suggest that herring spawn in only one small area within the Marine LSA south of Victoria on Vancouver Island (Hay and McCarter 2012; see Figure 4.2.20). This spawning area is approximately 2,000 m from the shipping lanes along the outer edge of the Marine LSA, where wake wave heights from Project-related marine vessels are predicted to be less than 0.1 m when they reach the shoreline. Wake waves of this height are well within the range of natural wave conditions (DFO 2013a, Thompson 1981) and are not likely to be of sufficient force to dislodge herring roe. Outside of the Marine LSA, the nearest herring spawning locations are located in Whytecliff Park in West Vancouver and Roberts Bank in Tsawwassen (Figure 4.2.20). These locations are 3 to 4 km away from the shipping lanes. Given this distance, wake waves reaching these areas are not expected to be detectable from existing wave conditions.

The Marine RSA encompasses some of the busiest shipping lanes in BC as well as herring spawning areas and DFO Important Areas for Pacific herring (see Volume 8C [TERMPOL Studies], BC MCA 2010, Jamieson and Levesque 2012a,b), yet there are no instances of stranding of Pacific herring or egg loss due to vessel wake documented in the literature. The impact balance of injury or mortality to Pacific herring due to vessel wake is considered to be negative due to the potential for egg loss from intertidal substrate. However, based on available information, wake waves generated by Project-associated tankers and tugs are not expected to result in a detectable change in spawn mortality rate and consequently are considered to be of negligible magnitude (Table 4.3.6.3, point 2[a]). A summary of the rationale for all of the significance criteria is provided below.

- **Spatial Boundary** - Marine LSA – residual effects to Pacific herring will be limited to intertidal habitats within the Marine LSA due to the low magnitude of the predicted wake wave heights outside of the Marine LSA.

- **Duration** - long-term – vessel transits along the shipping lanes will be initiated during the operations phase and will extend for the life of the Project.
- **Frequency** - periodic – the event causing vessel wake is the transit of Project-related tankers and tugs, which will occur, on average, two times per day (one inbound and one outbound) for the operational life of the Project.
- **Reversibility** - medium-term – in the unlikely event that Pacific herring are injured or killed as a result of vessel wake, this effect will be reversible within one generation of Pacific herring, which is approximately 4 years.
- **Magnitude** - negligible – residual effects of vessel wake on Pacific herring will not be detectable from existing conditions.
- **Probability** - low – residual effects of vessel wake on Pacific herring are unlikely.
- **Confidence** - high – based on a good understanding by the assessment team of the cause-effect relationships between vessel wake and the intertidal spawning areas of Pacific herring.

#### 4.3.6.6.3 Marine Fish and Fish Habitat Indicator - Pacific Salmon

The following subsection provides the evaluation of significance of the potential residual effect on the Pacific salmon indicator.

**Injury or Mortality to Pacific Salmon Due to Vessel Wake**

In the Strait of Georgia and Juan de Fuca Strait, adult Pacific salmon migrate along coastal routes to their natal rivers to spawn and juvenile salmon often remain in shallow inshore waters for several months before moving offshore (DFO 2001, Hart 1973). Within the Marine RSA, salmon migration routes include Boundary Pass, Haro Strait, Saanich Inlet, and nearshore areas around the Gulf Islands and Victoria (DFO 2004) (see Figure 4.2.21).

Wake waves generated by vessels have the potential to strand juvenile Pacific salmon foraging or migrating along shoreline habitats, resulting in injury or mortality. Consequently, this residual effect is considered to have a negative impact balance. In general, fish strandings are more likely to occur in sheltered environments with low relief beaches, where wave run-up is more pronounced. Along steeper, rockier shorelines, waves typically break over shorter distances and are unlikely to result in fish stranding. The natural exposure of the shoreline habitat is also an important factor in determining the likelihood of strandings. Juvenile salmon migrating or foraging along shorelines routinely exposed to wind-driven waves are more likely to be acclimated to the physical forces imparted by breaking waves and are less likely to be inadvertently stranded.

Studies that have investigated that juvenile salmon strandings have focused on the lower reaches of large river systems, suggesting that this effect is a greater concern in the sheltered environments of rivers than it is in the marine environment. Several studies have documented strandings in the lower Columbia River by vessel wake from large, deep-draft vessels (Hinton and Emmett 1994, Pearson *et al*. 2006, Pearson and Skalski 2011). In these studies, 0+ year Chinook salmon were found to be most often affected (51 to 91 per cent of all fish stranded). Coho and chum salmon represented a low percentage of fish strandings. Pearson and Skalski

(2011) found that strandings were the result of an interaction between various factors including river location, salmon density in the shallows, ship characteristics, river elevation and beach characteristics. Given the complexity of factors controlling the incidence of fish strandings, the results of these studies are applicable only to the habitats in which the research was conducted (*i.e.*, low relief beaches in a riverine environment) and cannot be applied to the marine environment.

As discussed previously, shoreline areas within the Marine LSA may be subject to increased wave action due to wake waves from Project-related marine vessel traffic. However, the height of these waves is predicted to be well within the range of natural wave conditions, suggesting that juvenile salmon occupying nearshore habitats throughout the Marine LSA are acclimated to this level of wave exposure. In addition, shoreline habitats within the Marine LSA are dominated by anthropogenic structures and mixed substrates (*e.g.*, rock and sediment), with only 3.8 per cent comprised of fine-grained sediments (BC MFLNRO 2005) (Figure 4.2.19a-d). In these rockier habitats, wave run-up from wake waves on the order of 0.1 m is expected to be minimal and fish strandings are considered unlikely.

The Marine RSA encompasses some of the busiest shipping lanes in BC as well as Pacific salmon migration routes and DFO Important Areas for Pacific salmon (see Volume 8C [TERMPOL Studies], BC MCA 2010, Jamieson and Levesque 2012a,b), yet there are no instances of stranding of Pacific salmon due to vessel wake along marine shorelines documented in the literature. While fish strandings from vessel wake may be a concern in river environments, there is no evidence to suggest that this is a concern in the marine environment. Therefore, there is a low probability of injury or mortality to Pacific salmon due to vessel wake (Table 4.3.6.3, point 3[a]). A summary of the rationale for all of the significance criteria is provided below.

- **Spatial Boundary** - Marine LSA – residual effects on Pacific salmon will be limited to intertidal habitats within the Marine LSA due to the low magnitude of the predicted wake wave heights outside of the Marine LSA.
- **Duration** - long-term – vessel transits along the shipping lanes will be initiated during the operations phase and will extend for the life of the Project.
- **Frequency** - periodic – the event causing vessel wake is the transit of Project-related tankers and tugs, which will occur, on average, two times per day (one inbound and one outbound) for the operational life of the Project.
- **Reversibility** - medium-term – in the unlikely event that Pacific salmon are injured or killed as a result of vessel wake, this effect will be reversible within one generation of the species affected, which ranges from 2 years for pink salmon to 5 or 6 years for Chinook salmon.
- **Magnitude** - negligible – residual effects of vessel wake on Pacific salmon will not be detectable from existing conditions.
- **Probability** - low – residual effects of vessel wake on Pacific salmon are unlikely.
- **Confidence** - high – based on a good understanding by the assessment team of the cause-effect relationships between vessel wake and nearshore habitat use by juvenile Pacific salmon.

##### 4.3.6.6.4 Combined Effects of Increased Project-Related Marine Vessel Traffic on Marine Fish and Fish Habitat

The evaluation of the combined effects of increased Project-related marine vessel traffic on the marine fish and fish habitat indicators considers collectively the assessment of the likely potential residual effects on the following indicators: intertidal habitat; Pacific herring and Pacific salmon. Given that the residual effects on both the Pacific herring and Pacific salmon indicators are unlikely to occur, the potential residual effects associated with the intertidal habitat are considered to represent the combined effects of increased Project-related marine vessel traffic on marine fish and fish habitat (Table 4.3.6.3, point 4[a]). Readers should refer to the intertidal habitat indicator above for the evaluation of significance.

#### *4.3.6.7 Potential United States Effects*

Vessel wake is not expected to be detectable from existing wave conditions along most of shoreline in the Marine RSA due to the average channel width of 22–28 km in the Strait of Georgia and Juan de Fuca Strait (Thompson 1981) and the relatively rapid rate at which wake waves decrease in height away from the transiting tankers and escort tugs (Tables 4.3.6.4 and 4.3.6.5).

Only 10 km of US shoreline along the San Juan Islands is located within 2,000 m of the shipping lanes. These areas may be subject to increased wave action due to wake waves from Project-related marine vessel traffic; however, wake wave heights at the shoreline are predicted to be less than 0.1 m. Based on a review of natural wave conditions and long-term buoy data in the Marine RSA (DFO 2013a, Thompson 1981), the wake waves would be well within the range of natural wave conditions.

No differences in intertidal habitats, Pacific herring or Pacific salmon populations, or natural wave conditions in the US and Canadian portions of the Marine RSA were identified that would change the nature of the effects assessment. Therefore, the effects are expected to be similar in Canadian and US waters.

#### *4.3.6.8 Summary*

As identified in Table 4.3.6.3, 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 marine fish and fish habitat indicators. Consequently, it is concluded that the residual environmental effects of operation activities associated with increased Project-related marine vessel traffic on marine fish and fish habitat will be not significant.

### *4.3.7 Marine Mammals*

Marine mammals are a key component of the marine environment, and play important roles in marine food webs, both as top predators and as prey. In addition to their high ecological value, marine mammals have high cultural and socio-economic importance to Aboriginal communities, British Columbians, Canadians, and visitors from abroad. The waters along the Project shipping lanes provide important habitat for a large number of marine mammal species, and are often a key destination for whale-watching and marine tourism activities on the coast of BC.

This subsection of the ESA considers the potential effects of the increase in Project-related marine vessel traffic on marine mammals. The increase in Project-related marine vessel traffic, and associated underwater noise from tankers and tugs, may cause sensory disturbance for marine mammals. Potential disturbance responses include temporary displacement, startle responses, increased energy expenditure, reduced foraging efficiency, communication masking, change in activity state, and/or increased stress. The potential for permanent or temporary auditory injury is also evaluated. Potential effects associated with marine mammal-vessel strikes are assessed under Accidents and Malfunctions (see Section 4.3.13). Potential Project-related effects on marine fish and fish habitat (*i.e.,* potential prey) were assessed in Section 4.3.6 above and were determined to be unlikely and of negligible magnitude. Potential Project-related effects on freshwater fish and fish habitat (*i.e.,* potential prey) were assessed in Section 7.2.7 of Volume 5A and were determined to be of low to medium magnitude. Potential for effects associated with contaminants is addressed in Sections 4.3.2 Marine Sediment and Water Quality, Section 4.3.13 (bilge water release), and Section 5.0(oil spills).

The assessment of potential effects to marine mammals from Project-related marine vessel traffic has been developed to support the following regulatory, policy and cultural objectives:

- compliance with the *Fisheries Act, 1985* and Marine Mammal Regulations with respect to disturbing a marine mammal in Canadian waters;
- protection for species at risk, consistent with the objectives of the federal *SARA*, and in compliance with prohibitions against killing, harming, harassing, capturing or taking an individual of a wildlife species that is listed as endangered or threatened;
- compliance with the NEB Filing Manual (2013c), the *CEA Act, 2012*, and provincial and local policies;
- management of marine mammal species within the context of any relevant recovery strategies or management plans, and in consideration of key threats identified in such plans;
- special attention to species of importance to the culture of Aboriginal communities whose traditional territories overlap the shipping lanes; and
- consideration of the *Endangered Species Act, 1973* and *Marine Mammal Protection Act, 1972* with respect to disturbing a marine mammal in US waters.

#### *4.3.7.1 Assessment Indicators and Measurement Endpoints*

Development of this assessment has considered potential Project-related effects with respect to all marine mammal species within the Marine RSA. However, it is impractical and unnecessary to conduct a detailed assessment for every species that may be present in the Marine RSA. Best practice for the assessment of potential effects on a wide range of species that share much in common with respect to Project-related risks is to select a representative group of indicator species upon which to focus the assessment. Therefore, three marine mammal indicator species have been selected for more detailed assessment to represent the full range of potential effects to a broad range of marine mammal species. The process for selecting indicators for marine mammals began with a review of marine mammal species known to be present year-round or seasonally within the Marine RSA (see Section 4.3.7.2).

The indicator species were selected to fit all or most of the following criteria:

- they have life requisites shared by a broad group of other marine mammal species;

- they are likely to regularly or seasonally use habitats within the Marine RSA;
- they are a species of conservation concern, are considered restricted in range, or are associated with critical habitat or a sensitive ecological community in the Marine RSA;
- they are sensitive to effects associated with increased Project-related marine vessel traffic or have been documented as a species susceptible to anthropogenic disturbances;
- measurement endpoints and the mechanism by which they are affected by potential Project-related impacts are comparable across the group of species they have been selected to represent;
- there is an established baseline of information on their biology, population abundance, and distribution;
- they are a species whose disappearance could alter or disrupt the function of the ecosystem;
- they have been identified as important to 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/or regulatory studies within the Marine RSA.

The final selection of indicators took into consideration: experience gained during previous projects with similar ecological conditions and potential issues; feedback from government agencies and stakeholders; and professional judgment of the assessment team.

Ultimately, the three indicator species selected to represent potential effects from the increase in Project-related marine vessel traffic are: southern resident killer whale (*Orcinus orca*); humpback whale (*Megaptera novaeangliae*); and Steller sea lion (*Eumetopias jubatus* ssp. *monteriensis*). These species are broadly representative of the three diverse taxonomic groups of marine mammals (*i.e.,* toothed whales, baleen whales, and pinnipeds) that are found in the Marine RSA and each indicator meets most or all of the criteria described above. All of the indicator species are highly mobile and are, at times, widely distributed throughout the Marine RSA.

An overview of the marine components of the Marine Transportation ESA was presented at the North Vancouver Marine ESA Workshop on May 22, 2013. The presentation included identification of key issues and effects, proposed indicators, and spatial boundaries for all marine elements. During this workshop, feedback was received from marine mammal researchers from the Vancouver Aquarium concerning the need to explicitly consider fin whales with respect to potential vessel strikes. This recommendation was considered as part of the indicator selection process.

Fin whales are seasonally present within the Marine RSA in small numbers. Although a recognized species of conservation concern, fin whales are considered sufficiently represented within the assessment of potential routine effects through the humpback whale indicator, due to their similar physiology (*i.e.,* baleen whales), functional hearing group (*i.e.,* low-frequency specialists), and the humpback whale's more abundant local population (*i.e.,* greater likelihood for interaction). While fin whales are recognized as being at potentially higher risk of vessel strikes (relative to humpback whales), vessel strikes are assessed under Accidents and Malfunctions (see Section 4.3.13) and appropriate consideration of baleen whales in general (including both fin and humpback whales) is provided in that subsection.

A similar concern was raised by a member of the North Vancouver Marine ESA Workshop audience over the lack of inclusion of the harbour porpoise as a separate indicator. In the initial selection of a marine mammal indicator representative of odontocetes (*i.e.,* toothed whales), both the harbour porpoise and the southern resident killer whale were considered. The southern resident killer whale was ultimately selected because its designated critical habitat overlaps almost entirely with the Marine RSA and because it is considered to be of greater conservation concern (*i.e.,* it is listed as Endangered under *SARA*). In contrast, the harbour porpoise is listed as Special Concern. However, the harbour porpoise was included as an additional indicator in the acoustic modelling study and, therefore, results can be assessed for comparability with killer whales.

A meeting was also held with DFO in Kamloops on September 25, 2013 to present a high-level overview of the Marine ESA approach, including spatial boundaries, key issues and effects, and indicators. DFO did not raise any concerns with the information provided and did not provide any specific feedback regarding marine mammals.

A summary of the rationale for the selection of each of these indicators, based on the criteria listed above, is provided in Table 4.3.7.1.

For the assessment of effects on marine mammals associated with increased Project-related marine traffic, the measurement endpoints include both quantitative and qualitative metrics as follows:

- the potential for injury and/or sensory disturbance, evaluated qualitatively based on predicted potential increases in underwater sound pressure levels (SPLs; in dB re: 1μPa) and sound exposure levels (SELs; dB re: 1 μPa2-s); and
- the spatial extent of marine mammal habitat affected (*i.e.*, instantaneous distance from sound source in km) and relative importance and quality of that habitat.

The qualitative potential for effects of increased underwater noise was assessed based on a comparison between results of predicted modeling of underwater SPLs and commonly-applied injury and disturbance thresholds for marine mammals. The spatial extent of potentially affected habitat was also calculated based on the acoustic modeling exercise and noise criteria, and importance of this habitat was assessed qualitatively relative to importance and availability of suitable habitat in the rest of BC. The degree of change in these endpoints was used to characterize and determine the significance of the residual environmental effects of the increased Project-related marine vessel traffic on marine mammals within the context of existing conditions.

Table 4.3.7.1 provides a summary of the measurement endpoints considered for each indicator.

## TABLE 4.3.7.1

## ASSESSMENT INDICATORS AND MEASUREMENT ENDPOINTS FOR MARINE MAMMALS

| Marine Mammals Indicator | Measurement Endpoints | Rationale for Indicator Selection |
|---|---|---|
| Southern resident killer whale (*Orcinus orca*) | • Qualitative potential for (1) injury, and (2) sensory disturbance, based on predicted underwater sound pressure levels (in dB re: 1μPa) and sound exposure levels (in dB re: 1 μ$Pa^2$-s), due to the increase in Project-related marine traffic.<br>• Spatial extent of marine mammal habitat affected (*i.e.*, instantaneous distance from sound source in km) and relative importance and quality of that habitat. | • Representative odontocete (*i.e.,* toothed whale; other species in the Marine RSA include harbour porpoise, Dall's porpoise, and Pacific white-sided dolphin)<br>• Known presence and abundance in the Marine RSA, particularly during summer and fall<br>• *SARA*-listed species: Endangered<br>• Critical habitat overlaps the shipping lanes<br>• Potential sensitivity to underwater noise, as noted in DFO Recovery Strategy<br>• Best hearing sensitivity to mid to high-frequency noise (*i.e.,* represents a separate functional hearing group from the other two indicators)<br>• Well-studied species with an established baseline of population information<br>• Valued for socio-economic and cultural importance |
| Humpback whale (*Megaptera novaeangliae*) | | • Representative mysticete (*i.e.,* baleen whale; other species in the Marine RSA include fin whale, grey whale, and minke whale)<br>• Known presence in portions of the Marine RSA, particularly during summer and fall<br>• *SARA*-listed species: Threatened<br>• Critical habitat partially overlaps the shipping lanes<br>• Potential sensitivity to underwater noise, as noted in DFO Recovery Strategy<br>• Best hearing sensitivity to low-frequency noise (*i.e.,* represents a separate functional hearing group from the other two indicators)<br>• Well-studied species with an established baseline of population information<br>• Known to have high site fidelity to feeding areas<br>• Valued for socio-economic and cultural importance |
| Steller sea lion (*Eumetopias jubatus* ssp. *monteriensis*) | | • Representative pinniped (*i.e.,* seal or sea lion; other species in the Marine RSA include harbour seal and California sea lion)<br>• Known presence in the Marine RSA year-round, peak numbers during fall and winter<br>• *SARA*-listed species: Special Concern<br>• Major year-round and seasonal haulout sites identified near the shipping lanes<br>• Uses both marine and terrestrial habitat within the Marine RSA<br>• Potential sensitivity to Project-related effects noted in DFO Management Plan<br>• While less sensitive to underwater noise than other two indicators, represents a separate functional hearing group<br>• Well-studied species with an established baseline of population information<br>• Valued for socio-economic and cultural importance |

### *4.3.7.2 Spatial Boundaries*

Spatial boundaries used for the assessment of potential effects of increased Project-related marine traffic on marine mammals are defined as follows:

- **LSA** - There is no separately defined LSA for marine mammals; residual effects are all assessed within the Marine RSA (below).
- **Marine RSA** - comprised of a large portion of the Salish Sea, including the inland marine waters of the southern Strait of Georgia and Juan de Fuca Strait and their connecting channels, passes and straits. The Marine RSA is generally centred on the marine shipping lanes, which extend from the Westridge Marine Terminal through Burrard Inlet, south through the southern part of the Strait of Georgia, the Gulf Islands and Haro Strait, westward past Victoria and through Juan de Fuca Strait out to the 12 nautical mile limit of Canada's territorial sea. The western boundary of the Marine RSA extends further out to sea than the western boundary of the Salish Sea and the northern boundary of the Marine RSA is limited to the southern portion of the Strait of Georgia. Puget Sound is excluded from the Marine RSA.

Many species of marine mammals are migratory, with ranges that may cover tens of thousands of kilometres and encompass large sections of the North Pacific Ocean. The spatial boundaries of the Marine RSA were not selected to cover the entire range of all marine mammal species found there. However, the boundaries reasonably reflect the potential extent of residual effects associated with increased Project-related marine traffic within Canada's territorial sea waters. The Marine RSA encompasses diverse populations of resident and seasonally-present marine mammals, seasonally important foraging areas, breeding habitat, terrestrial haulout sites for pinnipeds, and critical habitat under *SARA* for both southern resident killer whales and humpback whales.

Study area boundaries for marine mammals are shown in Figure 4.2.2.

### *4.3.7.3 Marine Mammals Context*

#### 4.3.7.3.1 Shipping

The assessment of potential effects of the increase in Project-related marine vessel traffic is centered on the established in-bound and out-bound marine shipping lanes and considered in the context of the volume and activity of existing traffic in the Marine RSA. The shipping lanes are officially determined and set by Transport Canada. In the Marine RSA, they provide designated routes through the Salish Sea, commencing at Burrard Inlet and extending through several major waterways, including the southern part of the Strait of Georgia, Haro Strait and Juan de Fuca Strait, out to the 12 nautical mile limit of Canada's territorial sea. The lanes are confined within narrow waterways for only a small portion of the route out to sea, primarily within Burrard Inlet east of First Narrows, and within Boundary Pass and Haro Strait where the vessels pass a complex of small islets and channels. The shipping lanes are generally centred in the middle of the channels and only 5 per cent of the total length of shoreline in the Canadian portion of the Marine RSA is located within 2,000 m of the shipping lanes.

These marine shipping lanes, among the busiest in the province, are an established route for all types of commercial vessels and are the mandatory routing for cargo ships, cruise ships, and tankers that transit these waters on a daily basis (see Volume 8C, BC MCA 2010, CCG 2013b).

In 2012, cargo and bulk carrier traffic made up approximately 32 per cent of the number of reportable vessel movements in the Marine RSA, with tug and passenger traffic making up a further 28 per cent and 14 per cent, respectively ('vessel movements' based on counts of vessels within 5 cross sections; see Table 5-1 of TERMPOL 3.2, Volume 8C, TR8C-2). All tanker traffic in 2012 (including vessels not associated with the existing Westridge Marine Terminal operations) accounted for 4 per cent of overall vessel movements in the Marine RSA.

While current loadings at the Westridge Marine Terminal fluctuate based on market conditions, five tankers and three barges are typically handled each month. These are accounted for in the above estimates. The expansion of the terminal is expected to result in an increase in Project-related traffic of approximately 29 partially-loaded Aframax tanker calls per month. To account for potential fluctuations and to allow the assessment to be conservative, the marine mammals modelling was conducted for approximately 30 partially-loaded Aframax tanker calls (*i.e.,* 60 transits) per month. There will also be an increase in tug traffic associated with these vessel movements (*e.g.*, 240 movements per month in Burrard Inlet and 120 movements per month in Haro Strait). Based on current conditions (*i.e.,* not accounting for growth, future developments, or Project-related increases in tug traffic), the increase in Project-related tankers will make up approximately 58 per cent of all tanker movements in the Marine RSA, and will increase the relative number of tanker movements to approximately 9 per cent of total vessel movements in and out of the shipping lanes. Overall, the additional Project-related vessels (tugs and tankers) will make up approximately 11.9 per cent of reportable vessel movements in and out of the shipping lanes, and account for an increase of 13.5 per cent over current vessel movements (extrapolated from TERMPOL 3.2, Volume 8C-2). The above estimates for vessel traffic do not account for projected increases in traffic or future developments, nor do they include smaller commercial vessels such as fishing charters and whale-watching fleets, as well as the many recreational vessels that transit the same waters as the shipping lanes and wind through the numerous inlets and waterways of the Gulf and San Juan islands.

Project-specific underwater noise resulting from the increase in tanker and tug numbers is most meaningful when considered relative to existing underwater sound levels. Existing underwater noise in the vicinity of the marine shipping lanes is a combination of natural and man-made sound. The introduction of underwater noise occurs as an individual event for each vessel that passes by a specific location. All vessel activity in the Marine RSA is a source of underwater noise, and the existing Trans Mountain-related shipping forms part of the existing acoustic environment. Relative to current Trans Mountain-related shipping, no changes to the types of noise generated or the intensity of the individual tankers or tanker/tug combinations is expected. The change in underwater sound levels that are expected to occur due to increased Project-related traffic is the result of the increased number of pass-by vessel occurrences, which are expected to be on average one laden tanker (plus associated escort tugs) and one empty tanker daily. This increase in events could increase day and night average ambient underwater sound levels in the Marine RSA.

#### 4.3.7.3.2 Marine Mammal Presence

A total of 33 species (or ecotypes) of marine mammals can be found in BC, and 22 of these have been recorded in the Marine RSA on at least one occasion (see Section 4.2.7.4). While many of these species are observed year-round, some are seasonal or migratory, while others are considered only rare or accidental sightings. Marine mammals use many habitats within the Marine RSA, from terrestrial use of rocky islets, sandbars, docks and piers to all marine waterways from the deeper waters of the shipping lanes to the shallower backwater shorelines and inlets. Large aggregations of a particular species may gather in certain areas, often attracted by ocean conditions that are favourable for concentrating prey. At other times, individuals may be distributed broadly, so that specific occurrence and distribution within the Marine RSA is in a state of constant flux.

The most commonly observed species of toothed whales in the Marine RSA include killer whales, harbour porpoises (*Phocoena phocoena*), Dall's porpoises (*Phocoenoides dalli*), and large aggregations of Pacific white-sided dolphins (*Lagenorhynchus obliquidens*). DFO Important Areas for harbour porpoises in the Marine RSA are shown in Figure 4.2.22. Critical habitat for southern resident killer whales has been officially designated for the trans-boundary waters of Haro Strait, Boundary Pass, Juan de Fuca Strait and the southern portion of the Strait of Georgia, as well as Puget Sound (DFO 2009b) (see Figure 4.2.22).

The most commonly observed baleen whale is the humpback whale, although the minke whale (*Balaenoptera acutorostrata*) and grey whale (*Eschrichtius robustus*), as well as the occasional fin whale (*Balaenoptera physalus*) are also observed. The western-most portion of the Marine RSA overlaps humpback whale critical habitat (DFO 2013h) (see Figure 4.2.22). This area, which extends offshore beyond the Marine RSA and Canada's 12 nautical mile limit, has been identified as an area of importance for a potentially distinct sub-population of humpback whales that occupies southern BC and northern Washington State waters (DFO 2013h).

The most common pinniped is the harbour seal (*Phoca vitulina richardsi*), followed by the Steller and California (*Zalophus californianus*) sea lions. Northern fur seal (*Callorhinus ursinus*), and northern elephant seal (*Mirounga angustirostris*) may be seen in small numbers in the western extent of the Marine RSA. Male sea otters (*Enhydra lutris*), mostly from the Washington State population, are also observed in small numbers in the western part of Juan de Fuca Strait and Gulf Islands, though do not appear to have established permanently in the Marine RSA at this time.

Up until the late nineteenth century, large baleen whales, including the humpback whale, were a common sight in the Strait of Georgia. Even fin whales, generally more common to offshore and exposed coastal waters, were historically seen on occasion in these more protected waters (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 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). While they have not returned to historic levels, sightings of humpback whales in the Marine RSA have increased in recent years, particularly in the westward portion, which has recently been designated as critical habitat (DFO 2013h).

Historically, marine mammals such as harbour seals were a major source of food for the Aboriginal people of Burrard Inlet (BIEAP 1995). DFO Important Areas for harbour seals in the Marine RSA are shown in Figure 4.2.22. Currently, marine mammals are a major viewing attraction for tourists and local residents, and whale watching companies from Victoria, Vancouver and some Gulf Islands run multiple trips daily during the peak whale watching season of late spring, summer and early fall.

#### 4.3.7.3.3 Existing Marine Mammal Stressors

Marine mammals in the Marine RSA and in many similarly urbanized marine waterways in North America and throughout the world's oceans face a variety of anthropogenic threats and stressors. These vary in intensity and relative importance for individual species, but broadly speaking, include: chemical contamination from both legacy contaminants and current inputs; reductions in prey abundance or quality; physical disturbance; acoustic disturbance or injury from both acute and chronic sources; risk of collisions; risk of entanglements; and, climate change. Many of these threats are identified in DFO's Recovery Strategies and Management Plans for *SARA*-listed marine mammal species (*e.g.,* DFO 2010a, 2011, 2013a).

These effects may act cumulatively and in an additive fashion. For example, some disturbances reduce time available for or efficiency of foraging (*e.g.,* Williams *et al.* 2006) and may be of greater consequence for populations that are already prey-limited.

### *4.3.7.4 Potential Effects and Mitigation Measures*

#### 4.3.7.4.1 Effects Considerations

A thorough review of possible issues to include in the assessment of potential Project effects on marine mammals was based on the professional experience of the assessment team and relevant literature. Identified potential effects included auditory injury or sensory disturbance from both underwater and atmospheric noise. Effects of atmospheric noise were eventually scoped out by the assessment team based on past experience with similar projects and a determination of low likelihood of effects of importance for marine mammals. The rationale for this decision is discussed briefly below.

**Potential Effects on Prey**

Potential Project-related effects of increased Project-related marine vessel traffic on marine fish and fish habitat (*i.e.,* potential prey) were assessed in Section 4.3.6 above. This assessment determined that residual effects of the Project on both the Pacific herring and Pacific salmon indicators are unlikely and of negligible magnitude. Potential Project-related effects on freshwater fish and fish habitat (*i.e.,* potential prey) were assessed in Section 7.2.7 of Volume 5A and were determined to be of low to medium magnitude. As such, indirect effects to marine mammals associated with potential Project-related loss of prey (as the result of direct effects to fish and fish habitat) were not considered further. The potential for reduced marine mammal foraging efficiency as a result of underwater noise is addressed under the assessment of residual effects of sensory disturbance, presented below.

**Potential Effects of Increased Contaminants**

Potential residual effects of Project-related marine vessel traffic on marine water and sediment quality are discussed in Section 4.3.2 above and are not addressed further in this subsection.

Potential effects associated with any accidental release from vessels are addressed in Sections 4.3.13 (for bilge water containing fuels, oils and/or lubricants) and 5.0 (for oil spills).

**Potential Effects of Atmospheric Noise**

Pinnipeds on land may be sensitive to human disturbance. Behavioural responses by Steller sea lions onshore have been documented for both natural and anthropogenic disturbances, though the degree and type of response may vary (*e.g.,* agitating head, vocalizing, fleeing into the water) and depend on location (Kucey 2005, Kucey and Trites 2006). Repeated disturbance of rookeries or haulouts by construction, aircraft, boats or fishing activities may result in temporary or even permanent abandonment of these areas (Kucey 2005, Lewis 1987). Displacement from rookeries during the pupping season is of primary concern as this may result in pup mortality (*i.e.,* from being trampled, drowned, or separated from their mothers) or increased energetic costs to both mothers and pups should feeding or nursing opportunities be interrupted (DFO 2010a). Since there are no rookeries within or in close proximity to the Marine RSA, these effects are not considered further.

Displacement into the water from haulouts may slightly increase energetic costs or the risk of predation from transient killer whales; however, the DFO Management Plan for the Steller Sea Lion (2010a) states that Steller sea lions "often habituate to chronic disturbances" and notes that there are currently haulout sites in "high traffic areas close to major urban centres such as Vancouver and Victoria". The closest approach of the marine shipping lanes to a Steller sea lion haulout is 1 km, at Trial Islands. However, current shipping activity passes at this distance and Steller sea lions continue to use this haulout location. This is not predicted to change as a result of the increase in Project-related atmospheric vessel noise. As such, the potential effect of atmospheric noise on marine mammals is not discussed further. The increase in atmospheric sound levels in the Marine RSA was assessed for human receptors in Section 4.3.5 above.

#### 4.3.7.4.2 Identified Potential Effects

The identified potential effects on marine mammals associated with the increase in Project-related marine vessel traffic include auditory injury and sensory disturbance.

Loud underwater noise has the potential to result in temporary or permanent auditory injury (*i.e.,* temporary or permanent threshold shifts [TTS or PTS]) to marine mammals in close proximity to the sound source (Richardson *et al.* 1995). To determine potential effects of Project-related vessel-based underwater noise on marine mammals, sound source levels from tankers and tugs (based on literature values and acoustic modelling) were contrasted with threshold sound levels that have been predicted to cause temporary and permanent auditory injury in marine mammals.

The production of loud underwater noise could also cause sensory disturbance to marine mammals (sometimes referred to in the literature as behavioural disruption or disturbance). Sensory disturbance 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 (*i.e.,* the animal's activity state at the time); and the species in question. Results of the acoustic modelling were contrasted with threshold sound levels that have been predicted to induce behavioural disturbance. Below these thresholds, marine mammals may still be able to detect Project-related noise, and this may interfere with their communication or ability to perceive other important acoustic signals in their environment (*i.e.,* masking). While no thresholds exist for quantifying the potential for such effects, or their importance at the population level, the spatial extent over which Project-related sounds will be detectable by marine mammals is discussed.

#### 4.3.7.4.3 Injury Criteria and Disturbance Thresholds

Noise-induced PTS, TTS, 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 2013g).

Different thresholds are typically used for impulsive noise (single or multiple pulses; *e.g.,* explosions or pile driving) versus non-pulse sound sources (*e.g.,* shipping). Since increased Project-related marine vessel traffic will introduce only non-pulse sounds to the marine environment, thresholds which relate only to pulse-type noise are not provided or discussed further in this assessment. Further details on effects and thresholds related to pulse-type noise are presented in Section 7.6.11 of Volume 5A.

In the absence of Canadian legislation or guidelines for non-pulse sound sources, the ESA considered two alternative sets of commonly-applied thresholds.

The first set of thresholds, developed by Southall *et al.* (2007; hereafter referred to as the Southall *et al.* thresholds), is used primarily to evaluate the potential for permanent injury (*i.e.,* PTS). Sound levels capable of inducing injury 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 PTS-inducing SELs, and are based on a comprehensive analysis of existing research. Southall *et al.*'s proposed injury criteria for SELs are summarized in Table 4.3.7.2. Different thresholds are proposed 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 NOAA in the US to issue *Marine Mammal Protection Act* (*MMPA*) permits and conduct *Endangered Species Act* Section 7 consultations (NOAA Fisheries 2013). These are considered interim conservative thresholds to be used until formal guidance is available. The NOAA criteria are frequently used to evaluate sensory disturbance because Southall *et al*. did not recommend specific numeric criteria for the onset of sensory disturbance for non-pulse sound sources. The NOAA criteria also set thresholds for SPLs deemed capable of potentially causing PTS, but only for impulsive sounds. The NOAA criteria are summarized alongside Southall *et al.*'s in Table 4.3.7.2. Both metrics are considered in this assessment. While NOAA is currently revising its criteria, with specific reference to different sound sources (*e.g.,* explosives; Finneran and Jenkins 2012), criteria specific to shipping noise are not yet available.

**TABLE 4.3.7.2**

**MARINE MAMMAL INJURY CRITERIA AND SENSORY DISTURBANCE THRESHOLDS USED IN THE ESA**

| Species Group | Southall *et al.* Injury Criteria (PTS-onset)[1,2] | Southall *et al.* TTS-onset Thresholds | NOAA 'Behavioural Disruption' Thresholds[3] |
|---|---|---|---|
| | SEL[4] (dB re: 1 μPa$^2$-s)[5] | SEL[4] (dB re: 1 μPa$^2$-s)[5] | RMS SPL[6] (dB re: 1 μPa) |
| Pinnipeds | 203 | 183 | 120 |
| Cetaceans | 215 | 195 | 120 |

**Notes:**

1 Shipping is an example of a non-pulse noise. Thresholds for pulse noises such as impact pile driving are not presented above.

2 The term "auditory injury" as used by NOAA or Southall *et al.* is intended to refer strictly to permanent auditory damage (*i.e.*, PTS) and the column of injury criteria above thus reflects only the onset levels for PTS (not TTS). However, the terms 'permanent auditory injury' and 'temporary auditory injury' are used in this ESA 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).

3 The term "behavioural disruption" is used by NOAA, and the term "behavioural disturbance" is used by Southall *et al.* 2007. For the purposes of this ESA, both of these terms and associated thresholds are encapsulated under the effect of "sensory disturbance".

4 Values taken from Southall *et al.* 2007.

5 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 (all SPL values used in this ESA are RMS). SELs are a measure of received sound energy (the dB level of the time integral of the squared-instantaneous sound pressure normalized to a 1-s period ) and values presented in Table 4.3.7.2 were developed to reflect M-weighted SELs by functional hearing group (see Southall *et al.* 2007). Functional hearing groups and M-weighted SELs reflect the fact that different species hear best at different frequency ranges. Only unweighted SELs (*i.e.*, SELs that do not account for species-specific hearing ranges) are modelled and used in this assessment. Comparison of unweighted source levels and M-weighted thresholds is expected to give a conservative estimate of the Southall PTS and TTS onset distances, since unweighted levels are always higher than M-weighted values.

6 Values taken from NOAA Fisheries 2013.

7 RMS SPL = Root Mean Square Sound Pressure Level (SPLs values presented in this report are all RMS unless otherwise noted; units in dB re: 1 μPa); SEL = Sound Exposure Level (always referenced in this ESA in units of dB re: 1 μPa2-s); PTS = Permanent Threshold Shift; TTS = Temporary Threshold Shift.

### 4.3.7.4.4 Summary of Acoustic Modelling Results

### Sound Pressure Level (SPL) Modelling Scenarios and Results

Project-related marine vessel traffic will increase by approximately 30 Aframax tanker calls to the Westridge Marine Terminal per month (*i.e.,* an additional 720 tanker transits through the Marine RSA each year). This number is expected to be a maximum, and the actual number of tanker calls will fluctuate monthly. A potential concern associated with the proposed expansion is that increased levels of underwater noise from vessel traffic may negatively affect marine mammals such as the *SARA*-listed southern resident killer whale and humpback whale. As part of the ESA, JASCO Applied Sciences Ltd. (JASCO) performed an underwater acoustic modelling study to predict underwater sound levels generated by vessel traffic associated with the Project. Detailed results and discussion are presented in Appendix A of the Marine Resources - Marine Transportation Technical Report (Volume 8B, TR 8B-1). Summary tables of some of these results are provided below and are used in the following sections to assess potential acoustic effects of increased vessel traffic on marine mammals.

The JASCO study modelled the acoustic footprint (in RMS SPLs) produced during a single pass of an outbound tanker and accompanying tug at four representative locations along the shipping lanes in the Marine RSA.

- **Scenario 1** - Strait of Georgia – An Aframax tanker, plus one un-tethered accompanying tug at 500 m from the tanker's stern, both travelling at a normal transiting speed of 13 knots.
- **Scenario 2** - Haro Strait – An Aframax tanker, plus one accompanying tug tethered to the tanker's stern at 50 m, both travelling at a normal transiting speed of 10 knots.
- **Scenario 3** - Juan de Fuca Strait – An Aframax tanker, plus one un-tethered accompanying tug at 500 m from the tanker's stern, both travelling at a normal transiting speed of 15 knots.
- **Scenario 4** - North of Cape Flattery – A solo Aframax tanker transiting at a normal transiting speed of 15 knots

Locations of each modelling scenario are shown on Figure 4.3.1. The different speeds were chosen to reflect predicted maximum speeds in each area, which vary based on local restrictions and requirements for escort tug accompaniment (tethered or un-tethered). When the underwater noise modeling program was initiated, tugs were not expected to accompany outbound tankers to the west of Scenario 3. Since completion of acoustic modelling, Trans Mountain has proposed to add an additional un-tethered tug, to travel in the vicinity of outbound laden tankers between Race Rocks and the 12 nautical mile limit and be available to assist if the tanker encounters navigational problems. Expected speeds for the tanker and tug in this area will be in the range of 10 to 12 knots (while 15 knots was modelled to be conservative, as increased speed generally causes increased underwater noise). The additional tug will contribute additional underwater noise above what was modelled for Scenario 4; however, the reduced speeds from 15 knots to 10 or 12 knots for both tanker and tug are likely to partially offset the effects of the additional vessel. Changes to this scenario are, in the professional judgment of the assessment team, not expected to alter the conclusions presented in the ESA. Revised acoustic modelling will be undertaken and filed as supplemental information in Q1 2014 to confirm these predictions (see Section 4.5).

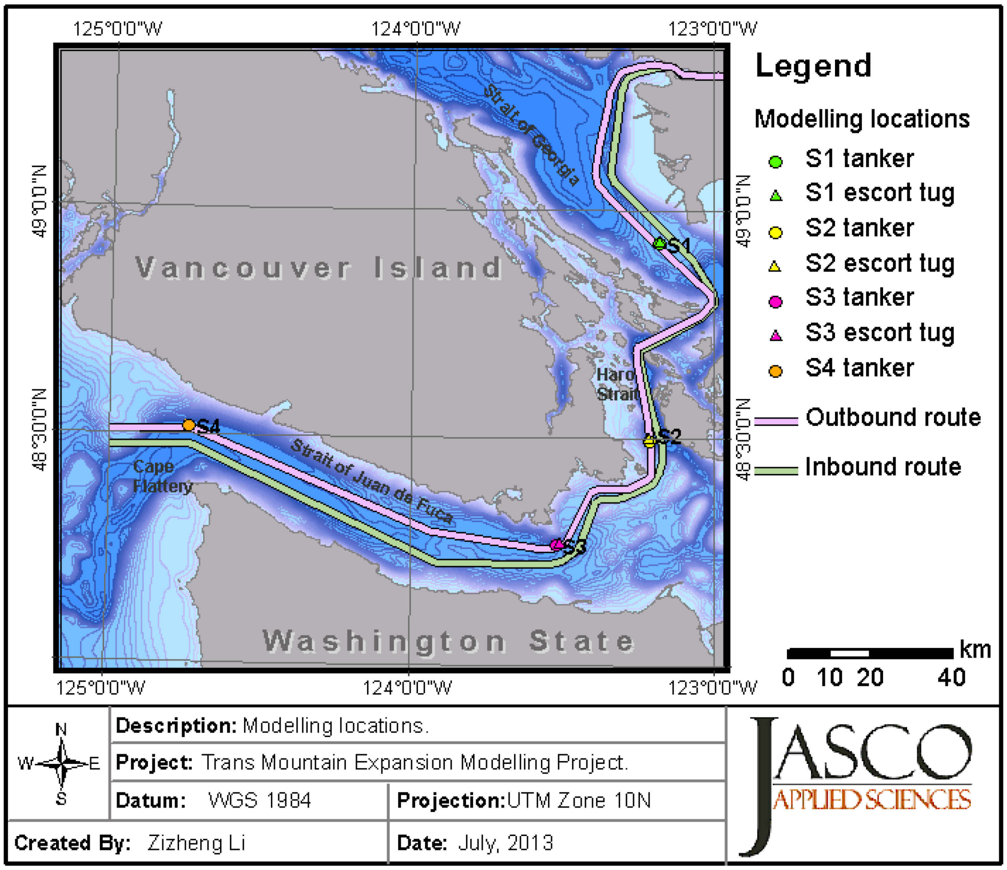



**Figure 4.3.1 Map of Marine Acoustic Modeling Study Area, Showing Inbound and Outbound Shipping Lanes and Four Modeled Source Locations**

The acoustic source levels used in the modeling study to represent tankers and tugs associated with the Project were derived from measurements of similar vessels obtained from the available literature. Table 4.3.7.3 shows the radii (in km) to the SPL contours for each of the four scenarios described above.

### TABLE 4.3.7.3

### RADII OF UNDERWATER SOUND PRESSURE LEVEL CONTOURS FOR SCENARIOS 1 TO 4

| RMS SPL[1] (dB re: 1 µPa)[2] | Scenario 1 (13 knots, un-tethered tug) | | Scenario 2 (10 knots, tethered tug) | | Scenario 3 (15 knots, un-tethered tug) | | Scenario 4 (15 knots, no tug) | |
|---|---|---|---|---|---|---|---|---|
| | $R_{max}$ (km)[3] | $R_{95\%}$ (km)[4] | $R_{max}$ (km) | $R_{95\%}$ (km) | $R_{max}$ (km) | $R_{95\%}$ (km) | $R_{max}$ (km) | $R_{95\%}$ (km) |
| **120** | 5.28 | 4.79 | 5.44 | 3.64 | 8.1 | 7.13 | 8.55 | 6.52 |
| **130** | 1.56 | 1.42 | 0.82 | 0.73 | 2.96 | 2.65 | 1.27 | 1.18 |
| **140** | 0.54 | 0.49 | 0.18 | 0.17 | 0.79 | 0.7 | 0.22 | 0.21 |

**Notes:**
1 SPL = Sound Pressure Level.
2 Results taken from Table 8 in Appendix A of the Marine Resources - Marine Transportation Technical Report (Volume 8B, TR 8B-1). Only radii for SPL values up to 140 dB re: 1 µPa (where calculated R95% distances drop to 500 m or less) are summarized here. Radii for SPLs up to 190 dB re: 1 µPa are presented in Table 8 as referenced above. At resolutions of less than a few hundred metres, the model assumes that all noise originates from the propeller of the loudest vessel (*i.e.*, the tug in all but Scenario 4).
3 Rmax is the maximum distance (in km) from the source to the given noise threshold in any direction (equivalent to R100%). For cases where the ensonification to a specific level is discontinuous and small pockets of higher received levels occur far beyond the main ensonified volume (*e.g.*, due to convergence of sound rays), Rmax would be much larger than R95% and, therefore, could be misleading if not given alongside R95%.
4 R95% is the radius of a circle that encompasses 95% of the grid points whose value is equal to or greater than the threshold value. For a given threshold level, this radius always provides a range beyond which no more than 5% of a uniformly distributed population would be exposed to sound at or above that level, regardless of the geometrical shape of the noise footprint. Distances to various SPL thresholds discussed in this assessment will always refer to the R95% values.

Table 4.3.7.4 presents predicted exposure times for a stationary marine mammal in close proximity to the shipping lane at each scenario location, during a single transit of Project-related marine vessels. This translates to potential daily exposure of an individual marine mammal to sensory disturbance from Project-related marine vessels for approximately 4 per cent of the day (based on the worst case scenario [*i.e.,* Scenario 3] and assuming a single exposure to both Project-related marine vessel transits in a 24-hour period). Actual exposure times would be less for animals swimming away from the vessel (either by chance or as part of a negative behavioural response), but could be more for animals swimming alongside or ahead of the vessel (either also by chance, as a result of attraction to the vessel, or as a negative behavioural response if it occurs within confined channels). Fast-moving and highly mobile species such as killer whales may also be exposed to the same vessel more than once over the course of a single transit through the Marine RSA.

**TABLE 4.3.7.4**

**LENGTH OF EXPOSURE TO SOUND LEVELS CAPABLE OF CAUSING SENSORY DISTURBANCE TO A STATIONARY MARINE MAMMAL FOR SCENARIOS 1 TO 4**

| | Scenario 1 (13 knots) | Scenario 2 (10 knots) | Scenario 3 (15 knots) | Scenario 4 (15 knots, no tug) |
|---|---|---|---|---|
| Length of Exposure (in minutes) of a Stationary Marine Mammal to SPLs[1] Exceeding Sensory Disturbance Thresholds (*i.e.,* > 120 dB re: 1 μPa)[2] | 24 | 24 | 31 | 28 |

**Notes:** 1 SPL = Sound Pressure Level.

2 Calculated based on values presented in Table 4.3.7.3, assuming a single transit of Project-related marine vessels, passing a stationary marine mammal in close proximity to the shipping lane, and exposed to SPLs > 120 dB re: 1 μPa both before and after the passing of the vessel (*i.e.*, two times the R95% distance).

## Audiograms

The potential for anthropogenic noise to affect a marine mammal depends not just on the sound level (in decibels) or type of sound (impulse or non-pulse), but also on how well the animal can hear the noise. Noises at frequencies that animals cannot hear well are less likely to disturb them. Audiograms are species-specific sensitivity curves that represent an animal's auditory detection threshold (*i.e.,* the point at which they are able to first hear a sound) as a function of frequency (Erbe 2002). Different species of marine mammals can be classed into different functional hearing groups based on their hearing sensitivity at different frequencies. Southall *et al.* (2007) identified four functional hearing groups for marine mammal exposure to underwater noise:

- low-frequency cetaceans (hearing frequencies of 7 Hz to 22 kHz; baleen whales, including humpback whales, grey whales, and fin whales);
- mid-frequency cetaceans (hearing frequencies of 150 Hz to 160 kHz; various odontocetes, including killer whales and Pacific white-sided dolphins);
- high-frequency cetaceans (hearing frequencies of 200 Hz to 180 kHz; various odontocetes, including harbour porpoise and Dall's porpoise); and
- pinnipeds in water (hearing frequencies of 75 Hz to 75 kHz; pinnipeds, including Steller sea lions and harbour seals).

The acoustic modelling study calculated audiogram-weighted levels (*i.e.,* noise levels above hearing threshold, expressed in units of dB re: hearing threshold (dB re: HT) for the three marine mammal indicators, each of which represents a separate functional hearing group. Audiogram-weighted levels were also calculated for harbour porpoises, and these were found to be appropriately represented by the killer whale indicator (as the representative odontocete and mid to high-frequency hearing specialist; acoustic modeling results specific to harbour porpoises are available in Appendix A of the Marine Resources - Marine Transportation Technical Report (Volume 8B, TR 8B-1). Therefore, the southern resident killer whale is considered to be an appropriate indicator for assessing effects of underwater noise on other toothed whales, including porpoises and dolphins.

Sound levels less than 0 dB re: HT are below the typical hearing threshold for a species and, therefore, are expected to be inaudible. Because of this, audiogram-weighted contour maps can be used to predict the extent to which a noise will be audible to a particular species.

**Ambient Noise**

In addition to an individual species' ability to hear sounds at different frequencies, the ambient background noise of the environment will also affect the zone within which a particular sound is detectable. Ambient noise is the composite noise from all sources in a given environment, from both natural and anthropogenic sources, and it varies with time and location (Bradley 1996). Natural sources of ambient noise include wind and waves, precipitation, biological sources, and tidal currents. Wind and waves are a main source of naturally occurring noise for frequencies from <1 Hz to at least 50 kHz. The interactions between precipitation and ocean surface can be an important component across frequencies from several hundred hertz to greater than 20 kHz. Marine mammals, and some fish and shrimp, are biological sources for ambient noise, covering a frequency band from <10 Hz to >200 kHz. Anthropogenic sources of ambient noise in BC include ship and boat traffic, aircraft, dredging and construction, sonars, explosions, and ocean acoustic studies. Commercial shipping noise is the major contributor to ambient noise for frequencies from 5–500 Hz, and this source of chronic low frequency noise has been increasing steadily alongside the shipping industry's growth in vessel number, size, and power (Andrew *et al.* 2002, NRC 2003a, Tyack 2008, Wenz 1962).

Current levels of ambient background noise in the Marine RSA limit the zone of detectability of noise originating specifically from Project-related marine vessels, although the background itself may be made up of audible noise from numerous other vessels. Ambient noise levels were estimated for the modelling study based on a review of available published ambient measurements for the area. Results of this review show that marine traffic is the dominant source of underwater noise in the Marine RSA, and primary noise sources identified include (in no particular order): bulk carriers, container ships, cruise ships, barges, tugs, tankers, coast guard vessels, ferries, fishing vessels, whale watching boats, recreational boats, sea planes, and wind and wave noise. The variability of ambient noise in the Marine RSA stems primarily from fluctuations in volume of vessel traffic. Other noise sources (*e.g.,* wind, waves, rain, distant shipping, etc.) are likely to dominate when it is relatively quiet. Table 4.3.7.5 presents the estimated range of average ambient noise in the Marine RSA weighted by different marine mammal species audiograms. Values differ between species as a result of the different frequency ranges within which each functional hearing group hears best (*i.e.,* results have been audiogram-weighted for each species). The upper limit reflects ambient noise as heard by the individual species under 'loud' baseline conditions (*e.g.,* during periods of dense vessel traffic). Lower limits reflect audiogram-weighted ambient noise under 'quiet' background conditions.

### TABLE 4.3.7.5

### ESTIMATED RANGE OF AVERAGE AMBIENT AUDIOGRAM-WEIGHTED NOISE IN THE MARINE RSA

| Ambient Noise | Audiogram-weighted ambient noise SPL (dB re: HT)[1,2,3] | | | |
|---|---|---|---|---|
| | Humpback Whale | Killer Whale | Harbour Porpoise | Steller Sea Lion |
| Upper Limit | 75 | 64 | 57 | 37 |
| Lower Limit | 52 | 45 | 38 | 14 |

**Notes:**

1 Table 9 in Appendix A of the Marine Resources - Marine Transportation Technical Report (Volume 8B, TR 8B-1).

2 HT = hearing threshold.

3 The range of ambient noise SPLs presented represents the predicted range of background conditions under both 'loud' (*i.e.*, lower limit) and 'quiet' (*i.e.*, upper limit) conditions in the Marine RSA, within the species-specific hearing range, and in the absence of Project-related marine vessels.

Table 4.3.7.6 shows the estimated distance that underwater noise from Project-related marine vessels is predicted to be detectable by various marine mammal species after accounting for both species-specific hearing abilities and predicted ambient underwater noise levels (*i.e.,* the distance at which Project-related noise becomes audible over background levels). Minimum distances reflect the extent to which Project-specific sounds will be distinguishable from the background under 'loud' baseline conditions. Maximum distances reflect the extent to which Project-specific sounds are distinguishable under 'quiet' background conditions. Beyond these distances, current levels of background noise in the Marine RSA are expected to mask the ability of marine mammals to detect Project-related marine vessels. Note that these distances are those at which incremental Project-specific underwater noise is predicted to be detectable and do not represent the distances at which sensory disturbance is expected to occur.

### TABLE 4.3.7.6

### ESTIMATED MINIMUM AND MAXIMUM ZONE OF DETECTABILITY ($R_{95\%}$) ABOVE AMBIENT NOISE, FOR SCENARIOS 1 TO 4

| Marine mammal species[1] | Scenario (13 knots) | | Scenario 2 (10 knots) | | Scenario 3 (15 knots) | | Scenario 4 (15 knots, no tug) | |
|---|---|---|---|---|---|---|---|---|
| | Min. km (loud background)[2] | Max. km (quiet background) | Min. km (loud background) | Max. km (quiet background) | Min. km (loud background) | Max. km (quiet background) | Min. km (loud background) | Max. km (quiet background) |
| Killer whale | 12.1 | 79.7 | 2.6 | 43.2 | 14.4 | 88.9 | 14.1 | 89.9 |
| Harbour porpoise | 12.1 | 84.5 | 2.6 | 47.4 | 14.3 | 93.6[3] | 14.3 | 107.3[3] |
| Humpback whale | 12.1 | 87.3 | 7.8 | 47.2 | 14.8 | 93.8[3] | 15.0 | 107.3[3] |
| Steller sea lion | 12.1 | 84.7 | 2.6 | 47.5 | 14.3 | 93.7[3] | 14.3 | 107.3[3] |

**Notes:**

1 Data from Table 15 in Appendix A of the Marine Resources - Marine Transportation Technical Report (Volume 8B, TR 8B-1).

2 Minimum and maximum distances correspond to the upper and lower limits of ambient noise, respectively.

3 Maximum extent restricted by modelling boundary.

#### 4.3.7.4.5 Assessment of Potential for Residual Effects of Auditory Injury

**Cumulative Sound Exposure Level Modelling and Results**

To estimate distances to Southall *et al.*'s PTS- and TTS-onset thresholds, a different acoustic modelling approach was taken. At each of the four modelling scenario locations, cumulative broadband SELs for Project-related marine vessels were modelled along the shipping lanes. Modelled cumulative SELs reflect the total acoustic energy emitted by Project-related marine vessels in the Marine RSA over 24 hours. The calculations were based on the number of Project-related tankers and tugs assumed to transit both the inbound and outbound shipping lanes over this 24 hour period (*i.e.,* assuming a monthly average of 30 partly-loaded Aframax-sized tanker calls [60 transits]). Further details on the modelling and assumptions related to escort tug transits are provided in Appendix A of the Marine Resources - Marine Transportation Technical Report (Volume 8B, TR 8B-1). Cumulative SELs were computed for a static receiver (*i.e.,* a stationary marine mammal) passed by a transiting tanker and escort tug at a range of distances (*i.e.,* 10 to 500 m). To measure the cumulative SEL radius at this scale of resolution (*i.e.,* to within 10 m), the model assumes that all noise originates from the propeller of the loudest vessel (*i.e.,* the tug in all but Scenario 4, which has no tug). Estimated distances to Southall *et al.*'s TTS-onset thresholds for both cetaceans and pinnipeds are shown in Table 4.3.7.7. The model showed that sound levels were insufficient for PTS-onset at any distance from the Project-related marine vessels.

**TABLE 4.3.7.7**

**ESTIMATED DISTANCES TO TEMPORARY THRESHOLD SHIFT-ONSET THRESHOLDS FOR SCENARIOS 1 TO 4**

| TTS[1]-onset threshold (dB re: 1 μPa²-s)[2,3] | Scenario 1 (13 knots) | Scenario 2 (10 knots) | Scenario 3 (15 knots) | Scenario 4 (15 knots, no tug) |
|---|---|---|---|---|
| **195 (cetaceans)** | < 10 m | < 10 m | 13 m | < 10 m |
| **183 (pinnipeds)** | 25 m | 17 m | 29 m | 10 m |

**Notes:**
1 TTS = temporary threshold shift.
2 Values taken from Southall *et al*. 2007.
3 SELs are a measure of received sound energy (the dB level of the time integral of the squared-instantaneous sound pressure normalized to a 1-s period ) and values presented in Table 4.3.7.7 were developed to reflect M-weighted SELs by functional hearing group (see Southall *et al*. 2007). Only unweighted SELs (not the M-weighted SELs) are modelled and used in this assessment. Comparison of unweighted source levels and M-weighted thresholds is expected to give a conservative estimate of the Southall TTS onset distances, since unweighted levels are always higher than M-weighted values.

**Permanent Auditory Injury (PTS)**

Under the Southall *et al.* criteria, cumulative broadband SELs are not predicted to exceed PTS-onset thresholds for cetaceans or pinnipeds under any of the four modelled scenarios (see Appendix A of the Marine Resources - Marine Transportation Technical Report (Volume 8B, TR 8B-1). Based on these results, no permanent auditory injury to marine mammals is expected as the result of the increase in Project-related marine vessel transit through the Marine RSA, and the potential for residual effects of PTS is not discussed further.

**Temporary Auditory Injury (TTS)**

Under the Southall *et al.* criteria, cumulative SELs are only predicted to exceed TTS thresholds for pinnipeds at distances of less than 30 m from the vessel's propellers, and for cetaceans at less than 15 m from the vessel's propellers (see Table 4.3.7.7). To measure the SPL radius at this scale of resolution, the model assumes that all noise originates from the propeller of the loudest vessel (*i.e.,* the tug in all but Scenario 4). As such, marine mammals would need to approach within 30 m of the vessel propellers to be exposed to sound levels potentially capable of causing TTS. It is unlikely that a marine mammal would approach this close to the vessels' operating propellers, and exposure to cumulative SELs capable of causing TTS is considered similarly unlikely. Based on these results, no temporary auditory injury to marine mammals is expected as the result of vessel transit through the Marine RSA, and the potential for residual effects of TTS is not discussed further.

#### 4.3.7.4.6 Mitigation Measures

While Trans Mountain can actively enforce restrictions on tankers docked at the Westridge Marine Terminal to comply with Trans Mountain operating practices and standards, once the tanker departs from the terminal, Trans Mountain has little direct control over the operating practices of the tankers or tugs as Project-related marine vessels are owned and operated by a third party. Marine transportation in Canadian waters is authorized and regulated through the *Canada Shipping Act, 2001* and related legislation, and regulations are administered by Transport Canada and the CCG. As such, no direct mitigation has been proposed by Trans Mountain for effects associated with increased Project-related marine transportation.

However, PMV is in the midst of developing a program to look at the current levels of underwater noise in the Strait of Georgia and surrounding waters and to consider options for reducing potential environmental effects of noise from marine traffic on marine mammals. This program will be a collaborative effort, led by PMV, and supported by TC, DFO, and the CCG. It will involve the Chamber of Shipping and the PPA as key stakeholders, as well as other major marine shipping industry representatives. The program will involve the deployment of a network of hydrophones in the Strait of Georgia and Haro Strait that will be used to measure the acoustic signatures of vessels and to monitor the activities of southern resident killer whales and other cetaceans. Data collected through the program will contribute to the development of mitigation measures aimed at reducing acoustic disturbance to marine mammals. PMV is expected to release more details on the program in early 2014.

Trans Mountain is strongly supportive of this regionally-based collaborative industry-government approach to developing viable solutions that could be applied to the marine transportation industry as a whole. Trans Mountain met with PMV in late 2013 and expressed its interest in contributing in a meaningful capacity to the development and implementation of the proposed program. Trans Mountain is also willing to support the outcomes (*i.e.*, research findings and recommended mitigations) that result from the PMV program or a similar government-industry effort. Trans Mountain will be furthering conversation with PMV in early 2014 to establish how to best support and participate in current and future endeavours on this topic.

Table 4.3.7.8 shows the identified potential effects and residual effects associated with Project-related marine vessel traffic on marine mammal indicators. The identification of these effects are based on the results of literature reviews, desktop analyses, acoustic modeling, engagement with government agencies and other stakeholders (Section 3.0), and the professional experience of the assessment team.

## TABLE 4.3.7.8

## POTENTIAL EFFECTS, MITIGATION MEASURES AND RESIDUAL EFFECTS OF INCREASED PROJECT-RELATED MARINE VESSEL TRAFFIC ON MARINE MAMMALS

| Potential Effect | Spatial Boundary[1] | Key Mitigation Measures in Place/Additional Recommendations | Potential Residual Effect(s) |
|---|---|---|---|
| **1. Marine Mammals Indicator – Southern Resident Killer Whale** | | | |
| 1.1 Auditory injury or sensory disturbance | RSA | • Project-related marine vessels are owned and operated by a third party. Marine transportation in Canadian waters is authorized and regulated through the *Canada Shipping Act* and related legislation and regulations are administered by Transport Canada and the CCG.<br>• Trans Mountain would be interested in supporting and participating in a joint industry-government advisory group that would be charged with determining and/or developing effective mitigation measures to reduce potential effects of underwater noise on marine mammals in the region. | • Sensory disturbance due to underwater noise from vessels (may include temporary displacement, startle response, increased energy expenditure, reduced foraging efficiency, communication masking, change in activity state, and/or increased stress). |
| **2. Marine Mammals Indicator – Humpback Whale** | | | |
| 2.1 Auditory injury or sensory disturbance | RSA | • Project-related marine vessels are owned and operated by a third party Marine transportation in Canadian waters is authorized and regulated through the *Canada Shipping Act* and related legislation and regulations are administered by Transport Canada and the CCG.<br>• Trans Mountain would be interested in supporting and participating in a joint industry-government advisory group that would be charged with determining and/or developing effective mitigation measures to reduce potential effects of underwater noise on marine mammals in the region. | • Sensory disturbance due to underwater noise from vessels (may include temporary displacement, startle response, increased energy expenditure, reduced foraging efficiency, communication masking, change in activity state, and/or increased stress). |
| **3. Fish and Mammals Indicator – Steller Sea Lion** | | | |
| 3.1 Auditory injury or sensory disturbance | RSA | • Project-related marine vessels are owned and operated by a third party Marine transportation in Canadian waters is authorized and regulated through the *Canada Shipping Act* and related legislation and regulations are administered by Transport Canada and the CCG.<br>• Trans Mountain would be interested in supporting and participating in a joint industry-government advisory group that would be charged with determining and/or developing effective mitigation measures to reduce potential effects of underwater noise on marine mammals in the region. | • Sensory disturbance due to underwater noise from vessels (may include temporary displacement, startle response, increased energy expenditure, reduced foraging efficiency, communication masking, change in activity state, and/or increased stress). |

**Note:** 1 RSA = Marine RSA

#### *4.3.7.5 Potential Residual Effects*

The potential residual environmental effect on marine mammals indicators associated with increased Project-related marine vessel traffic is sensory disturbance due to underwater noise from vessels (may include temporary displacement, startle response, increased energy expenditure, reduced foraging efficiency, communication masking, change in activity state, and/or increased stress) (Table 4.3.7.8).

#### 4.3.7.5.1 Sensory Disturbance

Marine mammals rely on sound for nearly all aspects of their life functions including navigation, mate selection, predator avoidance, prey detection, communication, and generally sensing their environment (Payne and Webb 1971, Tyack and Clark 2000). Underwater sound levels produced during marine transportation activities that are below PTS or TTS levels of concern may therefore still elicit behavioural responses that affect marine mammal populations (Nowacek *et al.* 2007, Richardson *et al.* 1995, Southall *et al.* 2007). DFO's *Recovery Strategy for Northern and Southern Resident Killer* identified underwater noise and associated sensory disturbances as one of several threats to this population, while acknowledging the uncertainty around potential long-term effects of this disturbance (DFO 2011a).

The degree of sensory disturbance experienced by a marine mammal 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 in question (Richardson *et al.* 1995, Southall *et al.* 2007). Sensory disturbance may also vary widely in form, ranging from non-observable physiological responses (such as increases in stress hormones [Rolland *et al.* 2012]), or decreases in ability to detect other sounds in the environment (*i.e.,* masking or reductions in communication space [Clark *et al.* 2009]), to overt physical reactions such as startle responses, changed activity budgets, and reduced time spent feeding (Williams *et al.* 2006, Lusseau *et al.* 2009). Habitat avoidance may exclude animals from important foraging or breeding areas (Morton and Symonds 2002). While current science cannot predict the potential population consequences of increased underwater noise (Wartzok *et al.* 2005), repeated disturbance from whale-watching has, over the long term, affected population-level parameters (Bejder *et al.* 2006, Lusseau and Bejder 2007).

Southall *et al.*'s proposed criteria do not provide quantitative thresholds for sensory disturbance. As such, only the NOAA behavioural disruption criteria (*i.e.,* 120 dB re: 1 µPa for both cetaceans and pinnipeds) are used in the quantitative comparison with predicted Project-related SPLs for the Marine RSA. Based on results of the acoustic modelling study, noise levels associated with increased Project-related marine vessel traffic within the Marine RSA are expected to exceed the NOAA threshold for behavioural disruption. SPLs above this threshold are predicted to extend for 4 to 7 km (R95%) from the Project vessels in the absence of other noise (*i.e.,* not accounting for current ambient acoustic conditions; see first row of Table 4.3.7.3). While this assessment considers potential effects across the entire Marine RSA, effects of sensory disturbance from underwater noise will be centered on the shipping lanes within a roughly 14 km wide corridor (*i.e.,* 4 to 7 km on either side of the vessel). As noted earlier, Project-related marine vessels and other large vessels are required to remain within designated shipping lanes during inbound and outbound transits.

Distance from the shipping lane to shore exceeds this value (7.13 km) along 33 per cent of the inbound shipping lanes and along 49 per cent of the outbound shipping lanes in the Marine RSA. For example, the distance between the outbound shipping lane and the Canadian shoreline at Carmanah Point in Juan de Fuca Strait is 9 km, whereas the zone of sensory disturbance (*i.e.,* 95 per cent radius to 120 dB re: 1 μPa) is predicted to extend roughly 6.5 km from the shipping lane at this location (see Scenario 4, Table 4.3.7.3). This means that there are portions of the Marine RSA that marine mammals could access that are beyond the zone of sensory disturbance directly attributable to Project-related marine vessels. Although vessels will be moving continuously along the shipping lane, and noise associated with Project-related marine vessels will therefore be transient at any one particular location, potential effects are most likely for marine mammals that are in the vicinity at the time of vessel transit through 'pinch point' locations. At these locations, the influence of sensory disturbance would extend to the nearest shoreline and all animals within these constricted waterways would be exposed. For example, at Race Rocks Ecological Reserve, the distance to the outbound shipping lane is 4.7 km, while the zone of sensory disturbance is predicted to extend 7.1 km (in both directions) from the shipping lane at this location (see Scenario 3, Table 4.3.7.3).

While areas of the Marine RSA further than 7 km away from the shipping lanes will not be exposed to Project-related SPLs predicted to cause sensory disturbance, marine mammals will nonetheless be able to detect Project-related marine vessel traffic noise over much longer distances. SPLs below NOAAs behavioural disruption threshold may still affect an animal's communication space (*i.e.,* the predicted area over which they can communicate) (Clark *et al.* 2009) or cause physiological stress responses (Rolland *et al.* 2012). Based on the broad range of ambient conditions in the Marine RSA reported in the literature (*i.e.,* from quiet to loud), Project-related marine vessel traffic will be discernible above ambient conditions for distances ranging from 2 km (loud noise conditions) to over 100 km (quiet noise conditions; see Table 4.3.7.6). Most ambient noise variability in the Marine RSA is the result of vessel traffic types, movement patterns and site-specific physical conditions (Bassett *et al.* 2012). The large range in distances of detectability primarily reflects the large difference in ambient conditions (*i.e.,* roughly 20 to 30 dB) between quiet periods and periods of high marine traffic volume (see acoustic modelling study for further details on ambient noise conditions and modelling).

It is not possible to quantify how much time an individual or population of marine mammals may be exposed to noise resulting specifically from increased Project-related marine vessels, as both the vessels and marine mammals are in a near constant state of motion, and at any one time, their occurrence may or may not overlap. However, some general temporal exposure predictions can be made. It will take Project-related tankers and accompanying escort tugs approximately 12 hours (based on an average speed of 13 knots across 296 km of shipping lanes) to complete one transit of the Marine RSA, and on average, there will be two transits every 24 hours. Therefore, on average, the Project will result in the presence of a Project-related tanker (with potential escort tug depending on location and whether the tanker is empty or full), at some location in the Marine RSA at all times for the life of the Project. Under a hypothetical scenario, a stationary marine mammal in proximity to the shipping lane during a single Project-related marine vessel pass could be exposed to sensory disturbance for 24 to 31 minutes (approximately 2 per cent of each day for each passage; see Table 4.3.7.4), depending on the speed of the vessel and site-specific physical conditions. However, since some species such as killer whales are highly mobile, there is potential for an individual to interact with the same Project-related marine vessel more than once during a single day (*e.g.,* for marine mammals circling an island and re-encountering the vessel further along the shipping lanes). Overall, it is expected that exposure of any particular individual to Project-based sensory disturbance is unlikely to exceed much more than 0.5 to 2 hours a day (*i.e.,* 2 per cent to 8 per cent of each day assuming up to two exposures per transit for each of the two Project-related marine vessel transits in a 24-hour period).

While exposure of a stationary marine mammal in the Marine RSA to a Project-related marine vessel will be intermittent (*i.e.,* two vessel transits per day), this daily exposure will occur throughout the life of the Project. Most studies report that marine mammal behaviour returns to normal after sound production ceases (Richardson *et al.* 1995, Southall *et al.* 2007). In consideration of only routine effects associated with the Project, it is therefore expected that the time between vessel transits would allow marine mammals to recover from the sensory disturbance before the next transit of a Project-related marine vessel transit, were it not for the current existence of other vessel traffic in the Marine RSA.

While marine mammals may not encounter another Project-related marine vessel for the remainder of the day, they are very likely to encounter other marine vessels (*e.g.,* other tankers, container ships, cruise ships, ferries, fishing vessels, tourism vessels, tugs, barges and recreational vessels) within minutes to hours of the passing of the Project-related marine vessel. Assuming that similar potential sensory disturbance exposure times and extents may result from other marine traffic in the area, over the life of a marine mammal whose home range or critical habitat overlaps the Marine RSA, exposure to underwater noise from vessel traffic for any individual is likely much more frequent, and could conceivably approach near-continuous sensory disturbance.

Shipping is not a novel activity in the Marine RSA, and many species that use this area regularly are likely to have become 'habituated' to sounds associated with marine transportation activities. However, while habituation is likely to reduce the occurrence of high energy startle responses, which are considered more likely in response to a novel or acute sound source, there may be other costs associated with habituation and continued use of this environment (*e.g.,* need to increase communication signal duration [Miller *et al.* 2000] or amplitude [Holt 2008]). Holt (2008) found that for every 1 dB increase in underwater noise, killer whales will attempt to compensate by increasing their vocalizations by 1 dB.

Marine mammals continue to use these waters and there has been no observed long-term avoidance of this area. This fact alone; however, is not evidence that current ambient noise levels are not causing some degree of disturbance. Much of the habitat in the Marine RSA has been recognized as important for marine mammals, and has been designated as critical for two species (southern resident killer whale and humpback whale). As distribution of many marine mammal species is often highly correlated to the distribution of their prey, the importance of accessing key foraging grounds may to some degree outweigh other negative aspects (*e.g.,* loud ambient conditions) associated with that habitat.

#### *4.3.7.6 Significance Evaluation of Potential Residual Effects*

The measurement endpoints for marine mammals include both quantitative and qualitative measurement of potential Project effects. Predicted underwater noise from the increase in Project-related marine vessel traffic was estimated using methods established in previous acoustic studies (see detailed report in Appendix A of the Marine Resources - Marine Transportation Technical Report (Volume 8B, TR 8B-1). There is a lack of Canadian regulatory thresholds, standards, or guidelines for evaluating potential residual effects of underwater noise from vessel traffic (or other sources) on marine mammals. Therefore, this assessment considers thresholds used for other Canadian projects and in other parts of the world (*e.g.,* in the US). The importance of marine mammal habitat affected by the Project was evaluated qualitatively based on a review of available research literature. Overall findings were based primarily on the professional judgment of the assessment team.

Table 4.3.7.9 provides a summary of the significance evaluation of the potential residual environmental effects of Project-related increases in vessel traffic on marine mammal indicators. The rationale used to evaluate the significance of each of the residual environmental effects is first provided below for each indicator.

**TABLE 4.3.7.9**

**SIGNIFICANCE EVALUATION OF POTENTIAL RESIDUAL EFFECTS OF INCREASED PROJECT-RELATED MARINE VESSEL TRAFFIC ON MARINE MAMMALS**

| Potential Residual Effects | Impact Balance | Spatial Boundary[1] | Temporal Context | | | Magnitude | Probability | Confidence | Significance[2] |
|---|---|---|---|---|---|---|---|---|---|
| | | | Duration | Frequency | Reversibility | | | | |
| **1 Marine Mammals Indicator – Southern Resident Killer Whale** | | | | | | | | | |
| 1(a) Sensory disturbance due to underwater noise. | Negative | RSA | Long-term | Periodic | Immediate | High | High | Low | Significant |
| **2 Marine Mammals Indicator – Humpback Whale** | | | | | | | | | |
| 2(a) Sensory disturbance due to underwater noise. | Negative | RSA | Long-term | Periodic | Immediate | Medium | High | Low | Not Significant |
| **3 Marine Mammals Indicator – Steller Sea Lion** | | | | | | | | | |
| 3(a) Sensory disturbance due to underwater noise. | Negative | RSA | Long-term | Periodic | Immediate | Low | High | High | Not Significant |
| **4 Combined Effects of Increased Project-Related Marine Vessel Traffic on Marine Mammals** | | | | | | | | | |
| 4(a) Combined effects of increased Project-related marine vessel traffic on the marine mammals indicators (1[a], 2[a] and 3[a]). | Negative | RSA | Long-term | Periodic | Immediate | High | High | Low | Not Significant to 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.

**3** Refer to the discussion on Southern Resident Killer Whales below for the rationale for the evaluation.

#### 4.3.7.6.1 Marine Mammals Indicator - Southern Resident Killer Whale

The following subsection provides the evaluation of significance of the potential residual effect on the southern resident killer whale indicator.

### Sensory Disturbance of Southern Resident Killer Whales Due to Underwater Noise

Southern resident killer whales are listed as Endangered under Schedule 1 of *SARA*. This is due in large part to their small population size of only 82 individuals (*i.e.,* J Pod = 26, K Pod = 19 and L Pod = 37 as of July 1, 2013) (Center for Whale Research 2013). A large portion of the Marine RSA has been designated as critical habitat under *SARA*; this includes the following transboundary waters of BC and Washington State: Juan de Fuca Strait, Haro Strait, Boundary Pass, the Southern Gulf Islands, and the southern portion of the Strait of Georgia (DFO 2009b, 2011) (see Figure 4.2.22). One hundred percent of the designated southern resident killer whale critical habitat that has been identified in Canadian waters falls inside the boundaries of the Marine RSA. The portion of this transboundary area that falls under US jurisdiction was designated as critical habitat under the US *Endangered Species Act* in 2006 (National Marine Fisheries Service [NMFS] 2006a,b).

Federal designation of the importance of this habitat is based on consistent and prolonged seasonal occupancy of southern resident killer whales in this area (DFO 2011a) (see Figure 4.2.23). On average, J Pod (representing a third of the entire population) spends some of its time in the Marine RSA during every month of the year, and appears to seldom leave this region (Ford *et al.* 2000, Osborne 1999, Osborne *et al.* 2001). K and L pods are more common in the western portion of the Marine RSA, particularly from late spring through fall (DFO 2011a, The Whale Museum 2011). On certain occasions, all whales are seen together in the same area – an event referred to as a 'superpod'.

According to DFO's *Recovery Strategy for Northern and Southern Resident Killer Whale* (DFO 2011a) and the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) *Assessment and Update Status Report on the Killer Whale* (COSEWIC 2008), key threats to the southern resident killer whale population include: chemical and biological contaminants; reductions in the availability or quality of prey (primarily Chinook and chum salmon); and physical and acoustic disturbance. DFO has included the environment's acoustic attributes in their designation of critical habitat for southern resident killer whales, and sources of acoustic disturbance are noted as including both high-intensity sounds (such as those produced by seismic surveys) and "chronic sources such as vessel traffic" (DFO 2011a). At this time, DFO has not identified any standards or thresholds that describe what ambient sound levels might provide appropriate acoustic habitat for killer whales or other marine mammals (within critical habitat areas or elsewhere). As noted below, these threats are inter-related.

An acoustic modelling study by MacGillivray *et al.* (2012) predicted two audiogram-weighted behavioural thresholds for killer whales, based on behavioural disturbance responses by northern resident killer whales reported in the literature (*i.e.,* Williams *et al.* 2002a,b). The study determined that at received sound levels of approximately 64 dB re: HT, killer whales overtly avoided a whale-watching boat, while at received SPLs of approximately 57 dB re: HT, they exhibited subtle avoidance responses. Based on the predicted values presented in Table 4.3.7.5, current background noise levels under the loudest conditions in the Marine RSA already exceed the values calculated by MacGillivray *et al.* (2012) as being capable of causing subtle behavioural responses in killer whales, and are equal to levels capable of causing overt behavioural responses. This comparison is based on current ambient conditions, before the introduction of noise associated with increased Project-related marine vessel traffic.

The Marine RSA encompasses a busy marine intersection of a wide range of vessel traffic travelling to and from the urban ports of Vancouver, Victoria, and Seattle, as well as locally around each of these centres and the Gulf and San Juan islands. While current ambient underwater noise conditions may already exceed levels predicted to cause sensory disturbance, not all of this noise is associated with commercial shipping activities (*i.e.,* tankers, tugs, cargo containers, and bulk carriers). This area also contains high levels of vessel traffic associated with passenger lines (*i.e.,* ferries and cruise ships), commercial and recreational fishing vessels, and both commercial tourism and general recreational vessels. Commercial whale-watching has been recognized as a potential stressor for many marine mammal populations around the world (Baker and Herman 1989, Corkeron 2004, Lusseau and Bejder 2007). In an acoustic modelling study of whale-watching vessels operating around southern resident killer whales in this region, Erbe (2002) predicted that noise from fast-moving whale-watching boats was audible to killer whales for distances over 16 km, was able to mask killer whale calls for over 14 km, might elicit behavioural responses over 200 m, and could even cause TTS of 5 dB over distances of 450 m. While Canadian and US agencies have collaborated to develop whale-watching guidelines (Be Whale Wise 2013, DFO 2013p), southern resident killer whales are in the presence of whale-watching boats (both commercial and pleasure boat-based) for 12 hours a day during summer months (Lusseau *et al.* 2009) as well as most of the daylight hours during the late spring and early fall periods.

Increases in sensory disturbance may also act additively with other stressors in the environment. One of the primary concerns associated with the effects of acoustic disturbance is that it can reduce the amount of time spent feeding. A study by Williams *et al.* (2006) examined the effects of disturbance from boat traffic in Johnstone Strait, BC, on the population of northern resident killer whales. The researchers found that in the presence of boats, killer whales spent a statistically-significant less amount of time feeding. The potential energetic cost associated with this loss in feeding opportunity may have resulted in an estimated 18 per cent decrease in energy intake (Williams *et al.* 2006). The vessels in Williams *et al.*'s 2006 study were primarily commercial fishing traffic, which would have been transiting the area tangentially to the killer whales. Similar results were observed by Lusseau *et al.* (2009), who measured a statistically significant negative effect on foraging for southern resident killer whales in the presence (*i.e.,* within 100 m and 400 m) of vessel traffic. Whales were statistically significantly less likely to be foraging (and significantly statistically more likely to be traveling) when boats were nearby (within 100 m) (Lusseau *et al.* 2009). The long-term consequences of reduced foraging in the presence of vessels could be exacerbated for populations that are already prey-limited, as may be the case for southern resident killer whales (Lusseau *et al.* 2009, DFO 2011a, Williams *et al.* 2011).

While sensory disturbance may lead to observable responses such as changes in activity state, the efficiency of foraging may also be affected if ambient noise levels interfere with an animal's ability to communicate. A recent study by Williams *et al.* (2013) looked at ambient noise conditions at 12 locations in BC, and assessed how the current acoustic environment might be affecting marine mammal communication space. Haro Strait and the waters off southeastern Vancouver Island are the main concentration area for southern resident killer whales in the Marine RSA (Ford *et al.* 2000). Williams *et al.* (2013) found that the long-term spectral averages in Haro Strait were dominated by broadband noise, characteristic of ship engines and high noise levels from vessel traffic were found to be nearly continuous over 24 hours. In the frequency bands that killer whales use for social communication, median noise levels in Haro Strait were high enough to reduce killer whale communication space by up to 62 per cent under typical conditions, and by up to 97 per cent under the noisiest conditions (calculated over an 8 km range and relative to the median quietest "normal noise conditions" recorded at any of the 12 sites; Williams *et al.* 2013). Previous research has also shown that boat noise can mask killer whale echolocation ability (Bain and Dahlheim 1994). Underwater noise from marine vessels, including Project-related marine vessels could result in an unknown degree of communication masking, which could reduce southern resident killer whales' ability to navigate, detect or capture prey, or detect and communicate with conspecifics. The magnitude or population-scale implications of such effects are unknown.

DFO's *Recovery Strategy for Northern and Southern Resident Killer Whale* states that: "Both physical and acoustic disturbance from human activities may be key factors causing depletion or preventing recovery of resident killer whale populations" (DFO 2011a). Based on available scientific knowledge, it is concluded that past and current activities (including all forms of mortality, high contaminant loads, reduced prey, and sensory and physical disturbance) have resulted in significant adverse cumulative effects to the southern resident killer whale population. The recent historical decline of the southern resident killer whale population and its current status (*i.e.,* endangered) support this conclusion. However, given the current state of knowledge, and the ability of threats to interact with one another, it is not possible to completely partition how each threat may be affecting the population.

While the endangered status of southern resident killer whale is assumed to represent a currently-existing significant adverse cumulative effect, there are currently no quantitative Canadian thresholds with respect to assessing sensory disturbance for marine mammals associated with underwater noise, nor are there recommended Canadian standards or guidelines with respect to what would be appropriate ambient SPLs or SELs for southern resident killer whale critical habitat. Trans Mountain has little influence over the operating practices of the tankers or tugs as Project-related marine vessels are owned and operated by a third party; however, Trans Mountain expects that through its tanker acceptance process the calling vessels are maintained and operated to high industry standards. These vessels and other marine transportation in Canadian waters is authorized and regulated through the *Canada Shipping Act, 2001.* Related legislation and regulations are administered by Transport Canada and the CCG. The increase in Project-related marine vessel traffic is also expected to be proportionately small relative to overall current marine transportation activities in the Marine RSA. Despite operating legally, the Project will contribute additional underwater noise that could affect the southern resident killer whale population. As such, even though the Project contribution to overall sensory disturbance effects is small, the potential effects of increased Project-related marine vessel traffic are determined to be significant for southern resident killer whales.

A summary of the rationale for all of the significance criteria is provided below (Table 4.3.7.9, point 1[a]).

- **Spatial Boundary** - Marine RSA – residual effects of sensory disturbance on southern resident killer whales will be concentrated along the shipping lanes in the Marine RSA and will decrease with distance from the sound source (*i.e.*, tankers and tugs).
- **Duration** - long-term – tanker transits and the associated production of underwater noise along the shipping lanes will be initiated during the operations phase and will extend for the life of the Project.
- **Frequency** - periodic – Project-related marine vessel traffic will increase by approximately 30 Aframax tanker calls to the Westridge Marine Terminal per month (*i.e.*, an additional 720 tanker transits each year). It will take Project-related marine vessels approximately 12 hours to complete one transit of the Marine RSA, and on average, there will be two transits every 24 hours. Southern resident killer whales are highly mobile; however, on average exposure to a single transit will likely be limited to a maximum of two exposures per day (*i.e.*, periodic).
- **Reversibility** - immediate – southern resident killer whales would likely recover from the direct effects of a single event causing sensory disturbance (*i.e.*, single passing of a Project-related tanker/tug) immediately (*i.e.*, in less than two days).
- **Magnitude** - high – Project-related underwater noise within the Marine RSA will exceed NOAA's regulatory standards for sensory disturbance. While there are no Canadian regulatory standards with respect to this effect, the NOAA thresholds are used as commonly-applied environmental standards. Southern resident killer whales within 4 to 7 km of the shipping lanes are expected to be

disturbed by vessel traffic and this effect will occur throughout the Canadian designated critical habitat for this endangered population.

- **Probability** - high – underwater noise produced by Project-related marine vessels is expected to exceed the current NOAA standards for sensory disturbance within 4 to 7 km of the transiting vessels. As such, there is a high probability that southern resident killer whales in the Marine RSA will experience some degree of sensory disturbance as a result of increased Project-related marine vessel traffic.
- **Confidence** - low – there is no precedent (*e.g.*, environmental assessments for other projects) for attempting to assess significance of the effects of sensory disturbance from underwater noise associated with marine shipping on southern resident killer whales. What is known with certainty concerning this population is its small size, recent population trends, endangered status, and relative importance of this area (*i.e.*, critical habitat). Recent ambient noise measurement studies have been conducted in the Marine RSA and results are available in the literature (Williams *et al.* 2013; see also Appendix A of the Marine Resources - Marine Transportation Technical Report (Volume 8B, TR 8B-1). Project-related marine vessel source levels were not directly measured but surrogate vessels from the literature are deemed appropriate and acoustic modeling followed standard practices. Disturbance from vessels and underwater noise have been shown through numerous studies to alter behaviour, cause compensatory responses, and interfere with normal activity patterns, but the greatest source of uncertainty is the linkage of sensory disturbance effects to population-level consequences and the degree to which such effects can be attributed to underwater noise from Project-related marine vessels and other ships and boats.

Other toothed whales that may be observed in the Marine RSA include Dall’s porpoises, harbour porpoises, Pacific white-sided dolphins and the other ecotypes of killer whales (*i.e.,* northern residents, transients and offshores). While many of these other species of toothed whale are common in the area, no critical habitat has been identified within the Marine RSA for any species of toothed whale other than southern resident killer whales (designated) and transient killer whales (potential). DFO Important Areas for harbour porpoise have also been identified in the Marine RSA. Most of these species belong to the same functional hearing group, with the exception of harbour porpoises. While species such as harbour porpoises may be somewhat more sensitive than southern resident killer whales to high frequency sounds, and may show more pronounced responses to disturbance, acoustic modelling of harbour porpoises suggest that the extent of sensory disturbance is expected to be generally comparable across all toothed whale species found within the Marine RSA. As such, effects of sensory disturbance to the southern resident killer whale indicator are expected to be conservative with respect to potential effects to all toothed whales.

The increase in Project-related marine vessel traffic will contribute additional underwater noise to the existing adverse acoustic conditions in the Marine RSA. Based on results of acoustic modelling, this noise will be detectable by toothed whales over large distances and may cause sensory disturbance within 4 to 7 km of the shipping lanes. However, Project-specific effects are expected to contribute a proportionately small component of the overall marine transportation sources for underwater noise. For southern resident killer whales, it was determined that the current status of that population meant that any residual effect beyond current levels was undesirable, and furthermore, the entire population spends much of its time in the Marine RSA. For that reason, effects on southern resident killer whales were determined to be significant. In contrast, residual effects of the Project will affect only localized portions of the overall North Pacific (or Canadian) populations of toothed whales in the Marine RSA. As such, and in consideration of the notable differences between population status, abundance, and occurrence of southern resident killer whales versus the various other species of toothed whales in the Marine RSA, effects of increased Project-related marine vessel traffic on toothed whales (other than southern resident killer whales) are deemed to have a negative impact balance, but are not significant.

These comparisons are in no way meant to diminish the importance of maintaining functional acoustic habitats for all marine mammal species. Instead, they only serve to highlight that the specific and unique biology and circumstances of southern resident killer whales do not apply equally to any other species of toothed whale in the Marine RSA.

#### 4.3.7.6.2 Marine Mammals Indicator - Humpback Whale

The following section provides the evaluation of significance of the potential residual effect on the humpback whale indicator.

**Sensory Disturbance of Humpback Whales Due to Underwater Noise**

Humpback whales are listed as Threatened under Schedule 1 of *SARA*. They appear to be present in most of the Marine RSA in a comparatively lower density than some other areas of BC (DFO 2013h) and are present in the area, particularly south of Victoria and around Cape Flattery, primarily during summer and fall (see Figure 4.2.24). DFO has designated humpback whale critical habitat for four areas in BC, including an area off southwest Vancouver Island that overlaps slightly with the western-most portion of the Marine RSA (DFO 2013h) (see Figure 4.2.22). Critical habitat that overlaps the Marine RSA is based primarily on summer observations of concentrations of humpback whales in the area east of Barkley Canyon and between La Pérouse Bank and Nitinat Canyon, and on the shelf edge near the southern portion of Juan de Fuca Canyon (Ford *et al.* 2010), though most of these large concentrations are just outside the Marine RSA.

Activities identified by the *DFO Humpback Whale Recovery Strategy* as "likely to destroy or degrade critical habitat" include vessel traffic, toxic spills, overfishing, seismic exploration, sonar and pile driving (DFO 2013h). The COSEWIC *Assessment and Update Status Report on the Humpback W*hale also includes noise disturbance amongst its list of key threats (COSEWIC 2011).

Baleen whales, such as the humpback whale, lack the high-frequency echolocation systems of odontocetes, and are instead believed to be more sensitive to the low to medium underwater noise frequencies in which they sing and vocalize (Au *et al.* 2006, Richardson *et al.* 1995). Therefore, they are generally more likely than toothed whales to be able to hear sound levels in the frequency range of commercial shipping. This difference between functional hearing groups is noted in Table 4.3.7.5, where current background noise levels under the loudest conditions in the Marine RSA are predicted to be higher for humpback whales than for killer whales or harbour porpoises (*i.e.,* relative to each species' different hearing thresholds).

Humpback whales produce a wide variety of vocalizations, and use sounds to contact one another, during mating displays and long-distance migrations, and to coordinate feeding behaviours (Cerchio and Dahlheim 2001, Payne and McVay 1971, Sharpe 2001). Most existing studies specific to behavioural reactions of humpback whales in response to underwater noise relate to impulsive sounds such as seismic airguns or explosives (McCauley *et al.* 2000, Todd *et al.* 1996); those that involve non-pulse sounds often relate to whale-watching (Corkeron 1995). Baker and Herman (1989) reported on the responses of humpback whales in Alaska during opportunistic passing of medium and large vessels at distances greater than 400 m. Whales exhibited behavioural changes such as decreased respiration rates and increased dive times when vessels were within 4,000 m. Overall, the study documented short-term behavioural changes in response to vessels and the authors suggested that high vessel traffic volumes could displace whales from preferred feeding habitat (Baker and Herman 1989).

NOAA's behavioural disruption threshold is not species-specific (*i.e.,* it has not been audiogram-weighted or developed to reflect different functional hearing groups); however, it remains the most commonly applied regulatory threshold for assessing sensory disturbance. Based on this metric, sensory disturbance is possible for all marine mammals within 4 to 7 km of Project-related marine vessels (not accounting for current ambient acoustic conditions; see first row of Table 4.3.7.3). Unlike for killer whales, there are currently no quantitative sensory disturbance thresholds relative to humpback whale hearing thresholds (*i.e.,* in dB re: HT). Although it is possible to estimate how far Project-related marine vessel traffic might be discernible to humpback whales above ambient conditions (*i.e.,* from 8 km to over 100 km based on the broad range of ambient conditions in the Marine RSA reported in the literature; see Table 4.3.7.6), based on the available data, there is no species-specific way to determine at what point within this distance humpback whales might exhibit sensory disturbance or any implications of such disturbance.

At this time, no scientific study has established a causal link between increased vessel noise and population-level effects on humpback whales (Wartzok *et al.* 2005), though potential mechanisms have been observed in other cetacean populations (Lusseau and Bejder 2007). As noted for killer whales, Williams *et al.* (2013) found indications that humpback whales in the noisiest regions in BC may be losing communication space. In the frequency bands that humpback whales use for communication, median ambient noise levels in Haro Strait were determined to be high enough to reduce humpback whale communication space by up to 52 per cent under typical conditions, and by up to 94 per cent under the noisiest conditions (calculated over a 32 km range and relative to the median quietest "normal noise conditions" recorded at any of 12 sites in BC) (Williams *et al.* 2013).

The increase in Project-related marine vessel traffic will contribute additional underwater noise to the Marine RSA. Based on results of acoustic modelling, this noise will be detectable by humpback whales over large distances and may cause sensory disturbance within 4 to 7 km of the shipping lanes. While the acoustic environment in many areas of the humpback whale's range may currently exceed environmental standards for sensory disturbance, the North Pacific population is not only stable, but has been growing at an annual rate of approximately 4.9 per cent since 1993 (Cascadia Research 2008). Unlike for southern resident killer whales, DFO has identified critical habitat for humpback whales in other areas of BC, and humpback whales in Canada belong to a much larger population (*i.e.,* 2008 estimate of 18,302 individuals in the North Pacific) (Cascadia Research 2008). Based on photo-identification studies (from 1992 to 2006) and a minimum number alive (MNA) estimate of the 2006 BC humpback whale population size (1,620 individuals), 208 humpback whales have been identified in the southwest Vancouver Island critical habitat area; this represents approximately 13 per cent of the BC coast-wide MNA (DFO 2010b).

These comparisons are in no way meant to diminish the importance of maintaining functional acoustic habitats for humpback whales or any marine mammal species. Instead, they only serve to highlight that the specific and unique biology and circumstances of southern resident killer whales (*i.e.,* small population size with no external recruitment potential, 100 per cent Marine RSA overlap with entire known Canadian critical habitat, etc.) do not apply equally to North Pacific humpback whales, or any other species of baleen whale in the Marine RSA.

Underwater noise associated with increased Project-related marine vessel traffic will add to the existing background noise in the Marine RSA. However, Project-specific effects are expected to contribute a proportionately small component of the overall marine transportation sources for underwater noise. These residual effects of the Project will affect a relatively small, localized component of the overall North Pacific (or Canadian) humpback whale population, and only during periods of the year when they are present in the Marine RSA. As such, effects of increased Project-related marine vessel traffic on humpback whales are deemed to have a negative impact balance, but are not significant.

A summary of the rationale for all of the significance criteria is provided below (Table 4.3.7.9, point 2[a]).

- **Spatial Boundary -** Marine RSA – residual effects of sensory disturbance on humpback whales will be concentrated along the shipping lanes in the Marine RSA and will decrease with distance from the sound source (*i.e.,* tankers and tugs).
- **Duration** - long-term – tanker transits and the associated production of underwater noise along the shipping lanes will be initiated during the operations phase and will extend for the life of the Project.
- **Frequency** - periodic – Project-related marine vessel traffic will increase by approximately 30 Aframax tanker calls to the Westridge Marine Terminal per month (*i.e.,* an additional 720 tanker transits each year). It will take Project-related marine vessels approximately 12 hours to complete one transit of the Marine RSA, and on average, there will be two transits every 24 hours.
- **Reversibility** - immediate – humpback whales would likely recover from the direct effects of a single event causing sensory disturbance (*i.e.,* single passing of a Project-related tanker/tug) immediately (*i.e.,* in less than two days).
- **Magnitude** - medium – Project-related underwater noise within the Marine RSA will exceed NOAA's regulatory standards for sensory disturbance. While there are no Canadian regulatory standards with respect to this effect, the NOAA thresholds are used as commonly-applied environmental standards. Humpback whales within 4 to 7 km of the shipping lanes are expected to be disturbed by vessel traffic. The Marine RSA overlaps a small portion of the identified Canadian critical habitat for this species and only a small proportion of the much larger North Pacific population of humpback whales occurs seasonally in the Marine RSA. For these population status reasons, the magnitude is rated as medium.
- **Probability** - high – underwater noise produced by Project-related marine vessels is expected to exceed the current NOAA standards for sensory disturbance within 4 to 7 km of the transiting vessels. As such, there is a high

probability that humpback whales will experience some degree of Project-related sensory disturbance while in the Marine RSA.

- **Confidence** - low – Recent ambient noise measurement studies have been conducted in the Marine RSA and results are available in the literature (Williams *et al.* 2013; see also Appendix A of the Marine Resources - Marine Transportation Technical Report (Volume 8B, TR 8B-1). Project-related marine vessel source levels were not directly measured but surrogate vessels from the literature are deemed appropriate and acoustic modeling followed standard practices. Disturbance from vessels and underwater noise have been shown through numerous studies to alter behaviour, cause compensatory responses, and interfere with normal activity patterns, but the greatest source of uncertainty is the linkage of sensory disturbance effects to population-level consequences and the degree to which such effects can be attributed to underwater noise from Project-related marine vessels and other ships and boats. The primary rationale for the difference in significance determination between humpback whales and southern resident killer whales is the marked difference in status, population size, distribution, and relative use and importance of the Marine RSA.

Other baleen whales that frequent the Marine RSA on occasion include fin whales, grey whales, and minke whales. While these other species of baleen whale are not altogether uncommon in the area, neither is any considered particularly abundant. No critical habitat or DFO Important Areas have been identified within the Marine RSA for any species of baleen whale other than humpback whales. All baleen whales belong to the same functional hearing group, and while species such as fin whales may be somewhat more sensitive than humpback whales to low frequency sounds associated with shipping, effects of sensory disturbance to the humpback whale indicator are expected to be generally comparable to effects on all baleen whale species found within the Marine RSA. Furthermore, based on its distribution and abundance in the Marine RSA, the humpback whale is deemed more likely to be exposed to effects associated with the increase in Project-related marine vessel traffic, and some of these effects will occur within humpback whale critical habitat. As such, effects of sensory disturbance to the humpback whale indicator are expected to adequately address potential effects to all baleen whales, and residual effects to baleen whales as a result of the increase in Project-related marine vessel traffic are determined to be not significant.

#### 4.3.7.6.3 Marine Mammals Indicator - Steller Sea Lion

The following section provides the evaluation of significance of the potential residual effect on the Steller sea lion indicator.

**Sensory Disturbance of Steller Sea Lions Due to Underwater Noise**

Steller sea lions are listed as Special Concern under Schedule 1 of *SARA*. While there are no designated critical habitats or rookeries (*i.e.,* breeding areas) within the Marine RSA, a Marine Protected Area (MPA) at Race Rocks protects an important winter haulout site (COSEWIC 2003c). In addition to several other major winter haulouts and one year-round haulout at Carmanah Point, there are several minor haulouts located in the Marine RSA and both male and female Steller sea lions are present here year-round (see Figure 4.2.25).

The DFO Steller Sea Lion Management Plan list the following as threats of moderate concern for Steller sea lions: prey reduction (from either fisheries competition, or environmental change and variability); environmental contaminants; physical disturbance when on terrestrial habitat (pups on rookeries); and toxic spills (DFO 2010a). There are no current threats of high concern listed and acoustic disturbance when in aquatic habitat is listed as low concern.

Pinnipeds vocalize both in air and underwater but generally over a lower, more restricted bandwidth than most other marine mammals (*i.e.,* between 100 Hz and several tens of kHz) (Southall *et al.* 2007). Likewise, their hearing capabilities differ above and below water (Kastak and Schusterman 1998, Schusterman 1981), though they may be disturbed by introduced noise in either media. Southall *et al.* (2007) developed their noise exposure criteria without reference to any behavioural measures of hearing for Steller sea lions, either atmospheric or underwater. They instead estimated an auditory bandwidth for all pinnipeds of 75 Hz to 30 kHz in air, and 75 Hz to 75 kHz underwater, based on studies involving other species (Southall *et al.* 2007). Since then, there have been a few studies specific to hearing in Steller sea lions.

California sea lions are best adapted to hearing in air, with greatest sensitivity from 2 to 8 kHz (Kastak and Schusterman 1998). Recent research suggests that the closely-related Steller sea lion has similar high frequency atmospheric hearing limits, with sensitivity that increases with frequency up to 10 kHz, and then decreases towards 20 to 32 kHz (*i.e.,* they have good atmospheric hearing from 1 to 20 kHz) (Mulsow *et al.* 2011). Steller and California sea lion hearing sensitivity have also been found to be essentially the same in air and underwater, except in the highest frequencies of their hearing range (Hemilä *et al.* 2006, Mulsow and Reichmuth 2010). Kastelein *et al.* (2005) found that the female Steller sea lion showed highest underwater hearing sensitivity from 16 to 25 kHz, while the male was most sensitive to underwater frequencies of 1 to 16 kHz. As such, the thresholds proposed by Southall *et al.* conservatively capture the bandwidths of greatest hearing sensitivity for Steller sea lions, both in air and underwater.

Pinnipeds in the water have typically been shown to tolerate close vessel approaches, even congregating around fishing vessels (California sea lions) (Richardson *et al.* 1995). Most marine acoustic energy of vessel sounds is concentrated in the 50 to 500 Hz range (NRC 2003a, Ross 1976). Since Steller sea lions have poor underwater hearing sensitivity below 1,000 Hz (Kastelein *et al.* 2005), most of the acoustic energy of Project-related marine vessels in the Marine RSA will not be audible to Steller sea lions. Based on the results presented in Table 4.3.7.5, the estimated average ambient noise in the Marine RSA above Steller sea lion audiograms ranges from 14 to 37 dB re: HT. Based on the audiogram-weighted sound contour maps produced during acoustic modelling, noise produced by Project-related marine vessels will for the most part fall below 35 dB re: HT, except within a few km of the vessels (see Figures 26 to 29 and Table 13 in Appendix A of the Marine Resources – Marine Transportation Technical Report (Volume 8B, TR 8B-1). Therefore, noise produced by the increase in Project-related marine vessels will primarily be within the predicted range of current ambient conditions in the Marine RSA; Project-specific vessel traffic will be most detectable directly along the shipping lane during a vessel transit. Effects of increased Project-related marine vessel traffic on Steller sea lions are therefore determined to be not significant.

A summary of the rationale for all of the significance criteria is provided below (Table 4.3.7.9, point 3[a]).

- **Spatial Boundary** - Marine RSA – residual effects of sensory disturbance on Steller sea lions will be concentrated along the shipping lanes in the Marine RSA and will decrease with distance from the sound source (*i.e.*, tankers and tugs).

- **Duration** - long-term – tanker transits and the associated production of underwater noise along the shipping lanes will be initiated during the operations phase and will extend for the life of the Project.
- **Frequency** - periodic – Project-related marine vessel traffic will increase by approximately 30 Aframax tanker calls to the Westridge Marine Terminal per month (*i.e.*, an additional 720 tanker transits each year). It will take Project-related marine vessels approximately 12 hours to complete one transit of the Marine RSA, and on average, there will be two transits every 24 hours.
- **Reversibility** - immediate – Steller sea lions in the Marine RSA are expected for the most part to be habituated to regular traffic movements along the shipping lanes and a large part of the acoustic energy produced by Project-related (and other large commercial vessels) is expected to be inaudible. The addition of underwater noise associated with the increase in Project-related traffic that is audible to Steller sea lions is expected to be within the range of current ambient conditions. While individuals in the water are expected to move away from vessels, large-scale disturbance around the haulouts is not expected, and individuals are likely to recover from the direct effects of sensory disturbance immediately.
- **Magnitude** - low – there are no rookeries, critical habitat or DFO Important Areas for Steller sea lions in the Marine RSA, and introduced noise from Project-vessels (relative to Steller sea lion hearing) will mostly be within the range of current ambient conditions. Little if any detectable effects are predicted as a result of the increase in current traffic, which will be concentrated along the shipping lanes.
- **Probability** - high – underwater noise produced by Project-related marine vessels is expected to exceed the current NOAA standards for sensory disturbance within 4 to 7 km of the transiting vessels. However, these thresholds do not factor in species-specific hearing abilities, and based on audiogram-weighted analyses, Project-related marine vessels will for the most part be undetectable to Steller sea lions outside of current ambient conditions. There is a high probability that Steller sea lions will experience some degree of Project-related sensory disturbance while in the Marine RSA.
- **Confidence** - high – pinnipeds in water and away from rookeries are known to be fairly tolerant of even close vessel approaches and the Marine RSA does not include any rookeries, critical habitat, DFO Important Areas or other habitat identified as being key to Steller sea lions.

Other pinnipeds that frequent the Marine RSA include harbour seals and California sea lions, as well as less common sightings of elephant seals and northern fur seals. While harbour seals do breed in the Marine RSA, they do not have specific breeding rookeries as do Steller sea lions and breeding occurs throughout BC. DFO Important Areas for harbour seals in the Marine RSA are shown in Figure 4.2.22. No critical habitat has been identified for any species of pinniped within the Marine RSA. All pinnipeds belong to the same functional hearing group, and effects of sensory disturbance to the Steller sea lion indicator are expected to be comparable to effects on all pinniped species found within the Marine RSA. As such, effects to pinnipeds as a result of the increase in Project-related marine vessel traffic are determined to be not significant.

#### 4.3.7.6.4 Combined Effects of Increased Project-Related Marine Vessel Traffic on Marine Mammals

The evaluation of the combined effects of increased Project-related marine vessel traffic on marine mammals considers collectively the assessment of the likely potential residual effects on the following indicators: southern resident killer whale, humpback whale, and Steller sea lion. The assessment of these indicator species for the selected effects is considered to adequately represent potential Project effects on all marine mammals within the Marine RSA.

A summary of the assessment conclusions for combined effects is provided below and presented in Table 4.3.7.9 (point 4[a]). Where two indicators had different criterion conclusions, the more conservative assessment was carried forward to the combined effects assessment.

- **Spatial Boundary** - Marine RSA – concentrated along the shipping lanes and will decrease with distance from the sound source (*i.e.*, tankers and tugs).
- **Duration** - long-term – tanker transits and the associated production of underwater noise along the shipping lanes will be initiated during operations and extending through the life of the Project.
- **Frequency** - periodic – Project-related marine vessel traffic increase by approximately 30 Aframax tanker calls to the Westridge Marine Terminal per month (*i.e.*, an additional 720 tanker transits each year). It will take Project-related marine vessels approximately 12 hours to complete one transit of the Marine RSA, and on average, there will be two transits every 24 hours.
- **Reversibility** - immediate – marine mammal species would likely recover from the direct effects of a single event causing sensory disturbance (*i.e.*, single passing of a Project-related tanker/tug) immediately (*i.e.*, in less than two days).
- **Magnitude** - high – Project-related underwater noise within the Marine RSA will exceed NOAA's regulatory standards for sensory disturbance. While there are no Canadian regulatory standards with respect to this effect, the NOAA thresholds are used as commonly-applied environmental standards. Southern resident killer whales within 4 to 7 km of the shipping lanes are expected to be disturbed by vessel traffic and this effect will occur throughout the Canadian designated critical habitat for this endangered population.
- **Probability** - high – underwater noise produced by Project-related marine vessels is expected to exceed the current NOAA standards for sensory disturbance within 4 to 7 km of the transiting vessels. As such, there is a high probability that marine mammal species will experience some degree of Project-related sensory disturbance while in the Marine RSA.
- **Confidence** - low - disturbance from vessels and underwater noise have been shown through numerous studies to alter behaviour, cause compensatory responses, and interfere with normal activity patterns, but the greatest source of uncertainty is the linkage of sensory disturbance effects to population-level consequences and the degree to which such effects can be attributed to underwater noise from Project-related marine vessels and other ships and boats.

Given that past and current activities are considered to have caused significant adverse effects on the southern resident killer whale population, the residual effects associated with the increase in Project-related marine vessel activity on this species was considered to be significant. Project-related effects on humpback whale and Steller sea lion populations in the Marine RSA are considered to be not significant.

##### *4.3.7.7 Potential United States Effects*

As there are no Canadian regulatory standards with respect to sensory disturbance due to the increase in Project-related underwater noise, the US regulatory standards for sensory disturbance (*i.e.*, NOAA's) were used in the above assessment as commonly-applied environmental standards. No differences in the indicators or acoustic conditions in the US and Canadian portions of the Marine RSA were identified that would change the nature of the effects assessment. Therefore, the effects are expected to be similar in Canadian and US waters.

##### *4.3.7.8 Summary*

As identified in Table 4.3.7.9, given the current Endangered status of the southern resident killer whale population, residual effects associated with increased Project-related marine vessel traffic on marine mammals are considered to be significant.

#### ***4.3.8 Marine Birds***

This subsection of the ESA considers the potential effects of the increased project-related marine vessel traffic on marine birds. Key issues for marine birds were identified through discussions with provincial and federal government agencies, including EC, and the professional judgment of the assessment team based on extensive experience working on marine terminal and transportation projects in BC. The increased Project-related marine vessel traffic and associated potential visual, acoustic and physical disturbances from large vessels may cause marine birds to flush from and avoid important open water or nearshore feeding and rearing habitats. Individuals that become disoriented can subsequently strike or collide with vessels, particularly at night when vessels have work area and operating lights, or during fog or inclement weather conditions of low visibility. Project-related issues are identified as:

- sensory disturbance and subsequent behavioural alterations resulting from visual presence, wake waves, atmospheric and underwater noise from Project-related marine vessels; and
- potential injury or mortality from strikes or collisions with Project-related marine vessels.

The assessment of potential effects to marine birds from Project-related marine vessel traffic has particular objectives which include, but are not limited to, ensuring there is:

- compliance with the BC *Wildlife Act*, the *CEA Act, 2012*, and the *Migratory Birds Convention Act* (MBCA) with respect to harassment, harm or mortality of birds or bird nesting areas;
- protection for marine bird species at risk, consistent with the objectives of the federal *SARA*, the NEB Filing Manual (2013c), and provincial and local policies related to biodiversity and wildlife habitat conservation (*e.g.*, provincial best management practices);

- management of marine bird species in the context of associated ecological values within the shipping lanes and Marine RSA; and
- special attention to species of importance to the culture and traditional harvest of Aboriginal communities whose traditional territories overlap with the shipping lanes.

*4.3.8.1 Assessment Indicators and Measurement Endpoints*

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. Therefore, a suite of marine bird indicator species, each representing a group of birds with a similar ecological niche, has been selected to represent the effects to a broad range of marine bird species consistent with standard environmental practice (Lindenmayer *et al.* 2000, Mallory *et al.* 2010). The process for selecting indicators for the assessment of effects to marine birds began with a review of existing marine habitats and associated bird species known to be present seasonally within the Marine Birds LSA for marine transportation (see Section 4.3.8.2) that could be affected by Project-related marine vessel traffic. Potential effects from the increased Project-related marine vessel traffic are represented by five selected indicator species: surf scoter; fork-tailed storm-petrel; pelagic cormorant; glaucous-winged gull; and Cassin's auklet. These five species each represent a subset of the diverse assemblage of resident and migrant marine birds that use distinct niches within the matrix of marine and coastal habitats of the Marine Birds LSA. Indicators were selected to fit all or most of the following criteria:

- they are resident in, or seasonally utilize, habitats within the Marine Birds LSA 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 are associated with a confined or sensitive ecological community;
- there is an established baseline to describe 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 one or more coastal Aboriginal communities; and
- they have previously been useful indicators in regional effects-based assessments and, therefore, have been the focus of academic and/or regulatory studies within the Marine Birds LSA.

The selection of a suite of marine bird indicators was discussed with senior representatives of government agencies, including EC. The final selection took into consideration feedback from regulators, Aboriginal communities and stakeholders, and the professional judgment of the assessment team. All of the indicator species are highly mobile and are, at times, widely distributed throughout the Marine RSA. The final selection of indicators focused on marine birds that are:

- of conservation or regional importance;
- have an established baseline of information available and, therefore, are likely to be present seasonally within the Marine Birds LSA and Marine RSA;
- resident, migrant breeders or overwintering species; and/or
- a species belonging to an ecological guild not otherwise well-represented (*e.g.*, pelagic foragers, represented by fork-tailed storm-petrel).

**Fork-tailed storm-petrels** may be affected by sensory disturbance from increased Project-related marine vessel traffic, and has minimal potential to be subjected to injury or mortality as a result of collisions with vessel structures. This species is abundant and widespread using offshore areas and the continental shelf break for up to eight months during the non-breeding season. In the breeding season, it feeds close to colonies in nearshore waters along the shipping lanes and in small groups on the continental shelf. Following ships during the day, it is also attracted by boat lights at night which can cause disorientation. Lights from ocean going vessels attract individuals that often collide with them becoming momentarily dazed and incapable of flying away (USFWS 2006). The fork-tailed storm-petrel has similar requirements to other pelagic bird species that occasionally use the open waters of the Marine RSA, such as short-tailed albatross. It has been known to be sensitive to marine environmental disturbances.

**Cassin's auklets** are a breeding resident species of conservation concern (provincial list status – Blue). Cassin's auklets may be affected by sensory disturbance from increased Project-related marine vessel traffic, and the consequent avoidance of nearshore foraging habitat. Breeding primarily occurs along the coast of BC. It spends its life, resting and feeding, on the open sea and only comes ashore to colonies after dark during the breeding season and leaves before dawn. This behaviour makes auklets vulnerable to injury or mortality from bird strikes or collisions with Project related marine vessels during inclement weather or from night-lighting on vessels. During the non-breeding season, it is most abundant in waters over the continental shelf. Direct threats to local populations include human and sensory disturbance, fisheries-related mortality, mammal predation at colonies and food supply limitations. It has similar habitat requirements to other sensitive alcid species (Hentze 2006, USFWS 2006), such as murrelets and murres, that rely on the open water and nearshore areas for foraging on fish and crustaceans.

**Surf scoters** are a seasonally resident seabird species of conservation concern (provincial list status – Blue) widely distributed along the BC coastline, especially during spring and fall migration periods. The Marine RSA provides staging and overwintering habitat for multi-aged aggregations of a few hundred to several thousand individuals that forage on benthic invertebrates within 1 km of shore. Surf scoters may be affected by sensory disturbances from Project-related marine vessels, particularly in narrow channels and passages, and consequently flush and avoid important nearshore and intertidal foraging habitat. Southward migration from inland breeding areas is usually at night (Butler and Savard 1985), therefore, it may be vulnerable to disorientation from night-lighting and potential injury or mortality as a result of collisions with vessel infrastructure. Non-breeding habitat includes sheltered freshwater and marine bays, harbours and lagoons. It has similar requirements to other resident and seasonally present seabirds that feed on nearshore invertebrates, and to waterfowl species using shoreline habitats.

**Pelagic cormorants** are a resident and locally breeding species of conservation concern (provincial list status – Red). Pelagic cormorants may be affected by sensory disturbance during vessel operations particularly within narrow channels, and potential injury or mortality as a result of collisions with vessel infrastructure during inclement weather events. Active breeding colonies are present on rocky cliffs of islands or headlands within the narrow passage of Haro Strait. The number of pelagic cormorant nests within the Strait of Georgia had declined by approximately 54 per cent between 1987 and 2000 (Chatwin *et al.* 2002) potentially from the effects of nearshore fisheries and gillnet mortalities (USFWS 2006); however, in recent years populations have been stable (Crewe *et al.* 2012). The species is traditionally important to coastal Aboriginal communities as a harvest species (USFWS 2006). The species is sensitive to disturbance, especially near nesting sites and in areas experiencing increased recreational boating activity. Pelagic cormorants dive in the littoral-benthic zone for solitary fish and invertebrates. It has similar foraging and breeding requirements to other piscivorous birds within the Marine RSA, such as common merganser.

**Glaucous-winged gulls** are an abundant resident and locally breeding species eating fish, small birds, eggs, small mammals, invertebrates and refuse. Glaucous-winged gulls may be affected by sensory disturbances during vessel operations, and have a marginal potential for injury or mortality from collisions with vessel infrastructure during weather events or from disorientation as a result of vessel operating or night=time work lights. The gull is an abundant resident and locally breeding species eating fish, small birds, eggs, small mammals, invertebrates and refuse. It has been traditionally harvested by south coast Aboriginal communities (individuals and eggs) (Fediuk and Thom 2003, First Nations Health Council 2011b). Although generally an inshore species, it does venture from the coast where it is often seen around fishing vessels at sea. The gull may feed pelagically as far as the continental shelf (approximately 100 km from shore). The gull has similar requirements to other marine bird species as a generalist in the current context of the both natural and disturbed marine environments, and to other adaptive species in disturbed environs, such as northwestern crow.

Rationale for the selection of each of the indicators is summarized in Table 4.3.8.1.

The increased Project-related marine vessel traffic has the potential to affect marine birds through direct changes in habitat availability from wake effect, sensory disturbance and consequent avoidance in important habitats, and the risk of injury or mortality from Project–related marine vessels. Qualitative measurement endpoints associated with these effects have been identified for each indicator (Table 4.3.8.1). Sensory disturbance was qualitatively assessed for each indicator species based on potential flushing or disturbance threshold, and behaviour alterations or habitat avoidance that might result from marine vessel noise and activity. The likelihood of injury or mortality was qualitatively assessed for each of the indicators based on the potential for strikes or collisions with project-related marine vessels. The predicted degree of change in these parameters was used to characterize, and determine the significance of, potential direct and cumulative environmental effects from the Project.

## TABLE 4.3.8.1

## ASSESSMENT INDICATORS AND MEASUREMENT ENDPOINTS FOR MARINE BIRDS

| Marine Bird Indicator | Measurement Endpoints | Rationale for Indicator Selection |
|---|---|---|
| Fork-tailed storm-petrel | • Qualitative measure of the likelihood of sensory disturbance from the visual presence of vessels, wake waves and atmospheric or underwater noise<br>• Qualitative measure of the potential for injury or mortality of marine birds from vessel strikes | • Resident breeder<br>• Documented as sensitive to light disturbance from vessels at night<br>• Established baseline of bird biology, population abundance and distribution<br>• Sensitive to anthropogenic disturbances<br>• Similar requirement to rare and sensitive pelagic seabirds, such as albatross, jaegers, shearwaters and other petrel species |
| Cassin's auklet | | • Resident breeder<br>• Species of conservation concern<br>• Sensitive to anthropogenic disturbances<br>• Known effects from marine vessels including fisheries-related mortalities<br>• Congregates in mixed species alcid flocks<br>• Established baseline of bird biology, population abundance and distribution<br>• Represents other alcid species |
| Surf scoter | | • Winter resident and spring/fall migrant<br>• Species of conservation concern<br>• Congregates in large flocks during migration and overwintering periods<br>• Established baseline of bird biology, population abundance and distribution<br>• Sensitive to anthropogenic disturbances<br>• Similar requirements to other seabirds and waterfowl using nearshore and intertidal zones, such as goldeneyes and harlequin ducks |
| Pelagic cormorant | | • Breeding resident<br>• Species of conservation concern<br>• Declining in population abundance<br>• Established baseline of bird biology, population abundance and distribution<br>• Traditionally important to Aboriginal communities as a harvest species<br>• Sensitive to vessel and other anthropogenic disturbances<br>• Similar requirement to other littoral zone and deep foraging piscivores such as grebes, loons and other cormorant species |
| Glaucous-winged gull | | • Breeding resident<br>• Abundant population as a generalist in natural and disturbed environments<br>• Established baseline of bird biology, population abundance and distribution<br>• Known attraction to vessels as an opportunistic feeder<br>• Traditionally important to Aboriginal communities as a harvest species<br>• Similar requirements to a wide range of marine birds including other gulls, jaegers and terns |

#### *4.3.8.2 Spatial Boundaries*

Spatial boundaries for the assessment of marine birds include the geographic extent within which the potential effects of the Project are expected to be measurable. The regional setting includes species of conservation concern, breeding sites and marine habitats of particular importance to marine birds, including substantial and internationally important breeding colonies, areas of known seasonal congregations and staging areas, IBAs and other marine conservation areas. The spatial boundaries have been identified as the Marine Birds LSA and the Marine RSA.

- **Marine Birds LSA** - includes the inbound and outbound marine shipping lanes, the area between the shipping lanes where it exists and a 1 km buffer extending from the outermost edge of each shipping lane. The shipping lanes extend from the Westridge Marine Terminal in Burnaby, through Burrard Inlet, south through southern part of the Strait of Georgia, the Gulf Islands and Haro Strait, then westward past Victoria and though Juan de Fuca Strait out to the 12 nautical mile limit of Canada's territorial sea.
- **Marine RSA** - comprised of a large portion of the Salish Sea, including the inland marine waters of the southern Strait of Georgia and Juan de Fuca Strait and their connecting channels, passes and straits. The Marine RSA is generally centred on the marine shipping lanes, which extend from the Westridge Marine Terminal through Burrard Inlet, south through the southern part of the Strait of Georgia, the Gulf Islands and Haro Strait, westward past Victoria and through Juan de Fuca Strait out to the 12 nautical mile limit of Canada's territorial sea. The western boundary of the Marine RSA extends further out to sea than the western boundary of the Salish Sea and the northern boundary of the Marine RSA is limited to the southern portion of the Strait of Georgia. Puget Sound is excluded from the Marine RSA.

The marine birds study areas also follow guidance indicated by the NEB in the letter titled Filing Requirements Related to the Potential Environmental and Socio-Economic Effects of Increased Marine Shipping Activities (NEB 2013b), received by Trans Mountain on September 10, 2013. The letter indicates that the marine transportation assessment should take place out to the 12 nautical mile limit of Canada's territorial seas.

Study area boundaries for marine birds are shown in Figure 4.2.2.

#### *4.3.8.3 Marine Bird Context*

The Marine RSA falls within the Strait of Georgia, Haro Strait and Juan de Fuca Strait, all of which are within the Salish Sea, an inland area of ocean that extends from Olympia, Washington northward to Campbell River, BC. To the east it is bounded by the mainland coasts of BC and Washington State, and the Fraser River Delta, which drains into the Strait of Georgia. The Olympic Peninsula of Washington State is to the southwest. Numerous islands and islets belonging to either the Gulf Islands or the San Juan Islands form an archipelago of diverse marine habitats with associated dependent marine life.

The shipping lanes are an established route for all types of vessels and are among the busiest shipping lanes on the Pacific coast. Marine vessels including cargo ships, cruise ships and oil tankers are required to use these distinct shipping lanes for navigational and safety purposes (BC MCA 2010, CCG 2013b, Volume 8C, TERMPOL Studies). Most commercial vessels use the Strait of Georgia to access the 23 major marine terminals in Burrard Inlet, two automobile terminals, and a cargo and container terminal along the Fraser River and the Deltaport at Roberts Bank. In 2012, tug and barge transits made up approximately 49 per cent of the total sailed nautical miles, with cargo and ferry traffic making up a further 18 per cent and 15 per cent, respectively (Volume 8C, TERMPOL Studies). Tanker and cargo traffic from Vancouver uses Haro Strait to access international waters via the Juan de Fuca Strait. In 2012, passenger ferries made up approximately 38 per cent of the total sailed nautical miles in Haro Strait, with cargo traffic making up a further 21 per cent (Volume 8C, TERMPOL Studies).

Marine and coastal ecosystems are subject to dramatic large-scale changes and fluctuations in productivity. El Niño events result in elevated water temperatures and decreased abundance of prey species, which can lead to reduced reproductive output and survival rates for marine birds. Human activities and disturbances exacerbate these natural pressures. Much of the marine shoreline within the Marine RSA is developed for industrial or residential use, with the exception of some federally and provincially-designated conservation areas including MPAs, RCAs, WMAs, Ecological Reserves, Provincial Parks and State Parks. There are 20 IBAs present within the Marine RSA, which range in size from 140 ha to 153,717 ha (see Marine Birds – Marine Transportation Technical Report, Volume 8B, TR 8B-2). Marine areas that are adversely affected by recreation, commercial fishing, human developments, and vessel operations reduce habitats available for marine birds.

Marine birds require marine and coastal habitats during all or a part of their life cycle (Croxall *et al.* 2012). The Salish Sea supports diverse populations of seasonally present bird species using important foraging areas, such as marine upwellings, shallow open water and the continental shelf. The Marine RSA encompasses many large breeding and staging areas that are in close proximity to the shipping lanes. Breeding colonies of double-crested cormorants, pelagic cormorants, black oystercatchers, rhinoceros auklets, Cassin's auklets, tufted puffins, pigeon guillemots, great blue herons, fork-tailed storm petrels, Leach's storm-petrels, and glaucous-winged gulls are documented within the Salish Sea (Chatwin *et al.* 2002, Elliot *et al.* 2005, Vermeer 1983, Wahl *et al.* 1981). Extensive nest sites are located on Protection Island, Tatoosh Island, Smith and Minor Islands, Mandarte Island, and Race Rocks (Wahl *et al.* 1981) (Figure 4.2.26). Multiple non-colonial species also breed in these areas (Burton 2010, Wahl *et al*. 1981).

An estimated 124 marine bird species (Campbell *et al.* 1990, Stevens 1995) in the Marine RSA use coastal terrestrial habitats (above high-water mark); foreshore (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). Species of conservation concern reported within the Marine RSA include short-tailed albatross, Brandt's cormorant, double-crested cormorant, western grebe, great blue heron, Cassin's auklet, common murre, tufted puffin, horned puffin, marbled murrelet, surf scoter, red knot, long-billed curlew and peregrine falcon (Badzinski *et al.* 2008, BC CDC 2013).

### *4.3.8.4 Potential Effects and Mitigation Measures*

#### **4.3.8.4.1 Effects Considerations**

The potential for effects from Project-related marine vessel traffic is considered in the context of the volume and activity of existing traffic in the established in-bound and out-bound shipping lanes. The lanes are confined for a small portion of the entire route out to sea, primarily within Burrard Inlet east of First Narrows, and within Haro Strait where the vessels pass a complex of small islets and channels. Average channel width in the Strait of Georgia and Juan de Fuca

Strait is approximately 22 to 28 km (Thompson 1981); therefore, the greatest proportion of the Marine Birds LSA surrounding the shipping lanes is open water habitat.

A thorough review of potential issues to include in the assessment of potential Project effects on marine birds was based on the assessment team's experience and relevant scientific literature. Additional issues were raised through consultation with Aboriginal communities, government agencies and other stakeholders; however, some were eventually scoped out by the assessment team based on past experience with similar projects. These included recommendations to assess other indicator species such as black oystercatcher, great blue heron and western grebe. Oystercatchers and herons use shoreline habitats within the Marine RSA, and effects to these species from routine operations would be associated with wake effects. As indicated in the detailed assessment of wake effects in Section 4.3.6.6 for Marine Fish and Fish Habitat, only 5 per cent of the total length of shoreline in the Canadian portion of the Marine RSA is located within 2 km of the shipping lanes. These areas include shoreline in Burrard Inlet, Haro Strait and the area around Victoria on Vancouver Island. Wake waves from Project-related marine vessel traffic are expected to be well within the range of natural wave conditions. Wave height would dissipate rapidly at increasing distances from the vessels. Any temporary disturbance to intertidal habitat due to vessel wake would not normally be detectable from existing conditions and, therefore, marine birds are unlikely to be disturbed to any substantial extent by wave heights from Project-related marine vessels. As such, there is no anticipated potential effect of vessel wake on marine birds and it is not discussed further.

Western grebes are of conservation concern and seasonally present within the Marine RSA in small groups. Although an important species of concern, western grebes are represented in the assessment of effects to various foraging guilds by selected indicator species, primarily the pelagic cormorant, due to its conservation status, similar foraging strategy, importance as a resident breeder and its abundant local population.

#### 4.3.8.4.2 Identified Potential Effects

The potential for environmental effects on marine birds is assessed by first identifying the ecology and habitat requirements of species using the study area and then considering these with respect to the increased Project-related marine vessel traffic. The potential effects associated with marine shipping were based on the results of a literature review, desktop analyses, TMRU studies, and expertise of the assessment team. Consultation with senior representatives of government agencies (primarily EC) and other relevant stakeholders provided additional information on potential effects and recommendations for mitigation. The increased Project-related marine vessel traffic has potential to adversely affect marine birds through sensory disturbances from the visual presence of vessels and/or atmospheric and underwater noise, which then may result in behaviour alterations. Injury or mortality could result from bird disorientation from night-lighting during vessel operations, and consequent bird strikes or collisions with vessels.

**Behaviour Alterations or Sensory Disturbance**

Physiological responses of animals to visual disturbance may include increased heart rate and respiration, increased blood flow to skeletal muscle, increased body temperature, elevations of blood sugar and reduced blood flow to the skin and digestive organs, a "fight or flight" response (Knight and Gutzwiller 1995), which is key to improving their chances of survival under adverse conditions. Non-lethal disturbance stimuli caused by humans can create a response in birds analogous to predation risk (Frid and Dill 2002). Noise disturbances can cause increased energy expenditure in seabirds especially during breeding periods (Jungius and Hirsch 1979).

Repeated disturbance events over time decreases the time and energy spent in fitness-enhancing activities such as feeding, parental care or mating and results in lowered fitness levels. The bird's level of perceived risk depends on the particular species, the environmental variables present and factors related to natural predation risk. These energetic trade-offs can indirectly affect population survival and reproduction.

Marine birds have been documented as particularly sensitive to various human-related disturbances (Birdlife International 2012b, Carney and Sydeman 1999, Ruddock and Whitfield 2007, Smith 2000), the degree of which is dependent on the species. BC MOE (2004) identifies disturbance by vessel traffic in at-sea foraging sites as a threat to marine birds, with some species more sensitive to approaching vessels than others (Schwemmer *et al.* 2011). Studies have shown that atmospheric noise and visual disturbances can cause a flight or panic response near colonies that can result in avoidance of important habitats or abandonment of nests (DND 1994, Dufour 1980). Marbled murrelets and pelagic cormorants have exhibited a strong flushing response when recreational vessels are within 70 m and 150 m, respectively. Some species may even react before the possibility of visual detection by a boat-based observer. In a study of cormorants by Hentze (2006), over 60 per cent of cormorants reacted at 150 m. Some species or individuals chose to fly and leave the feeding area completely, others dove and resurfaced a short distance away from the boat (Bellefleur *et al.* 2009, Hentze 2006). Kittlitz's murrelets foraging at nearshore areas have had temporarily suppressed feeding by passing vessels, although normal behaviour resumed within the same day (Agness *et al.* 2008). Variables such as season, sea state, hour, bird group size, vessel speed, approach distance, approach angle, average bird density, location, and average prey density all combine to influence marine bird flushing distances (Hentze 2006).

Anthropogenic noise sources can mask communication, displace animals from preferred foraging or breeding habitat, disrupt predator-prey interactions and in extreme cases, cause hearing loss. The atmospheric sound levels required to cause disturbance or damage to hearing in birds are believed to be high (>90 dB re 20 uPa), and generally of high intensity or long duration (DND 1994). There is evidence that some sea birds are markedly disturbed (if not injured) by impulse sound levels in air, in the 120 dB re 20 uPa range (Black 2005). Marine birds located near transiting vessels may respond to atmospheric noise by panic, flushing and moving away for the duration of the disturbance.

There is little information in the literature to evaluate marine bird response to disturbance from underwater noise. Underwater dB-levels are represented differently from atmospheric dB-levels and may be adjusted by adding 25.5 dB to the airborne dB-level to get a comparable underwater dB-level. Furthermore, as a result of the much higher acoustic impedance of water compared to air, another 36 dB correction is required, making an airborne sound pressure level of, for example, 90 dB re 20 uPa comparable to an underwater 151.5 dB re 1 uPa (Slabbekoorn *et al.* 2010). Underwater vessel noise varies as a function of vessel size, speed and design. In general, large vessels create louder and lower frequency sounds than smaller vessels (Richardson *et al.* 1995). Noise is produced by propeller cavitation and the broadband source levels from a VLCC can exceed 205 dB re 1 uPa at source (Richardson *et al.* 1995). Other tankers are reported as typically emitting underwater sound between 169 and 200 dB re1 uPa at source. Black-footed penguins (*Spheniscus demersus*) have been documented as sensitive to frequencies within the range of 100 Hz to 15 kHz (Wever *et al.* 1969). The underwater call playback of a chase-boat engine noise from 150 m has been used to reduce waterfowl predation pressure on molluscs (Ross *et al.* 2001). Many seabirds spend a substantial portion of their lives under the water and most likely have sensory adaptations to facilitate aquatic life history. Although there is substantial variation among species (*e.g.*, species-specific disturbance thresholds, scale of displacement, recovery times or resilience) and under differing conditions, previous research indicates that birds may habituate to low noise levels that are continuous or predictable (Gladwin *et al.* 1988). Hearing effects in birds are well documented on land but effects from underwater noise depends on how often and deeply seabird species dive, their tendency to be disturbed by noise, and their ability to adapt to excess noise (Dooling 1978). With few data or measurements of underwater hearing abilities in birds, and a paucity of literature on the effects of underwater noise on bird behaviour, it is difficult to directly assess potential effects of underwater noise on marine birds found in the Marine RSA. Potential effects of underwater noise are considered as part of the assessment of potential general sensory disturbance.

Speckman *et al.* (2004) found that marbled murrelets in Alaska were reasonably habituated to the physical presence of transiting marine vessels, such that they tended to paddle away, or dive, rather than fly, which is more energetically intensive. Birds tend to habituate to disturbance when it is predictable and not associated with a negative experience such as fright or harm (Steidl and Anthony 2000, Ward and Stehn 1989). Habituation may occur to various degrees in some species, and could continue to occur in the Marine RSA; however, this is difficult to measure without extensive research, and also difficult to separate from the disturbances caused by other human or vessel activities along the shipping lanes.

Sensory disturbances in the Marine Birds LSA could result in the alteration of their normal movement patterns to avoid vessel noises or activities. Atmospheric and underwater noise, and activity during vessel operations, could cause birds to avoid preferred sites within the Marine Birds LSA, and consequently reduce habitat effectiveness (see Figure 4.2.3). Currently, there are abundant populations of marine birds using habitats that overlap areas of high shipping activity, such as Haro Strait, the Fraser River, Burrard Inlet and the Strait of Georgia. However, vessel traffic near seabird colonies in the region is a relatively common occurrence and; therefore, Project-related shipping activity is not expected to present a new environmental effect.

**Likelihood of Injury or Mortality**

Injury or mortality may occur as a result of marine bird interactions with Project-related marine vessel activities. Major sources of artificial light in the marine environment include vessels, marine terminals, lighthouses, light-induced fisheries and oil/gas platforms. 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). Light-induced bird strikes are known to occur when vessels navigate during darkness (Merkel and Johansen 2011) and the likelihood of injury or mortality increases when visibility is reduced by fog and extreme weather conditions (Birdlife International 2003, Greer *et al.* 2010). Variables that can combine to influence the likelihood of strikes include weather conditions, season and lunar phase, and the species and age of birds. (Montevecchi 2006). In a few cases, mass collisions of hundreds or thousands of seabirds have been documented during storm events (Black 2005). Some species groups, such as alcids (Merkel and Johansen 2011, Stumpf *et al.* 2011), are more responsive or confused and, therefore, more susceptible to night-lights and the potential for collisions with vessel infrastructure. In a study off the coast of Greenland by Merkel and Johansen (2011), all reported bird strikes occurred during the night or in twilight, from 4 pm to 5 am, and with a higher frequency during the dark mid-winter period. In 26 of the 42 cases, visibility was reduced due to snow or rain. These types of events have also been documented at various shipping areas around the world (Black 2005, Merkel and Johansen 2011, Montevecchi 2006). This information is lacking for the Marine RSA; however, and no specific thresholds for evaluating the effect have been identified.

Potential effects associated with the increased Project-related marine vessel traffic on marine bird indicators are listed in Table 4.3.8.2. The summary of recommended mitigation measures provided in Table 4.3.8.2 was principally developed in accordance with provincial regulatory guidelines including Develop with Care 2012 (BC MFLNRO 2012).

**TABLE 4.3.8.2**

**POTENTIAL EFFECTS, MITIGATION MEASURES AND RESIDUAL EFFECTS OF INCREASED PROJECT-RELATED MARINE VESSEL TRAFFIC ON MARINE BIRDS**

| Potential Effect | Spatial Boundary[1] | Key Mitigation Measures in Place/Additional Recommendations | Potential Residual Effect(s) |
|---|---|---|---|
| **1. Marine Birds Indicators – Fork-tailed Storm-petrel, Cassin's Auklet, Surf Scoter, Pelagic Cormorant, Glaucous-winged Gull** | | | |
| 1.1 Behavioural alteration or sensory disturbance | RSA | • No mitigation is recommended since Project-related marine vessels will be operated by third-party subcontracting corporations acting under relevant shipping and piloting authorities. Marine transportation in Canadian territorial waters is regulated through the *Canada Shipping Act* administered by Transport Canada and the CCG. | • Sensory disturbance, stress, behavioural changes or avoidance of important habitats. |
| 1.2 Likelihood of injury or mortality | LSA | • No mitigation is recommended since Project-related marine vessels will be operated by third-party subcontracting corporations acting under relevant shipping and piloting authorities. Marine transportation in Canadian territorial waters is regulated through the *Canada Shipping Act* administered by Transport Canada and the CCG. | • Injury or mortality events. |

**Note:** 1 LSA = Marine Birds LSA; RSA = Marine RSA

The objectives of the Project are to ensure that industry-accepted practices are implemented to avoid, or limit, any potential adverse effects from activities related to vessel operations as well as implement acceptable and effective mitigation measures and environmental management procedures. Through a background of ecological knowledge of the surrounding local and regional marine areas, and the implementation of appropriate management practices and measures, it is predicted that the Project can meet the objectives for protection of marine bird species, species at risk and regulatory compliance, and traditional and regional biodiversity values through reductions in the potential for sensory disturbances, injury or mortality.

#### *4.3.8.5 Potential Residual Effects*

Residual effects are those that are predicted to remain after mitigation measures have been applied. The potential residual environmental effects on the marine birds indicators associated with the increased Project-related marine vessel traffic (Table 4.3.8.2) are as follows:

- sensory disturbance, stress, behavioural changes or avoidance of important habitats; and
- injury or mortality events.

#### *4.3.8.6 Significance Evaluation of Potential Residual Effects*

In general, non-significant effects can occur in a population in a localized manner over a short period of time (similar to natural variation) and have no measurable and/or meaningful adverse effect on the integrity of the population as a whole (BC EAO 2013, FEARO 1994c). A residual adverse effect is considered significant when a population of a species is sufficiently affected to cause a change beyond which natural recruitment (*i.e.*, reproduction and immigration from unaffected areas) will not return the regional population to its former level. Significant effects have a high probability of a permanent or long-term and high magnitude effect that cannot be technically mitigated.

The magnitude of effect on most indicators from increased likelihood of mortality and sensory disturbance can be determined qualitatively. This is the most appropriate approach to evaluate the potential residual environmental effects without measurable standards to compare them to. Evaluation of the significance of these potential residual effects relies on the professional judgment of the assessment team that includes members with extensive environmental impact assessment experience in marine environments. Mitigation measures are intended to avoid or reduce the severity of potential effects.

Table 4.3.8.3 provides a summary of the evaluation of significance of residual effects on the marine birds indicators from the increased Project-related marine vessel traffic.

**TABLE 4.3.8.3**

**SIGNIFICANCE EVALUATION OF POTENTIAL RESIDUAL EFFECTS OF INCREASED PROJECT-RELATED MARINE VESSEL TRAFFIC ON MARINE BIRDS**

| Potential Residual Effects | Impact Balance | Spatial Boundary[1] | Temporal Context | | | Magnitude | Probability | Confidence | Significance[2] |
|---|---|---|---|---|---|---|---|---|---|
| | | | Duration | Frequency | Reversibility | | | | |
| **1. Marine Birds Indicator – Fork-tailed Storm-petrel** | | | | | | | | | |
| 1(a) Behavioural alteration or sensory disturbance. | Negative | RSA | Long-term | Periodic | Short-term | Low | High | High | Not significant |
| 1(b) Likelihood of injury or mortality. | Negative | LSA | Long-term | Occasional | Medium-term | Low | Low | High | Not significant |
| **2. Marine Birds Indicator – Cassin's Auklet** | | | | | | | | | |
| 2(a) Behavioural alteration or sensory disturbance. | Negative | RSA | Long-term | Periodic | Short-term | Medium | High | High | Not significant |
| 2(b) Likelihood of injury or mortality. | Negative | LSA | Long-term | Occasional | Medium-term | Low | Low | High | Not significant |
| **3. Marine Birds Indicator – Surf Scoter** | | | | | | | | | |
| 3(a) Behavioural alteration or sensory disturbance. | Negative | RSA | Long-term | Periodic | Short-term | Medium | High | High | Not significant |
| 3(b) Likelihood of injury or mortality. | Negative | LSA | Long-term | Occasional | Medium-term | Low | Low | High | Not significant |
| **4. Marine Birds Indicator – Pelagic Cormorant** | | | | | | | | | |
| 4(a) Behavioural alteration or sensory disturbance. | Negative | LSA | Long-term | Periodic | Short-term | Medium | High | High | Not significant |
| 4(b) Likelihood of injury or mortality. | Negative | LSA | Long-term | Occasional | Medium-term | Low | Low | High | Not significant |

**TABLE 4.3.8.3**

**SIGNIFICANCE EVALUATION OF POTENTIAL RESIDUAL EFFECTS OF INCREASED PROJECT-RELATED MARINE VESSEL TRAFFIC ON MARINE BIRDS (continued)**

| Potential Residual Effects | Impact Balance | Spatial Boundary[1] | Temporal Context: Duration | Temporal Context: Frequency | Temporal Context: Reversibility | Magnitude | Probability | Confidence | Significance[2] |
|---|---|---|---|---|---|---|---|---|---|
| **5. Marine Birds Indicator – Glaucous-winged Gull** | | | | | | | | | |
| 5(a) Behavioural alteration or sensory disturbance. | Negative | LSA | Long-term | Periodic | Short-term | Low | High | High | Not significant |
| 5(b) Likelihood of injury or mortality. | Negative | LSA | Long-term | Occasional | Medium-term | Low | Low | High | Not significant |
| **6. Combined Effects of Increased Project-related Marine Vessel Traffic on Marine Birds** | | | | | | | | | |
| 6(a) Combined effects of increased Project-related marine vessel traffic on the marine birds indicators (1[a], 2[a], 3[a], 4[a] and 5[a]). | Negative | RSA | Long-term | Periodic | Short-term | Medium | 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.

### 4.3.8.6.1 Marine Birds Indicator - Fork-tailed Storm-petrel

The following subsections provide the evaluation of significance of the potential residual effects on the fork-tailed storm-petrel indicator.

**Sensory Disturbance, Stress, Behavioural Changes or Avoidance of Important Habitats**

The fork-tailed storm-petrel moves offshore during the non-breeding season and is most associated with the continental shelf and shelf break (Shuford and Gardali 2008). The fork-tailed storm-petrel rarely lands, fluttering low over offshore waves, sometimes in flocks, hovering over the ocean to capture fish and zooplankton from the surface of the water. This will reduce the potential for the extent of sensory disturbances that might affect surface or diving foragers. The increase in large vessel traffic introduced by the Project is unlikely to have long-term effects that are detectable within the regional population of fork-tailed storm-petrel considering the context of the existing high volume large vessel traffic within the Marine RSA, and the highly pelagic nature of this species. The physical presence of vessels and noise is anticipated to result in localized, regular, and short-term sensory disturbance (*i.e.*, the avoidance of preferred or important habitats) that is considered to have a negative impact balance. Observations within the Marine RSA during the fall are most likely to occur near Race Rocks as indicated by previously documented observations (Bird Studies Canada 2013b) and somewhat distant from marine vessels, so the probability of substantial disturbance events is low. Flushing and noise disturbances may happen in close range of the vessel, depending on the vessel activity and existing sea conditions but is expected to have a lower probability of affecting this species compared to other indicators. Fork-tailed storm-petrels may be partially habituated to the presence and activity of marine traffic, since they commonly forage by following ships during the day to take advantage of discarded food. The magnitude of the residual effects on fork tailed storm-petrel associated with sensory disturbance caused by the increased Project-related marine vessel traffic is considered to be low (Table 4.3.8.3, point 1[a]). A summary of the rationale for all of the significance criteria is provided below.

- **Spatial Boundary** - Marine RSA – effects may extend beyond the Marine Birds LSA under certain at-sea conditions considering the pelagic, wide-ranging and agile flight pattern of storm-petrels.
- **Duration** - long-term – the event causing sensory disturbance to fork-tailed storm-petrels is the operation of Project-related marine vessels which occurs for the life of the Project.
- **Frequency** - periodic – the event causing sensory disturbance to fork-tailed storm-petrels is the passage of Project-related marine vessels which will occur intermittently, but repeatedly, with regular vessel transits at the potential rate of twice per day, for the life of the Project.
- **Reversibility** - short-term – recovery from the effects of sensory disturbance may be interrupted by subsequent vessels or other marine activities and, therefore, may not be reversible in immediately but in some period greater than 2 days but less than one year.
- **Magnitude** - low – the effects will be detectable at the individual level but marginal to negligible on the population level with consideration for the context of high volume large vessel traffic currently within the study area, and the tendency for storm-petrels to follow ships opportunistically.
- **Probability** - high – the Project is likely to cause sensory disturbance to fork-tailed storm-petrel.
- **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 study area.

**Injury or Mortality Events**

Fork tailed storm-petrels are attracted by night-lighting on marine vessels which can result in harmful or fatal collisions with ship infrastructure (USFWS 2006), although these events have been uncommon (Black 2005, Le Corre *et al.* 2002). The residual effect of injury or mortality associated with the increased Project-related marine vessel traffic is considered to have a negative impact balance. Accounting for the low abundance of individuals likely to be present seasonally, the probability of a fork-tailed storm-petrel being hit by, or colliding with, Project-related marine vessels is anticipated to be low (Table 4.3.8.3, point 1[b]). With consideration for the presence of navigational and work lights, and associated light effects from many vessels within the shipping lanes at night, it would be difficult to isolate the effects of additional lighting associated directly with the increase in vessels from the Project. A summary of the rationale for all of the significance criteria is provided below.

- **Spatial Boundary** - Marine Birds LSA – effects are confined to the vicinity of the shipping lanes for Project-related marine vessels.

- **Duration** - long-term – the event causing injury or mortality effects on fork-tailed storm-petrel is the operation of the increased Project-related marine vessel traffic, which will continue for the life of the Project.
- **Frequency** - occasional – the event leading to a potential injury or mortality will occur intermittently and sporadically for the life of the Project.
- **Reversibility** - medium-term – the effect of an event of mortality will be restored in one generation of recruitment and maturity for individuals of that species.
- **Magnitude** - low – the effects will not be detectable at regional population levels.
- **Probability** - low – injury and mortality are possible but 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, and data pertinent to the coastal region.

#### 4.3.8.6.2 Marine Bird Indicator - Cassin's Auklet

The following subsections provide the evaluation of significance of the potential residual effects on the Cassin's auklet indicator.

**Sensory Disturbance, Stress, Behavioural Changes or Avoidance of Important Habitats**

Cassin's auklets breed in colonies at established sites within the western portion of Marine RSA near Juan de Fuca Strait. During the non-breeding season, they spend most of the time at sea in upwellings, with southern populations likely moving north (Ainley *et al.* 2011) and northern ones moving south to the continental shelf. Cassin's auklets forage during both day and night, usually in small groups, and occasionally in large flocks. During the non-breeding season, larger flocks are vulnerable to disturbance. There is unlikely to be more than a low level of habituation to an increase in the presence and activity of marine vessel traffic, as indicated by scientific literature that documents the sensitivities of these and other alcid species to various sources of disturbance (Hentze 2006). Considering the existing relatively high volume of vessel traffic within the Marine Birds LSA and Marine RSA, the increase in large vessel traffic introduced by the Project is likely to have short-term effects on individuals and small groups; however, it is unlikely that these residual effects will be detectable in the regional population of Cassin's auklet. This effect is considered to have a negative impact balance. The physical presence of vessels and noise is anticipated to result in localized, regular sensory disturbances to Cassin's auklet considered to be of medium magnitude (Table 4.3.8.3, point 2[a]). A summary of the rationale for all of the significance criteria is provided below.

- **Spatial Boundary** - Marine RSA – effects may extend beyond the Marine Birds LSA depending on at-sea conditions, the known sensitivity of the species, season (*e.g.*, breeding), and age of individuals.
- **Duration** - long-term – the event causing sensory disturbance to Cassin's auklet will be initiated during operations and occur for the life of the Project.

- **Frequency** - periodic – sensory disturbance to Cassin's auklet will occur intermittently, but repeatedly, with regular transits potentially twice per day, for the life of the.
- **Reversibility** - short-term – recovery from the effect of sensory disturbance may be interrupted by subsequent vessels or other marine activities and, therefore, may not be reversible immediately but in some period greater than 2 days but less than one year.
- **Magnitude** - medium – the effects will be detectable at the individual level, but low to moderate on the population level considering the context of high volume large vessel traffic conditions currently within the study area, the regularity of Project-related marine vessel transits twice per day, and the known sensitivity of alcid species to disturbance.
- **Probability** - high – the Project is likely to cause sensory disturbance to Cassin's auklet.
- **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 coastal region.

**Injury or Mortality Events**

Cassin's auklets are among the group of marine birds, the alcids, documented as vulnerable to night lighting on marine vessels, due to their tendency to fly long distances at night to and from the nesting colony, sometimes resulting in harmful or fatal collisions with ship infrastructure. The potential effect from Project-related marine vessel traffic resulting in injury or mortality is considered to have a negative impact balance, especially during the breeding season. Bird strikes or vessel collisions are expected to be uncommon and sporadic; however, considering the presence of navigational and work lights, and the associated light effects from all vessels using these same the shipping lanes at night, it would be difficult to isolate the direct effects of additional lighting associated with the Project. Therefore, the residual effect on Cassin's auklet is considered to be of low magnitude (Table 4.3.8.3, point 2[b]). A summary of the rationale for all of the significance criteria is provided below.

- **Spatial Boundary** - Marine Birds LSA – effects are confined to the vicinity of the shipping lanes for Project-related marine vessels.
- **Duration** - long-term – the event causing potential injury or mortality effects on Cassin's auklet is the operation of the Project-related marine vessel traffic, which will continue for the life of the Project.
- **Frequency** - occasional – the event leading to a potential injury or mortality effect may occur intermittently and sporadically for the life of the Project.
- **Reversibility** - medium-term – the effect of an event of mortality will be restored in one generation of recruitment and maturity for individuals of that species.
- **Magnitude** - low – the effects are not expected to be detectable at regional population levels.

- **Probability** - low – injury and mortality is possible but 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, and data pertinent to the coastal region.

#### 4.3.8.6.3 Marine Bird Indicator - Surf Scoter

The following subsections provide the evaluation of significance of the potential residual effects on the surf scoter indicator.

**Sensory Disturbance, Stress, Behavioural Changes or Avoidance of Important Habitats**

Surf scoters are seasonally migrant and not known to breed in the Marine RSA. Effects from sensory disturbance would be limited to the wintering, migrating and moulting periods (late summer to late spring when large rafts of foraging birds are present, primarily in nearshore areas with abundant benthic resources. A smaller proportion of the non-breeding population is found in open waters during this time. The vessel activity and noise is anticipated to result in localized, regular, short-term disturbances primarily in narrower portions of the shipping lanes, such as in Haro Strait. Depending on the time of year, large aggregations of surf scoters (*e.g.*, thousands in spring foraging on Pacific herring spawn) could be vulnerable to effects; however, groups of birds are expected to move away from vessels. If the disturbance is not substantial, normal behaviors and activities should resume within a relatively short time–frame, depending on whether the recovery period is interrupted by subsequent marine activities. The impact balance of residual sensory disturbance to surf scoter is considered to be negative. The change in large vessel traffic introduced by the Project will be long term; however, it is unlikely that adverse effects would be detectable within the relatively large regional population of surf scoters considering the context of high volume vessel traffic within the Marine RSA (Table 4.3.8.3 point 3[a]). Surf scoters may be somewhat habituated to the presence and activity of marine vessel traffic, although this has not been assessed in the region, and is somewhat less likely in birds that are present seasonally and not resident. A summary of the rationale for all of the significance criteria is provided below.

- **Spatial Boundary** - Marine RSA – effects may extend beyond the Marine Birds LSA depending on at-sea conditions, the bird activity and season (*e.g.*, breeding), group size and age of individual surf scoters.
- **Duration** - long-term – the event causing the potential sensory disturbance to surf scoter will be initiated during operations and occur for the life of the Project.
- **Frequency** - periodic – sensory disturbance to surf scoter will occur intermittently, but repeatedly, due to regular transits potentially twice per day, for the life of the Project .
- **Reversibility** - short-term – recovery from the effects of sensory disturbance may be interrupted by subsequent vessels or other marine activities and, therefore, may not be reversible immediately but in some period greater than 2 days but less than one year.

- **Magnitude** - medium – the effects will be detectable at the individual level, marginal to seasonally moderate on the population level considering the high volume large vessel traffic conditions currently within the study area and the potential for large aggregations of birds during overwintering in channels and nearshore habitats.
- **Probability** - high – the Project is likely to cause sensory disturbances to surf scoters.
- **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 Project area.

**Injury or Mortality Events**

Surf scoters migrate from inland breeding areas in fall, usually flying at night. They are, therefore, considered potentially vulnerable to night-lighting on marine vessels, during migration, and to disorientation during inclement weather, fog and low visibility. Bad weather events can result in harmful or fatal collisions with vessel infrastructure, although these events are not often documented in this species (Savard *et al.* 1998). Consequently, although potential adverse effects are considered to have a negative impact balance, bird strikes or collisions are expected to be uncommon. And it would be difficult to isolate the direct effects of lighting associated with the increase in vessels from the Project from those effects of navigational and work lights present on other vessels in the shipping lanes. The magnitude of the residual effect on surf scoter is considered to be of low magnitude (Table 4.3.8.3, point 3[b]). A summary of the rationale for all of the significance criteria is provided below.

- **Spatial Boundary** - Marine Birds LSA – effects are confined to the vicinity of the shipping lanes for Project-related marine vessels.
- **Duration** - long-term – the event causing potential injury or mortality effects on surf scoter is the operation of Project-related marine vessel traffic, which will continue for the life of the Project.
- **Frequency** - occasional – the event leading to a potential injury or mortality effect may occur intermittently and sporadically for the life of the Project.
- **Reversibility** - medium-term – the effect of an event of mortality will be restored in one generation of recruitment and maturity for individuals of that species.
- **Magnitude** - low – the effects will potentially occur to individuals but will not likely be detectable at regional population levels.
- **Probability** - low – injury and mortality is possible; however, is 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, and data pertinent to the coastal region.

#### 4.3.8.6.4 Marine Bird Indicator - Pelagic Cormorant

The following subsections provide the evaluation of significance of the potential residual effects on the pelagic cormorant indicator.

**Sensory Disturbance, Stress, Behavioural Changes or Avoidance of Important Habitats**

The regional population of pelagic cormorants is abundant year-round and habitat use is primarily focused in nearshore areas for fishing. This species is known to have one of the largest flushing distances among marine birds, depending on age, season and sea conditions. Any disturbance effects would be considered to have a negative impact balance and would primarily be expected to occur in the narrow portions of the shipping lanes used for feeding, such as in Haro Strait. Although the sensitivity of pelagic cormorants to human disturbances is well documented, they have also been known to use developed sites for foraging, and commercial structures and vessels for perching and resting. While the change in large vessel traffic introduced by the Project is likely to have long-term adverse effects, it is unlikely that these effects would be detectable at the regional population level for pelagic cormorants considering their likely familiarity with the high volume of vessel traffic present within the study area. A level of habituation to the presence and activity of marine traffic in some areas might be assumed with their tendency to utilize man-made structures, although habituation has not previously been assessed in the Marine RSA. Consequently, the residual effect of sensory disturbance on pelagic cormorants associated with the increased Project-related marine vessel traffic is considered to be of medium magnitude (Table 4.3.8.3, point 4[a]). A summary of the rationale for all of the significance criteria is provided below.

- **Spatial Boundary** - Marine Birds LSA – effects are likely to be limited to the Marine Birds LSA in a ZOI specific to the site-specific sensitivity of the pelagic cormorant (approximately 500 m), depending on weather conditions, bird age and activity, and season.
- **Duration** - long-term – the event causing potential sensory disturbance to pelagic cormorant will be initiated during operations and occur for the life of the Project.
- **Frequency** - periodic – the event causing a potential sensory disturbance will occur intermittently but repeatedly, with potential regular transits twice per day, for the life of the Project.
- **Reversibility** - short term – recovery from the effects of sensory disturbance may be interrupted by subsequent vessels or other marine activities and, therefore, may not be reversible immediately but in some period greater than 2 days but less than one year.
- **Magnitude** - medium – the effects will be detectable at the individual level but marginal to moderate on the population level considering the high volume large vessel traffic conditions currently within the study area and the potential sensitivity of pelagic cormorants to underwater and surface disturbances within narrow channels.
- **Probability** - high – the Project is likely to cause sensory disturbance to pelagic cormorants.

- **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 coastal region.

**Injury or Mortality Events**

Cormorants have previously been documented (ConocoPhilips Alaska 2011) as vulnerable to lighting effects from marine vessels, especially at night and can become disoriented during periods of low visibility or inclement weather. The potential for events resulting in harmful or fatal collisions with vessel infrastructure are not expected due to their familiarity with and use of artificial structures to perch, and their affinity for nearshore areas. Residual effects will have a negative impact balance, although, bird strikes or vessel collisions are expected to be uncommon. Considering the presence of navigational lights and light effects from all vessels within the shipping lanes, it might be difficult to attribute strike events directly to the increase in lighting from Project-related vessels. The residual effect on pelagic cormorant is considered to be of low magnitude (Table 4.3.8.3, point 4[b]). A summary of the rationale for all of the significance criteria is provided below.

- **Spatial Boundary** - Marine Birds LSA – effects are confined to the vicinity of the shipping lanes for Project-related marine vessels.
- **Duration** - long-term – the event causing potential injury or mortality effects on pelagic cormorant will be initiated during operations and continue for the life of the Project.
- **Frequency** - occasional – the event leading to potential injury or mortality may occur intermittently and sporadically for the life of the Project.
- **Reversibility** - medium-term – the effect of an event of mortality will be restored in one generation of recruitment and maturity for individuals of that species.
- **Magnitude** - low – there may be effects to individuals but effects will not be detectable at regional population levels.
- **Probability** - low – injury and mortality is possible; however, is 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, and data pertinent to the coastal region.

#### 4.3.8.6.5 Marine Bird Indicator - Glaucous-winged Gull

The following subsections provide the evaluation of significance of the potential residual effects on the glaucous-winged gull indicator.

**Sensory Disturbance, Stress, Behavioural Changes or Avoidance of Important Habitats**

Glaucous-winged gulls are ubiquitous within the Marine RSA and breed at many locations near the shipping lanes. Although generally an inshore species, it does venture out to sea following fishing vessels for discarded catch and foraging for fish and other foods as far as the continental shelf. The impact balance of potential residual effects on glaucous-winged gulls arising from sensory disturbance associated with the increased Project-related marine vessel traffic is considered to be negative. Because of their strong association with existing vessel traffic, including commercial and recreational fishing, within the study area, this species has a low likelihood of adverse effects. The change in large vessel traffic introduced by the Project is likely to be long-term, but unlikely to be detectable in the high-density population of glaucous-winged gulls within the region. There is likely to be habituation to the presence and activity of marine traffic, as is evident from their predominance and adaptability to anthropogenically altered habitats. Consequently, the magnitude of potential residual effects on glaucous-winged gull from sensory disturbance is considered to be of low magnitude (Table 4.3.8.3, point 5[a]). A summary of the rationale for all of the significance criteria is provided below.

- **Spatial Boundary** - Marine Birds LSA – effects of sensory disturbance are unlikely to extend beyond the Marine Birds LSA due to the smaller ZOI for the adaptable glaucous-winged gull compared to other marine bird indicators.
- **Duration** - long-term – the event causing potential sensory disturbance to glaucous-winged gull will be initiated during operations and occur for the life of the Project.
- **Frequency** - periodic – the event leading to potential injury or mortality may occur intermittently; however, repeatedly during regular vessel transits for the life of the Project.
- **Reversibility** - short-term – recovery from the effects of sensory disturbance may be interrupted by subsequent vessels or other marine activities and, therefore, may not be reversible immediately but in some period greater than 2 days but less than one year.
- **Magnitude** - low – the effects will be detectable at the individual level negligible on the population level considering the high volume of vessel traffic present within the Marine RSA and the tendency for gulls to become associated with human-influenced environments, follow fishing vessels, and their opportunistic use of habitats.
- **Probability** - high – the Project is likely to have an effect on glaucous-winged gulls.
- **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 Project area.

**Injury or Mortality Events**

Glaucous-winged gulls have been documented (ConocoPhilips Alaska 2011) as striking marine vessels and structures during relatively extreme weather, periods of low visibility or disorientation. Gulls tend to roost on or near the shoreline at night and, therefore, night-lighting from vessels in the shipping lanes are unlikely to adversely affect them except under abnormal circumstances. These mortality events associated with vessels have harmful or fatal results, although are uncommon in this species. Potential effects are expected to have a negative impact balance, although, events of injury or mortality is expected to be rare. The residual effect on glaucous-winged gull is considered to be of low magnitude (Table 4.3.8.3, point 5[b]).

A summary of the rationale for all of the significance criteria is provided below.

- **Spatial Boundary** - Marine Birds LSA – effects are confined to the shipping lanes for Project-related marine vessels.
- **Duration** - long-term – the event causing potential injury or mortality effects on glaucous-winged gull will be initiated during operations and continue for the life of the Project.
- **Frequency** - occasional – the effect will occur rarely to intermittently and sporadically for the life of the Project.
- **Reversibility** - medium-term – the effect of an event of mortality will be restored in one generation of recruitment and maturity for individuals of that species.
- **Magnitude** - low – the effects will not be detectable at regional population levels.
- **Probability** - low – injury and mortality is possible; however, is 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 and data pertinent to the area.

#### 4.3.8.6.6 Combined Effects of Increased Project-Related Marine Vessel Traffic on Marine Birds

The evaluation of the combined effects of increased Project-related marine vessel traffic on the marine bird indicators considers, collectively, the likelihood of potential residual effects on the following indicators: fork-tailed storm-petrel; Cassin’s auklet; surf scoter; pelagic cormorant; and glaucous-winged gull. Given that the likelihood of injury to or mortality of any indicators is low, the potential residual effects associated with sensory disturbance represents the combined effects of increased Project-related marine vessel traffic on marine birds (Table 4.3.8.3, point 6[a]).

The Strait of Georgia is one of the busiest waterways on the Pacific Coast of North America (Parks Canada 2013) and the assessment of combined effects has been considered in this context. Effects are assessed within an existing setting of high volume vessel activity within the Marine RSA and with the standards set by the existing regulatory framework. The results of the marine birds assessment does not contradict any management objectives of established regional marine conservation plans.

Marine birds are likely to be affected by sensory disturbances from marine shipping activities that may cause the flushing of birds from preferred habitats in the Marine Birds LSA and Marine RSA on a repeated basis through regular transits of Project-related marine vessels in the shipping lanes twice per day. Depending on the species, this may generate indirect behavioural alterations and increased energetic costs to individuals, especially during the breeding season. Marine birds are present in the shipping lanes throughout the year, with various species using these habitats seasonally for migration and staging, overwintering, moulting and foraging. The adverse effects of sensory disturbances will be localized and short-term with each passing of a vessel. The number of injuries or events of mortality are expected to be low throughout the life of the Project within the Marine Birds LSA or Marine RSA. Individual encounters will be relatively brief and are not expected to be detrimental to the viability, stability and overall wellbeing of the diverse populations of marine birds.

Residual effects from the increased Project-related marine vessel traffic have a high probability of occurrence for the long-term but with a low to medium magnitude. A summary of the rationale for all of the significance criteria is provided below.

- **Spatial Boundary** - Marine RSA – effects are primarily confined to the Marine Birds LSA because sensory disturbances will dissipate with increasing distance from the vessel and the threshold of disturbance for birds is conservatively accommodated in the Marine Birds LSA extent; however, considering the wide-ranging activity of some pelagic species, and the particular vulnerability of other species to disturbances, it may extend to the Marine RSA in certain seasons and under particular at-sea conditions.
- **Duration** - long-term – the event causing potential injury or mortality effects on marine birds will be initiated during operations and continue for the life of the Project.
- **Frequency** - periodic – disturbance events may occur intermittently but repeatedly for the life of Project-related marine vessel operations.
- **Reversibility** - short-term - the recovery from the effects of sensory disturbance from each vessel interaction, including the potential for associated behavioural alterations, may not be immediate due to the possibility of subsequent interruption by other vessels and/or marine activities and, therefore, reversibility may take longer than 2 days but should be less than one year.
- **Magnitude** - medium – the effects will be detectable at the individual level, and may have marginal effects on the populations of some sensitive colonial breeding species in narrow channels areas, but will generally be low to medium with consideration for the context of high volume vessel traffic that currently exists within the Marine RSA.
- **Probability** - high – the Project is likely to cause adverse effects to varying degrees and under some conditions on marine birds.
- **Confidence** - high – based on a good understanding by the assessment team on pathways of effect between the increased Project-related marine vessel activities and marine birds, and with baseline data relevant to the coastal region.

#### *4.3.8.7 Potential United States Effects*

During the breeding season, seabirds cross terrestrial/marine ecological and political boundaries on a regular basis to forage. Even relatively ‘local’ species cross multiple jurisdictions within a day (*e.g.*, state lands and waters, and federal waters) while pelagic species may transit through international waters on a daily, weekly, or monthly time-frame. Seabird life-histories expose individuals and populations to environmental conditions affecting both terrestrial and marine habitats (Jodice and Suryan 2010). No differences in open water or intertidal habitats, vessel activity or natural wave conditions in the US and Canadian portions of the Marine RSA were identified that would change the nature of the effects assessment.

The same types of effects from shipping assessed in Canadian waters are expected to be present in US waters where the marine bird species compositions and the volume of large marine vessel traffic is similar or greater in US waters. However, federal and state management policies may be slightly different than provincial policies. Since the jurisdiction of agencies does not cross the land-sea boundary in the same manner as the seabirds they are managing, these management efforts are often facilitated by multi-agency communication and collaboration. Therefore, the effects from marine vessel traffic are expected to be similar in Canadian and US waters.

#### *4.3.8.8 Summary*

As identified in Table 4.3.8.3, 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 marine birds. Consequently, it is concluded that the residual environmental effects on marine birds from operational activities associated with the increased Project-related marine vessel traffic will be not significant.

### ***4.3.9 Marine Species at Risk***

For the purpose of the assessment, marine species at risk are considered to include all federally and provincially-listed marine species of conservation concern, as follows:

- any marine species listed as Endangered, Threatened, or Special Concern under *SARA* (Government of Canada 2013a);
- any marine species recommended for SARA-listing by COSEWIC (Government of Canada 2013b); and
- any marine species identified on the BC Conservation Data Centre's (BC CDC) Red or Blue lists (BC CDC 2013).

Table 4.2.9.1 of Section 4.2.9 lists the marine species at risk that have been identified as likely to occur within the Marine RSA. This list includes 20 marine fish and invertebrate species, 11 marine mammal species (or ecotypes) and 19 marine bird species. Potential effects of the increased Project-related marine vessel traffic on these species are assessed through the use of indicators in Section 4.3.6, Section 4.3.7 and Section 4.3.8.

In selecting the indicators for marine fish, marine birds and marine mammals, preference was often given to species at risk. For example, Pacific salmon were selected as an indicator for marine fish and fish habitat, in part, to represent the two salmon populations known to occur within the Marine RSA that are listed under COSEWIC (*i.e.*, Interior Fraser coho – Endangered and Cultus sockeye – Endangered). Likewise, the pelagic cormorant (BC CDC – Red list) was selected as an indicator for marine birds as well as the Steller sea lion (*SARA* – Special Concern), humpback whale (*SARA* – Threatened) and southern resident killer whale (*SARA* – Endangered) were selected as indicators for marine mammals.

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. For example, Pacific salmon were determined to be an appropriate choice for assessing the potential effects of vessel wake, since juvenile salmon are known to use shoreline habitats within the Marine RSA for foraging and migration. In contrast, although the yelloweye rockfish is listed as a species of Special Concern under *SARA*, this deep-water species is unlikely to ever interact with vessel wake. As such, it was not selected as an appropriate indicator, since there are no probable pathways of effect between potential Project impacts and yelloweye rockfish.

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 Marine RSA; and the degree to which the species is considered to be sensitive to potential Project effects. For example, in the selection of a marine mammal indicator representative of odontocetes (toothed whales), both the harbour porpoise and the southern resident killer whale were considered. The southern resident killer whale was ultimately selected, since its designated critical habitat overlaps almost entirely with the Marine RSA and since it is considered to be of greater conservation concern (*i.e.*, it is listed as Endangered under *SARA*, while the harbour porpoise is listed as Special Concern).

While acknowledged differences remain between species represented underneath the indicators (*e.g.*, seasonal timing in the area, preferred habitat, prey etc.), the most important consideration remains that the similarities or differences in how the potential impacts of the Project manifest for a specific organism, and whether these are adequately captured by the assessment of the indicator. In cases where subtle differences in potential effects for non-indicator species at risk may not be entirely covered by the indicator species, such considerations are noted under the assessment of the indicator. For example, given the known sensitivities of harbour porpoise to underwater noise, a brief discussion of harbour porpoises is included within the consideration of killer whales as the representative toothed whale. Most importantly, while determinations of significance focus on the individual indicator species, industry best management practices were 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 marine 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 marine fish, marine birds and marine mammals were carefully selected to ensure that the full range of potential Project effects on species at risk was addressed and mitigations to reduce these effects will apply to all species at risk, not just the indicators. Refer to Section 4.3.6, Section 4.3.7 and Section 4.3.8 for the significance rationale for applicable indicator species. No significant adverse effect on marine species at risk has been identified as a result of the increased Project-related marine vessel traffic, with the exception of the potential effect of sensory disturbance on southern resident killer whale, which was identified as significant.

#### *4.3.10 Traditional Marine Resource Use*

This subsection considers the potential effects of increased Project-related marine vessel traffic associated with the expansion of the Westridge Marine Terminal in Burnaby, BC on TMRU of the coastal waters of southwest BC and US waters that are covered by the spatial boundaries of the Marine RSA.

Coastal Aboriginal community's connection to the marine environment is profound. Traditional use of the marine environment includes the subsistence practices of hunting, fishing and plant gathering, movement by travelways, and cultural traditions and customs practiced at gathering places and sacred areas. The potential residual effects discussed in this subsection apply to traditional marine resource users in both Canadian and US waters within the Marine RSA.

Issues associated with the current volume of tanker traffic, total marine vessel traffic in the study areas, and future increases in vessel traffic associated with general population growth are not assessed. Project-specific effects of the construction and operation of the proposed expansion of the Westridge Marine Terminal are addressed separately in Volume 5B. The Traditional Marine Resource Use - Marine Transportation Technical Report (Volume 8B, TR 8B-5) provides further information on existing conditions related to use of Canadian and US coastal waters, including potential issues and interactions with the TMRU of potentially affected Aboriginal communities.

#### *4.3.10.1 Assessment Indicators and Measurement Endpoints*

For the purposes of this assessment, TMRU is described in terms of:

- subsistence activities and sites; and
- cultural sites.
- Table 4.3.10.1 summarises the assessment indicators, measurement endpoints and the rationale for their selection. The indicators selected represent components of the marine environment that are of particular value or interest to Aboriginal communities. The indicators have been selected based on initial feedback from Aboriginal communities and government agencies and were refined based on this feedback to reflect the components valued by traditional resource users, which are often holistic in nature and span both the biophysical and social disciplines. Potential Project-related effects on TMRU are linked to the biophysical elements (*e.g.,* marine fish, marine mammals and marine birds) and this assessment of TMRU relies in part on the results of the assessment of the relevant biophysical elements.

The measurement endpoints used to assess Project-related effects of increased marine vessel traffic on the indicators include quantitative and qualitative parameters, chosen based on available biophysical and socio-economic information, and a review of other assessments of similar projects.

**TABLE 4.3.10.1**

**ASSESSMENT INDICATORS AND MEASUREMENT ENDPOINTS FOR TRADITIONAL MARINE RESOURCE USE**

| Traditional Marine Resource Use Indicators | Measurement Endpoints | Rationale for Indicator Selection |
|---|---|---|
| Subsistence activities and sites | • Hunting<br>• Fishing<br>• Plant gathering<br>• Travelways | The selection of indicators and measurement endpoints reflect the NEB Filing Manual (2013c) requirements for traditional land and resource use in Table A-3 and considered key issues and interests identified during Aboriginal and stakeholder engagement. They also considered feedback from participants in the North Vancouver and Victoria ESA Workshops. |
| Cultural sites | • Gathering places<br>• Sacred areas | |

### *4.3.10.2 Spatial Boundaries*

Spatial boundaries used for the assessment of potential effects of Project-related marine vessel traffic on TMRU are defined as follows.

- **Marine LSA** - The Marine LSA for TMRU incorporates the primary ZOI likely to be affected by marine vessel wake, atmospheric and underwater noise generated by transiting tankers. The area has been allocated as the in-bound and outbound shipping lanes plus a buffer that encompasses the LSA boundaries of marine fish and fish habitat, marine mammals and marine birds since TMRU is dependent on these resources (Table 4.3.10.2). There is no separately defined LSA for marine mammals since potential effects are assessed within the Marine RSA (below). This includes the inbound and outbound marine shipping lanes, the area between the shipping lanes, where it exists, and a 2 km buffer extending from the outermost edge of each shipping lane. The shipping lanes extend from the Westridge Marine Terminal in Burnaby, through Burrard Inlet, south through the southern part of the Strait of Georgia, the Gulf Islands and Haro Strait, then westward past Victoria and through the Juan de Fuca Strait out to the 12 nautical mile limit of Canada's territorial sea, corresponding to the line of longitude of Buoy J.

- **Marine RSA** - The Marine RSA is the area where the direct and indirect influence of other marine activities could overlap with Project-specific marine transportation effects, potentially resulting in residual or cumulative effects on TMRU. This area encompasses a large portion of the Salish Sea and it generally extends from the western to eastern boundaries of the Salish Sea; however, it confines the northern and southern extents to exclude the central and northern Strait of Georgia and Puget Sound, respectively. Major waterways in the Marine RSA that overlap with the marine shipping lanes extending from the Westridge Marine Terminal through Burrard Inlet, south through the southern part of the Strait of Georgia, the Gulf Islands and Haro Strait, westward past Victoria and Juan de Fuca Strait out to the 12 nautical mile limit of Canada's territorial sea.

**TABLE 4.3.10.2**

**INPUTS TO TRADITIONAL MARINE RESOURCE USE LSA BOUNDARIES**

| Resource Component | Local Study Area | ESA Reference |
|---|---|---|
| Marine Fish and Fish Habitat | Includes the inbound and outbound marine shipping lanes, the area between the shipping lanes where it exists, and a 2 km buffer extending from the outermost edge of each shipping lane. The shipping lanes extend from the Westridge Marine Terminal in Burnaby, through Burrard Inlet, south through southern part of the Strait of Georgia, the Gulf Islands and Haro Strait, then westward past Victoria and though Juan de Fuca Strait out to the 12 nautical mile limit of Canada's territorial sea. | Marine Fish and Fish Habitat, Section 4.3.6 |
| Marine Birds | Includes the inbound and outbound marine shipping lanes, the area between the shipping lanes where it exists, and a 1 km buffer extending from the outermost edge of each shipping lane. The shipping lanes extend from the Westridge Marine Terminal in Burnaby, through Burrard Inlet, south through southern part of the Strait of Georgia, the Gulf Islands and Haro Strait, then westward past Victoria and though Juan de Fuca Strait out to the 12 Nautical Mile limit of Canada's territorial sea. | Marine Birds, Section 4.3.8 |

The TMRU spatial boundaries have evolved based on feedback during Aboriginal and stakeholder engagement. Stakeholder feedback resulted in the extension of the Marine LSA and Marine RSA beyond the Burrard Inlet to out to the 12 nautical mile limit of Canada's territorial sea. The TMRU study area evolved to include the areas of the Marine LSA and Marine RSA that extend into US waters. In addition, the TMRU study areas follow guidance provided by the NEB in the letter titled Filing Requirements Related to the Potential Environmental and Socio-Economic Effects of Increased Marine Shipping Activities (NEB 2013b), received by Trans Mountain on September 10, 2013. The letter indicates the marine transportation assessment should take place out to the 12 nautical mile limit of Canada's territorial seas.

Maps of the spatial study boundaries for TMRU are provided in Section 4.2.

#### *4.3.10.3 Traditional Marine Resource Use Context*

Of the 27 marine and inlet Aboriginal communities engaged on the Project with Trans Mountain, the following 21 communities have been identified as having an interest in the Project or having interests potentially affected by the increased Project-related marine vessel traffic:

- Esquimalt Nation;
- Cowichan Tribes;
- Halalt First Nation;
- Hwlitsum First Nation;
- Pacheedaht First Nation;
- Penelakut First Nation;
- Semiahmoo First Nation;
- Stz'uminus First Nation (Chemainus);

- Lyackson First Nation;
- Malahat First Nation;
- Pauquachin First Nation;
- Scia'new Indian Band (Beecher Bay);
- Tsartlip First Nation;
- Tsawout First Nation;
- Tsawwassen First Nation;
- Tseycum First Nation;
- Katzie First Nation;
- Kwikwetlem First Nation;
- Musqueam Indian Band;
- Squamish Nation; and
- Tsleil-Waututh Nation.

Traditional marine resource use studies (TMRU studies) were initiated for the Project in 2012 and are ongoing (Section 4.2.10.2). Participation in the TMRU studies, either as TERA-facilitated or community directed using a third-party consultant, was discussed with Aboriginal communities based on an indicated interest in participating in these studies. The Traditional Marine Resource Use – Marine Transportation Technical Report (Volume 8B, TR 8B-5) prepared by TERA incorporates the results of the preliminary interests identified by participating Aboriginal communities as received by Trans Mountain to date.

Esquimalt Nation conducted a TERA-facilitated TMRU study that included a map review and community interviews focusing on the Crown lands and waters within the asserted traditional territory of Esquimalt Nation crossed by the Marine RSA. Each phase of the TERA-facilitated TMRU study is described in further detail in the Traditional Marine Resource Use - Marine Transportation Technical Report (Volume 8B, TR 8B-5).

To date, preliminary interests were identified to Trans Mountain by Esquimalt Nation, Semiahmoo First Nation, Hwlitsum First Nation and by Cowichan Nation Alliance on behalf of Penelakut First Nation, Halalt First Nation, Hwlitsum First Nation, Stz'uminus First Nation and Cowichan Tribes. Table 4.3.10.3 provides the results to date of the the Esquimalt Nation TMRU study for the Project, as well as the preliminary interests identified by participating Aboriginal communities that may be affected by increased Project-related marine vessel traffic. Further details regarding the progress of each participating community's TMRU study and the preliminary interests received at the time of application filing can be found in the Traditional Marine Resource Use – Marine Transportation Technical Report (Volume 8B, TR 8B-5).

## TABLE 4.3.10.3

## TRADITIONAL MARINE RESOURCE USE IDENTIFIED TO DATE BY PARTICIPATING ABORIGINAL COMMUNITIES WITHIN OR IN PROXIMITY TO THE MARINE RSA

| Location | Activity/Site Type | Description | Location Relative to Shipping Lanes | Location Relative to Marine RSA | Shipping Lanes Crossed to Access Activity/Site? |
|---|---|---|---|---|---|
| **Esquimalt Nation** | | | | | |
| Bear Mountain | Hunting | Ducks in the past | 14 km northwest | Northwest of RSA | No |
| Sooke Inlet | Hunting | Ducks in the past | 8 km north | Within RSA | No |
| East Sooke Park | Hunting | Ducks and deer in the past | 10 km north | North of RSA | No |
| Albert head | Fishing | Ling Cod | 4 km west | Within RSA | No |
| Beacon Hill | Fishing | Sea Urchins | 2 km north | North of RSA | No |
| Ross Bay | Fishing | Sea Urchins | 2 km north | Within RSA | No |
| Dallas Road | Fishing | Salmon in the past | 2 km off coast at Dallas Road | Within RSA | No |
| Brother Island | Fishing | Scrooge Rocks, which are used to collect ling cod eggs | 3 km north | Within RSA | No |
| Race Rocks | Fishing | Ling cod | 3 km north | Within RSA | No |
| Salish Sea | Fishing | Halibut | Encompasses portions of the outbound shipping lane | Within RSA | Yes |
| Sidney Channel | Fishing | Salmon year round | 10 km west | Within RSA | No |
| Port Hardy | Fishing | Clam digging from Esquimalt to Port Hardy in the past. | 3 km west | From Vancouver Island to within RSA | No |
| Goldstream | Hunting<br>Fishing<br>Plant gathering | Deer and elk in the past.<br>Chum, coho, during low tides it is good for sole harvesting. Site shared by many bands. Clam digging.<br>Salmon berry harvest | 25 km north | North of RSA | No |
| Discovery Island | Fishing | Crabbing in the past | 1 km west | Within RSA | No |
| Catham Island | Fishing | Crabbing in the past | 1 km west | Within RSA | No |
| Saanich | Fishing | Clam digging at very low tide | 11 km west | West of RSA | No |
| Inskip Island | Fishing | Clam digging and rock sticker digging at very low tide | 6 km north | Within RSA | No |

## TABLE 4.3.10.3

## TRADITIONAL MARINE RESOURCE USE IDENTIFIED TO DATE BY PARTICIPATING ABORIGINAL COMMUNITIES WITHIN OR IN PROXIMITY TO THE MARINE RSA (continued)

| Location | Activity/Site Type | Description | Location Relative to Shipping Lanes | Location Relative to Marine RSA | Shipping Lanes Crossed to Access Activity/Site? |
|---|---|---|---|---|---|
| Beecher Bay | Fishing | Crabbing, clam digging, and octopus harvest, salmon, halibut, ling cod | 5 km north | Within RSA | No |
| Esquimalt Lagoon | Hunting<br>Fishing | Ducks in the past.<br>Clam digging and crabbing at Cooper's Cove in the past | 7.5 km northwest | Northwest of RSA | No |
| Orveas Bay | Fishing | Collecting clams, mussels, oysters, and urchins | 7.5 km north | Within RSA | No |
| Sooke Basin | Fishing | Clam digging at every point on basin beaches | 10 km north | Within RSA | No |
| Fisgard Lighthouse | Fishing | Clams and rock stickers in the past | 7.5 km northwest | Northwest of RSA | No |
| Esquimalt Harbour | Fishing | Clams in the past | 8 km northwest | Within RSA | No |
| Victoria Harbour | Gathering place | Historic Village | 3 km north | North of the RSA | No |
| Portage Inlet | Gathering place | Historic Village | 6 km northwest | Northwest of the RSA | No |
| Esquimalt | Gathering place | Current Village | 4.5 km northwest | Northwest of the RSA | No |
| Small Pox Island | Sacred area | Burial site in the past, now a naval base | 6.5 km north | North of the RSA | No |
| Leprosy Island | Sacred area | Burial site, also called D'Arcy Island | 3 km west | West of the RSA | No |
| Beecher Bay | Sacred area | Rock Art site | 5 km north | On land, adjacent RSA | No |
| Large Bedford Island | Sacred area | Rock Art site | 5 km north | On land, adjacent RSA | No |
| **Cowichan Tribes** | | | | | |
| Salish Sea | Subsistence activities | No details provided | Unknown | Within RSA | Unknown |
| Unspecified | Cultural sites | No details provided | Unknown | Unknown | Unknown |
| **Halalt First Nation** | | | | | |
| Salish Sea | Subsistence activities | No details provided | Unknown | Within RSA | Unknown |
| Unspecified | Cultural sites | No details provided | Unknown | Unknown | Unknown |

**TABLE 4.3.10.3**

**TRADITIONAL MARINE RESOURCE USE IDENTIFIED TO DATE BY PARTICIPATING ABORIGINAL COMMUNITIES WITHIN OR IN PROXIMITY TO THE MARINE RSA (continued)**

| Location | Activity/Site Type | Description | Location Relative to Shipping Lanes | Location Relative to Marine RSA | Shipping Lanes Crossed to Access Activity/Site? |
|---|---|---|---|---|---|
| **Hwlitsum First Nation** | | | | | |
| Salish Sea | Subsistence activities | No details provided | Unknown | Within RSA | Unknown |
| Unspecified | Cultural sites | No details provided | Unknown | Unknown | Unknown |
| **Penelakut Tribe** | | | | | |
| Salish Sea | Subsistence activities | No details provided | Unknown | Within RSA | Unknown |
| Unspecified | Cultural sites | No details provided | Unknown | Unknown | Unknown |
| **Semiahmoo First Nation** | | | | | |
| Semiahmoo Bay | Subsistence activities and sites | Traditional fishing area | Unknown | Within RSA | Unknown |
| Boundary Bay | Subsistence activities and sites | Traditional fishing area | Unknown | Within RSA | Unknown |
| Mud Bay | Subsistence activities and sites | Traditional fishing area | Unknown | Within RSA | Unknown |
| Strait of Georgia | Subsistence activities and sites | Traditional fishing area | Unknown | Within RSA | Unknown |
| Unspecified | Subsistence activities and sites | Traditional fishing and shellfish gathering sites | Unknown | Unknown | Unknown |
| Unspecified | Cultural sites | Traditional practices and culture | Unknown | Unknown | Unknown |

Trans Mountain continues to engage with Aboriginal communities and will continue to facilitate TMRU studies with interested communities. The results from ongoing TMRU studies will be provided to the NEB as completed.

Given the similar types of marine environments in Washington State and BC, TMRU is expected to be similar in US and Canadian waters. Where available, descriptions of existing conditions related to TMRU within US waters are provided in Section 4.2.10.3.

### *4.3.10.4 Potential Effects and Mitigation Measures*

The potential effects on TMRU associated with the increased Project-related marine vessel traffic were identified based on the results of the literature review, desktop analysis and TMRU studies, as well as through ongoing engagement with participating Aboriginal communities (see Sections 3.0 and 4.2.10.2).

The results of the literature/desktop review indicate that Aboriginal communities have historically used or presently use the Marine RSA to maintain a traditional lifestyle and continue to use marine resources throughout the Marine RSA for a variety of purposes including fish, shell-fish, mammal and bird harvesting, aquatic plant gathering, and spiritual/cultural pursuits as well as through the use of navigable waters within the Marine RSA to access subsistence resources, neighbouring communities and coastal settlements (Section 4.2.10.3).

The increased marine vessel traffic associated with the proposed expansion and operation of the Westridge Marine Terminal has the potential to directly and indirectly disrupt subsistence hunting and fishing, and plant gathering through changes to local harvesting locales as well as the broader ecological system.

A general increase in marine vessel traffic in the region has the potential to result in changes to the distribution and abundance of subsistence resources due to wake effects on shoreline habitats and sensory disturbance. Similarly, sensory disturbance has the potential to result in disruptions to cultural activities (*e.g.*, gathering places, sacred areas), whereby noise and activity as a result of increased marine vessel traffic may influence the focus and intent of ceremonial activities.

In addition, the navigable waters within the Marine RSA are used to access subsistence resources, neighbouring communities and coastal settlements (Section 4.2.10.3). TMRU activities can occur year round. In addition, the shipping lanes must be traversed to access TMRU sites.

Potential interactions with the TMRU of potentially affected Aboriginal communities already exist. However, the increased Project-related marine vessel traffic raises the likelihood of such interactions. All vessels are required to follow Transport Canada rules in order to avoid conflict when passing and possible collision.

Trans Mountain will require that a tug would accompany the Project-related tankers for the entire transit through the Strait of Georgia and between Race Rocks and the 12 nautical mile to assist with navigation. The tug escort is an enhancement to existing tug requirements. The tug can be tethered for extra navigational assistance if needed (refer to Table 4.3.10.3, Point 1.1 for a list of key mitigation measures with respect to marine safety). Refer to Section 5.3.2 for more detail on the enhanced tug escort as a safety measure.

#### 4.3.10.4.1 Effects Considerations

A range of issues potentially related to TMRU was identified during desktop research and Aboriginal engagement; however, were not included in the assessment. These include:

- the potential effect of increased Project-related marine vessel traffic on coastal habitation sites; and
- the potential effects of increased Project-related marine vessel traffic on inland fisheries.

Concerns about the potential for interactions between Project-related marine vessel traffic and habitation sites and inland fisheries were identified through the desktop review and through ongoing Aboriginal engagement. Both issues are considered outside the scope of this assessment, since normal operation of Project-related marine vessel traffic is not considered to interact with land-based activities. Nonetheless, the Traditional Marine Resource Use – Marine Transportation Technical Report (Volume 8B, TR 8B-5) provides information of the existing conditions related to habitation sites and inland fisheries that may occur within or in proximity to the Marine RSA for consideration of the potential effects of a marine spill on marine users assessed in Section 5.0.

The potential occurrence and associated effects of damage or loss of gear, collisions and other non-spill accidental interactions between Project-related marine vessels and traditional marine resource users are discussed in Section 4.3.11.

The potential effects of credible worst case and smaller marine spills on marine users are discussed in Section 5.0.

#### 4.3.10.4.2 Identified Potential Effects

Potential effects associated with increased Project-related marine vessel traffic on TMRU indicators are listed in Table 4.3.10.3. These interactions are based on the results of the literature review, desktop analysis and engagement with participating Aboriginal communities (see Section 3.0) and the professional experience of the assessment team.

A summary of mitigation measures provided in Table 4.3.10.3 was principally developed in accordance with KMC standards as well as industry best practices related to specific elements such as marine fish and fish habitat, marine mammals and marine birds.

**TABLE 4.3.10.3**

**POTENTIAL EFFECTS, MITIGATION MEASURES AND RESIDUAL EFFECTS OF INCREASED PROJECT-RELATED MARINE VESSEL TRAFFIC ON TRADITIONAL MARINE RESOURCE USE**

| Potential Effect | Spatial Boundary[1] | Key Mitigation Measures in Place/Additional Recommendations | Potential Residual Effect(s) |
|---|---|---|---|
| **1. Traditional Marine Resource Use Indicator – Subsistence Activities and Sites** | | | |
| 1.1 Disruption of subsistence hunting activities | RSA | • Refer to Section 4.3.7 Marine Mammals for key recommendations and mitigation relevant to sensory disturbance, wake waves, atmospheric and underwater noise and mammal injury or motility.<br>• Refer to Section 4.3.8 Marine Birds for key recommendations and mitigation relevant to behavior alterations, sensory disturbance, wake waves, atmospheric and underwater noise and bird injury or mortality.<br>• Refer to Section 4.3.3 Marine Air Emissions, Section 4.3.4 Marine GHG Emissions and Section 4.3.5 Marine Acoustic Environment for measures pertaining to nuisance air and noise emissions, respectively.<br>• Project tankers shall utilize the common shipping lanes, already used by all large commercial vessels for passage between the Pacific Ocean and Port Metro Vancouver. | • Disruption of subsistence hunting activities.<br>• Alteration of subsistence resources.<br>Disruption of traditional marine resource user activities from Project-related marine vessel wake (refer to Section 4.3.11). |

## TABLE 4.3.10.3

## POTENTIAL EFFECTS, MITIGATION MEASURES AND RESIDUAL EFFECTS OF INCREASED PROJECT-RELATED MARINE VESSEL TRAFFIC ON TRADITIONAL MARINE RESOURCE USE (continued)

| Potential Effect | Spatial Boundary[1] | Key Mitigation Measures in Place/Additional Recommendations | Potential Residual Effect(s) |
|---|---|---|---|
| **1. Traditional Marine Resource Use Indicator – Subsistence Activities and Sites** | | | |
| 1.1 Disruption of subsistence hunting activities (cont'd) | See above | • Trans Mountain will continue to provide information about Project-related shipping to other marine users. Specifically:<br>- provide regular updated information on Project-related marine vessel traffic to fishing industry organizations, Aboriginal communities, and other affected stakeholders, where possible through the Chamber of Shipping of BC (COSBC); and<br>- initiate a public outreach program prior to Project operations phase. Communicate any applicable information on Project-related timing and scheduling with fishing industry organisations, Aboriginal communities and other affected stakeholders.<br>• Transport Canada requires all vessels, including tankers, to comply with the International Regulations for Preventing Collisions at Sea (with Canadian Modifications) and other major international maritime conventions.<br>• Transport Canada requires compliance by all vessels with the *Canada Shipping Act,* 2001*, Collision Regulations,* the *Navigation Safety Regulations* pursuant to the Act and other applicable regulations and standards, except Government or Military vessels.<br>• The CCG ensures that all large vessels, including Project-related tankers, register with MCTS for communications with port authorities and CCG, and employ Automatic Identification Systems (AIS).<br>• The CCG requires compliance with the CCG fishing vessel advisory notice for commercial ships and fishing vessels using the inside passage waters of British Columbia during the commercial fishing season. This notice refers to all inside marine waters of BC.<br>• The PPA requires compliance with the PPA Compulsory Pilotage Areas (PPA 2013).<br>• PMV ensures compliance with PMV's MRA regulations, including "Clear Narrows" regulations (PMV 2010).<br>• Trans Mountain will require a tug accompanies the Project-related tankers through the Strait of Georgia and between Race Rocks and the 12 nautical mile limit in addition to tug requirements to assist with navigation. The tug can be tethered for extra navigational assistance if needed. | |

## TABLE 4.3.10.3

## POTENTIAL EFFECTS, MITIGATION MEASURES AND RESIDUAL EFFECTS OF INCREASED PROJECT-RELATED MARINE VESSEL TRAFFIC ON TRADITIONAL MARINE RESOURCE USE (continued)

| Potential Effect | Spatial Boundary[1] | Key Mitigation Measures in Place/Additional Recommendations | Potential Residual Effect(s) |
|---|---|---|---|
| 1.2 Disruption of subsistence fishing activities | RSA | • Mitigation measures listed in potential effect 1.1 are applied by the appropriate parties.<br>• Transport Canada and the Transportation Safety Board carry out investigations at the appropriate level in case of a collision between vessels.<br>• Refer to Section 4.3.13 Accidents and Malfunctions.<br>• Tanker owners have third-party insurance coverage in place to address vessel damage, gear loss or injury<br>• Tanker owners have third-party insurance coverage in place to address vessel damage, gear loss or injury.<br>• Transport Canada and the Transportation Safety Board carry out investigations at the appropriate level in case of an incident with high potential for loss like collision between vessels. | • Disruption of subsistence fishing activities.<br>• Alteration of subsistence resources.<br>• Disruption of traditional marine resource user activities from Project-related marine vessel wake (refer to Section 4.3.11). |
| 1.3 Disruption of plant gathering activities | RSA | • Mitigation measures listed in potential effects 1.1 and 1.2 are applied by the appropriate parties. | • Disruption of subsistence plant gathering activities.<br>• Alteration of subsistence resources.<br>• Disruption of traditional marine resource user activities from Project-related marine vessel wake (refer to Section 4.3.11). |
| 1.4 Disruption of use of travelways | RSA | • Mitigation measures in potential effects 1.1 and 1.2 are applied by the appropriate parties.<br>• Trans Mountain will provide regular updated information on Project-related marine vessel traffic to shipping associations, such as Chamber of Shipping. | • Alteration of traditional marine resource users' vessel movement patterns (refer to Section 4.3.11 MCRTU).<br>• Disruption of traditional marine resource user activities from Project-related marine vessel wake (refer to Section 4.3.11) |

**TABLE 4.3.10.3**

**POTENTIAL EFFECTS, MITIGATION MEASURES AND RESIDUAL EFFECTS OF INCREASED PROJECT-RELATED MARINE VESSEL TRAFFIC ON TRADITIONAL MARINE RESOURCE USE (continued)**

| Potential Effect | Spatial Boundary[1] | Key Mitigation Measures in Place/Additional Recommendations | Potential Residual Effect(s) |
|---|---|---|---|
| **2. Traditional Marine Resource Use – Cultural Sites** | | | |
| 2.1 Disturbance of gathering places | LSA | • Mitigation measures in potential effects 1.1 and 1.2 will be applied by the appropriate parties.<br>• Trans Mountain will continue to engage affected Aboriginal communities, throughout the operational life of the Project.<br>• Refer to Section 4.3.3 Marine Air Emissions, Section 4.3.4 Marine GHG Emissions and Section 4.3.5 Marine Acoustic Environment for measures pertaining to nuisance air and noise emissions, respectively. | • Increased sensory disturbance for marine users (refer to Section 4.3.11).<br>• Disruption of traditional marine resource user activities from Project-related marine vessel wake (refer to Section 4.3.11) |
| 2.2 Disturbance of sacred sites | LSA | • Mitigation measures in potential effects 1.1 and 1.2 will be applied by the appropriate parties.<br>• Trans Mountain will continue to engage affected Aboriginal communities, throughout the operational life of the Project.<br>• Refer to Section 4.3.3 Marine Air Emissions, Section 4.3.4 Marine GHG Emissions and Section 4.3.5 Marine Acoustic Environment for measures pertaining to nuisance air and noise emissions, respectively. | • Increased sensory disturbance for marine users (refer to Section 4.3.11).<br>• Disruption of traditional marine resource user activities from Project-related marine vessel wake (refer to Section 4.3.11)<br>• Negative user perspectives of increased marine vessel traffic. (refer to Section 4.3.11) |

**Notes:** 1 LSA = Marine LSA; RSA = Marine RSA.

### *4.3.10.5 Potential Residual Effects*

The potential residual socio-economic effects on TMRU indicators associated with increased Project-related marine vessel traffic (Table 4.3.10.3) are:

- disruption of subsistence hunting, fishing and plant gathering activities;
- alteration of subsistence resources;
- alteration of traditional marine resource users' vessel movement patterns;
- disruption of traditional marine resource user activities from Project-related marine vessel wake;
- increased sensory disturbance for marine users; and
- negative user perspectives of increased marine vessel traffic.

As noted by the cross-references appearing in Table 4.3.10.3, all components of the marine environment are understood to support the marine resource base and habitat conditions essential to the practice of traditional activities. As such, many potential residual effects discussed below, though presented with respect to traditional marine resource use, are assessed in consideration of all pertinent biophysical resources known or assumed to be of importance to Aboriginal communities for traditional use.

#### *4.3.10.6 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 that is considered to be the appropriate method. Consequently, a qualitative assessment for TMRU 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 4.3.10.4 provides a summary of the significance evaluation of the potential residual socio-economic effects of increased Project-related marine vessel traffic on TRMU. The rationale used to evaluate the significance of each of the residual socio-economic effects is provided below.

**TABLE 4.3.10.4**

**SIGNIFICANCE EVALUATION OF POTENTIAL RESIDUAL EFFECTS OF INCREASED PROJECT-RELATED MARINE VESSEL TRAFFIC ON TRADITIONAL MARINE RESOURCE USE**

| Potential Residual Effects | Impact Balance | Spatial Boundary[1] | Temporal Context: Duration | Temporal Context: Frequency | Temporal Context: Reversibility | Magnitude | Probability | Confidence | Significance[2,3] |
|---|---|---|---|---|---|---|---|---|---|
| **1. Traditional Marine Resource Use Indicator - Subsistence Activities and Sites** | | | | | | | | | |
| 1(a) Disruption to subsistence activities. | Negative | RSA | Long-term | Periodic | Long-term | Low | High | Moderate | Not significant |
| 1(b) Alteration of subsistence resources. | Negative | RSA | Long-term | Periodic | Long-term | Low to high | High | Moderate | Significant |
| 1(c) Alteration of traditional marine resource users' vessel movement patterns. | Negative | RSA | Long-term | Periodic | Short- to long-term | Low to medium | High | High | Not significant |
| 1(d) Disruption of traditional marine resource user activities from Project-related marine vessel wake. | Negative | LSA | Long-term | Occasional | Short-term | Low to medium | Low | Moderate | Not significant |
| 1(e) Combined effects on the subsistence activities and sites indicator (1[a] and 1[b]). | Negative | RSA | Long-term | Periodic | Long-term | Low to high | High | Moderate | Significant |

**TABLE 4.3.10.4**

**SIGNIFICANCE EVALUATION OF POTENTIAL RESIDUAL EFFECTS OF INCREASED PROJECT-RELATED MARINE VESSEL TRAFFIC ON TRADITIONAL MARINE RESOURCE USE (continued)**

| Potential Residual Effects | Impact Balance | Spatial Boundary[1] | Temporal Context | | | Magnitude | Probability | Confidence | Significance[2,3] |
|---|---|---|---|---|---|---|---|---|---|
| | | | Duration | Frequency | Reversibility | | | | |
| **2. Traditional Marine Resource Use Indicator – Cultural Sites** | | | | | | | | | |
| 2(a) Increased sensory disturbance for marine users. | Negative | LSA | Long-term | Periodic | Short-term | Low | High | High | Not significant |
| 2(b) Disruption of marine user activities from Project-related marine vessel wake. | Negative | LSA | Long-term | Occasional | Short-term | Low to medium | Low | Moderate | Not significant |
| 2(c) Negative user perspectives of increased Project-related marine vessel traffic. | Negative | RSA | Long-term | Continuous | Long-term | Low | High | Moderate | Not significant |
| 2(d) Combined effects on the cultural sites indicator (2[a] and 2[c]). | Negative | RSA | Long-term | Periodic to continuous | Long-term | Low to medium | High | High | Not significant |
| **3. Combined Effects of Increased Project-Related Marine Vessel Traffic on Traditional Marine Resource Use** | | | | | | | | | |
| 3(a) Combined effects of increased Project-related marine vessel traffic on the traditional marine resource use indicators (1[e] and 2[d]). | Negative | RSA | Long-term | Periodic | Long-term | Low to high | High | High | Significant |

**Notes:** 1 LSA = Marine LSA; RSA = Marine RSA

2 **Significant Residual Socio-Economic Effect:** a residual socio-economic effect is considered significant if the effect is predicted to be:

- high magnitude, high probability, long-term or permanent reversibility, and any spatial boundary that cannot be technically or economically mitigated.

3 Significant effects are only predicted to traditional marine resource use as it relates to southern resident killer whales. See Section 4.3.7 for the determination of significance for marine mammals.

### 4.3.10.6.1 Traditional Marine Resource Use Indicator – Subsistence Activities and Sites

The following discusses the significance rationale for the potential residual effects identified related to the subsistence activities and sites indicator.

#### Disruption of Subsistence Hunting, Fishing and Plant Gathering Activities

The disruption of subsistence hunting, fishing and plant gathering activities is a potential residual effect of interactions between traditional resource user vessels and Project-related marine vessel traffic that could occur when Project-related marine vessels are in transit in the shipping lanes.

Resources used and activities associated with TMRU are located within the Marine RSA and situated along or near shipping lanes. Based on the results of the TMRU studies and the desktop analysis, travel corridors are essential for conducting traditional activities and accessing locations for traditional harvesting, and the shipping lanes must be traversed to access TMRU sites. Subsistence harvesting and associated travel can occur within the Marine RSA year round. Key issues and concerns relevant to increase Project-related marine vessel traffic and the disruption of subsistence hunting, fishing and plant gathering activities include potential change in access to the resources and potential for disturbance to the resource harvesters.

The shipping lanes used by the Project are established routes for all types of vessels and are among the busiest shipping lanes in BC (see Volume 8C TERMPOL Study Reports). Transits of Project-related marine vessel traffic through the Marine RSA will increase from once a week to approximately once a day. This could result in a Project-related marine vessel being in the shipping lane at the same time traditional resource user vessels wish to use the shipping lane for traditional harvesting or cross the shipping lane to access harvesting areas. Traditional marine resource user vessels are required to keep the shipping lanes clear, however are permitted to cross the shipping lanes and harvest in and near the lanes when it is considered safe. Project-related marine vessel traffic could restrict access to traditional use areas, particularly if the resource users' travel occurs at the same time and in the same location as the Project vessel's transit. This could result in limiting the ability to harvest in certain areas, missed harvesting opportunities, or an increase in travel time to reach a destination, all which could reduce access to marine resources.

Sensory disturbance from the Project has the potential to result in disruptions to subsistence activities. Noise and visual disturbance as a result of increased marine vessel traffic may deflect resource harvesters from using areas or could influence the focus of the activity, particularly if the Project-related marine traffic occurs at the same time and place as the subsistence activities. This could result in harvesters choosing other locations for their traditional activities, and increased travel time to reach a destination.

In addition, damage or loss to fishing vessels or fishing gear may result from interactions between Project-related marine vessels and traditional marine resource users' fishing vessels. All vessels, including those associated with the Project, are required to follow Transport Canada rules to avoid conflict and possible collision. Although these incidents are rare, they have occurred in the past (refer to Section 4.3.11.6 for a discussion of potential incidents between deep draft vessels and fishing vessels). Lost opportunities for traditional resource harvesting may result if an incident occurs.

The impact balance of this potential residual effect is considered to be negative. The spatial boundary is the Marine RSA, since traditional resource user vessels that are required to cross the shipping lanes may be displaced to other areas in the Marine RSA. The duration of the event causing the disruption of commercial fishing activities is long-term and the reversibility of the residual effect is considered to be long-term, since all effects of Project-related marine vessel traffic would extend for the operational life of the Project.

Since traditional resource user vessels could be encountered by Project-related marine vessels whenever these vessels are transiting through the shipping lanes, the frequency of the event is periodic. The magnitude of the effect is considered to be low, since it is expected that the Project-related disruption would only be temporary, that the frequency of Project-related marine vessels would be once a day, and because disruptions already occur in relation to all large vessels currently using the shipping lanes. Confidence in this evaluation is moderate; although the locations of subsistence activities can be approximated based on known locations of historical harvesting areas (Section 4.2.10.3), the exact movements, timing and frequency of traditional resource user vessel activity cannot be precisely known (Table 4.3.10.4, point 1[a]). A summary of the rationale for all of the significance criteria is provided below.

- **Spatial Boundary** - Marine RSA – interactions between Project-related marine vessels and hunting, fishing and plant gathering activities that lead to delays or disruptions in these subsistence activities could occur at any point along the shipping lanes, and may also indirectly affect the distribution of vessels in other areas of the Marine RSA.

- **Duration** - long-term – interactions between Project-related marine vessels and subsistence activities will begin during the operations phase and will extend for the operational life of the Project.
- **Frequency** - periodic – Project-related marine vessels will be present daily in the shipping lanes over the operational life of the Project.
- **Reversibility** - long-term – the potential disruptions to subsistence activities are expected to extend throughout the operations phase of the Project.
- **Magnitude** - low – subsistence activities may be interrupted due to increased Project-related marine vessel traffic; however, are likely to be resumed in most cases once the vessel has passed.
- **Probability** - high – interactions between Project-related marine vessels and traditional resource user vessels that disrupt subsistence activities are considered to have a high likelihood of occurrence.
- **Confidence** - moderate – there is a good understanding of general cause-effect relationships between increased Project-related marine vessels and interactions with subsistence hunting, fishing and plant gathering activities; however, further Aboriginal community engagement will increase confidence and the robustness of the significance evaluation.

**Alteration of Subsistence Resources**

Based on the results of effects assessments for marine mammals, marine birds and marine fish and fish habitat, alteration of subsistence resources is a potential residual effect of interactions between traditional marine resources and Project-related marine vessel traffic that could occur due to wake effects on shoreline habitats, behavioural alteration or sensory disturbance to subsistence resources when Project-related marine vessels are in transit in the shipping lanes.

Based on the results of the TMRU studies and the desktop analysis, subsistence marine resources harvested are found throughout the Marine RSA, and include marine mammals, fish, shellfish and marine vegetation. Harvesting of these marine resources can occur year round throughout the Marine RSA. Table 4.2.10.1 and Table 4.2.10.2 present the range of marine resources that have been or continue to be harvested. Key issues and concerns relevant to the increase in Project-related marine vessel traffic and the alteration of subsistence resources include potential change in the resources harvested. Changes to the distribution and abundance of resources could in turn result in loss or alteration of harvesting areas, which could result in indirect effects such as harvesters having to spend more time and money to travel further for subsistence activities.

The results of effects assessments for marine mammals, marine birds and marine fish and fish habitat indicate that although there may be residual effects due to the increase in Project-related marine vessel traffic the effects are considered to be not significant, with the exception of southern resident killer whales. It has been determined that there is a currently-existing significant adverse cumulative effect on this population. While the endangered status of the southern resident killer whale prohibits the current hunting of this species, historical data indicates that killer whale populations were once, and may continue to be, a traditionally harvested resource within the Marine RSA (see Section 4.2.10.3) (DFO 2011b).

A review of marine management plans appropriate to the Marine RSA (Section 4.3.1.5) reveals that the plans typically reference the management of marine ecosystems with respect to coastal and marine planning, conservation and management initiatives. The Provincial Marine Protected Areas in British Columbia (Ministry of Sustainable Resource Management 2002) specifically references the importance of killer whale habitat, but does not reference harvesting of killer whales. The remaining plans reviewed listed in Section 4.3.1.5 do not reference killer whales, their habitat, or the harvesting of killer whales.

The impact balance of this residual effect is considered negative. The spatial boundary is the Marine RSA since potential effects of Project-related marine vessel traffic may extend beyond the Marine LSA into the ZOI of site-specific sensitivities of traditionally harvested marine resources. The duration of the event causing the effects to marine resources that support traditional harvesting activities are expected to extend throughout the operations phase of the Project.

While the locations of subsistence activities within the Marine RSA can be approximated based on known locations of historical harvesting areas (Section 4.2.10.3), the extent and current use by traditional resource users of these locations is not precisely known (Table 4.3.10.4, point 1[b]).

Since potential effects on traditionally harvested marine resources are expected whenever Project related vessels transit through the shipping lanes, the frequency of the event is periodic. The magnitude of the effect is considered to range between low and high, and is dependent on each target species' site-specific sensitivities. As described in Section 4.3.7.6, southern resident killer whales within 4 to 7 km of the shipping lanes are expected to be disturbed by vessel traffic and this effect will occur throughout the Canadian designated critical habitat for this endangered population. The assessment of marine mammals has determined the magnitude of this effect on southern resident killer whales is expected to be high; this determination takes into consideration past and current activities resulting in a currently existing significant adverse cumulative effect on this population. Hunting of the southern resident killer whale is currently prohibited, but they have been harvested in the past. Although future harvesting of the southern resident killer whale may be unlikely given the recent historical decline of this population, substantial changes in the availability of a single traditionally harvested resource may also be reflected throughout the broader ecological system and the availability of marine resources overall given the uncertainty associated with cascading marine predator-prey effects. Confidence in this evaluation is moderate. A summary of the rationale for all of the significance criteria is provided below.

- **Spatial Boundary** - Marine RSA – potential effects may extend beyond the Marine LSA into the ZOI of target marine resources.
- **Duration** - long-term – the event causing effects to traditionally harvested marine resources are expected to extend throughout the operations phase of the Project.
- **Frequency** - periodic – Project-related marine vessels will be present daily in the shipping lanes over the operational life of the Project.

- **Reversibility** - long-term – the effects of disturbance to traditionally harvested marine resources will be dependent on each target species' sensitivities and could extend greater than 10 years when the Project is no longer in operation.
- **Magnitude** - low to high – the effects assessment results for marine fish and fish habitat, marine mammals and marine birds indicates that effects to traditionally harvested marine resources may be detectable and is dependent on each target species' sensitivities, with the exception of the southern resident killer whale population whereby residual effects are beyond environmental and regulatory standards.
- **Probability** - high – the effects of disturbance to traditionally harvested marine resources will also affect subsistence resources.
- **Confidence** - moderate – there is a good understanding of general cause-effect relationships between increased Project-related marine vessels and interactions with traditionally harvested marine resources available for subsistence activities; however, further Aboriginal community engagement will increase confidence and the robustness of the significance evaluation.

**Alteration of Traditional Marine Resource Users' Vessel Movement Patterns**

The increase in Project-related marine vessel wake traffic may result in alteration of traditional marine resource users' vessel movement patterns (Table 4.3.10.4, point 1[c]). This potential residual effect is assessed under the commercial fisheries and aquaculture indicator in Section 4.3.11. The significance evaluation of this residual effect is provided Table 4.3.11.3, point 1(b). A discussion of this residual effect in Section 4.3.11, which includes all marine resource users, provides an explanation of the rationale of the significance criteria.

**Disruption of Traditional Marine Resource User Activities from Project-Related Marine Vessel Wake**

Project-related marine vessel wake traffic may result in increased disruption of marine user activities (Table 4.3.10.4, point 1[d]. This residual effect is assessed under the commercial fisheries and aquaculture indicator in Section 4.3.11. The significance evaluation of this residual effect is provided in Table 4.3.11.3, point 1(e). A discussion of this residual effect in Section 4.3.11, which includes all marine resource users, provides an explanation of the rationale of the significance criteria.

**Combined Effects of Increased Project-Related Marine Vessel Traffic on Subsistence Activities and Sites**

An evaluation of the combined effects considers those residual socio-economic effects that are likely to occur. For the subsistence activities and sites indicator, likely residual socio-economic effects include disruption to subsistence activities and alteration of subsistence resources (Table 4.3.10.4, points 1[a], 1[b] and 1[c]).

The combined effect on the subsistence activities and sites indicator is considered to have a negative net impact balance. The spatial boundary is the Marine RSA. Although the spatial boundary of the interaction is likely to occur within the shipping lanes or Marine LSA, the effects may be felt throughout the Marine RSA. The duration of the event is long-term, over the life of the Project, and the frequency is periodic. Project-related marine vessels will transit daily in the shipping lanes and interactions with traditional resource users are considered to be likely. The magnitude of any interactions is considered to be low to medium, while traditional resource user activity may resume once the vessels have passed, the effects to traditionally harvested marine resources may be detectable and are dependent on each target species' sensitivities, with the exception of the southern resident killer whale population whereby residual effects are beyond environmental and regulatory standards. A summary of the rationale for all of the significance criteria for combined effects on subsistence activities and sites is provided below.

- **Spatial Boundary** - Marine RSA – the combined socio-economic effects on subsistence activities and sites could occur at any point in the Marine RSA.
- **Duration** - long-term – Project-related marine vessel traffic that may cause combined socio-economic effects on subsistence activities and sites will occur for the duration of the operations phase of the Project.
- **Frequency** - periodic – the passage of Project-related marine vessel traffic that could cause combined socio-economic effects on subsistence activities and sites will occur intermittently but repeatedly over the life of the Project.
- **Reversibility** - long-term – overall, the reversibility is long-term as the combined effects may occur for the duration of the operations phase and could extend greater than 10 years when the Project is no longer in operation.
- **Magnitude** - low to high – the combined effects will be detectable by traditional resource users; however, may only be felt while Project-related marine vessels are nearby yet the effects on traditionally harvested marine resources range from negligible to detectable and are dependent on each target species' sensitivities, with the exception of the southern resident killer whale population whereby residual effects are beyond environmental and regulatory standards.
- **Probability** - high – the combined effects are considered to be likely to occur during the life of the Project.
- **Confidence** - moderate – there is a good understanding of general cause-effect relationships between increased Project-related marine vessels and disruptions to subsistence activities and sites; however, further Aboriginal community engagement will increase confidence and the robustness of the significance evaluation.

#### 4.3.10.6.2 Traditional Marine Resource Use Indicator – Cultural Sites

The following discusses the significance rationale for the potential residual effects identified related to the cultural sites indicator.

**Increased Sensory Disturbance for Marine Users**

The increase in Project-related marine vessel wake traffic may result in increased sensory disturbance for marine users (Table 4.3.10.4, point 2[a]). This potential residual effect is assessed under the marine recreational use indicator in Section 4.3.11. The significance evaluation of this residual effect is provided in Table 4.3.11.3, point 3(g). A discussion of this residual effect in Section 4.3.11, which includes all marine resource users, provides an explanation of the rationale of the significance criteria.

### Disruption of Marine User Activities from Project-Related Marine Vessel Wake

Project-related marine vessel wake traffic may result in increased disruption of marine user activities (Table 4.3.10.4, point 2[b]. This residual effect is assessed under the marine recreational use indicator in Section 4.3.11. The significance evaluation of this residual effect is provided in Table 4.3.11.3, point 3(f). A discussion of this residual effect in Section 4.3.11, which includes all marine resource users, provides an explanation of the rationale of the significance criteria.

### Negative User Perspectives of Increased Project-Related Marine Vessel Traffic

Increased Project-related marine vessel traffic may result in negative user perspectives for marine users (Table 4.3.10.4, point 2(c)). This residual effect is assessed under the marine recreational use indicator in Section 4.3.11. The significance evaluation of this residual effect is provided in Table 4.3.11.3, point 3(a). A discussion of this residual effect in Section 4.3.11, which includes all marine resource users, provides an explanation of the rationale of the significance criteria.

### Combined Effects of Increased Project-Related Marine Vessel Traffic on Cultural Sites

An evaluation of the combined effects considers those residual socio-economic effects that are likely to occur. For the cultural sites use indicator, likely residual socio-economic effects include negative user perspectives of increased Project-related marine vessel traffic and increased sensory disturbance to marine users (Table 4.3.10.4, points 2[a] and 2[c]). The disruption of marine user activities from Project-related marine vessel wake is unlikely to occur and, consequently, was not considered in the evaluation of combined effects on the marine recreational use indicator in Section 4.3.11 MCRTU. The significance of this residual effect is provided in Table 4.3.11-3 (point 3[h]). A detailed assessment of these combined effects in Section 4.3.11, which includes traditional marine resource users, provides an explanation of the rationale of the significance criteria.

### Combined Effects of Project-Related Marine Vessel Traffic on Traditional Marine Resource Use

The evaluation of the combined effects of increased Project-related marine vessel traffic on the TMRU indicators considers collectively the assessment of the following indicators: subsistence activities and sites; and cultural sites. The combined residual effects considered to be likely are: disruption of subsistence hunting, fishing and plant gathering activities; alteration of subsistence resources; increased sensory disturbance to marine users; and negative user perspectives of Project-related marine vessel traffic. Where two indicators had different criterion conclusions, the more conservative assessment was carried forward to the combined effects assessment.

Combined effects from increased Project-related marine vessel traffic on TMRU have high probability of occurrence that are long-term and with a low to high magnitude given the predicted residual effects on the southern resident killer whale population (Table 4.3.10.4, point 3[a]). Effects are considered in the context of existing high-volume vessel activity within the Marine RSA and an existing regulatory framework as well as in the context of the availability of a traditionally harvested resource to meet the cultural and subsistence needs of potentially affected Aboriginal peoples. The results of the TMRU assessment do not contradict any management objectives of established regional marine conservation plans or planning documents for marine environments under federal and provincial jurisdiction. A summary of the rationale for all of the significance criteria for combined effects on TMRU is provided below.

- **Spatial Boundary** - Marine RSA – combined socio-economic effects on TMRU could occur at any point in the Marine RSA.
- **Duration** - long-term – the event causing the combined residual effects on TMRU is the transit of Project-related marine vessels which occurs throughout the operational life of the Project.
- **Frequency** - periodic – the event causing the combined residual effects on TMRU is the transit of Project-related marine vessels which occurs intermittently but repeatedly throughout the operational life of the Project.
- **Reversibility** - long-term – the combined residual effects will occur throughout the operational life of the Project and may be reversible when the Project-related marine vessel traffic is no longer in operation.
- **Magnitude** - low to high – the combined residual effects will be detectable by traditional resource users but may only be felt while Project-related marine vessels are nearby. The effects to traditionally harvested marine resources range from negligible to detectable and are dependent on each target species' sensitivities, with the exception of the southern resident killer whale population whereby residual effects are beyond environmental and regulatory standards.
- **Probability** - high – the occurrence of combined residual effects on TMRU is considered to be likely.
- **Confidence** - high – there is a good understanding of the cause-effect relationships and of the data pertinent to the study area.

#### *4.3.10.7 Potential United States Effects*

The key issues that have been identified in Canadian waters are also considered to be similar in US waters. The shipping lanes in the Strait of Georgia, Haro Strait and Juan de Fuca Strait are located along the international boundary for much of the Marine RSA, and so the effects of Project-related marine vessels on other marine users are also considered to be similar in both countries. No differences in traditional marine resource use conditions in the US and Canadian portions of the Marine RSA were identified that would change the nature of the effects assessment. Therefore, the effects are expected to be similar in Canadian and US waters.

#### *4.3.10.8 Summary*

The results of the TMRU assessment do not contradict any management objectives of established regional marine conservation plans or planning documents for marine environments under federal and provincial jurisdiction. As identified in Table 4.3.10.4, the residual effects associated with increased Project-related marine vessel traffic on TMRU are considered not significant, with the exception of the expected residual effects on the southern resident killer whale population, which are considered to be significant (see Section 4.3.7).

### ***4.3.11 Marine Commercial, Recreational and Tourism Use***

This subsection of the ESA considers the potential effects of the Project-related increased marine vessel traffic associated with the expansion of the Westridge Marine Terminal in Burnaby, BC on other MCRTU of the coastal waters of southwest BC and US waters within the Marine RSA. Commercial use of the marine environment includes commercial fisheries and aquaculture and marine transportation of goods and services (*e.g.*, cargo and container ships, tankers, tugs and barges, and passenger ferries). Recreational uses include: fishing; boating; kayaking; and scuba diving. Tourism operators in coastal waters include: whale-watching vessels; commercial sport-fishing guides; boat charters; and cruise ships.

The potential residual effects discussed in this section apply equally to marine commercial, recreational and tourism users in both Canadian and US waters within the Marine RSA, due to the transboundary nature of the shipping lanes. The designated shipping lanes for deep draft vessels cross over the international boundary throughout much of the southern Strait of Georgia, Haro Strait and Juan de Fuca Strait. For example, in Juan de Fuca Strait the shipping lane for all deep draft inbound vessels is fully within US waters, while the outbound lane is in Canadian waters.

Project-related marine vessel traffic is expected to cause an increase from the current approximate frequency of 5 tankers per month visiting the terminal, to approximately 34 tankers a month, along with the required and additional planned tug escorts. Issues associated with the current volume of tanker traffic, of total marine vessel traffic in the study area, or of future increases in vessel traffic associated with general population growth are not assessed. Project-specific effects of the construction and operation of the proposed expansion of the Westridge Marine Terminal are addressed separately in Volume 5B. The Marine Commercial, Recreational and Tourism Use - Marine Transportation Technical Report (Volume 8B, TR 8B-6) provides further information on existing conditions related to use of BC and US coastal waters, including potential issues and interactions between users.

#### *4.3.11.1 Assessment Indicators and Measurement Endpoints*

Table 4.3.11.1 summarizes the assessment indicators, measurement endpoints and their rationale for MCRTU. The indicators selected represent components of the socio-economic environment that are of particular value or interest to Aboriginal communities, local communities and regulatory authorities. The indicators have been selected based on initial feedback from Aboriginal communities, local, regional and provincial government, and other stakeholders as well as public issues raised through media and professional judgment of the study team. For the purposes of this assessment, MCRTU is described in terms of:

- commercial fisheries and aquaculture;
- marine transportation;
- marine recreational use; and
- marine tourism use.

The measurement endpoints used to assess Project-related effects of increased marine vessel traffic on the indicators include quantitative and qualitative parameters, chosen based on available socio-economic information and a review of other assessments of similar projects.

**TABLE 4.3.11.1**

**ASSESSMENT INDICATORS AND MEASUREMENT ENDPOINTS FOR MARINE COMMERCIAL RECREATIONAL AND TOURISM USE**

| Marine Commercial, Recreational and Tourism Use Indicator | Measurement Endpoints | Rationale for Indicator Selection |
|---|---|---|
| Commercial fisheries and aquaculture | • Species-specific or group-specific fishing effort<br>• Fishing vessel traffic<br>• Access to fishing grounds<br>• Aquaculture operations | The selection of indicators and measurement endpoints considered key issues and interests identified during Aboriginal and stakeholder engagement. They also considered feedback from participants in the North Vancouver and Victoria ESA Workshops. |
| Marine transportation | • Use of shipping lanes<br>• Rail bridge operations in Burrard Inlet | |
| Marine recreational use | • Documented recreation and tourism use areas<br>• Marine facilities<br>• Access to recreation areas<br>• Quality of recreational experience<br>• Consistency with marine use plans | See above |
| Marine tourism use | | |

### *4.3.11.2 Spatial Boundaries*

Spatial boundaries used for the assessment of potential effects of Project-related marine vessel traffic on MCRTU are defined as follows.

#### 4.3.11.2.1 Local Study Area

The Marine LSA for MCRTU is the area within which Project-related marine vessel traffic is expected to interact with marine commercial, recreational and tourism users. This includes the inbound and outbound marine shipping lanes, the area between the shipping lanes, where it exists, and a 2 km buffer extending from the outermost edge of each shipping lane. The shipping lanes extend from the Westridge Marine Terminal in Burnaby, through Burrard Inlet, south through the southern part of the Strait of Georgia, the Gulf Islands and Haro Strait, then westward past Victoria and through Juan de Fuca Strait out to the 12 nautical mile limit of Canada's territorial sea, corresponding to the line of longitude of Buoy J.

Most deep draft vessels including Project-related tankers use the designated shipping lanes. Therefore, direct interactions between Project-related marine vessels and other marine users are reasonably expected to occur within the shipping lanes (CCG 2013b). The selection of the 2 km buffer area was based on potential measureable effects from other elements that pertain to marine users (*e.g.,* marine fish and fish habitat, marine mammals, marine acoustic environment). For example, the marine fish and fish habitat element has selected the 2 km Marine LSA to encompass the area in which vessel wake from a tanker would be expected to extend (Sections 4.2.6 and 4.3.6).

To examine nuances in marine use patterns, the Marine LSA is divided into four study regions, identified as the shipping lanes and a 2 km buffer extending from the outermost edge of each shipping lane, in the following areas (Figures 4.2.27 to 4.2.31).

- **Burrard Inlet** – west from the marine area around the Westridge Marine Terminal to the entrance to Vancouver's Outer Harbour.
- **Strait of Georgia** – southwest from the entrance to Vancouver Outer Harbour in the Strait of Georgia to Boundary Pass (near East Point on Saturna Island).
- **Haro Strait** – south from Boundary Pass through Haro Strait, past Turn Point on Stuart Island and continuing past Victoria to the Victoria Pilot Boarding Station.
- **Juan de Fuca Strait** – southwest from the Pilot Boarding Station near Victoria, then west through Juan de Fuca Strait, with the western boundary being the 12 nautical mile limit northwest of Cape Flattery, Washington State.

#### 4.3.11.2.2 Regional Study Area

The Marine RSA is the area where the direct and indirect influence of other marine activities could overlap with Project-specific marine transportation effects, potentially resulting in residual and cumulative effects on MCRTU. This area is comprised of a large portion of the Salish Sea, including the inland marine waters of the southern Strait of Georgia and Juan de Fuca Strait and their connecting channels, passes and straits. The Marine RSA is generally centred on the marine shipping lanes, which extend from the Westridge Marine Terminal through Burrard Inlet, south through the Strait of Georgia, the Gulf Islands and Haro Strait, westward past Victoria and through Juan de Fuca Strait out to the 12 nautical mile limit of Canada's territorial sea. The western boundary of the Marine RSA extends further out to sea than the western boundary of the Salish Sea and the northern boundary of the Marine RSA is limited to the southern portion of the Strait of Georgia. Puget Sound is excluded from the Marine RSA.

The spatial boundaries for MCRTU have evolved based on feedback during stakeholder engagement. Stakeholder feedback resulted in the Marine LSA and Marine RSA being extended beyond the Burrard Inlet to extend out to the 12 nautical mile limit of Canada's territorial sea. The MCRTU study area includes the areas of the Marine LSA and Marine RSA that extend into US waters. The MCRTU study areas also follow guidance indicated by the NEB in the letter titled Filing Requirements Related to the Potential Environmental and Socio-Economic Effects of Increased Marine Shipping Activities (NEB 2013b), received by Trans Mountain on September 10, 2013. The letter indicates that the marine transportation assessment should take place out to the 12 nautical mile limit of Canada's territorial seas.

Maps of the spatial boundaries for the assessment of MCRTU are provided in Section 4.2.

### *4.3.11.3 Marine Commercial, Recreational and Tourism Use Context*

MCRTU occurs throughout the coastal waters of southwestern BC, from the area around the Westridge Marine Terminal in Burrard Inlet, through the inland waterways of the Salish Sea and out to the North Pacific Ocean. The context for marine users in the Marine LSA and Marine RSA is provided for each marine region.

#### 4.3.11.3.1 Burrard Inlet

Burrard Inlet is a tidal salt-water inlet in the lower mainland of BC. About one million people live in the eight municipalities surrounding the inlet, namely: the cities of Vancouver, Burnaby and Port Moody on the south shore; the villages of Belcarra and Anmore on the east shore of Indian Arm and Port Moody Inlet; and the City of North Vancouver; the District of North Vancouver; and the District of West Vancouver on the north shore (BIEAP 2011; Statistics Canada 2012).

PMV oversees the operation of port facilities in Burrard Inlet, Delta and the Fraser River in the Lower Mainland (PMV 2013a). Marine terminals in Burrard Inlet include: terminals for container ships; cruise ship terminals; and cargo terminals (PMV 2013a). Other commercial uses include a commuter ferry service between Vancouver and North Vancouver and a seaplane aerodrome in the Inner Harbour. A large portion of the commercial vessel movements in Burrard Inlet consists of tug traffic, while assisting ships, engaging in towing activities, or in transit (see Volume 8C, TERMPOL Studies).

Commercial fisheries for species including Dungeness crab, prawns and shrimp occur in Burrard Inlet including portions of the Outer Harbour, the Central Harbour (near Westridge Marine Terminal) and Indian Arm (DFO 2013i,j,k). Section 4.2 provides detailed information on commercial fisheries in the Marine RSA. Marine recreational use of Burrard Inlet includes: kayaking; canoeing; cruising, paddle-boarding; kite surfing; windsurfing; fishing and swimming (Greater Vancouver Visitors and Convention Bureau 2013b). Fishing is popular throughout the inlet for salmon, groundfish and other species (Bird pers. comm.). The area is designated as a sportfishing area and is closed to the commercial groundfish fishery (DFO 2013m). Marine tourism uses in Burrard Inlet include: cruise ships berthing in the inner harbour; dive charters to sites in Indian Arm; and yacht cruises throughout the inlet. Boat and fishing charter companies and whale watching operators are based in marinas in the Inner Harbour and False Creek (and Convention Bureau 2013b).

#### 4.3.11.3.2 Strait of Georgia

The Strait of Georgia is a navigable channel situated between Vancouver Island and the mainland coast of BC, bounded at both ends by narrow passages and a large number of islands. Most of the population of BC is located on the periphery of the Strait of Georgia, and the strait is a waterway for a large variety of marine traffic. The Marine LSA and Marine RSA include the southern portion of the Strait of Georgia, between the approach to Vancouver Harbour and Juan de Fuca Strait. Commercial fishing in the Strait of Georgia occurs year-round for groundfish. Openings for other fisheries are variable and tend to occur between late-spring and late-fall. Prawns, shrimp, crab, salmon, herring and other species are fished commercially in various areas of the strait. Preferred fishing grounds include the approach to Vancouver harbour and nearshore areas of Richmond and Delta (*i.e.*, Roberts Bank).

The Strait of Georgia is a regionally important shipping channel. Marine terminals in Burrard Inlet, the Lower Mainland, and ports in Canada and the US generate commercial vessel traffic in the Strait of Georgia (CCG 2013b). Passenger ferries cross the Strait of Georgia between ferry terminals in the Lower Mainland, Vancouver Island, and the Southern Gulf Islands (BC Ferry Services 2013b). Marine recreational users including fishers and pleasure boaters use the strait to access destinations in the Gulf Islands, Vancouver Island and other locations. Recreational fishing occurs in many areas, in particular for salmon, halibut, rockfish and crab. Recreational shellfish harvesting occurs along shoreline areas for oysters, clams and other shellfish, subject to sanitary closures (DFO 2013l).

Tourism users include whale-watching operators and sportfishing guides. Commercial sportfishing guides operate out of Richmond and Vancouver, with charters targeting specific salmon species year-round around Vancouver, the Gulf Islands and Vancouver Harbour (Worldweb 2013).

#### 4.3.11.3.3 Haro Strait

Haro Strait is the main navigable channel in Canadian waters that connects the Strait of Georgia to Juan de Fuca Strait. Haro Strait also defines part of the international boundary between Canada and the US, dividing the Southern Gulf Islands from the US San Juan Islands. Haro Strait is approximately 50 km long, including Boundary Pass. The shipping lanes are situated on or near the international boundary for most of the strait. The strait is narrow throughout much of its length and has a number of known navigational hazards and strong tidal currents (CCG 2013a).

Commercial fishing for some species such as Dungeness crab occurs throughout Haro Strait. Other commercial fisheries such as the prawn trap fishery have short seasons; however, the prawn fishery is lucrative and Haro Strait is an important fishing area (DFO 2013j). Salmon, shrimp, red and green urchin and other species are also commercially fished in Haro Strait (DFO 2013j).

Commercial vessel traffic from terminals in Vancouver use Haro Strait to access international waters via Juan de Fuca Strait. Special operating rules for deep draft vessels are in place in navigationally constrained areas such as Turn Point (CCG 2013b).

Ferry services transport passengers and some cargo between ports in BC and Washington State, crossing the shipping lanes in the strait daily between Sidney on Vancouver Island and Anacortes in Washington (Washington State Department of Transportation 2013a). Passenger ferries also run regularly between Victoria, BC and Seattle Washington, and Victoria, BC and Port Angeles, Washington.

The Southern Gulf Islands are located in Haro Strait and are a key destination for recreational and tourism users. The Southern Gulf Islands contain marine parks and coastal campsites, which are popular destinations for marine recreational users including kayakers, boaters, fishers and scuba divers. Tourism uses include whale-watching and commercial sport fishing.

#### 4.3.11.3.4 Juan de Fuca Strait

Juan de Fuca Strait separates southeast Vancouver Island from the north coast of the State of Washington. The strait connects the Pacific Ocean with the Strait of Georgia and Puget Sound (US Office of Coast Survey 2013). The eastern entrance is marked by Race Rocks Ecological Reserve, south of Metchosin on Vancouver Island. The western boundary of the strait is generally defined by a north-south line between Cape Flattery, on the northeast edge of the Olympic Peninsula (US) to Carmanah Point on Vancouver Island. The international boundary runs down the centre of the strait. The Marine RSA extends another 12 nautical miles (about 22 km) west of this point into the Pacific Ocean, also defining the extent of Canada's Territorial Sea (DFO 2013i).

Commercial fishing in Juan de Fuca Strait includes fisheries for salmon, groundfish, crab and prawns. Salmon fisheries typically occur between April and September, subject to management decisions by DFO (2013b). Groundfish are fished year-round by trawlers and hook and line fisheries (DFO 2013m). Crabs and prawns are fished by trap in nearshore areas of Vancouver

Island (DFO 2013i, g). The eastern area of the strait south of Victoria Harbour can experience a high level of effort for both commercial and recreational fishers.

Aside from commercial fishing traffic, Juan de Fuca Strait is used by vessels including cargo and container ships, tankers bound for Westridge Marine Terminal and other Canadian and US terminals, cruise ships bound for Vancouver, Victoria and US ports, tugs and barges, and Canadian and US naval vessels. Marine recreational use in Juan de Fuca Strait includes: sailing; boating; fishing; surfing; and kayaking. The area is also known for high quality scuba diving. Marine tourism in Juan de Fuca Strait includes: sportfishing charters; kayak tours; and whale-watching tours.

#### 4.3.11.3.5 United States Marine Areas

The shipping lanes in the Strait of Georgia, Haro Strait and Juan de Fuca Strait are partly located within the coastal waters of Washington in the US and roughly follow the international boundary throughout much of the Salish Sea. The commercial fishing industry in Washington includes: major fisheries for halibut and other groundfish; salmon; albacore tuna; and shellfish (including Dungeness crab, shrimp and clams) (WDFW 2008). Port facilities in Washington generate commercial vessel traffic in the Strait of Georgia and other areas of the Salish Sea. Shipping lanes in Juan de Fuca Strait, the Strait of Georgia and Puget Sound are used by both Canadian and US-bound commercial marine vessels, including: tankers; bulk carriers; container ships; vehicle carriers; cruise ships; navy and coast guard vessels; tugs and barges; and passenger ferries (van Dorp 2008, Washington State Department of Transportation 2013a).

Marine recreational use in US areas includes boating, paddling, diving, fishing and whale-watching. Recreational users use shoreline and nearshore areas throughout the Marine RSA including marine parks, beaches and recreational fishing areas. Marine tourism in US waters within the Marine RSA includes whale-watching, commercial sport fishing, cruise ships, yacht charters, kayak outfitters and dive charters.

### *4.3.11.4 Potential Effects and Mitigation Measures*

The potential effects on MCRTU associated with the increased Project-related marine vessel traffic were identified based on the results of the literature review, desktop analysis, feedback during marine ESA Workshops, interviews, and Project-wide consultation with Aboriginal communities, government agencies and stakeholders (see Section 3.0). Potential interactions between marine users already exist. However, the increased Project-related marine vessel traffic increases the likelihood of such interactions.

Trans Mountain will require that a tug accompany the Project-related tankers through the entire transit, including in the Strait of Georgia and between Race Rocks and the 12 nautical mile limit to assist with navigation. The tug escort is an enhancement to existing tug requirements. The tug can be tethered for extra navigational assistance if needed (refer to Table 4.3.11.2, Point 1.1 for a list of key mitigation measures with respect to marine safety). The potential socio-economic effects of the additional tug escort include increased jobs and capital investment in the form of extra tugs. A full analysis of the positive economic effects was considered to be outside the scope of this assessment (refer to Section 5.3.2 for more detail on the additional tug escort as a safety measure).

#### 4.3.11.4.1 Effects Considerations

A range of issues potentially related to MCRTU was identified during desktop research, stakeholder engagement and in the media related to the Project; however, were not included in the assessment. These include:

- the potential effect of the increased Project-related marine vessel traffic on tourism revenues for the hotel industry;
- the potential effect of the increased Project-related marine vessel traffic on property values for waterfront properties;
- the potential effect of Project-related marine vessel wakes on aquaculture operations;
- the potential effect of Project-related marine vessel wakes on marine infrastructure or shorelines;
- the potential effect of Project-related marine vessel traffic on port service suppliers;
- the potential for interactions between Project-related marine vessels and float planes; and
- the potential effect of increased underwater noise from Project-related marine vessel traffic on the behaviour of southern resident killer whales.

Concern about the potential effects of the Project on the hotel industry and other businesses that rely on tourism was identified by participants at the North Vancouver and Victoria ESA Workshops. The potential effect on coastal property values with view of the shipping lanes was also identified through stakeholder consultation. Both issues are considered to be outside the scope of this ESA due to the difficulty in establishing a cause-effect relationship. While it is possible that normal operations of increased Project-related marine vessels could contribute to these effects, many other economic factors may affect tourism revenues and property values. The effect of the current movement of oil tankers on tourism and property values is not documented and would require considerable study in the context of the tourism and real estate sectors. Such issues have been noted by KMC during the Stakeholder Consultation and Engagement program related to the Project. Responses to such issues are discussed in Volume 3A, Public Consultation.

The potential effects of Project-related marine vessel wake on aquaculture operations were considered for inclusion in the ESA; however, the results of desktop analysis determined that no active aquaculture operations are present within the Marine LSA in Canadian waters. The effects of vessel wake on fish and fish habitat is described in Section 4.3.6. It was determined that the effects of vessel wake from Project-related marine vessels on fish and fish habitat would be negligible at a distance of approximately 2 km. As such, no potential effects on aquaculture from the Project have been identified.

The potential effects of Project-related marine vessel wake on marine infrastructure (*e.g.*, docks and berths) and shorelines were stated concerns by participants at the Victoria and North Vancouver Marine ESA Workshops. The wake generated by the transit of Project-related marine vessels generates waves which may reach shoreline areas where the shipping lanes are close to shore, such as between the First and Second Narrows in Burrard Inlet. Piloted vessels are required to travel at a maximum of six knots throughout much of Burrard Inlet (PMV 2010). Waves generated by Aframax tankers and associated escort vessels at this speed are not considered likely to affect marine infrastructure or shorelines (see Section 4.3.6 for more detail). The potential effects of Project-related marine vessel traffic on float plane operations were considered for inclusion in the ESA; however, these were scoped out due to the location of designated areas for float plane use in relation to the inbound and outbound shipping lanes in Burrard Inlet. While float plane operations are present in the Marine LSA in Burrard Inlet, there is a designated area in the Inner Harbour beyond which float planes are restricted. As such, no potential effects on float planes from the increased Project-related marine vessel traffic are anticipated.

Concerns about the effects of increased underwater noise resulting from a general increase in marine vessel traffic in critical habitat areas for southern resident killer whales are identified in Appendix E, Table 3.3.1. The potential effects of increased underwater noise from Project-related marine vessel traffic on the behaviour of southern resident killer whales are described and analysed in Section 4.3.7. An analysis of associated effects on marine tourism activities was considered to be outside the scope of the assessment of Project effects on MCRTU; however, it is acknowledged that Project-related residual effects on southern resident killer whales may have a concomitant effect on whale-watching operators.

The potential effect of Project-related marine vessel traffic on port service suppliers was considered to be potentially positive overall. Specifically, it is considered that the Project may have a positive economic effect on tug operators and providers of ships' services, such as pilots, fuel and food and provide opportunities for these businesses to expand or improve their productivity. An analysis of the potential economic benefits of the Project was considered to be outside of the scope of the assessment of Project-related effects on MCRTU; consequently, no further analysis was completed on this potential effect.

The potential occurrence and associated effects of collisions and other non-spill accidental interactions between Project-related marine vessels and other marine commercial, recreational and tourism users are discussed in this subsection. The avoidance of collisions and other accidents is the responsibility of all ships' masters and crews, in terms of compliance with regulations including: the *International Regulations for Preventing Collisions at Sea (1972) with Canadian Modifications* and the *Navigation Safety Regulations* under the *Canada Shipping Act,* 2001; Fishing Vessel Advisory Notices issued by the CCG (2013a); and the PPA Compulsory Pilotage Areas (PPA 2013).

The first level of responsibility to respond to marine incidents such as collisions is with ships' masters and crew; however, a collision or other interaction that takes place between Project-related marine vessels and other marine users is also a potential effect of the Project on other MCRTU vessels. Therefore, the significance of the potential residual effects of non-spill collisions on other marine users are evaluated in the following subsections, along with proactive steps to avoid collisions and other recommended mitigation measures.

The potential effects of credible worst case and smaller marine spills on marine users are discussed in Section 5.0.

It is recognised that marine commercial, recreational and tourism users of the Marine RSA are both Aboriginal and non-Aboriginal. While potential TMRU effects are discussed in Section 4.3.10, many commercial fishers and recreational marine users in the Marine RSA are

Aboriginal. The potential effects described in this subsection apply equally to Aboriginal and non-Aboriginal users.

#### 4.3.11.4.2 Identified Potential Effects

Potential effects associated with the increased Project-related marine vessel traffic on MCRTU indicators are listed in Table 4.3.11.2. These interactions are based on the results of the literature review, desktop analysis, interviews, Project-wide consultation and engagement with Aboriginal communities, government agencies and other stakeholders (Section 3.0), and the experience of the assessment team.

A summary of mitigation measures provided in Table 4.3.11.2 was principally developed in accordance with KMC standards as well as industry best practices.

**TABLE 4.3.11.2**

**POTENTIAL EFFECTS, MITIGATION MEASURES AND RESIDUAL EFFECTS OF INCREASED PROJECT-RELATED MARINE VESSEL TRAFFIC ON MARINE COMMERCIAL, RECREATIONAL AND TOURISM USE**

| Potential Effect | Spatial Boundary[1] | Key Mitigation Measures in Place/Additional Recommendations[2] | Potential Residual Effect(s) |
|---|---|---|---|
| **1. Marine Commercial Recreational and Tourism Use Indicator – Commercial Fisheries and Aquaculture** | | | |
| 1.1 Disruption of commercial fishing activities | LSA | • Project tankers shall utilize the common shipping lanes, already used by all large commercial vessels for passage between the Pacific Ocean and PMV.<br>• Trans Mountain will continue to provide information about Project-related shipping to other marine users. Specifically:<br>– provide regular updated information on Project-related marine vessel traffic to fishing industry organizations, Aboriginal communities, and other affected stakeholders, where possible through the Chamber of Shipping of BC (COSBC); and<br>– initiate a public outreach program prior to Project operations phase. Communicate any applicable information on Project-related timing and scheduling with fishing industry organisations, Aboriginal communities and other affected stakeholders.<br>• Transport Canada requires all vessels, including tankers, to comply with the *International Regulations for Preventing Collisions at Sea* (with Canadian Modifications) and other major international maritime conventions.<br>• Transport Canada requires compliance by all vessels with the *Canada Shipping Act,* 2001, *Collision Regulations,* the *Navigation Safety Regulations* pursuant to the Act and other applicable regulations and standards, except Government or Military vessels.<br>• The CCG ensures that all large vessels, including Project-related tankers, register with MCTS for communications with port authorities and CCG, and employ Automatic Identification Systems (AIS). | • Disruption of commercial fishing activities.<br>• Alteration of existing marine vessel movement patterns. |

## TABLE 4.3.11.2

## POTENTIAL EFFECTS, MITIGATION MEASURES AND RESIDUAL EFFECTS OF INCREASED PROJECT-RELATED MARINE VESSEL TRAFFIC ON MARINE COMMERCIAL, RECREATIONAL AND TOURISM USE (continued)

| Potential Effect | Spatial Boundary[1] | Key Mitigation Measures in Place/Additional Recommendations[2] | Potential Residual Effect(s) |
|---|---|---|---|
| **1. Marine Commercial Recreational and Tourism Use Indicator – Commercial Fisheries** | | | |
| 1.1 Disruption of commercial fishing activities (cont'd) | LSA | • The CCG requires compliance with the CCG fishing vessel advisory notice for commercial ships and fishing vessels using the inside passage waters of BC during the commercial fishing season. This notice refers to all inside marine waters of BC.<br>• The PPA requires compliance with the PPA Compulsory Pilotage Areas (PPA 2013).<br>• PMV ensures compliance with PMV's MRA regulations, including "Clear Narrows" regulations (PMV 2010).<br>• To enhance preventive measures currently in place through applicable legislation and regulations, implement May 2013 recommendations of Canadian Marine Pilot's Association Submission to the Tanker Safety Expert Panel.<br>• Trans Mountain will require tug escort of all Project-related tankers for the entire transit from the Westridge Marine Terminal to the Pacific Ocean. This enhancement is in addition to tug requirements to assist with navigation. The tug can be tethered for extra navigational assistance if needed. | • See above |
| 1.2 Marine vessel collisions with commercial fishers | RSA | • Mitigation measures listed in potential effect 1.1 are applied by the appropriate parties.<br>• Tanker owners have third-party insurance coverage in place to address vessel damage, gear loss or injury.<br>• Transport Canada and the Transportation Safety Board carry out investigations at the appropriate level in case of a collision between vessels.<br>• Refer to Section 4.3.13 Accidents and Malfunctions. | • Damage to marine vessels and/or injury.<br>• Damage or loss of gear.<br>• Disruption of marine user activities from Project-related marine vessel wake.<br>• Lost or reduced economic opportunity for commercial marine users. |
| 1.3 Marine vessel wake effects on small fishing vessels | RSA | | |
| 1.4 Sensory disturbance (*e.g.*, noise, visual effect, air quality) for commercial fishers | LSA | • Trans Mountain will continue to engage with those affected, including Aboriginal communities, throughout the operational life of the Project.<br>• Refer to Section 4.3.3 Air Emissions, Section 4.3.4 GHG Emissions and Section 4.3.5 Acoustic Environment for measures pertaining to nuisance air and noise emissions, respectively. | • Refer to Section 4.3.10 Traditional Marine Resource Use.<br>• Increased sensory disturbance for marine users. |
| 1.5 Change in distribution | RSA | • Refer to Section 4.3.6 Marine Fish and Fish Habitat. | • Lost or reduced economic |

## TABLE 4.3.11.2

## POTENTIAL EFFECTS, MITIGATION MEASURES AND RESIDUAL EFFECTS OF INCREASED PROJECT-RELATED MARINE VESSEL TRAFFIC ON MARINE COMMERCIAL, RECREATIONAL AND TOURISM USE (continued)

| Potential Effect | Spatial Boundary[1] | Key Mitigation Measures in Place/Additional Recommendations[2] | Potential Residual Effect(s) |
|---|---|---|---|
| and abundance of target species | | | opportunity (refer to potential effects 1.2 and 1.3 of this table). |
| **2. Marine Commercial, Recreational and Tourism Use Indicator – Marine Transportation** | | | |
| 2.1 Alteration of existing movement patterns of marine commercial users | LSA | • Mitigation measures in potential effect 1.1 are applied by the appropriate parties.<br>• Trans Mountain will provide regular updated information on Project-related marine vessel traffic to shipping associations, such as Chamber of Shipping. | • Alteration of existing marine vessel movement patterns (refer to potential effect 1.1 of this table). |
| 2.2 Increased rail bridge operations | LSA | • Mitigation measures in potential effect 1.1 are applied by the appropriate parties.<br>• PMV ensures procedures for bridge operations are correctly implemented and facilitate communications protocols between bridge operators and vessels.<br>• Trans Mountain will provide regular updated information on Project-related marine vessel traffic to CN Rail. | • Disruption to rail traffic on CN Rail Bridge at Second Narrows. |
| 2.3 Marine vessel collision with built infrastructure, marine facilities or shoreline with a commercial use<br>2.4 Marine vessel collisions with marine commercial users | LSA | • Mitigation measures listed in potential effect 1.1 are applied by the appropriate parties.<br>• Tanker owners have third-party insurance coverage in place to address vessel damage, gear loss or injury<br>• Transport Canada and the Transportation Safety Board carry out investigations at the appropriate level in case of a collision between vessels.<br>• Refer to Section 4.3.13 Accidents and Malfunctions. | • Damage to built infrastructure, marine facilities, or shorelines.<br>• Damage to marine vessels and/or (refer to potential effect 1.2 of this table).<br>• Lost or reduced economic opportunity (refer to potential effects 1.2 and 1.3 of this table). |
| **3. Marine Commercial, Recreational and Tourism Use Indicator – Marine Recreational Use** | | | |
| 3.1 Alteration of existing movement patterns of marine recreational users | LSA | • Mitigation measures in potential effect 1.1 are applied by the appropriate parties.<br>• Trans Mountain will provide regular updated information on Project-related marine vessel traffic to recreational organisations. | • Alteration of existing marine vessel movement patterns (refer to potential effect 1.1 of this table). |
| 3.2 Marine vessel collision with built infrastructure, marine facilities or shoreline with a recreational | LSA | • Mitigation measures listed in potential effect 1.1 are applied by the appropriate parties.<br>• Tanker owners have third-party insurance coverage in place to address vessel damage, gear loss or injury<br>• Transport Canada and the Transportation Safety Board carry out investigations at the appropriate level in case of a collision between vessels. | • Damage to built infrastructure, marine facilities, or shoreline (refer to potential effects 2.3 and 2.4 of this table). |

**TABLE 4.3.11.2**

**POTENTIAL EFFECTS, MITIGATION MEASURES AND RESIDUAL EFFECTS OF INCREASED PROJECT-RELATED MARINE VESSEL TRAFFIC ON MARINE COMMERCIAL, RECREATIONAL AND TOURISM USE (continued)**

| Potential Effect | Spatial Boundary[1] | Key Mitigation Measures in Place/Additional Recommendations[2] | Potential Residual Effect(s) |
|---|---|---|---|
| use. | | • Refer to Section 4.3.13 Accidents and Malfunctions. | |
| **3. Marine Commercial, Recreational and Tourism Use Indicator – Marine Recreational Use** | | | |
| 3.3 Marine vessel collisions with other marine recreational users<br><br>3.4 Marine vessel wake effects on small recreational vessels | LSA | • See above | • Damage to marine vessels and/or injury (refer to potential effect 1.2 of this table).<br>• Damage or loss to gear (refer to potential effect 1.3 of this table).<br>• Lost or reduced economic opportunity (refer to potential effects 1.2 and 1.3 of this table).<br>• Disruption of marine user activities from Project-related marine vessel wake (refer to potential effect 1.3 of this table).<br>• Refer to Section 5.0 Marine Spill Scenarios. |
| 3.5 Sensory disturbance (*e.g.*, noise, visual effect, air quality) for recreational users | RSA | • Trans Mountain will continue to conduct consultative discussions with those affected, including the Aboriginal community, throughout the operational life of the Project.<br>• Refer to Section 4.3.3 Air Emissions, Section 4.3.4 GHG Emissions and Section 4.3.5 Acoustic Environment for measures pertaining to nuisance air and noise emissions, respectively. | • Refer to Section 4.3.10 Traditional Marine Resource Use.<br>• Increased sensory disturbance for marine users (refer to potential effect 1.4 of this table). |
| 3.6 Negative recreational user perspectives of increased Project-related marine vessel traffic | RSA | • Mitigation measures listed in potential effects 1.1 to 1.4 are applied by the appropriate parties. | • Negative user perspectives of increased marine vessel traffic. |

## TABLE 4.3.11.2

## POTENTIAL EFFECTS, MITIGATION MEASURES AND RESIDUAL EFFECTS OF INCREASED PROJECT-RELATED MARINE VESSEL TRAFFIC ON MARINE COMMERCIAL, RECREATIONAL AND TOURISM USE (continued)

| Potential Effect | Spatial Boundary[1] | Key Mitigation Measures in Place/Additional Recommendations[2] | Potential Residual Effect(s) |
|---|---|---|---|
| **4. Marine Commercial Recreational and Tourism Use Indicator – Marine Tourism Use** | | | |
| 4.1 Alteration of existing movement patterns of marine tourism users | LSA | • Mitigation measures listed in potential effect 1.1 are applied by the appropriate parties.<br>• Trans Mountain will provide regular updated information on Project-related marine vessel traffic to tourism organisations. | • Alteration of existing marine vessel movement patterns (refer to potential effect 1.1 of this table). |
| 4.2 Marine vessel collisions with marine tourism users<br>4.3 Marine vessel collision with built infrastructure, marine facilities or shoreline with a tourism use<br>4.4 Marine vessel wake effects on small tourism operator vessels | LSA | • Mitigation measures listed in potential effect 1.1 are applied by the appropriate parties.<br>• Tanker owners have third-party insurance coverage in place to address vessel damage, gear loss or injury<br>• Transport Canada and the Transportation Safety Board carry out investigations at the appropriate level in case of a collision between vessels.<br>• Refer to Section 4.3.13 Accidents and Malfunctions. | • Damage to built infrastructure, marine facilities, or shorelines (refer to potential effects 2.3 and 2.4 of this table).<br>• Damage to marine vessels and/or injury (refer to potential effect 1.2 of this table).<br>• Damage or loss to gear (refer to potential effect 1.3 of this table).<br>• Lost or reduced economic opportunity (refer to potential effects 1.2 and 1.3 of this table).<br>• Disruption of marine user activities from Project-related marine vessel wake (refer to potential effect 1.3 of this table). |

**TABLE 4.3.11.2**

**POTENTIAL EFFECTS, MITIGATION MEASURES AND RESIDUAL EFFECTS OF INCREASED PROJECT-RELATED MARINE VESSEL TRAFFIC ON MARINE COMMERCIAL, RECREATIONAL AND TOURISM USE (continued)**

| Potential Effect | Spatial Boundary[1] | Key Mitigation Measures in Place/Additional Recommendations[2] | Potential Residual Effect(s) |
|---|---|---|---|
| 4.5 Sensory disturbance (*e.g.*, noise, visual effect, air quality) for tourism users | LSA | • Trans Mountain will continue to conduct consultative discussions with those affected, including the Aboriginal community, throughout the operational life of the Project.<br>• Refer to Section 4.3.3 Air Emissions, Section 4.3.4 GHG Emissions and Section 4.3.5 Acoustic Environment for measures pertaining to nuisance air and noise emissions, respectively. | • Refer to Section 4.3.10 Traditional Marine Resource Use.<br>• Increased sensory disturbance for marine users (refer to potential effect 1.4 of this table).<br>• Decrease in marine tourism activities. |
| 4.6 Negative tourism user perspectives of increased Project-related marine vessel traffic | RSA | • Mitigation measures listed in potential effect 3.5 are applied by the appropriate parties. | • Negative user perspectives of increased tanker traffic (refer to potential effect 3.5 of this table). |

**Notes:** 1 LSA = Marine LSA; RSA = Marine RSA

2 This may be coordinated with Trans Mountain's mitigation measure of providing information related to Project activities affecting marine use areas (*i.e.*, the construction and operations of the Westridge Marine Terminal), as outlined in the Socio-economic Management Plan in Volume 6B, Appendix C Section 8.4.10.

#### *4.3.11.5 Potential Residual Effects*

The potential residual socio-economic effects on marine commercial, recreational and tourism use indicators associated with the increased Project-related marine vessel traffic (Table 4.3.11.2) are:

- disruption of commercial fishing activities;
- alteration of existing marine vessel movement patterns;
- damage to marine vessels and/or injury;
- damage or loss of gear;
- disruption of marine user activities from Project-related marine vessel wake;
- lost or reduced economic opportunity for commercial marine users;
- increased sensory disturbance for marine users;

- increased disruption to rail traffic on CN Rail Bridge at Second Narrows;
- damage to built infrastructure, marine facilities, or shorelines;
- negative user perspectives of increased marine vessel traffic; and
- decrease in marine tourism activities.

As noted by the cross-references appearing in Table 4.3.11.2, many of these effects are pertinent to marine commercial users, recreational users and tourism users alike. Also, many vessels using the Marine RSA fall into multiple categories; some commercial users are also tourism users (*e.g.,* commercial sportfishing outfitters and whale-watching tours). As such, many potential residual effects discussed below, though presented in relation to a certain marine user category are assessed in relation to all pertinent marine users in an integrated manner.

*4.3.11.6 Significance Evaluation of Potential Residual Effects*

A qualitative assessment of MCRTU was determined to be the most appropriate approach to evaluate the significance of potential residual socio-economic effects due to a lack of regulatory thresholds, standards or guidelines for indicators associated with this element. Consequently, the evaluation of significance of each of the potential residual effects relies on the professional judgment of the assessment team that includes members with extensive socio-economic impact assessment and marine experience.

Table 4.3.11.3 provides a summary of the significance evaluation of the potential residual socio-economic effects of the increased Project-related marine vessel traffic on MCRTU. The rationale used to evaluate the significance of each of the residual socio-economic effects is provided below.

**TABLE 4.3.11.3**

**SIGNIFICANCE EVALUATION OF POTENTIAL RESIDUAL EFFECTS OF INCREASED PROJECT-RELATED MARINE VESSEL TRAFFIC ON MARINE COMMERCIAL, RECREATIONAL AND TOURISM USE**

| Potential Residual Effects | Impact Balance | Spatial Boundary[1] | Temporal Context | | | Magnitude | Probability | Confidence | Significance[2] |
|---|---|---|---|---|---|---|---|---|---|
| | | | Duration | Frequency | Reversibility | | | | |
| **1. Marine Commercial Recreational and Tourism Use Indicator – Commercial Fisheries and Aquaculture** | | | | | | | | | |
| 1(a) Disruption to commercial fishing activities. | Negative | RSA | Long-term | Periodic | Long-term | Low | Low | High | Not significant |
| 1(b) Alteration of existing marine vessel movement patterns. | Negative | RSA | Long-term | Periodic | Short- to long-term | Low to medium | High | High | Not significant |
| 1(c) Damage to marine vessels and/or injury. | Negative | LSA | Long-term | Accidental | Short-term to permanent | High | Low | High | Not significant |

## TABLE 4.3.11.3

## SIGNIFICANCE EVALUATION OF POTENTIAL RESIDUAL EFFECTS OF INCREASED PROJECT-RELATED MARINE VESSEL TRAFFIC ON MARINE COMMERCIAL, RECREATIONAL AND TOURISM USE (continued)

| Potential Residual Effects | Impact Balance | Spatial Boundary[1] | Temporal Context | | | Magnitude | Probability | Confidence | Significance[2] |
|---|---|---|---|---|---|---|---|---|---|
| | | | Duration | Frequency | Reversibility | | | | |
| 1(d) Damage or loss of gear. | Negative | LSA | Long-term | Accidental | Short-term | Low to medium | Low | Moderate | Not significant |
| 1(e) Disruption of marine user activities from Project-related marine vessel wake. | Negative | LSA | Long-term | Occasional | Short-term | Low to medium | Low | Moderate | Not significant |
| 1(f) Lost or reduced economic opportunity for commercial marine users. | Negative | RSA | Long-term | Accidental | Short- to medium-term | Low to high | Low | High | Not significant |
| 1(g) Increased sensory disturbance to marine users. | Negative | LSA | Long-term | Periodic | Short-term | Low | High | High | Not significant |
| 1(h) Combined effects on the commercial fisheries and aquaculture indicator (1[b] and 1[g]). | Negative | LSA to RSA | Long-term | Periodic | Long-term | Low to medium | High | High | Not significant |
| **2. Marine Commercial Recreational and Tourism Use Indicator – Marine Transportation** | | | | | | | | | |
| 2(a) Disruption to rail traffic on CN Rail Bridge at Second Narrows. | Negative | LSA specific to CN Rail Bridge at Second Narrows, Burrard Inlet | Long-term | Periodic | Short-term | Medium | High | High | Not significant |
| 2(b) Damage to built infrastructure, marine facilities or shorelines. | Negative | LSA specific to Burrard Inlet | Long-term | Accidental | Short- to medium-term | Low to high | Low | High | Not significant |
| 2(c) Alteration of existing marine vessel movement patterns. | Negative | RSA | Long-term | Periodic | Short- to long-term | Low to medium | High | High | Not significant |
| 2(d) Damage to marine vessels and/or injury. | Negative | LSA | Long-term | Accidental | Short-term to permanent | High | Low | High | Not significant |
| 2(e) Lost or reduced economic opportunity for commercial marine users. | Negative | RSA | Long-term | Accidental | Short- to medium-term | Low to high | Low | High | Not significant |
| 2(f) Combined effects on the Marine Transportation indicator (2[a] and 2[c]). | Negative | LSA to RSA | Long-term | Periodic | Long-term | Low to medium | High | High | Not significant |
| **3. Marine Commercial Recreational and Tourism Use Indicator – Marine Recreational Use** | | | | | | | | | |
| 3(a) Negative user perspectives of increased Project-related marine vessel traffic. | Negative | RSA | Long-term | Continuous | Long-term | Low | High | Moderate | Not significant |

## TABLE 4.3.11.3

## SIGNIFICANCE EVALUATION OF POTENTIAL RESIDUAL EFFECTS OF INCREASED PROJECT-RELATED MARINE VESSEL TRAFFIC ON MARINE COMMERCIAL, RECREATIONAL AND TOURISM USE (continued)

| Potential Residual Effects | Impact Balance | Spatial Boundary[1] | Temporal Context | | | Magnitude | Probability | Confidence | Significance[2] |
|---|---|---|---|---|---|---|---|---|---|
| | | | Duration | Frequency | Reversibility | | | | |
| 3(b) Alteration of existing marine vessel movement patterns. | Negative | RSA | Long-term | Periodic | Short- to long-term | Low to medium | High | High | Not significant |
| 3(c) Damage to built infrastructure, marine facilities, or shorelines. | Negative | LSA specific to Burrard Inlet | Long-term | Accidental | Short- to medium - term | Low to high | Low | High | Not significant |
| 3(d) Damage to marine vessels and/or injury. | Negative | LSA | Long-term | Accidental | Short-term to permanent | High | Low | High | Not significant |
| 3(e) Damage or loss of gear. | Negative | LSA | Long-term | Accidental | Short-term | Low to medium | Low | Moderate | Not significant |
| 3(f) Disruption of marine user activities from Project-related marine vessel wake. | Negative | LSA | Long-term | Occasional | Short-term | Low to medium | Low | Moderate | Not significant |
| 3(g) Increased sensory disturbance to marine users. | Negative | LSA | Long-term | Periodic | Short-term | Low | High | High | Not significant |
| 3(h) Combined effects on the marine recreational use indicator (3[a], 3[b] and 3[g]). | Negative | LSA to RSA | Long-term | Periodic to continuous | Long-term | Low to medium | High | High | Not significant |
| **4. Marine Commercial Recreational and Tourism Use Indicator – Marine Tourism Use** | | | | | | | | | |
| 4(a) Decrease in marine tourism activities. | Negative | RSA | Long-term | Continuous | Long-term | Medium | Low | High | Not significant |
| 4(b) Alteration of existing marine vessel movement patterns. | Negative | RSA | Long-term | Periodic | Short- to long-term | Low to medium | High | High | Not significant |
| 4(c) Damage to built infrastructure, marine facilities, or shorelines. | Negative | LSA specific to Burrard Inlet | Long-term | Accidental | Short- to medium-term | Low to high | Low | High | Not significant |
| 4(d) Damage to marine vessels and/or injury. | Negative | LSA | Long-term | Accidental | Short-term to permanent | High | Low | High | Not significant |
| 4(e) Damage or loss of gear. | Negative | LSA | Long-term | Accidental | Short-term | Low to medium | Low | Moderate | Not significant |
| 4(f) Lost or reduced economic opportunity for commercial marine users. | Negative | RSA | Long-term | Accidental | Short- to medium-term | Low to high | Low | High | Not significant |
| 4(g) Disruption of marine user activities from Project-related marine vessel wake. | Negative | LSA | Long-term | Occasional | Short-term | Low to medium | Low | Moderate | Not significant |
| 4(h) Increased sensory disturbance to marine users. | Negative | LSA | Long-term | Periodic | Short-term | Low | High | High | Not significant |
| 4(i) Combined effects on the marine tourism use indicator (4[b], and 4[h]). | Negative | LSA to RSA | Long-term | Periodic | Long-term | Low to medium | High | High | Not significant |

**TABLE 4.3.11.3**

**SIGNIFICANCE EVALUATION OF POTENTIAL RESIDUAL EFFECTS OF INCREASED PROJECT-RELATED MARINE VESSEL TRAFFIC ON MARINE COMMERCIAL, RECREATIONAL AND TOURISM USE (continued)**

| Potential Residual Effects | Impact Balance | Spatial Boundary[1] | Temporal Context | | | Magnitude | Probability | Confidence | Significance[2] |
|---|---|---|---|---|---|---|---|---|---|
| | | | Duration | Frequency | Reversibility | | | | |
| **5. Combined Effects of Increased Project-Related Marine Vessel Traffic on Marine Commercial, Recreation and Tourism Use** | | | | | | | | | |
| 5(a) Combined effects of increased Project-related marine vessel traffic on the MCRTU indicators (2[f], 3[h] and 4[i]). | Negative | RSA | Long-term | Periodic | Long-term | Low to medium | High | High | Not significant |

**Notes:** 1 LSA = Marine LSA; RSA = Marine RSA

2 **Significant Residual Socio-Economic Effect:** a residual socio-economic effect is considered significant if the effect is predicted to be:

- high magnitude, high probability, long-term or permanent reversibility, and any spatial boundary that cannot be technically or economically mitigated.

### 4.3.11.6.1 Marine Commercial, Recreational and Tourism Use Indicator – Commercial Fisheries and Aquaculture

The following discusses the significance rationale for the potential residual effects identified for the commercial fishing indicator.

**Disruption to Commercial Fishing Activities**

The disruption of commercial fishing activities is a potential residual effect of interactions between commercial fishing vessels and Project-related marine vessel traffic that could occur when Project-related marine vessels are in transit in the shipping lanes. Fishing vessels are permitted to cross and fish within shipping lanes if the area is clear; however, fishers are not permitted to impede the passage of other vessels (CCG 2013c). Transits of Project-related marine vessel traffic through the Marine RSA will increase from approximately weekly to daily. Disruption of fishing activities by Project-related marine vessel traffic may result in a missed fishing opportunity. Fishing vessels may be present in the shipping lanes during fishery openings in the Strait of Georgia and Juan de Fuca Strait (CCG 2013b). Incidents between deep draft vessels and vessels engaged in fishing are rare but not without precedent. In 1994, a collision occurred in heavy fog off Nova Scotia between a loaded bulk carrier “Federal Oslo” and a fishing vessel “Shelley Dawn II” that was actively hauling gear (TSB 2013). A lost fishing opportunity may result in a lost economic opportunity for the fisher.

Preferred fishing locations in some areas of the Marine RSA are situated along or near the shipping lanes. For example, areas of higher effort for the prawn trap fishery include around the shipping lanes in Haro Strait near Stuart Island. Openings for the salmon gillnet fishery occur around the mouth of the Fraser River, in the Roberts Bank area adjacent to the shipping lanes (CCG 2013b).

Smaller marine vessels including many fishing vessels are not required to register with the CCG Marine Communications and Traffic Services, and many are not equipped with AIS transponders, radar reflectors or other equipment that improves their visibility to large deep sea vessels, especially in poor weather (CCG 2013b). Transport Canada and the CCG continue to encourage small vessels to use technology to improve visibility.

Mitigation measures recommended for this residual effect include communication measures as described in Table 4.3.11.2. Project-related marine vessels will be fully compliant with all applicable navigational, communications and safety regulations as outlined in Section 1.1 and Table 4.3.11.2.

The impact balance of this potential residual effect is considered to be negative. The spatial boundary is the Marine RSA. Although interactions may occur wherever fishing grounds are in or near the shipping lanes, fishing vessels also may be displaced to other areas in the Marine RSA. The duration of the event causing the disruption of commercial fishing activities is long-term, and the reversibility of the residual effect is considered to be long-term, since all effects of Project-related marine vessel traffic would extend for the operational life of the Project.

Commercial fishing is permitted in the shipping lanes during fishing seasons (CCG 2013a). Since fishing boats could be encountered by Project-related marine vessels whenever these vessels are transiting through the shipping lanes, the frequency of the event is periodic. The magnitude of the effect is considered to be low, since it is expected that the disruption would be temporary in the unlikely event that a Project-related disruption did occur. Such disruptions to fishing activities are equally likely to occur in relation to all large vessels currently using the shipping lanes, and Project-related marine vessels will make up only a small portion of the total marine traffic (TMEP TERMPOL 3.2 in Volume 8C, TR 8C-2).

Confidence in this evaluation is high; although the possible locations of fishers can only be inferred based on known fishing season openings for specific fisheries and the locations of preferred fishing areas, incidents between marine vessels are rare and are mitigated by measures outlined in Table 4.3.11.3, point 1[a]). A summary of the rationale for all of the significance criteria is provided below.

- **Spatial Boundary** - Marine RSA – interactions between Project-related marine vessels and commercial fishing activities that lead to delays or disruptions in fishing activities could occur at any point along the shipping lanes and may also indirectly affect the distribution of vessels in other areas of the Marine RSA.
- **Duration** - long-term – interactions between Project-related marine vessels and commercial fishing activities will begin during the operations phase and will extend for the operational life of the Project.
- **Frequency** - periodic – Project-related marine vessels will be present daily in the shipping lanes over the operational life of the Project.
- **Reversibility** - long-term – the potential disruptions to commercial fishing activities are expected to extend throughout the operations phase of the Project.
- **Magnitude** - low – fishing activities may be interrupted due to increased Project-related marine vessel traffic, but are likely to be resumed in most cases once the vessel has passed.

- **Probability** - low – interactions between Project-related marine vessels and commercial fishing vessels that disrupt fishing activities are considered to have a low likelihood of occurrence.
- **Confidence** - high – there is a good understanding of general cause-effect relationships between increased Project-related marine vessels and interactions with commercial fishing activities in the Marine RSA.

**Alteration of Existing Marine Vessel Movement Patterns**

The alteration of existing marine vessel movement patterns is a potential residual effect of interactions between the increased Project-related marine vessel traffic and other marine vessels that could occur when Project-related marine vessels (or other marine vessels) are in transit at any point in the shipping lanes . Although this potential residual effect applies to the Marine RSA in general, marine vessels in Burrard Inlet may be the most affected due to the confined nature of this marine area. In Burrard Inlet, specific procedures are in place to ensure that tankers (including Project-related tankers) and other deep draft vessels are able to navigate through Burrard Inlet safely (PMV 2010). Aframax tankers are required to transit through the Second Narrows area in daylight hours only and only during slack tides. Vessels are required to retain a minimum underkeel clearance and to ensure adequate manoeuvrability in the First and Second Narrows (PMV 2010). During transits of all piloted marine vessels in Burrard Inlet, all other vessels must keep clear of the shipping lanes. The CCG MCTS must inform any other marine vessels intending to transit through the Narrows within 20 minutes of the transit time clearance for deep sea vessels; that is, other vessels are required to keep clear and wait until the cleared vessel has transited (PMV 2010). The Harbour Master for PMV and the CCG assist in keeping other vessels clear of the channel, and communicate with smaller vessels directly if necessary (PMV 2010). In addition, for laden tankers PMV provides a “Clear Narrows” procedure that also includes the use of a port patrol craft. The increased Project-related marine vessel traffic will result in more frequent tanker transits through Burrard Inlet, and may result in delays and inconvenience for other vessels as they keep clear of the channel. A limited amount of commercial fishing (*e.g.*, for Dungeness crab) occurs in areas of Burrard Inlet; however, it is possible that increased marine vessels transits may reduce the time available for fishing activity. For all commercial operators, changes to scheduling due to vessels waiting for Project-related marine vessels to transit could have financial repercussions.

Other areas of the Marine RSA where marine vessel movement patterns have the potential to be altered by the increased Project-related marine vessel traffic include locations of navigational concern along the shipping lanes (refer to Volume 8C, TR 8C-2, TERMPOL 3.2). These areas include Turn Point, which connects Haro Strait and Boundary Pass. Vessels entering the designated Special Operating Area around Turn Point are required to be in contact with one another to avoid vessels arriving at Turn Point simultaneously. Increased marine vessel traffic in navigationally constrained areas may affect the passage of other marine vessels and lead to alteration in movement patterns.

Other designated areas in the Marine RSA that may partially overlap with the shipping lanes are used for activities such as ocean dumping, military operations or offshore exploration. Ocean dumping sites are present in the Strait of Georgia near Point Grey and at Sand Heads offshore from the mouth of the Fraser River. Mariners are notified of ocean dumping activities and active military or exploration operations through VTS

Mitigation measures recommended for this residual effect include communication measures as described in Table 4.3.11.2. Project-related marine vessels will be fully compliant with all applicable navigational, communications and safety regulations as outlined in Section 1.1 and Table 4.3.11.2.

The potential alteration of existing marine vessel movement patterns applies to all marine users and is considered to have a net negative impact balance. The duration of the event causing the altered vessel movement patterns is considered to be long-term, since the Project-related marine vessel traffic would be present for the operational life of the Project. Since changes in vessel movements may occur whenever Project-related marine vessels are transiting though the Marine RSA, the frequency of the event is periodic. Reversibility of the residual effect is long-term because marine vessels have the potential to alter their movement patterns whenever they come into contact with Project-related marine vessel traffic throughout the life of the Project. The magnitude of the residual effect is considered to be low to medium. Marine vessels may be temporarily inconvenienced by the presence of Project-related marine vessels (low), but for some commercial fishing and other commercial vessels delays could have business implications (medium). In the case of fishing vessels the route alteration could potentially result in a delay or reduction in fishing activity. For example, commercial fishing vessels may choose to alter routes to fishing grounds or between ports to avoid increased marine vessel traffic, or fishers may not be able to fish in preferred locations due to increased Project-related marine vessel traffic. This is a conservative evaluation of magnitude, however, as discussions with marine users including commercial fishing industry representatives, recreational organizations, and marine tourism operators (identified in Table 2.1.1 in the Marine Commercial, Recreational and Tourism Use – Marine Transportation Technical Report in Volume 8B, TR 8B-6) indicated that the additional marine traffic that will be generated by the Project is unlikely to materially affect the activities of most marine users in the Marine RSA.

Generally, the potential for some alternation of marine vessel traffic in consideration of Project-related marine vessels is considered likely to occur and thus of high probability. However, specific effects will vary between marine vessel types, locations in the Marine RSA and choices of individual vessel operators. For example, due to the low levels of commercial fishing effort identified in Burrard Inlet, the probability of Project related marine vessel traffic affecting commercial fishing vessel movements in this part of the Marine RSA is considered to be unlikely. However, the movements of other commercial vessels and recreational vessels accessing marinas or terminals in Burrard Inlet are considered likely to be affected by increased Project-related marine vessel traffic, due to the “Clear Narrows” procedure and the navigational constraints already present (Table 4.3.11.3, point 1[b]). A summary of the rationale for all of the significance criteria is provided below.

- **Spatial Boundary** - Marine RSA – Alteration of existing marine vessel movement patterns due to interactions with increased Project-related marine vessel traffic could occur at any point in the Marine RSA and may also affect the distribution of vessels in other areas of the Marine RSA.
- **Duration** - long-term – interactions between Project-related marine vessels and other marine users would begin during the operations phase and extend for the operational life of the Project.
- **Frequency** - periodic – interactions between Project-related marine vessels and other marine users have the potential to occur intermittently; however, repeatedly over the life of the Project.

- **Reversibility** - short- to long-term – the reversibility of the residual effect could be temporary, if marine users change course to avoid Project-related marine vessels; however, the residual effect could be long-term if the user chose to alter their movement patterns to avoid all interactions with Project-related marine vessel traffic. .
- **Magnitude** - low to medium – commercial fishing vessels and other marine vessels may be temporarily inconvenienced by the presence of Project-related marine vessels (low), but delays may have business implications for some vessels (medium).
- **Probability** - high –generally, some alternation of marine vessel traffic in consideration of Project-related marine vessels is considered likely; however, the likelihood of effects will vary between marine vessel types, locations in the Marine RSA and choices of individual vessel operators.
- **Confidence** - high – there is a good understanding of general cause-effect relationships between increased Project-related marine vessel traffic and interactions with other marine users in the Marine RSA. .

**Damage to Marine Vessels and/or Injury**

The loss or damage to marine vessels as a result of the increased Project-related marine vessels is a negative potential residual effect that could occur at any point along the Marine LSA, for the operational life of the Project. The frequency of such events is considered to be accidental, with a low probability of occurrence. The Transportation Safety Board of Canada (TSB) is notified of marine collisions and other incidents that occur in Canadian waters when non-pleasure craft are involved, and also monitors incident statistics to identify trends and emerging safety issues (TSB 2013). In 2012, there were 236 shipping accidents reported across Canada and only 6 of the 236 accidents were collisions between vessels. However, the TSB has identified the safety of fishing vessels as an area of high concern since 45 per cent of all vessels involved in shipping accidents were fishing vessels (TSB 2013). Reported incidents involving fishing or other small vessels and cargo ships or tankers point to multiple potential causes such as lack of communications between vessels, sudden course changes, excessive speeds of the larger vessel in the presence of the smaller vessels, and poor estimation of the collision risk from both parties (TSB 2013).

Standard operating procedures that are implemented by most deep draft commercial marine vessels should aid in avoidance of collisions under most circumstances. These measures include: the widespread use of ship's radar; the compulsory use of CCG MCTS for most vessels to facilitate communications with ports and other vessels; the use of loudhailers on bridges to communicate with smaller vessels that are not registered with CCG MCTS; the compulsory use of pilots in coastal BC waters; the use of escort tugs in Haro Strait and Burrard Inlet; and other standard navigational measures. According to the IMO and as a *Canada Shipping Act* requirement it is mandatory for commercial vessels above 500 GT and SMS is currently practiced and enforced on all Project-tankers. Fishing vessels less than 24 m in length and 150 gross tonnes, and pleasure craft less than 30 m in length are not required to call in to VTS (CCG 2013a). Notices are issued by the CCG that specifically caution vessels to be aware of fishing activity at certain locations and times (CCG 2013b).

The TSB has recommended additional safety measures for commercial marine vessels, including mandatory Safety Management Systems (SMS), regardless of vessel size. SMS is a proactive system that includes regular safety drills and exercises, clear roles and responsibilities for crew, hazard identification systems and tools to improve vessel operations (TSB 2013).

The reversibility of the potential residual effect is considered to range from short-term to permanent. In the case of minimal damage, repairs could be completed in the short-term. However, in the case of vessel loss the reversibility may be long-term, and if injury or loss of life occurs the reversibility is considered to be permanent. The magnitude is, therefore, considered to be high, depending on the severity of the loss or damage to the marine vessel. Vessel damage or loss, and personal injury or loss of life, have serious ramifications for the marine user and, consequently, the magnitude of the residual effect is considered to be high (Table 4.3.11.3, point 1[c]). Vessel damage or loss can result in lost economic and long-term financial effects while the owner waits for repairs or replacement. In the case of injury, the effects equate to possible permanent loss in economic opportunity as well as family and community impacts. Compensation for vessel damages and injury are regulated under the MLA. Marine vessels carry insurance and liability is determined through the court process. A summary of the rationale for all of the significance criteria is provided below.

- **Spatial Boundary** - Marine LSA – collisions between Project-related marine vessels and other marine users could occur at any point in the shipping lanes in the Marine LSA.
- **Duration** - long-term – the possibility of collisions between Project-related marine vessels and other marine users would be present for the operational life of the Project.
- **Frequency** - accidental – collisions between Project-related marine vessels and other marine users that result in loss or damage to the vessels are expected to occur very rarely during the operational life of the Project.
- **Reversibility** - short-term to permanent – the reversibility of a loss or damage to a marine vessel may range from less than a year to several years if the vessel is salvageable; however, for a collision which resulted in vessel loss or injury, the actual loss or injury could be considered permanent.
- **Magnitude** - high – loss or damage to a marine vessel is considered to have severe modification to the socio-economic environment.
- **Probability** - low – collisions between Project-related marine vessels and other marine users that result in vessel loss or damage are considered to be unlikely due to general compliance with standard mitigation measures as described in the above rationale.
- **Confidence** - high – there is a good understanding of general cause-effect relationships between Project-related marine vessel traffic and the possibility of collisions with other vessels, based on marine collision statistics from the TSB.

**Damage or Loss of Gear**

Interactions between commercial fishing vessels, recreational fishing vessels or commercial fishing guide vessels and Project-related marine vessels may cause entanglement and damage or loss of fishing gear. This potential residual effect could occur wherever Project-related marine vessel traffic is present in the Marine LSA.

Gear damage or loss could potentially occur to commercial fishers, recreational fishers, or commercial fishing guides. Gillnet fishers are one example of a marine user group that may have a higher probability of gear loss or damage from transiting Project-related marine vessels. Gillnets are deployed from fishing vessels and are attached to the vessel at one end, with the net left to hang in the water to catch fish such as herring and salmon. Gillnets are often deployed near the mouths of rivers when salmon runs are returning to the river to spawn. The far end of the net is often equipped with a light to show its position, but the nets are difficult to spot for other ships (CCG 2013b). Nets can be hundreds of metres long (CCG 2013b). Gillnetters can be present between July and November in large numbers in the Roberts Bank area at the mouth of the Fraser River, while fishing intensively for returning salmon (CCG 2013b). Gillnets can extend many hundreds of metres from the fishing vessel, and could be entangled by passing ships where the net locations are not clearly visible. Some of this area is directly in the shipping lanes in the Strait of Georgia; however, due to the mitigation already in place, incidents of nets becoming entangled with large vessels are at best, rare in their occurrence.

The commercial and recreational crab trap fisheries also have the potential for gear loss. Crab and prawn traps are deployed on long fishing lines and left in the water for hours or days (DFO 2013i). Passing vessels can become entangled in crab trap lines. A BC Ferries vessel in Skidegate, Haida Gwaii recently was out of commission on two consecutive occasions when crab trap lines became tangled around the propeller (Canadian Broadcasting Corporation 2009).

Transiting marine vessels have the potential to run into fishing gear whenever fishing activities are occurring in or near the shipping lanes. Loss or damage to fishing gear could be an inconvenience or nuisance, and assuming that compensation plans are in place, replacement or repair of gear could be quickly expedited and financial compensation supplied as appropriate. The residual effect is considered to be of low magnitude; however, if fishing activity was curtailed or reduced as a result of gear loss and financial compensation was not adequate, the magnitude of the effect would be considered to be medium.

Gear interactions with large vessels are few and far between and can be mitigated by the measures for vessel communications described in previous subsections. The CCG Annual Notices to Mariners describe specific areas where fishers are likely to be present during fishing seasons, and cautions shipping vessels to avoid fishing gear (CCG 2013b). It is also possible to surmise that fishers have already adapted their fishing patterns in keeping with the location and use of the shipping lanes and that further helps alleviate possible gear interaction with large vessels.

The potential residual effect of damage or loss of gear is considered to have a negative impact balance. Frequency of this residual effect is accidental, since damage or loss of gear as a result of Project-related marine vessel interactions is expected to occur rarely during the operational life of the Project. The reversibility is considered to be short-term since fishing gear can be repaired or replaced typically within one year, although if the fisher is not compensated for gear loss or damage the reversibility period may be longer due to resulting financial loss. The magnitude of the effect is considered to be low to medium, ranging from a temporary inconvenience (low) to a disruption in fishing activity with potential financial ramifications (medium), depending on whether gear replacement was expedient or financial compensation was adequate (Table 4.3.11.3, point 1[d]).

Damage or loss of gear is considered to have a low probability of occurrence; however, this residual effect is more likely than vessel damage or loss due to the fact that gear such as fishing nets and lines are located over a much larger area than the fishing vessel from which they are deployed and are mostly located under the sea surface. Interactions with other vessels are, therefore, considered to be more likely to result in gear damage than vessel damage; however, occurrences are still not likely to be high due to general compliance with standard mitigation measures as described above.

A summary of the rationale for all of the significance criteria is provided below.

- **Spatial Boundary** - Marine LSA – damage or loss of gear could occur at any point along the shipping lanes within the Marine LSA.
- **Duration** - long-term – the possibility of damage or loss of gear is present for the operational life of the Project.
- **Frequency** - accidental – damage or loss of gear as a result of Project-related marine vessel interactions is expected to occur rarely during the operational life of the Project.
- **Reversibility** - short-term – damage or loss of gear from an accidental incident involving a Project-related marine vessel is considered reversible over the short term; damage could likely be resolved within one year during the operations phase
- **Magnitude** - low to medium – loss of fishing gear from entanglement with Project-related marine vessels ranges from an inconvenience (low) to a moderate modification of the socio-economic environment (medium) depending on whether gear replacement was expedient or financial compensation was adequate.
- **Probability** - low – damage or loss of gear is considered to be unlikely, but more likely than vessel damage or loss. Stakeholder consultation will increase confidence in ascertaining the probability of this residual effect.
- **Confidence** - moderate – there is a good understanding of general cause-effect relationships between Project-related marine vessel traffic and the possibility of fishing gear damage or loss.

**Disruption of Marine User Activities from Project-Related Marine Vessel Wake**

The increased disruption of marine user activities from Project-related marine vessel wake is a potential residual effect that is considered to have a net negative impact balance. This potential effect refers to the possibility that marine commercial, recreational or tourism users could be disrupted in their activities from the wake of transiting Project-related marine vessels, in the event that the user is adjacent to or within the shipping lanes at the time of transit. Specific marine users that may be affected include small commercial or recreational fishing vessels, kayaks and sailboats. During the Victoria ESA Workshop, it was noted that there are occurrences where fishing vessels in the shipping lanes are severely disrupted by the wake of large commercial vessels. The bow waves of deep draft have the potential to swamp a small vessel within the shipping lane. In addition, strong underwater currents can be caused by the engines of large ships that can create water turbulence behind large vessels. Small vessels may also be difficult to identify on the ship’s radar.

The increased disruption of marine user activities from Project-related marine vessel wake is considered to have a net negative impact balance. Although the spatial boundary of this potential residual effect is considered to be anywhere in the Marine LSA, specific areas where fishing or other recreational activities occur very close to the shipping lanes include the Vancouver Outer Harbour and its approach in the Strait of Georgia, the shipping lanes outside Roberts Bank at the mouth of the Fraser River, Haro Strait, the Discovery Islands and Chatham Islands groups off Victoria as well as Constance Bank, Race Rocks and Swiftsure Bank in Juan de Fuca Strait.

Wake effects from Project-related or other large marine vessel traffic are likely to affect small vessels that are too close to them. The frequency of occurrence is expected to be occasional rather than accidental, since there are many specific locations in the Marine RSA where users may be in close proximity to passing tankers in the shipping lanes. Also, some marine users may not aware of the effects that large vessels can have on smaller vessels. Reversibility is considered to be short-term, because effects on individual marine users would be limited to particular periods where Project-related marine vessels are in close proximity.

The probability of a disruption of marine user activities from Project-related marine vessel wake is considered to be low, due to the general compliance of marine users with navigational and safety regulations and if proposed mitigation measures, such as the communications measures, are followed (see Table 4.3.11.2). Nevertheless, in specific areas where this interaction has already been noted related to other large marine vessels, the increased Project-related marine vessel traffic may increase the possibility of this potential residual effect.

Confidence in the significance evaluation of this potential residual effect is moderate, due to limited examples of current interactions that small vessels have with wakes from transiting large marine vessels and the high variability of small vessel experiences. Confidence is also the result of the magnitude range, which is from low to medium (Table 4.3.11.3, point 1[e]). The range in magnitude of this effect is due to the factors such as the distance between the Project-related marine vessel and the smaller vessel, and the size and position of the smaller vessel. Therefore, the effect could range from an inconvenience to an unsafe situation for the smaller vessel. The inclusion of this effect as a potential residual effect is based on limited stakeholder consultation. Further stakeholder consultation may increase confidence. A summary of the rationale for all of the significance criteria is provided below.

- **Spatial Boundary** - Marine LSA – disruption of marine user activities from Project-related marine vessel wake effects could occur at any point along the shipping lanes in the Marine LSA.
- **Duration** - long-term – the disruption of marine user activities from Project-related marine vessel wake effects would be present for the operational life of the Project.
- **Frequency** - occasional – vessels are likely to be situated close enough to passing Project-related marine vessels that wake effects are felt only intermittently and sporadically over the assessment period.
- **Reversibility** - short-term – the disruption of marine user activities from an incident involving the wake from a Project-related marine vessel will occur only when the vessels are in close proximity.

- **Magnitude** - low to medium – Project-related marine vessel wake effects are considered to have a low to medium magnitude, ranging from an inconvenience (low) to a dangerous situation for the smaller vessel (medium).
- **Probability** - low – Project-related marine vessel wake effects may affect small vessels that are too close to transiting Project-related marine vessels; however, the probability is considered to be low (unlikely to occur) given the general compliance of marine users with navigational and safety regulations and the implementation of proposed mitigation measures. The increased Project-related marine vessel traffic may increase the probability of this potential residual effect.
- **Confidence** - moderate – there is a good understanding of the general cause-effect relationships between Project-related marine vessel wake and other marine users; however, confidence is based on limited examples of current interactions that small vessels have with wakes from transiting large marine vessels and the high variability of small vessel experiences (see earlier discussion in Section 4.3.6).

**Lost or Reduced Economic Opportunity for Marine Commercial Users**

The lost or reduced economic opportunity could apply to commercial fishers, marine transportation users, and tourism users. Lost economic opportunities to marine users could result from: damage or loss of marine vessels; damage to fishing gear; injury; physical displacement of marine users from the presence of Project-related marine vessels in transit or occupying anchorages within the Marine RSA; or a decrease in marine tourism customers related to the presence of Project-related marine vessels.

Commercial fishers that participate in fisheries with short seasons and limited openings such as the Fraser River sockeye salmon fishery and the roe herring fishery may be particularly vulnerable to financial losses, from lost economic opportunity. These fisheries often have single, brief annual openings when fishing is permitted. A lost opportunity due to an interaction with a Project-related marine vessel could result in a period of lost wages for the ship's captain and crew. Vessel damages to a whale-watching operator resulting from an interaction with a Project-related marine vessel may result in a lost economic opportunity if the operator cannot book tours while repairs are underway. However, such occurrences would be rare as tankers and accompanying tugs will be actively transiting through the shipping lanes and be in any one location only briefly. Lost or reduced economic opportunities are, therefore, expected to be minor as a result of interactions with Project-related marine vessels, and economic loss would only occur if the marine activity was prevented or severely disrupted.

Mitigation measures for this potential residual effect include compliance with the mitigation measures to avoid marine collisions (see Table 4.3.11.2). Marine liability law requires all marine vessels to have insurance, and liability is determined through the courts.

Lost or reduced economic opportunity is an indirect residual effect which is considered to have a negative impact balance. The frequency would be accidental, since this indirect effect would be a direct result of accidental interactions between Project-related marine vessels and other marine users.

The reversibility of the effect is short to medium-term, since the financial losses from lost economic opportunity could occur at any time throughout the operational life of the Project but would depend on the severity of the accident or the particular interaction. The magnitude of the economic loss depends on the severity of the incident, and could range from low to high. A severe incident between vessels may have notable effects on the livelihood of commercial fishers or other marine vessel operators (Table 4.3.11.3, point 1[f]). The probability of this residual effect is considered to be low due to compliance of the majority of marine users with applicable navigational regulations (Table 4.3.11.2). A summary of the rationale for all of the significance criteria is provided below.

- **Spatial Boundary** - Marine RSA – Financial loss due to lost economic opportunity could occur at any point in the Marine RSA.
- **Duration** - long-term – the possibility of lost economic opportunities due to interactions with Project-related marine vessels would be present for the operational life of the Project.
- **Frequency** - accidental – interactions with Project-related marine vessel traffic causing economic loss would be a rare occurrence.
- **Reversibility** - short- to medium-term –lost economic opportunities caused by accidental interactions between Project-related marine vessels and other marine vessels is reversible over the short or medium-term, depending on the severity of the accident or extent of the interaction. Magnitude: low to high – the indirect effect of economic loss may have mild or severe effects on the livelihood of commercial fishers. Compensation plans would reduce the magnitude of this effect; however, such plans are outside the responsibility of KMC.
- **Magnitude** - low to high – the indirect effect of economic loss may have mild or severe effects on the livelihood of commercial fishers. Compensation plans would reduce the magnitude of this effect; however, such plans are outside the responsibility of KMC.
- **Probability** - low – interactions between Project-related marine vessels and other marine users that result in economic loss are considered to be unlikely.
- **Confidence** - high – there is a good understanding of general cause-effect relationships between lost or reduced fishing opportunity resulting in economic loss for marine vessel operators.

**Increased Sensory Disturbance to Marine Users**

The increased sensory disturbance to marine users is a potential residual effect that could occur for all marine use categories. Sensory disturbance will predominantly apply to marine recreational users and clients of marine tourism operators as it pertains to the quality of their experience. The effect could apply to commercial fishers though it is likely to be less of a concern.

Since this residual effect refers to a sensory disturbance, the effect is not likely to extend far from the actual transit path of Project-related marine vessels. The visual effect of Project-related marine vessels transiting through the shipping lanes may be a nuisance to other marine users; however, once the tanker has passed, the nuisance effect quickly declines. The nuisance residual effect of dock lighting, noise and other sensory disturbance at the Westridge Marine

Terminal is considered separately as part of the human occupancy and resource use effects assessment in Section 7.6 of Volume 5B.

Aside from the visual effect of the increased presence of Project-related marine vessel traffic, the sensory disturbances related to noise and air emissions warrant separate discussion. The noise of a passing large vessel (including tankers) emanates from the ship's engines, and depending on the size and actual transit speed of the vessel may be heard from a distance. Another source of noise is the anchor chain being dropped or hauled in while vessels are anchoring, which may cause concern to residents near anchorage areas around the Westridge Marine Terminal and outer Vancouver Harbour (see Section 4.3.5). The potential residual effects of underwater noise on marine species that rely on sound for their orientation, such as killer whales, are assessed in Section 4.3.7

Exhaust emissions from large, deep draft ships are a source of air pollution. Mitigation is already in place through creation of the North American Emission Control Area (ECA) that requires all vessels passing within 200 NM of the coast to only use higher quality fuel. The standards are expected to progressively improve when additional regulations come in to force in 2015 and 2020 respectively. The significance of the effects of emissions from Project-related marine vessels is assessed separately in Section 4.3.3 and Section 4.3.4. In terms of sensory disturbance, the exhaust from Project-related marine vessels is considered to be a nuisance effect while the vessels are transiting near the affected marine user, and may remain a nuisance for a period after the ship has moved past depending on local winds and other microclimate factors (Section 4.3.3).

The increased sensory disturbance to marine users is considered to have a negative impact balance. The spatial boundary is the Marine LSA, since the effect could occur anywhere in or near the shipping lanes. The duration of the event causing increased sensory disturbance to marine users is the increased Project-related marine vessel traffic over the operational life of the Project which is considered to be long-term. The frequency is periodic since the effect would potentially occur only whenever Project-related marine vessels are nearby. As with many other potential residual effects of increased marine vessel traffic, the nuisance effect presumably applies equally to other deep sea vessels transiting through the Marine LSA.

The reversibility of this residual effect is short-term, since the effect would only occur when Project-related marine vessels are transiting near the marine user. Magnitude of this effect would be low because the sensory disturbance from one tanker would be specific to the proximity of the tanker, temporary, and reversible (Table 4.3.11.3, point 1[g]). The residual effect is considered to be likely for marine recreational and tourism users and unlikely for commercial users. A summary of the rationale for all of the significance criteria is provided below.

- **Spatial Boundary** - Marine LSA – negative sensory disturbance (*e.g.*, visual effects, noise, and air quality) from increased Project-related marine vessel traffic on other marine users could occur at any point in the shipping lanes in the Marine LSA.
- **Duration** - long-term – interactions between Project-related marine vessels and other marine users will begin during the operations phase and extend for the operational life of the Project.
- **Frequency** - periodic – the event causing an increase in sensory disturbance to marine users is presence of Project-related marine vessels, which will be

present in any given part of the Marine LSA intermittently but repeatedly throughout the operations phase of the Project.

- **Reversibility** - short-term – the sensory disturbance to marine users and the consequent quality of the marine user's experience will occur only when Project-related marine vessels are in close proximity to the user.
- **Magnitude** - low – sensory disturbance would be temporary, site-specific and reversible, and the nuisance effect would occur only when Project-related marine vessels are actively transiting areas where other marine users are present.
- **Probability** - high – it is likely that low-level sensory disturbance will occur for nearby marine users while Project-related marine vessels are transiting.
- **Confidence** - high – there is a good understanding of general cause-effect relationships and data pertinent to the study area.

**Combined Effects of Increased Project-Related Marine Vessel Traffic on Commercial Fishing**

An evaluation of the combined effects considers those residual socio-economic effects that are likely to occur. For the commercial fishing indicator, likely residual socio-economic effects include alteration of existing marine vessel movement patterns and increased sensory disturbance to marine users (Table 4.3.11.3, points 1[b] and 1[g]). The remaining potential residual effects are unlikely to occur and, consequently, were not considered in the evaluation of the combined effects on the commercial fishing se indicator.

Potential effects on commercial fishing vessels may be limited to the Marine LSA related to sensory disturbance from transiting Project-related marine vessels, but effects related to alteration of movement patterns could occur at any point in the Marine RSA and may also affect the distribution of vessels in areas of the Marine RSA. The duration of the potential combined residual effect on commercial fishing is considered long-term, as it is caused by the presence of Project-related marine vessels throughout the operational life of the Project. The frequency of the potential effect is considered periodic, since Project-related marine vessels will be present at particular points in the Marine RSA intermittently but repeatedly over the assessment period; consequently, Project-related marine vessels will transit any particular area where commercial fishing vessels may be present in a relatively brief period of time. The magnitude of the combined effect is considered low to medium. Sensory effects and alteration of movement patterns are likely to only represent an inconveince or nuisance for many commercial fishing operators who interact with Project-related marine vessels (low magnitude). However there is potential for alternation of movement patterns to result in business implications if fishers miss a catch opportunity due to delays or changes in access to select fishing locations at times (medium magnitude) (Table 4.3.11.3, point 1(h)). A summary of the rationale for all of the significance criteria is provided below.

- **Spatial Boundary** - Marine LSA to RSA – negative sensory disturbance (e.g., visual effects, noise, and air quality) from increased Project-related marine vessel traffic could occur at any point in the shipping lanes in the Marine LSA. Potential effects related to alteration of movement patterns could occur at any point in the Marine RSA and may also affect the distribution of vessels in areas of the Marine RSA.

- **Duration** - long-term – interactions between Project-related marine vessels and other marine users will begin during the operations phase and extend for the operational life of the Project.
- **Frequency** - periodic – interactions between Project-related marine vessels and other marine users have the potential to occur intermittently, however, repeatedly over the life of the Project.
- **Reversibility** - long-term – the potential residual effects on commercial fishing will occur throughout the operational life of the Project; however specific interactions will occur only when Project-related marine vessels are in close proximity to the user.
- **Magnitude** - low to medium – commercial fishing vessels may be temporarily inconvenienced by the presence of Project-related marine vessels (low), but delays may have business implications for some commercial fishing operators at select times (medium).
- **Probability** - high – it is likely that the combined effects on commercial fishing, as characterized, will occur for some operators.
- **Confidence** - high – there is a good understanding of general cause-effect relationships and data pertinent to the study area.

#### 4.3.11.6.2 Marine Commercial, Recreational and Tourism Use Indicator – Marine Transportation

The following subsection provides a discussion of the significance rationale for potential residual effects related to the Marine Transportation indicator.

**Disruption to Rail Traffic on CN Rail Bridge at Second Narrows**

The rail bridge at the Second Narrows in Burrard Inlet is operated by CN Rail, and is used by freight trains between Vancouver and North Vancouver, bound for terminals on the North Shore. Larger marine vessels including Project-related tankers require that the bridge be raised to accommodate passage through the Second Narrows. The CN Rail bridge operator is expected to make the bridge available to marine traffic with the lift span elevated within 30 minutes prior to the estimated time of arrival of a marine vessel (PMV 2010). Increased Project-related marine vessel traffic in the Second Narrows will cause an increase in the number of bridge lift span elevations, which may cause delays for freight trains using the bridge.

This potential residual effect of rail delays on the CN Bridge constitutes a general disruption to rail traffic, and is considered to have a negative impact balance. The spatial boundary is considered to be specific only to the bridge crossing within the Marine LSA since the residual effect is otherwise terrestrial and is outside the Marine LSA.

The reversibility of this effect is long-term (Table 4.3.11.3, point 2[a]). Bridge lift span elevations will be required by all Project-related tankers, and it is unlikely that the bridge will be replaced or that rail traffic will be re-routed elsewhere. The magnitude of the increased disruption of rail traffic is considered to be medium, because the change is clearly detectable in terms of increased rail bridge lift span elevations and the disruption to bridge traffic has commercial implications. Rail bridge operations can be resumed whenever the span is lowered. Confidence in this significance evaluation is high, because there is a good understanding of cause-effect relationships and of the data pertinent to the study area. A summary of the rationale for all of the significance criteria is provided below.

- **Spatial Boundary** - Marine LSA specific to CN Rail Bridge at Second Narrows, Burrard Inlet – rail delays on the CN Rail Bridge at the Second Narrows in Burrard Inlet will only occur at that specific location.
- **Duration** - long-term – the event causing the disruption of train traffic on the CN Rail Bridge is the transit of Project-related marine vessels which occurs throughout the operational life of the Project.
- **Frequency** - periodic – bridge lift span elevations would be required for every transiting Project-related tanker from the Westridge Marine Terminal. The event causing the disruption of train traffic on the CN Rail Bridge is the transit of Project-related marine vessels which occurs intermittently and is repeated throughout the operational life of the Project.
- **Reversibility** - short-term – the periodic disruption of train traffic on the CN Rail Bridge will occur when Project-related marine vessels are transiting through Burrard Inlet
- **Magnitude** - medium – although the change is clearly detectable in terms of increased rail bridge lift span elevations, the magnitude is considered to be medium, since bridge operations will be able to continue whenever the span is lowered.
- **Probability** - high – the likelihood of occurrence of this residual effect is high, since the elevation of the lift span is required for the passage of Project-related marine vessel traffic.
- **Confidence** - high – there is a good understanding of cause-effect relationships and of the data pertinent to the study area.

**Damage to Built Infrastructure, Marine Facilities or Shorelines**

Damage to built infrastructure, marine facilities, or shorelines as a result of the movements of Project-related marine vessel traffic is a potential residual effect considered to have a negative impact balance. The potential effect could occur anywhere in the Marine RSA where other marine structures or facilities are present in or near the shipping lanes. However, interactions specifically associated with the operations phase are primarily discussed with respect to Burrard Inlet, where the narrow marine area contains multiple bridges and related infrastructure, marinas, navigational aids, docks and many other marine facilities.

The potential residual effect is the result of accidental vessel strikes by Project-related marine vessels to marine infrastructure, and by definition the frequency is expected to be rare. The highest potential for vessel strikes is expected to be in the First and Second Narrows of Burrard Inlet and vessel strikes on marine infrastructure in this area have occurred in the past. In October of 1979, the ship *Japan Erica* struck the CN Rail Bridge at the Second Narrows and caused extensive damage. It was estimated at the time that the accident would reduce harbour capacity for grain exports by 15 percent. In 1979, the rail bridge was the only link between the grain storage silos on the North Shore and mainline CN and CP rail grain cars arriving from the

Canadian Prairies (Montreal Gazette 1979). Over Westridge Marine Terminal's 60 year operating history, there have been no known occurrences of marine vessels associated with the existing operations striking marine infrastructure in Burrard Inlet. The existing mitigation measures continue to provide significant alleviation to concerns of a vessel strike against the CN Rail Bridge.

The reversibility of any damage to built infrastructure, marine facilities or shorelines is considered short- to medium-term since the physical damage would likely be remediated over a relatively brief time period, depending on the degree of impact. The magnitude of such an accident is considered to range from low to high. A minor collision would likely have few repercussions, but a major impact may represent a severe modification to the socio-economic environment and have repercussions for commercial operations (Table 4.3.11.3, point 2[b]). The probability of accidental vessel strikes is considered to be low, given the safety regulations in place for transits of large vessels through Burrard Inlet. PMV has specific regulations in place for the safe navigation of large vessels, including the presence of marine pilots, multiple tugs for assisting and manoeuvring vessels in the event of a rudder malfunction or other potential problems, and transiting only in daylight and at high slack tides to avoid tidal currents and for adequate clearance with the sea floor (PMV 2010).

A summary of the rationale for all of the significance criteria is provided below.

- **Spatial Boundary** - Marine LSA specific to Burrard Inlet – damage to built infrastructure, marine facilities, or shorelines from strikes by Project-related marine vessels is assessed for Burrard Inlet because many marine facilities and other infrastructure are located in this region of the Marine LSA.
- **Duration** - long-term – the event causing the damage to built infrastructure, marine facilities or shorelines is the increased Project-related marine vessel traffic during the operations phase of the Project.
- **Frequency** - accidental – damage related to Project-related marine vessels would be a rare occurrence.
- **Reversibility** - short- to medium-term – the damage to built infrastructure, marine facilities or shorelines from an incident involving a Project-related marine vessel is reversible over the short or medium term, depending on the severity of the accident.
- **Magnitude** - low to high – a minor impact is likely to have minor repercussions (low), however, severe damage to marine infrastructure will result in a severe modification to the socio-economic environment (high)
- **Probability** - low – with the safety regulations in place for the transits of large marine vessels through Burrard Inlet, and the proven safety track record of marine vessels currently calling on Westridge Marine Terminal, it is unlikely that increased Project-related marine vessel traffic will cause damage to built infrastructure, marine facilities or shorelines.
- **Confidence** - high – there is a good understanding of the cause-effect relationships and of the data pertinent to the study area.

**Alteration of Existing Marine Vessel Movement Patterns**

Project-related tankers anchor in designated anchorages located in English Bay, the Inner Harbour and southern Indian Arm (PMV 2010). Outbound tankers and other deep draft marine vessels which miss the appropriate tidal window for transit must remain anchored in designated anchorage areas in English Bay until the next window is available.

If designated anchorages in PMV are fully occupied, inbound vessels must adjust their arrival times until a berth becomes available, or request alternative anchorages such as those managed by the Port of Nanaimo. With the increased Project-related marine vessel traffic, more anchorage areas may be required. An increase in commercial anchorages is likely to cause displacement of other users from these areas and a may lead to modification of the movement patterns of marine users. The Project does not seek to request any increases to the existing number of designated anchorage locations.

Passenger ferry vessels operated by BC Ferries, Washington State Ferries, the Alaska State Ferries and other private companies that use or cross the shipping lanes may be occasionally required to adjust their preferred routes due to the passage of Project-related marine vessels, as may be needed in the existing environment for other vessels. Passenger ferries must cross the shipping lanes at points in the Strait of Georgia, Haro Strait, and Juan de Fuca Strait, to access ports between Vancouver Island and the Lower Mainland or the US. Deep draft vessels have the right-of-way in the shipping lanes, and it is the responsibility of other ships that cross the shipping lanes to plan for route diversions, if necessary. The increase in marine vessel traffic resulting from the Project may cause short-term delays for passenger ferries in the straits, if vessels are required to chart a longer course or wait for marine vessels to pass.

The increased Project-related marine vessel traffic may result in the alteration of existing vessel movement patterns in relation to marine transportation users. The significance evaluation of this residual effect is provided in Table 4.3.11.3 (point 2[c]). Readers should refer to the more detailed discussion of this residual effect, which includes marine transportation users as well as other marine user types, under the commercial fishing indicator provided above for an explanation of the rationale of the significance criteria.

**Damage to Marine Vessels and/or Injury**

The increased Project-related marine vessel traffic may result in damage to marine vessels and or injury in relation to other marine commercial users. The significance evaluation of this residual effect is provided in Table 4.3.11.3 (point 2[d]). Readers should refer to the more detailed discussion of this residual effect, which includes other marine commercial users as well as other marine user types, under the commercial fishing indicator provided above for an explanation of the rationale of the significance criteria.

**Lost or Reduced Economic Opportunity for Marine Commercial Users**

The increased Project-related marine vessel traffic may result in lost or reduced economic opportunity in relation to other marine commercial users. The significance evaluation of this residual effect is provided in Table 4.3.11.3 (point 2[e]). Readers should refer to the more detailed discussion of this residual effect, which includes other marine commercial users as well as other marine user types, under the commercial fishing indicator provided above for an explanation of the rationale of the significance criteria.

**Combined Effects of Increased Project-Related Marine Vessel Traffic on Marine Transportation**

An evaluation of the combined effects considers those residual socio-economic effects that are likely to occur. For the marine transportation indicator, likely residual socio-economic effects include disruption to rail traffic on CN Rail bridge at Second Narrows and alteration of existing marine vessel movement patterns (Table 4.3.11.3, points 2[a] and 2[c]). The remaining potential residual effects are unlikely to occur and, consequently, were not considered in the evaluation of the combined effects on the other marine commercial use indicator.

The impact balance of the combined residual effects to the marine transportation indicator is negative. The lifting of the CN Rail Bridge at the Second Narrows in Burrard Inlet is required for passage of Project-related marine vessel traffic, and other marine vessels must stay clear of the area between the First and Second Narrows when vessels such as Aframax tankers are in transit.

Other marine vessels could be displaced by Project-related marine vessel traffic and may be inconvenienced or may need to occasionally alter their preferred routes or timing of transit. The duration of Project-related marine vessel traffic is long-term, extending over the life of the Project, and the frequency of the effect is considered periodic, since Project-related marine vessels will be transiting intermittently but repeatedly through the Marine RSA. The magnitude is low to medium; although effects on some users may constitute only a nuisance (low), effects on some marine commercial users may be detectable and may constitute restrictions on passage of marine vessels due to increased bridge span lifts, delays in rail transits across the CN Rail Bridge, and alteration in marine vessel movements (medium). These effects are considered to be likely, in particular in Burrard Inlet in the context of the geographical and navigational constraints already present. A summary of the rationale for all of the significance criteria is provided below.

- **Spatial Boundary** - Marine LSA to RSA -– rail delays on the CN Rail Bridge at the Second Narrows in Burrard Inlet will only occur at that specific location in the Marine LSA around Second Narrows in Burrard Inlet; potential effects related to alteration of movement patterns could occur at various points in the Marine RSA.

- **Duration** - long-term – the event causing the combined residual effects on the marine transportation indicator is the transit of Project-related marine vessels which occurs throughout the operational life of the Project.

- **Frequency** - periodic – the event causing the combined residual effects on the marine transportation indicator is the transit of Project-related marine vessels which occurs intermittently and is repeated throughout the operational life of the Project.

- **Reversibility** - long-term – overall, the combined residual effects will occur periodically throughout the operational life of the Project; however specific interactions will occur only when Project-related marine vessels are in close proximity to the user.

- **Magnitude** - low to medium – the combined residual effects will be at a minimum a nuisance (low); however, the effects may have business implications for some commercial vessel operators and rail bridge users (medium).

- **Probability** - high – the occurrence of combined residual effects on the marine transportation indicator is considered to be likely,
- **Confidence** - high – there is a good understanding of the cause-effect relationships and of the data pertinent to the study area.

#### 4.3.11.6.3 Marine Commercial, Recreational and Tourism Use Indicator – Marine Recreational Use

The following subsection provides the significance rationale for potential residual effects related to the marine recreational use indicator.

**Negative User Perspectives of Increased Project-related Marine Vessel Traffic**

Increased Project-related marine vessel traffic may result in negative user perspectives for marine recreational users, including boaters, paddlers (kayakers and canoeists), recreational fishers and scuba divers. This potential residual effect is included in the assessment as a result of comments from participants at the Victoria and Vancouver ESA Workshops. Participants stated concern about the anticipated increased Project-related marine vessel traffic due to a negative perception of oil tanker traffic, without specific objective views other than the increased possibility of oil spills.

This potential residual effect is considered to have a negative impact balance. Consultation and engagement conducted supported this impact balance assessment. The spatial boundary of this potential residual effect is expected to be the Marine RSA. Unlike a sensory disturbance effect, a negative perspective of Project-related marine vessel traffic is not limited to being physically near transiting tankers; however, is the result of the marine user's knowledge that oil tankers are present in BC coastal waters. Therefore, the frequency is continuous.

The duration is long-term since tankers will be present in regional marine waters for the operational life of the Project. The reversibility is also long-term since the increased Project-related traffic may remain a nuisance to some marine users for the operational life of the Project, whether or not tankers are physically present. The magnitude of this effect is low since the effect is considered to be that of a nuisance for some marine users. It is considered to be likely that this effect will continue to occur, given that the proposed Project has already generated diverse points of view in the media (Table 4.3.11.3, point 3[a]). A summary of the rationale for all of the significance criteria is provided below.

- **Spatial Boundary** - Marine RSA – Negative user perspectives of increased Project-related marine vessel traffic could occur at any point in the Marine RSA.
- **Duration** - long-term – the event resulting in negative user perspectives of increased Project-related marine vessel traffic will occur for the operational life of the Project.
- **Frequency** - continuous – user perspectives depend upon the knowledge that Project-related marine vessels are present; therefore, the frequency of this effect is continual over the assessment period.

- **Reversibility** - long-term – the residual effect is expected to be present as long as the Project is in operation.
- **Magnitude** - low – the presence of Project-related marine vessels will be a nuisance to some marine users.
- **Probability** - high – the presence of Project-related marine vessels is likely to cause negative user perspectives.
- **Confidence** - moderate – feedback from Project engagement and in the media indicates this potential residual effect will be likely for some stakeholders; however individual perspectives are highly variable.

**Alteration of Existing Marine Vessel Movement Patterns**

Recreational users and tourism operators may change their movement patterns in order to avoid Project-related marine vessel traffic, if the increase is perceived to have a negative effect on the quality of their experience. For recreational users, this may lead to long-term avoidance of certain areas that are near the shipping lanes. For example, recreational fishers in Juan de Fuca Strait often travel to the area around Swiftsure Bank, in the middle of the channel northwest of Cape Flattery, for high quality fishing for salmon, halibut and other species. The increased Project-related marine vessel traffic may reduce the quality of this experience. Another example is the area around Constance Bank, south of Victoria Harbour, where the shipping lanes overlap popular fishing areas. As the locations of Project tankers will always be available to subscribers to the ship tracking website, commercial fishing guides and others may alter movement patterns to avoid increased Project-related marine vessel traffic.

The increased Project-related marine vessel traffic may result in the alteration of existing vessel movement patterns in relation to some marine recreational users. The significance evaluation of this residual effect is provided in Table 4.3.11.3 (point 3[b]). Readers should refer to the more detailed discussion of this residual effect, which includes marine recreational users as well as other marine user types, under the commercial fishing indicator provided above for an explanation of the rationale of the significance criteria.

**Damage to Built Infrastructure, Marine Facilities or Shorelines**

The increased Project-related marine vessel traffic may result in damage to built infrastructure, marine facilities or shorelines in relation to marine recreational users. The significance evaluation of this residual effect is provided in Table 4.3.11.3 (point 3[c]). Readers should refer to the more detailed discussion of this residual effect, which includes marine recreational users as well as other marine user types, under the marine transportation indicator provided above for an explanation of the rationale of the significance criteria.

**Damage to Marine Vessels and/or Injury**

The increased Project-related marine vessel traffic may result in damage to marine vessels and or injury in relation to marine recreational users. The significance evaluation of this residual effect is provided in Table 4.3.11.3 (point 3[d]). Readers should refer to the more detailed discussion of this residual effect, which includes marine recreational users as well as other marine user types, under the commercial fishing indicator provided above for an explanation of the rationale of the significance criteria.

### Damage or Loss of Gear

The increased Project-related marine vessel traffic may result in damage or loss of gear in relation to marine recreational users. The significance evaluation of this residual effect is provided in Table 4.3.11.3 (point 3[e]). Readers should refer to the more detailed discussion of this residual effect, which includes marine recreational users as well as other marine user types, under the commercial fishing indicator provided above for an explanation of the rationale of the significance criteria.

### Disruption of Marine User Activities from Project-Related Marine Vessel Wake

Disruption of marine user activities from project-related marine vessel wake in relation to marine recreational users is considered to be not significant (Table 4.3.11.3, point 3[f]). The significance rationale for this residual effect applies to all marine users and is previously discussed in an integrated manner under the commercial fisheries indicator.

The increased Project-related marine vessel traffic may result in disruption of marine recreational activities from Project-related marine vessel wake. The significance evaluation of this residual effect is provided in Table 4.3.11.3 (point 3[f]). Readers should refer to the more detailed discussion of this residual effect, which includes marine recreational users as well as other marine user types, under the commercial fishing indicator provided above for an explanation of the rationale of the significance criteria.

### Increased Sensory Disturbance to Marine Users

Increased sensory disturbance from Project-related marine vessel traffic in relation to marine recreational users is considered to be not significant (Table 4.3.11.3, point 3[g]). The significance rationale for this residual effect applies to all marine users and is previously discussed in an integrated manner under the commercial fisheries indicator.

The increased Project-related marine vessel traffic may result in increased sensory disturbance to marine users in relation to marine recreational users. The significance evaluation of this residual effect is provided in Table 4.3.11.3 (point 3[g]). Readers should refer to the more detailed discussion of this residual effect, which includes marine recreational users as well as other marine user types, under the commercial fishing indicator provided above for an explanation of the rationale of the significance criteria.

### Combined Effects of Increased Project-Related Marine Vessel Traffic on Marine Recreational Use

An evaluation of the combined effects considers those residual socio-economic effects that are likely to occur. For the marine recreational use indicator, likely residual socio-economic effects include negative user perspectives of increased Project-related marine vessel traffic, alteration of existing marine vessel movement patterns and increased sensory disturbance to marine users (Table 4.3.11.3, points 3[a], 3[b] and 3[g]). The remaining potential residual effects are unlikely to occur and, consequently, were not considered in the evaluation of the combined effects on the marine recreational use indicator.

The likely combined residual effects on marine recreational users may be felt anywhere along the shipping lanes and other areas of the Marine RSA, All likely residual effects may be more pronounced in Burrard Inlet where marine users are likely to be affected to some degree by increased transits of large ships. Marine vessels greater than approximately 10 m in height based in marinas around the Second Narrows area may be affected by increased openings of the CN Rail Bridge, if increased Project-related marine vessel traffic reduces the daily opportunities for the passage of other vessels. Other marine users may be more aware of Project-related marine vessel transits in Burrard Inlet due to existing navigational constraints and so the area may have the most negative user perspectives due to close proximity to Project operations.

The duration of the event is long-term. The frequency of vessel transits will be periodic, occurring intermittently but repeatedly over the life of the Project. The effects may be an inconvenience to some users, causing effects such as delays to travel plans or general negative perspectives on the Project. The reversibility of the effects is considered to be long-term in general since effects will occur over the life of the Project. For sensory disturbance the reversibility is short-term as the nuisance effect is specifically related to the proximity of marine tankers. If long-term changes in preferred routes occur as a result of the Project, indirect impacts on local marinas or other businesses are possible. A summary of the rationale for all of the significance criteria is provided below.

- **Spatial Boundary** - Marine LSA to RSA – negative sensory disturbance (e.g., visual effects, noise, and air quality) from increased Project-related marine vessel traffic could occur at any point in the shipping lanes in the Marine LSA. Potential effects related to alteration of movement patterns could occur at any point in the Marine RSA and may also affect the distribution of vessels in areas of the Marine RSA.

- **Duration** - long-term – the event causing the combined residual effects on marine recreational use indicator is the transit of Project-related marine vessels which occurs throughout the operational life of the Project.

- **Frequency** - periodic to continuous – the passage of Project-related marine vessel traffic that could cause disruption to marine recreational use will occur intermittently; however, repeatedly over the life of the Project. The overall presence of Project-related marine vessels in the Marine RSA may be viewed as continuously affecting negative user perspectives.

- **Reversibility** - long-term – the combined residual effects will occur throughout the operational life of the Project; however, specific interactions will occur only when Project-related marine vessels are in close proximity to the user.

- **Magnitude** - low to medium – the combined residual effects are detectable by marine recreational users. In most cases the effects are likely to represent only an inconvenience to those affected; however, if marine recreational users alter preferred routes the magnitude may be considered to be medium.

- **Probability** - high – the occurrence of combined residual effects on marine recreational users is considered to be likely,

- **Confidence** - high – there is a good understanding of the cause-effect relationships and of the data pertinent to the study area.

#### 4.3.11.6.4 Marine Commercial, Recreational and Tourism Use Indicator – Marine Tourism Use

The following subsection provides the significance rationale for potential residual effects related to the marine tourism use indicator.

**Decrease in Marine Tourism**

It is perceived by some that increased marine vessel traffic from Project operations may indirectly lead to a decrease in marine tourism. This potential residual effect is included in the assessment as a result of comments received from the Vancouver and Victoria ESA Workshops. The comments were in reference to the operations phase of the Project and not specific to accidents or malfunctions. Participants referred to the image of BC as an international ecotourism destination with unspoiled wilderness attributes, and questioned whether increasing oil tankers in BC coastal waters would present an unfavourable image of BC to the world. The possibility of a decrease in marine tourism relates to the negative user perspectives of increased Project-related marine vessel traffic under the marine recreational use indicator.

This potential residual effect is considered to have a negative impact balance within the Marine RSA. The potential decrease in marine tourism that could be attributed to increased Project-related marine vessel traffic would occur for the operational life of the Project, and, therefore, is considered to be reversible in the long-term. The magnitude of this potential residual effect, should it occur, is considered medium; if a decline in coastal and marine tourism can be specifically attributed to increased Project-related marine vessel traffic then this residual effect is more than a nuisance or inconvenience (Table 4.3.11.3, point 4[a]).

The probability that this effect will occur is considered to be low; tankers have been transiting in the Marine RSA for 60 years, co-existing with the tourism industry. Any decrease in tourism could have any number of contributing factors and it is unlikely that increased Project-related marine vessel traffic could be directly attributed to a decline. Discussion with tourism organizations and marine tourism operators listed in Table 2.1.1 in the Marine Commercial, Recreational and Tourism Use – Marine Transportation Technical Report (Volume 8B, TR 8B-6) support this conclusion. A summary of the rationale for all of the significance criteria is provided below.

- **Spatial Boundary** - Marine RSA – a decrease in marine tourism activities could occur throughout the Marine RSA.
- **Duration** - long-term – the event resulting in a potential decrease in marine tourism use is the increased Project-related marine vessel traffic, which will occur for the operational life of the Project.
- **Frequency** - continuous – the decrease in marine tourism activities as a result of increased Project-related marine vessel traffic would occur continually over the assessment period.
- **Reversibility** - long-term – this residual effect is expected to continue over the operational life of the Project.

- **Magnitude** - medium – any decline in marine tourism, if it were to occur, would constitute a detectable modification to the socio-economic environment considered to be beyond that of a nuisance or inconvenience.
- **Probability** - low – the residual effect is considered to be unlikely, since tankers have been transiting in the Marine RSA for almost 60 years co-existing with the marine tourism industry.
- **Confidence** - high –there is a good understanding of the potential cause-effect relationship between the presence of Project-related marine vessels and a perceived decrease in marine tourism activities.

**Alteration of Existing Marine Vessel Movement Patterns**

Tourism operators may change their movement patterns in order to avoid Project-related marine vessel traffic, if the increase is perceived to have a negative effect on the quality of their clients' experience. This may lead to long-term avoidance of certain areas that are near the shipping lanes. For example, fishers in Juan de Fuca Strait often travel to the area around Swiftsure Bank, in the middle of the channel northwest of Cape Flattery, for high quality fishing of salmon, halibut and other species. The increased Project-related marine vessel traffic may reduce the quality of this experience. Commercial fishing guides may alter movement patterns to avoid increased Project-related marine vessel traffic.

The increased Project-related marine vessel traffic may result in the alteration of existing vessel movement patterns in relation to marine tourism use. The significance evaluation of this residual effect is provided in Table 4.3.11.3 (point 4[b]). Readers should refer to the more detailed discussion of this residual effect, which includes marine tourism use as well as other marine user types, under the commercial fishing indicator provided above for an explanation of the rationale of the significance criteria.

**Damage to Built Infrastructure, Marine Facilities or Shorelines**

The increased Project-related marine vessel traffic may result in damage to built infrastructure, marine facilities or shorelines in relation to marine tourism use. The significance evaluation of this residual effect is provided in Table 4.3.11.3 (point 4[c]). Readers should refer to the more detailed discussion of this residual effect, which includes marine tourism use as well as other marine user types, under the other marine commercial use indicator provided above for an explanation of the rationale of the significance criteria.

**Damage to Marine Vessels and/or Injury**

The increased Project-related marine vessel traffic may result in damage to marine vessels and or injury in relation to marine tourism use. The significance evaluation of this residual effect is provided in Table 4.3.11.3 (point 4[d]). Readers should refer to the more detailed discussion of this residual effect, which includes marine tourism use as well as other marine user types, under the commercial fishing indicator provided above for an explanation of the rationale of the significance criteria.

**Damage or Loss of Gear**

The increased Project-related marine vessel traffic may result in damage or loss of gear in relation to marine tourism use. The significance evaluation of this residual effect is provided in Table 4.3.11.3 (point 4[e]). Readers should refer to the more detailed discussion of this residual effect, which includes marine tourism use as well as other marine user types, under the commercial fishing indicator provided above for an explanation of the rationale of the significance criteria.

**Lost or Reduced Economic Opportunity for Commercial Marine Users**

The increased Project-related marine vessel traffic may result in lost or reduced economic opportunity in relation to marine tourism use. The significance evaluation of this residual effect is provided in Table 4.3.11.3 (point 4[f]). Readers should refer to the more detailed discussion of this residual effect, which includes marine tourism use as well as other marine user types, under the commercial fishing indicator provided above for an explanation of the rationale of the significance criteria.

**Disruption of Marine User Activities from Project-Related Marine Vessel Wake**

The increased Project-related marine vessel traffic may result in disruption of marine user activities from Project-related marine vessel wake in relation to marine tourism use. The significance evaluation of this residual effect is provided in Table 4.3.11.3 (point 4[g]). Readers should refer to the more detailed discussion of this residual effect, which includes marine tourism use as well as other marine user types, under the commercial fishing indicator provided above for an explanation of the rationale of the significance criteria.

**Increased Sensory Disturbance to Marine Users**

Increased sensory disturbance from project-related marine vessel traffic in relation to marine tourism users is considered to be not significant (Table 4.3.11.3, point 4[h]). The significance rationale for this residual effect applies to all marine users and is previously discussed in an integrated manner under the commercial fisheries indicator.

The increased Project-related marine vessel traffic may result in increased sensory disturbance to marine users in relation to marine tourism use. The significance evaluation of this residual effect is provided in Table 4.3.11.3 (point 4[h]). Readers should refer to the more detailed discussion of this residual effect, which includes marine tourism use as well as other marine user types, under the commercial fishing indicator provided above for an explanation of the rationale of the significance criteria.

**Combined Effects of Project-Related Marine Vessel Traffic on Marine Tourism Use**

An evaluation of the combined effects considers those residual socio-economic effects that are likely to occur. For the marine tourism use indicator, likely residual socio-economic effects include alteration of existing marine vessel movement patterns and increased sensory disturbance to marine users (Table 4.3.11.3, points 4[b] and 4[h]). The remaining potential residual effects are unlikely to occur and, consequently, were not considered in the evaluation of the combined effects on the marine tourism use indicator.

The likely combined residual effects on marine tourism users are considered to have a negative impact balance. Marine tourism use takes place throughout the Marine RSA. Tourism users may be in the shipping lanes to access destinations throughout the region. Of the many types of marine tourism users, commercial fishing charters may be affected for short durations for access to preferred fishing grounds near the shipping lanes when a tanker passes a particular location.

The duration of the event is long-term because tourism operators could be affected by the presence of Project-related marine vessel traffic throughout the life of the Project. The passage of Project-related marine vessels will be periodic as vessels will be present at any point in the Marine RSA only intermittently and briefly, but repeatedly, thoughout Project operations. The reversibility of the effects is considered to be long-term in general, since Project-related marine vessels will be present over the life of the Project; however effects related to sensory disturbance will only occur for specific times when in the proximity of Project-related marine vessels. The magnitude of the combined effects is low to medium. In most cases effects are likely to only represent an inconvenience or nuisance for tourism-related marine vessels (low); however, if the increased Project-related marine vessel traffic implications for business practices of some operators (medium) (Table 4.3.11.3, points 4[i]. For example, if the Project-related marine vessel traffic has a significant negative effect on southern resident killer whales due to increased sensory disturbance, the effect may extend to alterations in the operations of whale-watching vessels; however, whale-watching tour operators' routes are typically variable depending on the location of whales at specific times. More pronounced effects on marine tourism operators such as day cruises and commercial sport fishing charters may be felt in areas such as eastern Burrard Inlet where Project operations are in close proximity to other users. Marine tourism users accessing Indian Arm may be more affected in terms of access. A summary of the rationale for all of the significance criteria is provided below.

- **Spatial Boundary** - Marine LSA to RSA – negative sensory disturbance (e.g., visual effects, noise, and air quality) from increased Project-related marine vessel traffic could occur at any point in the shipping lanes in the Marine LSA. Potential effects related to alteration of movement patterns could occur at any point in the Marine RSA and may also affect the distribution of vessels in areas of the Marine RSA.
- **Duration** - long-term – the event causing the combined residual effects on marine tourism use indicator is the transit of Project-related marine vessels which occurs throughout the operational life of the Project.
- **Frequency** - periodic – the event causing the combined residual effects on marine tourism use is the transit of Project-related marine vessels which occurs intermittently and is repeated throughout the operational life of the Project.
- **Reversibility** - long-term – the combined residual effects will occur throughout the operational life of the Project.
- **Magnitude** - low to medium – the combined residual effects will be detectable by individual marine vessel operators, but in most cases are likely to represent an inconvenience or nuisance to those affected. However, the magnitude may be considered to be medium in cases of route alterations that may have business implications for commercial vessel operators.
- **Probability** - high – the occurrence of combined residual effects on marine tourism users is considered to be likely.
- **Confidence** - high – there is a good understanding of the cause-effect relationships and of the data pertinent to the study area.

**Combined Effects of Project-Related Marine Vessel Traffic on MCRTU**

The evaluation of the combined effects of increased Project-related marine vessel traffic on the MCRTU indicators considers collectively the assessment of the following indicators: commercial fishing; other marine commercial use; marine recreational use; and marine tourism use. The combined residual effects considered to be likely are: alteration of vessel movement patterns for all types of marine vessels; increased sensory disturbance to commercial fishers and recreational and tourism users; disruption to rail traffic on the CN Rail Bridge in Burrard Inlet; and negative user perspectives of Project-related marine vessel traffic.

Project-related marine vessels will be present in the shipping lanes for the life of the Project, at a frequency of approximately one daily transit, In the context of the total marine vessel traffic in the Marine RSA, the likely effects of Project-related marine vessels on other marine users are not considered to be significant, although the effects will be felt differently depending on the location and timing of the interaction. The combined residual effects may also be more pronounced for marine vessel types which are more likely to be present in the shipping lanes, such as fishing vessels and marine transportation vessels.

The overall effects of the Project on MCRTU are evaluated in consideration of the objectives of land and resource use management plans and government policies which contain a marine component. The Marine RSA contains shipping lanes servicing ports in the US and Canada, and the assessment of combined effects has been considered in this context. The results of the MCRTU assessment do not contradict any management objectives of established land and resource use management plans or government policies. A summary of the rationale for all of the significance criteria is provided below.

- **Spatial Boundary** - Marine RSA – the residual socio-economic effects on MCRTU could occur at any point in the Marine RSA.
- **Duration**:- long-term – the event causing the combined residual effects on MCRTU is the transit of Project-related marine vessels which occurs throughout the operational life of the Project.
- **Frequency** - periodic – the event causing the combined residual effects on MCRTU is the transit of Project-related marine vessels which occurs intermittently and is repeated throughout the operational life of the Project.
- **Reversibility** - long-term – the combined residual effects will occur throughout the operational life of the Project.
- **Magnitude** - low to medium – the combined residual effects will potentially be detectable by marine vessels. In most cases the effects are likely to represent only an inconvenience or nuisance to those affected; however, the magnitude may be considered to be medium in the case of route alterations that may have business implications for commercial vessel operators.
- **Probability** - high – the occurrence of combined residual effects on MCRTU, as characterized, is considered to be likely..
- **Confidence** - high – there is a good understanding of the cause-effect relationships and of the data pertinent to the study area.

#### *4.3.11.7 Potential United States Effects*

The key issues that have been identified in Canadian waters are also considered to be similar in US waters. The shipping lanes in the Strait of Georgia, Haro Strait and Juan de Fuca Strait are located along the international boundary for much of the Marine RSA, and so the effects of Project-related marine vessels on other marine users are also considered to be similar in both countries. The region is subject to co-management between US and Canadian agencies. For example, the USCG and the CCG share management of marine communications and traffic services in areas of overlap, and emergency tugs will assist vessels on both sides of the international boundary. Tourism operators such as whale-watching boats access all areas regardless of the international boundary. No differences in MCRTU conditions in the US and Canadian portions of the Marine RSA were identified that would change the nature of the effects assessment. Therefore, the effects are expected to be similar in Canadian and US waters.

#### *4.3.11.8 Summary*

As identified in Table 4.3.11.3, there are no situations for MCRTU indicators that would result in a significant residual socio-economic effect. Consequently, it is concluded that the residual socio-economic effects of increased Project-related marine vessel traffic on MCRTU will be not significant.

### *4.3.12 Human Health Risk Assessment*

This subsection outlines the nature of potential health risks to people associated with short-term and long-term exposures to the chemical emissions from the increased Project-related marine vessel traffic. As described in Section 4.2, the screening level HHRA was performed step-wise following a conventional risk assessment “paradigm”.

Details specific to the design of the HHRA for the marine transportation assessment as well as the results that emerged and the conclusions reached can be found in the Screening Level Human Health Risk Assessment of Marine Transportation in Volume 8B. Details regarding the HHRA conducted for marine spills can be found in Sections 5.6 and 5.7.

#### *4.3.12.1 Assessment Indicators and Measurement Endpoints*

For the purposes of the HHRA, the assessment indicators are people whose health might be adversely impacted as a result of exposures to the chemical emissions originating from increased Project-related marine vessel traffic through the marine shipping lanes. The choice of assessment indicators was based on the following factors.

- The need to assess the potential impacts of the chemical emissions on the health of people either living in the area (hereafter referred to as “residents”), or who might frequent the area for recreation or other purposes (hereafter referred to as “area users”).
- The need to consider the influence of the residents’ lifestyle characteristics, such as dietary patterns, on the potential chemical exposures caused by the Project, and the corresponding health risks that could be presented.
- The need to acknowledge that the manner and degree to which people may respond to chemical exposures can vary from one individual to another due to factors such as their age, sex and/or health status.

The assessment indicators used for the HHRA are described below:

- Residents:
  - **Aboriginal communities** – specific consideration was given to Aboriginal peoples living in the area to accommodate the unique opportunities for chemical exposures that might occur among these individuals, some of whom may practice a subsistence lifestyle, including the consumption of traditional foods such as game meat, marine food stuffs and natural plants.
  - **Urban dwellers** – people living in an urban environment, with allowance for potential chemical exposures through the consumption of home-garden produce and marine foodstuffs.
  - **Non-urban dwellers** – people living in a rural environment, practicing an agricultural lifestyle with reliance on home-grown foodstuffs, including beef, lamb, chicken, dairy, eggs and home-garden produce and marine foodstuffs.
- Area users – people who might frequent the area periodically for recreation or other purposes. Unlike the residents, it is unlikely that these individuals would remain in the area for extended periods of time, thereby precluding any reasonable opportunity for these people to be exposed to the COPC emissions on a long-term basis and/or through the regular consumption of locally grown or harvested foodstuffs.

The measurement endpoints for the HHRA refer to the potential adverse health effects that could be presented to the residents and area users from exposure to the COPC from increased Project-related marine vessel traffic along the marine shipping lanes. The assessment considers the toxic properties of the chemicals and the amount, frequency and duration of the exposure to the chemicals that people in the area might experience.

Distinction was made between the potential adverse health effects that might be presented to the indicators (residents and area users) on the basis of the following.

- The length of exposure (*i.e.*, short-term exposures lasting several hours to a few days versus long-term exposures lasting for several months or years, possibly up to a lifetime). The emissions associated with the increased Project-related marine vessel traffic along the marine shipping lanes will occur up to twice per day and will extend over the more than 50 year life of the Project, thereby presenting opportunity for both short-term and long-term exposure. For the purposes of the HHRA, the potential health risks associated with short-term and long-term exposure are referred to as acute and chronic health risks, respectively.
- The pathway of exposure (*i.e.*, the avenue(s) by which the residents and/or area users might be exposed to the COPC emissions from the increased Project-related marine vessel traffic). Since the chemicals will be emitted directly into the air, the primary pathway by which people could be exposed is via inhalation (*i.e.*, breathing in chemicals). Exposure through secondary pathways also could occur and is explored as part of the HHRA. For example, the chemicals might ‘fall-out’ or deposit from the air onto the ground or into the

water and enter the 'food chain' (*i.e.*, deposition of the chemicals directly onto the leafy surfaces of vegetables or other home-garden produce and/or deposition onto soils, with subsequent uptake by plants through the root system). The affected foods could then be consumed by people (*i.e.*, a secondary pathway). As a further example, the fall-out of the chemicals from the air could result in their appearance in sands along the shoreline or into the water, with the chemicals possibly taken up by shellfish and subsequently consumed by people (*i.e.*, another secondary pathway). More than one secondary pathway of exposure may be involved.

- The assessment indicator (*i.e.*, residents versus area users). Both indicators could, theoretically, be exposed to the emissions from the marine vessel traffic via inhalation on a short-term basis. However, the opportunity also exists for the residents to be exposed to the emissions on a longer-term basis through multiple pathways, including inhalation and/or secondary pathways (*e.g.*, consumption of home-grown produce, consumption of shellfish).

The assessment indicators and measurement endpoints evaluated as part of the HHRA are specified in Table 4.3.12.1 below.

**TABLE 4.3.12.1**

**ASSESSMENT INDICATORS AND MEASUREMENT ENDPOINTS FOR THE SCREENING LEVEL HUMAN HEALTH RISK ASSESSMENT**

| HHRA Indicator | | Measurement Endpoints | Rationale for Indicator Selection |
|---|---|---|---|
| Residents | Aboriginal peoples | Adverse health effects associated with:<br>• short-term inhalation of chemicals of potential concern (COPC)<br>• long-term inhalation of the COPC<br>• long-term exposures to the COPC through multiple pathways | The selection of indicators and measurement endpoints was guided by information contained in the NEB Filing Manual (2013c) as well as guidance provided by BC MOE, Health Canada and the Canadian Council of Ministers of the Environment (CCME) (see Section 3.0).<br>Specific consideration was given to the human health-related concerns identified through the various Aboriginal engagement and stakeholder consultation activities. |
| | Urban dwellers | | |
| | Non-urban dwellers | | |
| Area users | | Acute inhalation risks | |

### *4.3.12.2 Spatial Boundaries*

The spatial boundaries for the assessment of potential increased Project-related marine vessel traffic on human health were defined in terms of a HHRA LSA and the Marine Air Quality RSA, as described below (and as shown on Figure 4.2.32).

- **HHRA LSA** - includes the inbound and outbound marine shipping lanes, the area between the shipping lanes, where it exists, and a 5 km buffer extending from the outermost edge of each shipping lane. The shipping lanes extend from the Westridge Marine Terminal in Burnaby, through Burrard Inlet, south through the southern part of the Strait of Georgia, the Gulf Islands and Haro Strait, then westward past Victoria and through Juan de Fuca Strait out to the 12 nautical mile limit of Canada's territorial sea.

- **Marine Air Quality RSA** - a 150 km × 150 km area, generally centred on the marine shipping lanes, which extend from the Westridge Marine Terminal through Burrard Inlet, south through the southern part of the Strait of Georgia, the Gulf Islands and Haro Strait, westward past Victoria and Juan de Fuca Strait out to the 12 nautical mile limit of Canada's territorial sea.

The HHRA LSA represents the predicted spatial extent of the chemical emissions from the Project-related marine vessel traffic to which people along the shipping lanes might be exposed. The Marine Air Quality RSA was used for the purposes of assessing the cumulative health effects associated with the chemical emissions from the increased Project-related marine vessel traffic. The Marine Air Quality RSA was defined as the area for which ambient or background air quality data were obtained and all reasonably foreseeable developments were identified for the purposes of assessing the cumulative effects within the HHRA LSA.

#### *4.3.12.3 Screening Level Human Health Risk Assessment Context*

Information related to the HHRA context for the marine transportation component can be found in Section 4.2.12.4. The information outlines the current health status of people residing in the Marine Air Quality RSA and consists of population-based health statistics compiled by several Canadian and US-based health agencies. The health statistics relied on healthcare data collected by Health Authorities in BC and Washington. More specifically, the BC health information was based on health data compiled by the Fraser East and Fraser North HSDA of the FHA, the North Shore/Coast Garibaldi and Vancouver HSDAs of the VCHA, and the Central Vancouver Island and South Vancouver Island HSDAs of the VIHA. Health-based data for Washington were compiled by the counties of Whatcom, Jefferson, San Juan Islands and Clallam. The baseline health status is described principally in terms of cancer and respiratory health, since these indices have been identified as two of the more commonly-cited health concerns in the region and they are among the most relevant parameters for assessing the potential effects of exposures to COPC emissions. The baseline health information served as a benchmark for assessing the potential health impacts that might occur among the people residing in the Marine Air Quality RSA from exposure to the chemical emissions associated with the increased Project-related marine vessel traffic along the marine shipping lanes. Detailed information is presented in Tables 4.2.12.1 and for BC and Washington, respectively.

#### *4.3.12.4 Potential Effects and Mitigation Measures*

The HHRA evaluated the potential health risks to people associated with short-term and long-term exposures to the chemical emissions from the increased Project-related marine vessel traffic. The chemical emissions inventory for marine vessel traffic consisted of more than 100 chemicals, including CACs, metals, polycyclic aromatic hydrocarbons (PAHs), petroleum hydrocarbons, sulphur-containing chemicals and VOCs that were carried forward for consideration as COPC in the HHRA. The HHRA was completed using a series of conservative assumptions reflecting 'worst-case' circumstances, which collectively contributed to an exposure event being strictly hypothetical in nature, with a low probability of occurrence. In particular, the HHRA assumed that people would be found on both a short-term and long-term basis at the location within the HHRA LSA corresponding to the "maximum point of impingement" (MPOI). The MPOI refers to the location at which the highest ground-level air concentrations of each of the COPC would be expected to occur, and at which the exposures received by the people within the HHRA LSA would be greatest. The choice of the MPOI location was meant to ensure that any potential health effects that could result from exposure to the chemical emissions associated with the Project on the health of the people, regardless of where they might be found, would not be underestimated. The decision to use the MPOI to represent the location at which people would be found was made by default; that is, consideration was not given as to whether or not the MPOI location was suitable for a permanent residence and/or for residents to obtain their entire complement of locally grown or harvested foodstuffs, including garden vegetables, beef, chicken, dairy, eggs, game meat, fish, beach-foods and wild plants, from the local area.

The results of the HHRA revealed that, despite the conservative assumptions employed, with very few exceptions, the maximum predicted levels of exposure to the COPC (acting either singulary or in combination) remained below the levels of exposure that would be expected to cause health effects. In the majority of cases, the exposure levels were well below those associated with health effects. The exceedances revealed by the HHRA were very few in number and in virtually all cases were modest in magnitude. The high degree of conservatism incorporated into both the exposure estimates and the exposure limits used for comparison as part of the HHRA must be considered in the interpretation of the exceedances. Based on the weight of evidence, it is unlikely that people would experience health effects from the potential increase in chemical exposures associated with the increase in Project-related marine vessel traffic. A detailed quantitative HHRA will be conducted to expand on these findings with a report discussing the detailed HHRA to be submitted to the NEB in early 2014.

##### *4.3.12.5 Potential United States Effects*

No differences in the baseline conditions in the US and Canadian portions of the Marine Air Emissions RSA were identified that would change the nature of the effects assessment. Therefore, the effects are expected to be similar in Canadian and US waters.

##### *4.3.12.6 Summary*

The levels of exposure associated with the potential increase in Project-related marine vessel traffic are expected to remain below levels at which adverse health effects have been identified for the majority of the COPC. As such, adverse health effects are not expected as a result of these COPC emissions associated with the potential increase in Project-related marine vessel traffic. Those COPC associated with elevated health risks under the worst-case conditions assumed in the HHRA will be evaluated further in the comprehensive assessment.

#### *4.3.13 Accidents and Malfunctions*

Accidents and malfunctions are unplanned events that could result in significant adverse effects to human health, property or the environment; however, are unlikely to occur. While accidents and malfunctions are predicted to be unlikely for the increased Project-related marine vessel traffic, the potential consequences are evaluated so that emergency response and contingency planning can be identified to ensure the risk is further mitigated.

The following subsections contain an assessment of potential non-spill accidents and malfunctions from the increased Project-related marine vessel traffic. The potential effects of a spill from the increased Project-related marine vessel traffic are discussed in Section 5.0.

##### *4.3.13.1 Assessment Indicators and Measurement Endpoints*

Indicators considered in the assessment of accidents and malfunctions include those indicators previously described for the marine transportation elements in Sections 4.3.2 to 4.3.12. The measurement endpoints for accidents and malfunctions consist of a qualitative assessment of potential residual effects of accidents and malfunctions.

*4.3.13.2 Spatial Boundaries*

The spatial boundaries used in the effects assessment of accidents and malfunctions considered the applicable element-specific LSAs and RSAs as described in Sections 4.3.2 to 4.3.12. In general, the LSA is the ZOI in which socio-economic indicators are most likely to be affected by the operation of the increased Project-related marine vessel traffic. The RSA is considered the area where the direct and indirect influence of other marine activities could overlap with Project effects and cause cumulative effects on the indicator.

*4.3.13.3 Potential Effects and Mitigation Measures*

As stated in the NEB Filing Manual (NEB 2013c), an ESA must identify and assess the effects on workers, the public and biophysical and socio-economic elements of potential accidents and malfunctions. Events causing accidents and malfunctions could include equipment failure on tankers, human error, or natural perils such as floods, hurricanes or earthquakes.

Trans Mountain recognizes the high consequence potential of the operation of the increased Project-related marine vessel traffic. Trans Mountain is committed to keeping their operations safe and protecting their employees, facility users and visitors, the public and the environment. Trans Mountain strives to safeguard their facilities and to meet or exceed all applicable federal, provincial and local safety regulations.

**4.3.13.3.1 Incident Types**

Operation of tanker traffic is highly regulated in Canadian waters, and the marine shipping industry has a long history of safe operations. However, incidents such as accidental release of untreated bilge water, grounding of a vessel, the strike of a marine mammal, or the inadvertent venting of a tanker's cargo tank could occur. To ensure the continued safe and reliable operation of marine vessels off the coast of BC, many federal and international agencies regulate the movement of tanker traffic (see Section 1.4.1).

**Accidental Release of Bilge Water**

Bilge water results primarily from small weeps and leaks at the joints of moving machinery (pump glands) and the effects of condensation within the machinery spaces. It accumulates in the lowest part of the vessel's machinery spaces, such as the engine room, and may contain very small amounts of residual oils, lubricants, and grease, etc. It is processed and discharged periodically to prevent excess accumulation of water. Discharge of bilges when a vessel is in port is normally avoided.

Tankers of the size and type expected to be used by the Project are required to treat bilge water prior to discharge to the environment to reduce oil content to no more than 15 parts per million (mg/L) using a certified filtration or oil/water separator system and pumps. Accidental releases of bilge water can occur if the treatment equipment or any of the fitted sensors malfunctions while discharging treated bilge water, resulting in the release of oily water. Vessels with treatment systems are required to be fitted with automatic warning alarms and shut-off valves when the oil content exceeds 15 mg/L, which limits the potential for accidental releases of oily water. A small amount may be released between the alarm being triggered and stopping of discharge. A larger amount may be released during a total equipment failure if the alarm or the discharge-stopping mechanism does not function.

The requirement to treat bilge water is contained in the IMO MARPOL (IMO 2013b). In Canada, MARPOL is enforced through the *Vessel Pollution and Dangerous Chemicals* Regulations (annexed to the *Canada Shipping Act,* 2001). Regulations were put in place to prevent the recognized adverse effects of oil on water and sediment quality and on the health of marine birds and mammals. Bilge water must be treated before being discharged at sea or must be disposed of at an authorized facility.

**Non-spill Grounding of Vessel**

Collisions or groundings involving large cargo vessels such as tankers, bulk carriers and container ships are rare. Masters of these vessels are highly experienced mariners and are intimately familiar with the navigation and handling of their ships. In BC, this expertise is complemented with the local knowledge of BC Coast Pilots, who are required to be on board all vessels 300 DWT or larger that transit within BC's coastal waters. Tankers calling on the Westridge Marine Terminal are required to have two pilots on board when laden between the Westridge Marine Terminal berth and the Brotchie Ledge pilot boarding station (near Victoria). These pilots have intimate knowledge of their local waters, including the tides, currents, wind and wave conditions, transit procedures and traffic patterns. It is the responsibility of these pilots to advise the captain on local conditions and procedures in order to ensure the integrity of the vessel and the safety of its crew.

All large vessels transiting the shipping lanes are monitored by the CCG MCTS. Much in the same way airport control tower operators coordinate take-offs, landings and taxiing of aircraft, MCTS operators coordinate the movements of large vessels to ensure navigational safety and efficiency. All large vessels must also adhere to the rules and regulations established by the IMO and the *Canada Shipping Act*, including the *Collision Regulations*, which establish procedures for minimizing the risk of vessel collisions and groundings. Further risk mitigation is provided by rules established by the PMV and the PPA, such as the requirement for all laden tankers to be escorted by tugs through Burrard Inlet, Haro Strait and Boundary Pass, and timing restrictions for tankers transiting the Second Narrows.

With the stringent legislation governing the movements of oil tankers in Canadian waters, a collision or grounding event is considered very unlikely as noted in the Section 5.2. However, incidents have occurred in the past, and despite best efforts, could occur in the future.

The nature and magnitude of potential environmental and socio-economic effects of a tanker collision or grounding would depend on the type of incident and severity of impact. For the purposes of this assessment, it is assumed that the incident does not result in a breach of the hull, which could lead to foundering (*i.e.*, sinking). Further, it is assumed that the impact would result in damage to mechanical and/or electrical systems, which could affect propulsion and steerage. In such a scenario, escort tugs would be required to assist the tanker to berth.

In the event of a tanker collision with no release of product, potential effects to marine biophysical elements other than fish and fish habitat (*i.e.*, sediment and water quality, marine birds and marine mammals) would be negligible, if any, and are not considered further. Potential socio-economic effects exist and are discussed in this subsection.

During consultation with PMV and other agencies, the potential of a fire on a vessel was raised. The potential effect on the environment from a fire on a vessel while underway is the potential of a grounding from the disabling of the navigational systems. Therefore, the potential effects associated with a fire on a Project-related marine vessel are assessed under the effects related to a non-spill grounding of a vessel.

**Strike of a Marine Mammal**

All vessels, large or small, fast or slow, and regardless of what they are transporting (*e.g.*, oil, LNG, cargo, whale watching or passengers) have the potential to accidentally strike marine mammals. A vessel strike with a marine mammal may result in either physical injury or direct or indirect mortality. Most injuries sustained by marine mammals because of vessel strikes involve either blunt force trauma from impact on the bow of the vessel or lacerations from contact with propellers (Laist *et al.* 2001). Independent of where a vessel is transiting, the statistical likelihood of a vessel strike causing serious or fatal injury to a marine mammal depends on three factors: the probability of encounter; the probability of a strike occurring; and the probability that the strike results in severe or fatal injuries.

The probability of encounter is simply the likelihood of a marine mammal and vessel being in the same spot at the same time. This probability therefore depends in part, on whether the marine mammal and vessel are on a collision course, and is positively correlated with both the density of ship traffic and the density of marine mammals in a given area. Therefore, areas of overlap between high shipping traffic (*e.g.*, near major ports and along shipping lanes) and high marine mammal aggregation or concentration areas (*e.g.*, critical habitat, major feeding or breeding grounds, *etc.*) are at higher relative risk of an encounter (see for example Williams and O'Hara 2009).

The probability of a strike occurring considers whether a marine mammal and vessel actually make contact and, therefore, depends in part on the success or failure of any avoidance measure by either the marine mammal or vessel. The probability of strike has been positively correlated with the speed of the vessel. Kite-Powell *et al.* (2007) used data from observed encounters with right whales and from whale diving behaviour to model the probability of a strike based on vessel speed, and assuming the whale is initially on a collision course with the vessel. Based on this model, a large vessel travelling at 25 knots has a 50 per cent chance of striking a whale travelling in its path. At a speed of 10 knots, the chance of a strike is reduced to 30 per cent (Kite-Powell *et al.* 2007). The strike probability also varies by species. Smaller, faster species of marine mammals, such as dolphins, porpoises, and pinnipeds are more likely to exhibit successful avoidance responses and also present smaller surface areas for potential contact. In contrast, larger whales, such as the baleen whales, and in particular slower moving species such as right whales, are more prone to vessel strikes (Laist *et al.* 2001). Calves and resting whales also have reduced avoidance capacity.

The probability that a strike ultimately results in severe or fatal injury is also positively correlated to vessel speed. Vanderlaan and Taggart (2007) used historical records (1885 to 2002) of vessel strikes to large whales to mathematically model the probability of severe or lethal injury based on vessel speed. Vessel speeds of 18 knots and higher were predicted to have over a 92 per cent probability of lethality. Probabilities decreased with speed: from 78 per cent at 15 knots, 61 per cent at 13 knots, 31 per cent at 10 knots, to below 12 per cent at speeds of 7 knots or less (Vanderlaan and Taggart 2007). Based on historical records of motorized ship collisions with large whales, Laist *et al.* (2001) similarly concluded that serious injuries to whales are infrequent at vessel speeds of less than 14 knots, and rare at vessel speeds of less than 10 knots. Most reported lethal or severe injuries are caused by vessels 80 m or longer and by vessels traveling 14 knots or faster (Laist *et al.* 2001).

As noted above, different species have different likelihoods of being struck by a vessel. Jensen and Silber (2004) reviewed 292 records of ship strikes, and reported that fin whales were the most commonly struck species, while blue and sei whales were two of the least likely to be struck (although strikes that occur offshore are likely under-reported). Globally, humpback whales are the second most commonly struck species resulting in mortality or an unknown fate, on both an overall basis and after factoring in relative abundance (Jensen and Silber 2004, Laist *et al.* 2001). In BC, humpback whales are the most commonly struck species, as reported to the BC Marine Mammal Response Network (DFO 2013). Although strikes involving toothed whales remain possible, species such as killer whales are struck far less frequently than other whales and most historically reported instances involve smaller vessels moving at higher speeds. DFO's Recovery Strategy for the Transient Killer Whale recognizes collisions with vessels as a stressor with 'demonstrated' causal certainty, but a 'low' level of concern (DFO 2007). Likewise, vessel strikes involving any species of seal or sea lion are rare and DFO's Management Plan for Steller Sea Lions does not list vessel strikes as a potential threat (DFO 2010a).

According to strike event records obtained from DFO's Marine Mammal Incident Database (1973 to October 2012), only one confirmed/probable record of a pinniped strike has been reported in BC. This involved a Steller sea lion that was struck by a whale-watching boat near Race Rocks in 2009. There are also a few reports of harbour seal injuries that are consistent with vessel strikes, although many remain inconclusive and the strike events themselves were not witnessed. The Marine Mammal Incident Database (up to October 2012) has eight records of strikes with toothed whales that were confirmed or deemed likely to have occurred in BC: one involved a Dall's porpoise calf; one involved a harbour porpoise calf; and six involved killer whales (maximum vessel size reported for a killer whale strike was a ferry in the Strait of Georgia). It is important to note that data obtained from the BC Marine Mammal Incident Database was collected by voluntary reporting of dead and distressed animals. It is unknown to what extent all incidents are reported. As a result, absence of incidents at any location does not demonstrate absence of a threat in the report's timeframe. Furthermore, there remain a large number of uncertainties concerning the frequency, distribution and seasonality of strike events, and the ability to accurately collect records of such events. These include:

- unknown reporting compliance following a strike (either because the vessel operator did not know that a strike should be reported or to whom; refusal to report the incident; or the vessel operator was not aware that the strike even occurred). Despite the fact that pilots are expected to report marine mammal strikes, operators of large vessels are often unaware that a strike has occurred, and may be unable to determine the outcome of strike events;
- unknown frequency with which struck animals sink before they can be discovered/examined to determine cause of death, as well as ability to determine if the strike occurred pre- or post-mortem;
- limited capacity to re-sight and investigate carcasses of reported dead floating animals, free-swimming but potentially injured animals, or beach-cast carcasses in remote locations; and
- inconclusive cause of death determinations when examining carcasses in advanced stages of decomposition due to tissue autolysis.

Despite the above uncertainties, and the fact that vessel strike events are likely under-reported, the species' of marine mammal at highest relative risk of a vessel strike in the Marine RSA are most likely humpback whales and fin whales, along with other less frequently-observed species of baleen whales. The BC Marine Mammal Incident Database (up to October 2012) includes 19 records of humpback whale strike events, all of which occurred in BC between 2004 and 2011.

Most of these involved vessels less than 75 m in length, although larger vessels are also the least likely to detect and, therefore, report a strike event. Other records of baleen whale strike events include four records of grey whales, one fin whale, and three unidentified whales.

**Venting of a Tanker's Cargo Tank**

Pressure may accumulate in the cargo tanks of Project-related marine tankers as the crude oil export cargo vaporizes and releases gas into the headspace. Empty tankers waiting to load at Westridge would not normally discharge emissions while at anchor. However, if waiting with cargo onboard, given certain environmental conditions (*e.g.,* high solar radiation flux there could be a pronounced increase of temperature of the gases at the surface of the cargo in a tanker's cargo tanks). Such increase in temperature could lead to an increase in pressure of the tank that could cause the lifting of pressure relief devices fitted to the tanks (see Section 4.3.3). Factors such as increased product agitation and increased ambient and cargo temperatures that are more likely to occur on a hot summer day may also cause increases in pressure. Partially filled cargo holds would be more likely to pressurise as the head space above the liquid is larger.

If the build-up of gases in the cargo tank occurs rapidly and increases the pressure beyond safe levels despite normal venting, this elevated release rate has the potential to impact the local air quality and/or create nuisance odours. This venting could occur under most of the ship activity modes such as at anchor or in transit; however, not during product loading, when the vapour recovery unit is operating and fugitive vapours are being collected at the berth. The types of emissions to be vented to atmosphere from the relief valve would typically include petroleum hydrocarbons like methane, volatile organic compounds like toluene and reduced sulphur species like hydrogen sulphide.

All tankers in Canadian waters are required to have a VOC management plan.

#### 4.3.13.3.2 Identified Potential Effects

The potential effects associated with accidents and malfunctions from the pipeline and facilities component of the Project are provided in Volumes 5A and 5B. The potential direct and indirect effects of an operational pipeline or marine spill are evaluated in Volume 7 and Section 5.0, respectively, including the risk of a spill, the anticipated spill response and the potential effects for several spill scenarios. Events causing accidents and malfunctions from natural perils such as tornadoes, floods, hurricanes and earthquakes are discussed in Section 4.3.14.

Potential effects associated with accidents and malfunctions from the increased Project-related marine vessel traffic are listed in Table 4.3.13.1. These interactions are based on the results of the literature review, desktop analysis, consultation/engagement with Aboriginal communities, government agencies (*e.g.*, regulatory authorities, municipalities), stakeholders and the general public (Section 3.0), as well as the experience of the assessment team.

A summary of mitigation measures provided in Table 4.3.13.1 was principally developed in accordance with industry standards and regulatory guidelines including those from PMV, PPA, CCG, Transport Canada and the IMO.

## TABLE 4.3.13.1

## POTENTIAL EFFECTS, MITIGATION MEASURES AND RESIDUAL EFFECTS OF INCREASED PROJECT-RELATED MARINE VESSEL TRAFFIC ON ACCIDENTS AND MALFUNCTIONS

| Potential Effect | Spatial Boundary | Key Mitigation Measures in Place/Additional Recommendations | Potential Residual Effect(s) |
|---|---|---|---|
| 1.1 Change in marine water quality from an accidental release of contaminated bilge water | Marine RSA | • Transport Canada will ensure all tankers will comply with the pollution prevention provisions of the *Canada Shipping Act, 2001* and MARPOL.<br>• Trans Mountain will provide reception facilities at the Westridge Marine Terminal as necessary to service the needs of the Project-related marine vessels.<br>• Trans Mountain will screen the tankers nominated to call on the Westridge Marine Terminal to check that they do not have any malfunctions to pollution prevention equipment or history of non-adherence to provisions of the *Canada Shipping Act, 2001* and MARPOL.<br>• Trans Mountain will require all tankers to process and empty their bilges prior to arrival and to have the discharge valve of the bilge water locked while in Canadian waters. | • Degradation of marine water quality. |
| 2.1 Physical contact between a tanker's hull and marine subtidal habitat from a vessel grounding | Marine RSA | • Transport Canada and the CCG will monitor the movement of all tankers.<br>• Tankers will comply with regulations set out by the IMO and the *Canada Shipping Act, 2001*, including the *Collision Regulations*.<br>• Tankers will transit within the Transport Canada defined shipping lanes unless otherwise directed by the pilots or CCG MCTS operators.<br>• BCCP will ensure that all tankers follow transit procedures set out by PMV and the PPA, including escort tug requirements in Burrard Inlet, Haro Strait and Boundary Pass, and timing restrictions for the Second Narrows.<br>• Trans Mountain will require tug escort of all Project-related tankers for the entire transit from the Westridge Marine Terminal to the Pacific Ocean. This enhancement is in addition to tug requirements to assist with navigation. The tug can be tethered for extra navigational assistance if needed.<br>• TSB will investigate collisions and groundings. | • Alteration of subtidal habitat. |
| 3.1 Interference with navigation from a vessel grounding | Marine RSA | • Trans Mountain will apply mitigation measures listed in potential effect 1.1 of Table 4.3.11.2.<br>• To enhance preventive measures currently in place through applicable legislation and regulations, implement May 2013 recommendations of Canadian Marine Pilot's Association Submission to the Tanker Safety Expert Panel.<br>• Trans Mountain will require tug escort of all Project-related tankers for the entire transit from the Westridge Marine Terminal to the Pacific Ocean. This enhancement is in addition to tug requirements to assist with navigation. The tug can be tethered for extra navigational assistance if needed. | • Interference with navigation. |

**TABLE 4.3.13.1**

**POTENTIAL EFFECTS, MITIGATION MEASURES AND RESIDUAL EFFECTS OF INCREASED PROJECT-RELATED MARINE VESSEL TRAFFIC ON ACCIDENTS AND MALFUNCTIONS (continued)**

| Potential Effect | Spatial Boundary | Key Mitigation Measures in Place/Additional Recommendations | Potential Residual Effect(s) |
|---|---|---|---|
| 4.1 Physical injury or mortality of a marine mammal due to a vessel strike | Marine RSA | • Project-related vessels are owned and operated by a third party. Marine transportation in Canadian waters is authorized and regulated through the *Canada Shipping Act, 2001* and related legislation and regulations are administered by Transport Canada and the CCG.<br>• Trans Mountain would be interested in supporting and participating in a joint industry-government advisory group that would be charged with determining and/or developing effective mitigation measures to reduce potential effects on marine mammals. | • Physical injury or mortality of a marine mammal due to a vessel strike. |
| 5.1 Venting of tanker at anchor or in transit | Marine RSA | • Each tanker must be outfitted with pressure relief valves on each cargo tank as a safety measure.<br>• Tankers generally reduce the risk of emissions building in tanks by keeping a record of varying tank pressure, cooling the decks during daytime, cooling the cargo by taking water in the surrounding ballast tanks if possible, and loading the tanks that are used to as full as possible instead of leaving empty space in some tanks.<br>• KMC will screen the tankers nominated to call on the Westridge Marine Terminal to check that they are implementing a VOC management plan. | • Odours or degradation of local air quality. |

#### *4.3.13.4 Potential Residual Effects*

The potential residual effects that could occur as a result of non-spill accidents and malfunctions during the operations of the increased Project-related marine vessel traffic (Table 4.13.3.1) are:

- degradation of marine water quality;
- alteration of subtidal habitat;
- interference with navigation;
- physical injury or mortality of a marine mammal due to a vessel strike; and
- odours or degradation of local air quality.

#### *4.3.13.5 Significance Evaluation of Potential Residual Effects*

A qualitative assessment of accidents and malfunctions was determined to be the most appropriate approach to evaluate the significance of potential residual effects due to a lack of regulatory thresholds, standards or guidelines for indicators associated with elements described in Sections 4.3.2 to 4.2.12 as they relate to accidents and malfunctions. Consequently, the evaluation of significance of each of the potential residual effects relies on the professional judgment of the assessment team.

Table 4.3.13.2 provides a summary of the significance evaluation of the potential residual effects associated with accidents and malfunctions during operation of the increased Project-related marine vessel traffic. The rationale used to evaluate the significance of each of the residual effects is provided below.

**TABLE 4.3.13.2**

**SIGNIFICANCE EVALUATION OF POTENTIAL RESIDUAL EFFECTS OF INCREASED PROJECT-RELATED MARINE VESSEL TRAFFIC ON ACCIDENTS AND MALFUNCTIONS**

| Potential Residual Effects | Impact Balance | Spatial Boundary[1] | Temporal Context | | | Magnitude | Probability | Confidence | Significance[2] |
|---|---|---|---|---|---|---|---|---|---|
| | | | Duration | Frequency | Reversibility | | | | |
| (a) Degradation of water quality. | Negative | RSA | Immediate | Accidental | Short-term | Low | Low | High | Not significant |
| (b) Alteration of subtidal habitat. | Negative | RSA | Immediate | Accidental | Short to medium-term | Low | Low | High | Not significant |
| (c) Interference with navigation. | Negative | RSA | Immediate | Accidental | Short-term | Low to medium | Low | High | Not significant |
| (d) physical injury or mortality of a marine mammal due to a vessel strike | Negative | RSA | Immediate | Accidental | Short-term to permanent | Low to high | Low | Moderate | Not Significant |
| (e) Odours and degradation local of air quality. | Negative | RSA | Immediate | Accidental | Short-term | Low | Low | High | Not significant |

**Notes:** 1 RSA = Marine RSA. While the effect could occur anywhere within the Marine RSA, an accidental release would affect a localized area, not the entire 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.

**Significant Residual Socio-Economic Effect:** a residual socio-economic effect is considered significant if the effect is predicted to be:

- high magnitude, high probability, long-term or permanent reversibility, and any spatial boundary that cannot be technically or economically mitigated.

### 4.3.13.5.1 Degradation of Water Quality

Oil accidently released with bilge water is already mixed in the bilge water and typically spreads quickly as a sheen on the water surface. The oil begins breaking down immediately, through processes such as dissolution, sedimentation, bio-degradation, evaporation, weathering and dispersion (NRC 2003b). Degradation is facilitated by the thinness of the sheen and occurs rapidly for bilge water, compared to oil from a cargo spill. These processes would have a short-term effect on marine water quality, during dispersal of the sheen and degradation of the volatile hydrocarbon contaminants. There could be a longer-term increase (small and likely indistinguishable from ambient levels) in concentrations of persistent PAHs that reach the marine sediments.

Effects of oily bilge water on marine biota have not been well documented and are likely to be minimal, due to the low volume of oil released and its rapid dispersion. The oil may contribute to ambient and cumulative levels of persistent contaminants such as PAH in sediment. While not comparable to oily bilge water releases, the effects of oil spills on biota have been better documented, particularly for marine birds and mammals, which can be affected through direct contact with oil or chronic toxicity of hydrocarbon contaminants (Brown 2013).

The principal mitigation measure for minimizing potential effects of bilge water releases on the marine environment is compliance with the pollution prevention provisions of the *Canada Shipping Act,* 2001 and MARPOL. All Project-associated vessels are required, by law, to follow these regulations. Trans Mountain is committed to further mitigating potential effects of bilge water releases by using reputable vessel owners and operators who strictly adhere to regulations and ensure continued maintenance of vessel discharge treatment equipment and safety mechanisms.

The release of contaminated bilge water is prohibited by law. In the unlikely event of an accidental release of oily bilge water, a thin sheen would form over the water's surface but this would rapidly dissipate as the hydrocarbons volatilized and dispersed. The temporary increase in contaminant concentrations in the water column would quickly return to baseline conditions as the oil was weathered by physical forces and degraded by microbial activity.

The release of contaminated bilge water is expected to have a negative impact balance. A release of contaminated bilge water is illegal, unlikely to occur, and would result in only a short-term degradation of marine water quality (Table 4.3.13.2, point [a]). A summary of the rationale for all of the significance criteria is provided below.

- **Spatial Boundary** - Marine RSA – while an accidental release of oily bilge water could occur anywhere within the Marine RSA, there is likely to be rapid dispersion and evaporation of contaminants within a short distance of the vessel.
- **Duration** - immediate – introduction of oil would occur immediately upon release of bilge water.
- **Frequency** - accidental – bilge water releases are unplanned; discharge of bilge water is regulated.
- **Reversibility** - short-term – each event may take more than two days; however, less than or equal to one year to reverse the residual effect; sheen will rapidly evaporate or disperse.
- **Magnitude** - low – accidental releases typically are of small volumes and are not expected to result in quantifiable changes in baseline conditions (*e.g.*, sediment PAH levels) or to exceed sediment quality guidelines; the resulting sheen rapidly disperses and evaporates.
- **Probability** - low – bilge water discharges are regulated and accidental releases are a result of malfunction of the warning and discharge-stopping systems.
- **Confidence** - high – there is a good understanding of the cause-effect relationships between water contaminant conditions and potential for adverse effects on water quality, effectiveness of the regulations and mitigations.

#### 4.3.13.5.2 Alteration of Subtidal Habitat

In the unlikely event of a tanker grounding, the most probable effect on the marine biophysical environment would be the alteration of subtidal habitat. The nature of this alteration and the areal extent of habitat affected would depend on the speed of the vessel and the physical properties of the seabed (*e.g.*, substrate type, compactness, depth, slope). For soft sediment habitats, the tanker's hull would displace sediments perpendicular to the vessel's trajectory, carving a trench into the seafloor. For rocky habitats (*e.g.*, cobbles, boulders, bedrock), the physical impact would displace smaller, moveable rocks and may fracture extruding portions of bedrock. The area of habitat affected would be site- and scenario-specific; however, would likely range from several hundred to several thousand metres squared.

The physical impact of the tanker's hull on the seabed would likely result in the mortality of some benthic organisms, particularly those with limited ability to move. The particular species affected would depend on the habitat type; however, could include crabs, shrimps, clams, snails, anemones, sea cucumbers, and a variety of algae. A small number of benthic fish such as sculpins, gunnels, pricklebacks and flatfish could also be injured or killed; however, pelagic fish such as salmon and herring would likely move to avoid the vessel. Although organisms would begin recolonizing the affected area as soon as the grounded vessel was removed, it could take anywhere from several months to two years for the biotic community to return to pre-disturbance levels of diversity and abundance. During this time, the productive capacity of the habitat would be diminished.

Project-associated tankers transiting the shipping lanes within the Marine RSA are required to follow a number of procedures that are specifically designed to reduce the likelihood of collisions or groundings. These measures include mandatory pilotage (2 pilots), escort tug requirements in Burrard Inlet, Haro Strait and Boundary Pass, timing restrictions for transits through the Second Narrows, as well as a number of rules and regulations set out by the IMO and the *Canada Shipping Act*. With these measures in place, the likelihood of a grounding event resulting in the alteration of subtidal habitat is considered to be low. However, accidents can occur, and in the event of a grounding, subtidal habitat would be altered. The nature and magnitude of this effect would depend on a number of factors, including the physical properties of the seafloor, the species utilizing this habitat, and the speed of the vessel at impact.

Although it is difficult to estimate the area of subtidal habitat that would be altered as a result of a grounding event, it is conservatively estimated that a maximum of several thousand square metres of habitat would be affected. This is considered to have a negative impact balance. Within this area, benthic algae and invertebrates could be injured or killed as a result of crushing or burial, and a small number of bottom-dwelling fish may also be lost. The physical alteration of the habitat coupled with the loss of biota would result in a temporary reduction in the productive capacity of the affected habitat. The reversibility of this effect would depend on the type of habitat affected. Re-colonization would begin as soon as the tanker was removed; however, full recovery of species diversity and abundance could take between several months for soft sediment habitats to three years for rocky habitats. The magnitude of this effect would be low, since only a small fraction of marine subtidal habitat within the Marine RSA would be affected (Table 4.3.13.2, point [b]). A summary of the rationale for all of the significance criteria is provided below.

- **Spatial Boundary** - Marine RSA – although a tanker grounding event would most likely occur within the Marine LSA, it could occur at any shallow-water location within the Marine RSA.

- **Duration** - immediate – a tanker grounding event would occur over a short period of time.
- **Frequency** - accidental – a tanker grounding event would constitute a rare accident.
- **Reversibility** - short to medium-term – re-colonization of the affected area would begin as soon as the tanker was removed; however, full recovery of species diversity and abundance could take between several months and three years depending on the type of habitat affected.
- **Magnitude** - low – the area of subtidal habitat potentially affected by a grounded tanker (up to several thousand square metres) would represent a very small percentage of the total subtidal habitat present within the Marine RSA. Further, the injury or mortality of a small number of benthic organisms would not be detectable at the population level.
- **Probability** - low – numerous mitigation measures are in place to prevent vessel groundings and no Trans Mountain-associated tankers have ever grounded in over 60 years of operations.
- **Confidence** - high – based on a good understanding of the potential effects of subtidal habitat alteration on marine fish and fish habitat and the low probability of a grounding incident.

#### 4.3.13.5.3 Interference with Navigation

Marine incidents resulting in grounding or collision of Project-related marine tankers with other vessels, land or marine infrastructure may interfere with navigation of other marine vessels. This is considered to have a negative impact balance. The spatial boundary of the event is considered to be the Marine RSA. Navigation of other vessels could be disrupted by the presence of the stranded Project-related tanker within or near the designated shipping lanes. Marine vessels that are required to alter travel routes may be displaced to other areas in the Marine RSA. Additionally, if the Project-related tanker involved in the incident loses power prior to grounding or collision, the incident may occur outside the shipping lanes.

A grounding or collision with no loss of product could occur at any time during the operations phase of the Project; however, the frequency of the event occurring is considered to be accidental. Required mitigation measures that are implemented by most deep draft commercial marine vessels should aid in avoidance of groundings and collisions under most circumstances. These measures include: the widespread use of ship's radar; the compulsory use of VTS for larger vessels to facilitate communications with ports and other vessels; the use of loudhailers on bridges to communicate with smaller vessels that are not registered with VTS; the compulsory use of pilots in coastal BC waters; the use of escort tugs in Haro Strait and Burrard Inlet; and other standard navigational measures. The TSB has recommended additional safety measures for commercial marine vessels, including mandatory Safety Management Systems (SMS). SMS is a requirement for all Project-related tankers. SMS is a proactive system that includes regular safety drills and exercises, clear roles and responsibilities for crew, hazard identification systems and tools to improve vessel operations (TSB 2013). In addition, all tankers use navigational equipment that allows for frequent updates of the location of hazards and other navigational information (TSB 2013).

The reversibility of the residual effect of interference with navigation is likely to be short-term. Only if a stranded vessel is obstructing the navigation channel or if re-floating activities are obstructing the channel, will there be any interference with navigation for other vessels. Once the stranded vessel has been removed from the area, navigation should resume unobstructed. The exception may be in the case of a vessel strike with marine infrastructure such as a bridge, where the marine area may need to be closed for a longer period for replacement or repairs to infrastructure. The location of the incident in the Marine RSA is important to the assessment of the magnitude of the event. For example, a vessel grounding or collision in the Second Narrows in Burrard Inlet would be likely to pose a greater navigational obstruction than such an incident occurring in more open areas of the Marine RSA. In addition, a grounding or collision in Burrard Inlet may have increased implications for damage to marine infrastructure (*e.g.*, bridges, docks, and marinas) and to moored vessels. For recreational marine traffic, a short-term disruption may be an inconvenience; however, an incident that temporarily blocks the passage of commercial marine vessels may result in financial losses for the operators if shipping, fishing or tourism activities are disrupted. An incident involving the CN Rail Bridge may also disrupt rail traffic over the Second Narrows.

The probability of interference with navigation of marine vessels is low, since the grounding event is unlikely to take place (Table 4.3.13.2, point [c]). A summary of the rationale for all of the significance criteria is provided below.

- **Spatial Boundary** - Marine RSA – a grounding or collision of a Project-related tanker with no release of product could occur within or outside the shipping lanes in the Marine RSA.
- **Duration** - immediate – a grounding or collision of a Project-related tanker would occur over a short period of time.
- **Frequency** - accidental – a grounding or collision of a Project-related tanker with no release of product is likely to occur rarely during the operations phase.
- **Reversibility** - short-term – the residual effect of interference with navigation of marine vessels resulting from a grounding or collision of a Project-related tanker likely to be less than a year.
- **Magnitude** - low to medium – depending upon the location of the event, the magnitude of the residual effect is likely to range from low, being a nuisance to other vessels, or medium, resulting in delays for commercial vessels.
- **Probability** - low – numerous mitigation measures are in place to prevent vessel groundings and no Trans Mountain-associated tankers have ever grounded or collided with other vessels or marine infrastructure in over 60 years of operations.
- **Confidence** - high – the degree of certainty related to the significance evaluation is based on a good understanding of cause-effect relationships and data pertinent to the study area.

#### 4.3.13.5.4 Physical Injury or Mortality of a Marine Mammal Due to a Vessel Strike

A vessel strike with a marine mammal could result in physical injury or mortality of that individual, resulting in a negative impact balance. The spatial boundary of this effect is the

Marine RSA. The risk is concentrated along the shipping lanes. Areas of higher relative risk occur where shipping traffic overlaps with higher density areas for marine mammals. In the Marine RSA, this is most likely to be the western-most region, where more offshore species of baleen whale such as fin whale are expected to be more common. This area also overlaps with critical habitat for humpback whales, which are expected to be present here in higher densities (relative to other areas of the Marine RSA) primarily in the summer and fall.

The occurrence of a strike would be immediate (*i.e.,* upon contact). Actual frequency of vessel strikes in BC for any species of marine mammal and for any size or class of vessel are unknown and events are likely under-reported. However, the frequency of such events is considered accidental and rare for any particular vessel. Depending on the severity of the strike, an individual marine mammal may or may not recover from the event. While the primary effects associated with being struck are blunt-force trauma or lacerations, long-term consequences may include immediate direct mortality; indirect mortality resulting from complications or infection of internal or external injuries; long-term or permanent injuries; reduced fitness or fecundity; or short-term recoverable injuries. The magnitude of this effect may therefore range from low to high. While a strike resulting in minor injuries may be low magnitude, mortality of a *SARA*-listed species would be considered a high magnitude effect.

The overall probability of a Project-related vessel striking and injuring a marine mammal is considered low. While ship strikes leading to marine mammal fatalities can and do occur, such occurrences are infrequent relative to the number of vessels (of all sizes and classes) on the water. The probability for any particular vessel is therefore quite small, although the cumulative effects across all marine transportation activities may be an important threat in the consideration and development of management policies for species of conservation concern.

The potential effect of accidental physical injury or mortality of a marine mammal due to a vessel strike is determined to be not significant (Table 4.3.13.2, point [d]).

A summary of the rationale for all of the significance criteria is provided below.

- **Spatial Boundary** - Marine RSA – a vessel strike could occur at any location along the shipping lanes within the Marine RSA.
- **Duration** - immediate – a vessel strike event would be instantaneous and could occur at any time during the operations phase.
- **Frequency** - accidental – a marine mammal strike event with a Project-related vessel would constitute a rare accident.
- **Reversibility** - short-term to permanent – depending on the severity of the injury, an individual marine mammal may or may not recover from a vessel strike. At the population scale, recovery from the mortality of an individual would depend on the population in question, its generation time, and its conservation status. Whereas population-level effects for some species may be reversible in the medium-term, mortality of individuals listed as *Endangered* (*e.g.*, a North Pacific right whale) could have long-term or permanent population-level consequences.
- **Magnitude** - low to high – this would depend on the severity of the injury and the species in question. While a strike resulting in minor injuries may be low

magnitude, mortality of a *SARA*-listed species would be considered a high magnitude effect.

- **Probability** - low – while marine mammal vessel strikes can and do occur globally, the overall probability of an individual vessel striking and injuring or killing a marine mammal is low.
- **Confidence** - moderate – while the Project specific risk of this effect is considered to be low, the long-term per-incident consequences to individuals and the population-level frequency of occurrence of this effect is not well understood.

#### 4.3.13.5.5 Venting of Cargo Tank Vapours by a Tanker

The release of air emissions from an over-pressurized cargo tank in a Project-related marine tanker could result in degradation of air quality in the vicinity of the tanker. This is considered to have a negative impact balance. The spatial boundary of the event is considered to be the Marine RSA. The potential effect to air quality could occur outside of the Marine LSA, depending on the volume of emissions released from the tanker, the composition of the release of emissions, and environmental conditions at the location of the tanker at the time of the event.

A release of air emissions from an over-pressurized tanker could occur at any time during the operations phase of the Project; however, the frequency of the event occurring is considered to be accidental, as loaded tankers are not likely to be anchored for long enough periods for an occurrence. Required mitigation measures that are implemented by most deep draft commercial marine vessels should aid in avoidance of the release of air emissions from an over-pressurized tanker under most circumstances. These measures include cooling the decks during daytime; cooling the cargo by taking water in the surrounding ballast tanks, if possible; and loading the tanks that are used to as full as possible instead of leaving empty space in some tanks.

The reversibility of the residual effect of degradation of air quality is likely to be short-term. Once the emissions have been released from the cargo tank, they will dissipate into the atmospheric environment. Therefore, it is likely that the reversibility of the effect would be less than a year.

The magnitude of the event is anticipated to be low, given that the only effect of the short-term degradation of air quality is nuisance to nearby residents and marine users, if any.

The probability of degradation of air quality from the over-pressurization of a cargo tank in a Project-related marine vessel is low, since the sudden release of a large amount of pressure is unlikely to take place (Table 4.3.13.2, point [e]). A summary of the rationale for all of the significance criteria is provided below.

- **Spatial Boundary** - Marine RSA – a release of air emissions from an over-pressurized tanker could potentially affect areas beyond the Marine LSA.
- **Duration** - immediate – a release of air emissions from an over-pressurized tanker occurs over a short period of time.
- **Frequency** - accidental – a release of air emissions from an over-pressurized tanker is likely to occur only rarely during the operations phase.

- **Reversibility** - short-term – the residual effect of degradation of air quality resulting from release of air emissions from an over-pressurized tanker is likely to be reversed in less than a year.
- **Magnitude** - low – the magnitude of the residual effect is low since it may be a nuisance to nearby residents and marine users.
- **Probability** - low – several mitigation measures are in place to prevent release of air emissions from an over-pressurized tanker.
- **Confidence** - high – the degree of certainty related to the significance evaluation is based on a good understanding of cause-effect relationships and data pertinent to the study area.

#### *4.3.13.6 Combined Effects Resulting from Accidents and Malfunctions*

An evaluation of the combined effects considers those residual effects that are likely to occur. Since the probability of an accident or malfunction is low, an evaluation of combined effects of accidents and malfunctions is not warranted.

#### *4.3.13.7 Potential United States Effects*

The key issues relating to accidents and malfunctions that have been identified in Canadian waters are also considered to be similar in US waters. The shipping lanes in the Strait of Georgia, Haro Strait and Juan de Fuca Strait are located along the international boundary for much of the Marine RSA, and so the potential effects of accidents and malfunctions arising from Project-related marine vessels are considered to be similar. No differences in environmental or socio-economic conditions in the US and Canadian portions of the Marine RSA were identified that would change the nature of the effects assessment. Therefore, the effects are expected to be similar in Canadian and US waters.

#### *4.3.13.8 Summary*

As identified in Table 4.3.13.2, there are no situations arising from accidents and malfunctions that would result in a significant residual effect. Consequently, it is concluded that the residual effects arising from an accident or malfunction during the operation of the increased Project-related marine vessel traffic will be not significant.

### ***4.3.14 Changes to the Project Caused by the Environment***

Marine tanker traffic has been operating safely on the West Coast of Canada for well over 60 years. Knowledge gained from experience in previous years is reflected in the engineering design of tankers and federal and international regulatory guidelines that contribute to safe shipping.

#### *4.3.14.1 Environmental Conditions Not Considered*

Seismic activity was not considered to have the potential to adversely affect the increased Project-related marine vessel traffic during operations. An earthquake, either on land or under the ocean, would not produce a mechanism by which Project-related marine traffic could become affected. The marine shipping lanes are not in close enough proximity to the shoreline that an earthquake-related tsunami would produce a noticeably large wave (see TERMPOL 3.15 in Volume 8C [TR 8C-12] for more information).

Sea water rise was not considered to have the potential to adversely affect the increased Project-related marine vessel traffic during operations. There is no mechanism by which sea water rise could potentially affect or delay Project-related marine traffic.

#### *4.3.14.2 Potential Effects and Mitigation Measures*

Environmental conditions may have adverse effects on the increased Project-related marine vessel traffic. The following environmental conditions were identified by the assessment team as having the potential to adversely affect the marine transportation component of the Project:

- severe weather events including high wind speeds, heavy/persistent precipitation (*e.g.*, from storms), extreme temperatures, lightning, temperature inversions and rogue waves;
- low visibility; and
- changing weather trends.

Table 4.3.14.1 summarizes the potential effects of the environment on the increased Project-related marine vessel traffic.

**TABLE 4.3.14.1**

**POTENTIAL EFFECTS, MITIGATION MEASURES AND RESIDUAL EFFECTS OF CHANGES TO THE PROJECT CAUSED BY THE ENVIRONMENT**

| Potential Effect | Spatial Boundary | Key Mitigation Measures in Place/Additional Recommendations | Potential Residual Effect(s) |
|---|---|---|---|
| 1. Severe weather events | Marine LSA | • No additional mitigation measures recommended for the changes to the Project caused by the environment. | • Severe weather, low visibility or changing weather trends could delay Project-related marine vessels or contribute to the possibility of an accident. |
| 2. Low visibility | Marine LSA | • No additional mitigation measures recommended for the changes to the Project caused by the environment. | |
| 3. Changing weather trends | Marine LSA | • No additional mitigation measures recommended for the changes to the Project caused by the environment. | |

#### *4.3.14.3 Potential Residual Effects*

The potential residual effect of the changes to the increased Project-related marine vessel traffic caused by the environment (Table 4.3.14.1) is that severe weather or low visibility could delay Project-related marine vessels or contribute to the possibility of an accident.

Severe weather events (including high wind speeds, heavy/persistent precipitation [*e.g.*, from storms], extreme temperatures, lightning, temperature inversions and rogue waves) and low visibility could cause delays in Project-related marine vessel traffic. Severe weather and/or low visibility could cause tankers to lower their speeds, or stop transit in a safe location until weather conditions improve. Trans Mountain's operations are engineered with the possibility that Project-related marine vessels may not be able to transit Burrard Inlet for periods of days at a time due to weather. Slower tanker transit or the potential for a tanker to be anchored for multiple days due to adverse weather could have potential effects on the environment (*e.g.*, underwater noise, air quality). Since the assessment of potential environmental and socio-economic effects considers a general average of approximately 34 tankers per month, fluctuations in tanker transit time are considered in the assessment of potential effects.

Severe weather events and low visibility could increase the potential for a Project-related tanker to be involved in an accident (*e.g.*, high winds could cause the grounding of a tanker, although unlikely). Non-spill related accidents and malfunctions (*i.e.*, normal operations) are discussed in Section 4.3.13. The potential effects of a spill are discussed in Section 5.0.

Marine vessels, including those associated with the increased Project-related marine vessel traffic are designed to navigate safely in all extremely poor weather conditions. Vessels are staffed by trained mariners who are able to ensure the vessel's safety under poor conditions. General weather conditions in the Marine RSA are considered relatively benign, compared to other parts of the world and open ocean conditions. Weather reports and metrological information are obtained by the tankers using onboard equipment to assist in good decision making. Finally, BC pilots have their own weather limits and will not board or pilot Project-related vessels to sea if the conditions are not suitable, which ensures the transit cannot take place.

Changing weather trends are considered to have the potential to increase the frequency and magnitude of severe weather events. The consideration of severe weather events is inclusive of the potential for more frequent and harsher events in the future.

##### *4.3.14.4 Combined Effects of Changes to the Project Caused by the Environment*

An evaluation of the combined effects considers those residual effects that are likely to occur. Since the probability of environmental conditions affecting marine transportation is low, an evaluation of combined effects on increased Project-related marine vessel traffic caused by the environment is not warranted.

##### *4.3.14.5 Summary*

As identified in Table 4.3.14.1, the potential exists that severe weather, low visibility or changing weather trends could delay Project-related tankers or contribute to the possibility of an accident. Potential effects resulting from these events are considered to be unlikely. Marine vessel operators have been safely shipping in the Marine RSA for well over 60 years.

#### ***4.3.15 Summary of Environmental and Socio-Economic Effects***

##### *4.3.15.1 Summary of the Assessment of Potential Effects of the Project on the Environment*

The environmental and socio-economic effects associated with the Project are similar to those routinely encountered during existing marine transportation operations by vessels associated with Trans Mountain.

The potential environmental and socio-economic effects associated with the Project were identified through: consultation with the federal and provincial government representatives, other stakeholders and the general public; engagement with Aboriginal communities; review of existing literature; and the professional judgment of the assessment team. These potential effects were related to environmental and socio-economic elements including:

- physical elements such as marine sediment and water quality, marine air emissions, marine GHG emissions, and marine acoustic environment;

- biological elements such as marine fish and fish habitat, marine mammals, marine birds, and marine species at risk;
- socio-economic elements such as traditional marine resource use, marine commercial, recreational, and tourism use and human health; and
- accidents and malfunctions.

For the purposes of the marine transportation assessment, since Trans Mountain has little direct control over the actions of vessel owners and operators, mitigation is considered to include existing legislation and shipping standards that are monitored by several federal and international authorities (*e.g.*, PMV, PPA, CCG, Transport Canada, USCG and IMO). Trans Mountain expects that through its tanker acceptance process the calling vessels are maintained and operated to high industry standards.

Through the implementation of the mitigation measures, the residual effects associated with the increase in marine transportation on the environmental and socio-economic elements were considered to be not significant in all cases except one. Given that past and current activities are considered to have caused significant adverse effects on the southern resident killer whale population, the effects associated with the increased Project-related marine vessel traffic on this species is considered to be significant.

#### 4.3.15.2 Summary of the Changes to the Project Caused by the Environment

As identified in Table 4.3.14.1, the potential exists that severe weather, low visibility or changing weather trends could delay Project-related tankers or contribute to the possibility of an accident. Potential effects resulting from these events are considered to be unlikely. Marine vessel operators calling on the Westridge Marine Terminal have been safely shipping in the Marine RSA for over 60 years.

## 4.4 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. The cumulative effects assessment background and methodology described for onshore facilities in volumes 5A and 5B is also applicable to the effects of increased Project-related marine vessel traffic. The marine transportation cumulative effects assessment expands the scope of traditional environmental assessment to evaluate how combined vessel traffic may cause cumulative effects at both the local and regional scales.

The scope of the 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 marine transportation component 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 provincial and federal agencies and others 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 from all actions 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 will be directly affected by the project under review, as well as other projects or activities that overlap with these effects, need to be included in the project-specific cumulative effects assessment. This assessment therefore focuses on increased tanker and associated tug traffic from the Project (as identified in Section 2) in combination with the likely residual effects arising from other current or likely marine vessel traffic in the element-specific RSA (*i.e.*, Marine RSA or Marine Air Emissions RSA).

### *4.4.1 Methodology*

The marine transportation cumulative effects assessment applies the following steps.

- Identify potential residual effects of increased Project-related marine vessel traffic (Section 4.4.1.1).
- Determine spatial and temporal boundaries for each environmental and socio-economic indicator where residual effects have been identified (Section 4.4.1.2).
- Identify existing and reasonably foreseeable marine vessel traffic that may act in combination with the residual effects of Project-related marine vessel traffic (Sections 4.4.1.3 and 4.4.1.4).
- Identify potential cumulative effects (Section 4.4.1.5).
- Identify technically and economically feasible mitigation measures and industry standards, if any are warranted (Section 4.4.1.6).
- Determine the significance of the contribution of increased Project-related marine vessel traffic to cumulative effects (Section 4.4.1.7).

Each of the above steps is described below in the applicable methodology subsection. This cumulative effects assessment methodology has been developed based on FEARO's The Authority's Guide to the *Canadian Environmental Assessment Act*: Part II: The Practitioner's Guide (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), CEA Agency's Cumulative Effects Assessment Practitioners Guide (Hegmann *et al*. 1999), CEA Agency's Addressing Cumulative Environmental Effects under the *Canadian Environmental Assessment Act* (CEA Agency 2013), the *CEA Act, 2012* and the NEB Filing Manual (NEB 2013c) and is similar to the methodology used in Volumes 5A and 5B.

#### *4.4.1.1 Identify Residual Effects of Project-Related Marine Vessel Traffic*

The expectation of the NEB is that each residual environmental or socio-economic effect is evaluated for potential cumulative effects (see Guide A.2.7 of the NEB Filing Manual [2013c]). Nevertheless, Table A-2 of the NEB Filing Manual (2013c) indicates that likely residual effects for the GHG emissions element need not be subject to a cumulative effects assessment. Consequently, all other likely residual environmental and socio-economic effects identified in Section 5.0 are evaluated to determine the Project's contribution to potential cumulative effects.

As per Guides A.2.6 and A.2.7 of the NEB Filing Manual, if a physical, biological and socio-economic element or indicator evaluated in the environmental and socio-economic effects assessment (Section 4.3) had no residual effects predicted or effects were not considered likely, then these were excluded from the cumulative effects assessment. Therefore, the cumulative effects assessment is limited to elements or indicators with residual effects that could act cumulatively with residual effects from other marine vessel traffic.

### *4.4.1.2 Spatial and Temporal Boundaries*

#### 4.4.1.2.1 Spatial Boundaries

Spatial boundaries or ZOI for the effects of increased Project-related marine vessel traffic are variable based on a consideration of local and regional environmental setting and any common connections or links that the Project-related activities possess with other marine vessel traffic along the established marine transportation shipping lanes. The spatial boundaries used in the marine transportation cumulative effects assessment were determined to be the 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 Section 4.3.

#### 4.4.1.2.2 Temporal Boundaries

Current accepted practice for NEB applications is to use existing conditions for cumulative effects assessment. A general discussion of the historical developments and activities that have created existing conditions is included as background information (Section 4.4.1.3).

The temporal boundaries used in the cumulative effects assessment include the time period in which increased Project-related marine vessel traffic will occur (*i.e.,* the operations period or more than 50 years).

### *4.4.1.3 Existing Activities and Events*

Existing activities that are likely to occur in the Project area will vary depending on the spatial residual effects boundaries identified for the specific environmental or socio-economic element.

#### 4.4.1.3.1 Marine Industry and Commercial Fishing

Marine industry in the Marine RSA is concentrated in the Lower Mainland in the most populous region of BC (Chamber of Shipping 2011). PMV is Canada's busiest port and is the port authority mandated under the *Canada Marine Act* to be responsible for the safe and efficient movement of marine vessel traffic in Burrard Inlet (PMV 2013a). The port authority provides oversight for operations of 28 cargo and container terminals in the Lower Mainland (PMV 2013a). Most of the marine terminals are located in Burrard Inlet, including: cargo terminals for bulk products (*i.e.*, raw material commodities such as chemicals and petroleum products) and break-bulk products (*e.g.*, forest products); container terminals for transporting goods in intermodal containers; and two cruise ship terminals. Marine terminals along the lower Fraser River include cargo, container and automobile terminals.

Roberts Bank Superport is a twin-terminal port facility in Delta, BC that contains a coal terminal and a container terminal. Westshore Terminals exported 27.3 million tonnes of coal and coke in 2011 (Westshore Terminals 2013). The Deltaport container terminal at Roberts Bank is Canada's largest container terminal (PMV 2013a).

In 2012, PMV activities for terminals in Burrard Inlet, the Lower Fraser River, and Delta included:

- handling of approximately 123 million tonnes of cargo;
- handling over 3,000 calls by foreign vessels; and
- facilitating the transit of 191 cruise ship voyages, with over 600,000 passengers (PMV 2013a).

The City of Victoria is the major commercial centre on Vancouver Island. The port is used by deep sea ships and coastal and industrial traffic, including a cruise ship terminal at Ogden Point (Chamber of Shipping 2011).

Commercial fishing vessels employ a variety of fishing techniques for a large number of key targeted species and species groups, including salmon, herring, groundfish, crab, shrimp and prawn. Many species are fished year-round; however, the location and timing of specific commercial fishing activities depends upon the abundance and distribution of the targeted species or species assemblages, the season being fished, economic factors such as the value of the fishery, and regulations determined by DFO pursuant to the *Fisheries Act*.

Areas of the Marine RSA with the highest relative effort for certain fisheries were determined using spatial data obtained from DFO (for more detail, refer to the Marine Commercial, Recreational and Tourism Use – Marine Transportation Technical Report (Volume 8B, TR 8B-6). These areas include:

- salmon troll: Southern Gulf Islands;
- salmon seine: northwestern Juan de Fuca Strait;
- salmon gillnet: southern Strait of Georgia and northwestern Juan de Fuca Strait;
- groundfish trawl: western Juan de Fuca Strait and Southern Gulf Islands;
- groundfish hook and line (Schedule II fisheries): southern Strait of Georgia;
- rockfish hook and line (ZN fisheries): Haro Strait and western Juan de Fuca Strait;
- Dungeness crab trap: nearshore areas of Haro Strait along the Saanich Peninsula, and Southern Gulf Islands;
- prawn trap: nearshore areas of southeast Vancouver Island;
- shrimp otter trawl: Southern Gulf Islands; and
- shrimp beam trawl: Strait of Georgia along the shipping lanes west of Richmond and Delta, and southern Haro Strait.

The routes typically used by fishing vessels throughout the marine study area are summarized using information from the Marine Commercial, Recreational and Tourism Use – Marine Transportation Technical Report (Volume 8B, TR 8B-6).

Fishing vessels use the designated shipping lanes through the Strait of Georgia, Haro Strait and Juan de Fuca Strait, as well as most navigable channels in the study area. The use of travel routes depends on factors including the location of the fishing grounds, the location of the home port, weather, and navigational hazards.

In the Strait of Georgia, most fishing vessels travel in a north-south direction along Roberts Bank to access the southern straits, and east-west to access fishing grounds in Howe Sound and north of the study area. Fishing vessels must cross the shipping lanes in the Strait of Georgia to access fishing grounds in areas of the Southern Gulf Islands and southeast Vancouver Island. Fishing vessels also cross the Strait of Georgia from the west to access home ports, fishing grounds and processing facilities along the Fraser River. Fishing vessels use the shipping lanes in Juan de Fuca Strait, and seldom cross the Traffic Separation Zone down the middle of the strait. Smaller fishing vessels travel close to shore, in more sheltered waters outside of the main shipping lanes. The TMEP TERMPOL 3.2, Origin, Destination, and Marine Traffic Volume Survey (Volume 8C, TR 8C-2) provides more information on the movements of marine vessels, including fishing vessels, in the Marine RSA.

#### 4.4.1.3.2 Marine Transportation

The Strait of Georgia is a busy and regionally important shipping route. To address the efficient navigation and safety of marine vessels, a Marine Traffic Separation Scheme is in place throughout the Strait of Georgia, Haro Strait and Juan de Fuca Strait (CCG 2013a). Traffic Separation Schemes separate opposing streams of traffic by establishing inbound and outbound shipping lanes and associated navigational aids, as well as a separation zones between lanes in some areas (IMO 2013a). Most commercial vessels use the shipping lanes, although passenger ferries follow routes that often cross the shipping lanes between terminals.

Passenger ferries operated by BC Ferry Services use the Strait of Georgia for ferry service between ports on the Lower Mainland, Vancouver Island, and the Southern Gulf Islands. Ferries transit frequently between:

- Horseshoe Bay (West Vancouver) and Nanaimo (Vancouver Island);
- Tsawwassen (Delta) and Duke Point (Nanaimo area);
- Tsawwassen and Swartz Bay (north of Victoria); and
- Tsawwassen, Swartz Bay and the main Southern Gulf Islands (Salt Spring, Pender, Mayne, Galiano, and Saturna islands) (BC Ferry Services 2013b).

Other ferry services operating in the Marine RSA include Washington State Ferries, which carry passengers between Sidney and Anacortes in Washington State (Washington State Department of Transportation 2013a). From Victoria, Black Ball Ferry Line runs regular trips between Victoria and Port Angeles (Black Ball Ferry Line 2013). The Victoria Clipper is a passenger-only ferry service that runs high-speed catamarans daily between Victoria and Seattle (Clipper Navigations 2013). The Alaska Marine Highway System includes as part of its transportation network the Alaska ferry from Bellingham via Prince Rupert into Alaska. The ferry route is in the shipping lanes through the Strait of Georgia, continuing north through Johnstone Strait and Hecate Strait (State of Alaska 2013).

Marine transportation services are provided by a large fleet of tugboats and barges that operate throughout BC coastal waters. Some of the larger operators include Seaspan Marine

Corporation, Pacific Towing Services Ltd. and SMIT Harbour Towage (Transport Canada 2013c).

Barges operated by Seaspan Coastal Intermodal Company transport truck trailers and rail cars across the shipping lanes between terminals on the Fraser River and Nanaimo and Swartz Bay, north of Victoria (Transport Canada 2006).

In 2012, tug transits (*i.e.*, all tug and barge traffic) made up approximately 49 per cent of the total sailed nautical miles in the Strait of Georgia and Vancouver Outer Harbour, with cargo and ferry traffic making up a further 18 per cent and 15 per cent, respectively (refer to the TMEP TERMPOL 3.2, Volume 8C, TR 8C-2).

Log handling occurs in Burrard Inlet and along the Fraser River, and other log handling and storage areas are located in the Southern Gulf Islands, the Saanich Peninsula north of Victoria, and near Sooke and Port Renfrew on southern Vancouver Island (BC MCA 2012, Natland pers. comm.). Logs are also stored in numerous locations along the Fraser River. Mill & Timber Products in Port Moody handles and stores logs in Port Moody Inlet (Natland pers. comm.). 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.).

Aquaculture operations for shellfish and finfish are present in nearshore areas in Haro Strait as well as southwestern Vancouver Island. Active licenses for shellfish aquaculture operations for mussels, Manila clams, Pacific oysters and other shellfish are present in the Southern Gulf Islands, in sheltered areas near Saturna Island and Saltspring Island (DFO 2013n). Active licenses for Atlantic salmon, Manila clams and Pacific oysters are present in the Sooke Basin, west of Victoria (DFO 2013o).

#### 4.4.1.3.3 Marine Recreation

Marine recreational use of the Marine RSA includes fishing, boating (including sailboats and powerboats), kayaking and canoeing and scuba diving. Recreational use is inherently connected to specific designated areas including marine parks and reserves, and recreational fishery areas, but marine recreational activities also occur throughout the Marine RSA.

Recreational fishing activities, including economic activity generated by tourist and non-tourist anglers, contributed over $300 million to the provincial economy in 2011 (BC Stats 2013). Recreational fishing occurs throughout the study area, including in accessible nearshore areas close to population centres, such as Burrard Inlet and Victoria Harbour; at river mouths such as the Capilano River in Burrard Inlet; and in more remote but highly productive areas such as Swiftsure Bank at the western approach to Juan de Fuca Strait (Bird pers. comm.). Recreational fishers in tidal waters must obtain a tidal waters sport fishing license from DFO (DFO 2013l). Key species for recreational fishing include Chinook and coho salmon, and Pacific halibut (Sport Fishing Institute of BC 2013). Rockfish species, lingcod, other salmon species, prawn and Dungeness crab are also popular with recreational fishers (Sport Fishing Institute of BC 2013).

The Strait of Georgia is a major access route for boaters to areas in the Southern Gulf Islands, Vancouver Island, the US San Juan Islands, and many other destinations. Commonly used boating routes cross the shipping lanes north of Roberts Bank off Delta and at several other points from the east, to access Porlier Pass between Valdes Island and Galiano Island and Active Pass between Mayne Island and Galiano Island. Recreational boaters also cross the shipping lanes from the west to access the Fraser River. Yacht racing also takes place throughout the Marine RSA. TERMPOL 3.2, Volume 8C, TR 8C-2 provides more information on the movements of vessels in the Marine RSA.

The Southern Gulf Islands and the inshore areas of southeast Vancouver Island are highly popular recreational areas in the summer months for residents and tourists. Together, Boundary Pass and Haro Strait form the eastern boundary of the Gulf Islands National Park Reserve, designated to protect terrestrial and marine areas on many of the islands in the Gulf Islands archipelago (Parks Canada 2013b). The park reserve is an international destination for activities such as kayaking, canoeing, boating, scuba diving, coastal camping, whale-watching and wildlife viewing. An extensive marine trail network of paddling routes, access points and coastal campsites throughout coastal BC provides opportunities for kayakers, canoeists and other small craft (BC Marine Trails Network Association 2013). Many of the most accessible routes are located in the Gulf Islands National Park Reserve (Gulf Islands Tourism 2013). Coastal campsites are present on South Pender Island, Sidney Island and D'Arcy Island, in marine parks that are also part of the National Park Reserve. In the Victoria area, Discovery Island Marine Park off Oak Bay is also popular for kayaking. Kayakers use the coastal campsites on the south side of the islands in Rudlin Bay, as well as other campsites in the Chatham Islands to the north in Haro Strait (BC Parks 2013b).

#### *4.4.1.4 Reasonably Foreseeable Activities*

Reasonably foreseeable developments that are likely to occur in the Project area will vary depending on the spatial residual effects boundaries identified for the specific environmental or socio-economic element.

The criteria used to determine marine vessel traffic that may act cumulatively with the Project-related marine vessel traffic are:

- the marine vessel traffic is already travelling in the vicinity of increased Project-related marine vessels (*i.e.*, certain); or
- the marine vessel traffic is associated with a development that is either proposed (public disclosure), has been approved to be developed, but is not yet being developed in the vicinity of the Project, or is included in projections of likely future marine vessel traffic (*i.e.,* reasonably foreseeable) included in the TMEP TERMPOL 3.2 (Volume 8C, TR 8C, TR 8C-2).

TERMPOL 3.2 includes projected traffic increases compiled from PMV, Fraser River Port Authority and North Fraser Port Authority. Other activities and reasonably foreseeable developments included in the assessment are summarized below, from specific expansion plans as well as general projected increases in the RSAs.

#### **4.4.1.4.1 Specific Terminal Expansion Plans**

Trans Mountain surveyed other bulk terminals in the Vancouver Harbour to determine the potential increase in vessel traffic. Pacific Coast Terminals are currently planning to increase vessel calls projecting out to 2018.

#### **4.4.1.4.2 General Traffic Increase Projections**

Table 4.4.1.1 details the projected growth rates of vessel movements in the Marine RSA by vessel type for the TERMPOL 3.2 (see Volume 8C, TR 8C-2 for more details). Table 4.4.1.2 details numbers of 2012 sailings and compares Project-related tankers and total traffic to 2012 and predicted 2030 numbers. Since vessel traffic growth rates were provided for the entire Marine RSA, projected increases that have been calculated for each cross-section are considered to be a rough estimate. Projected total traffic increases in the Marine RSA are expected to vary between Burrard Inlet, English Bay, the Strait of Georgia, Haro Strait and Juan de Fuca Strait and are provided as a reasonably foreseeable approximation.

**TABLE 4.4.1.1**

**SUMMARY OF OTHER PROJECTED MARINE RSA VESSEL TRAFFIC GROWTH RATES**

| Ship Type | Projected Growth Rates in Marine RSA (% change per year) | | Total Change (%) |
|---|---|---|---|
| | 2012 to 2020 | 2020 to 2030 | |
| Tanker < 50,000 DWT | 2 | 2 | 42.8 |
| Tanker > 50,000 DWT | 2 | 2 | 42.8 |
| Chemical tanker | 2 | 2 | 42.8 |
| Liquefied petroleum/natural gas carrier | 2 | 2 | 42.8 |
| General cargo | 1 | 1 | 19.6 |
| Bulk cargo | 1 | 1 | 19.6 |
| Container | 1 | 1 | 19.6 |
| Tug | 1 | 1 | 19.6 |
| Tug with oil barge | 1 | 1 | 19.6 |
| Tug with chemical barge | 1 | 1 | 19.6 |
| Tug with tow | 1 | 1 | 19.6 |
| Government | 1 | 1 | 19.6 |
| Fishing | 0 | 0 | 0 |
| Passenger vessel | 1 | 1 | 19.6 |
| Other vessels > 20 m | 1 | 1 | 19.6 |
| Other vessels < 20 m | 1 | 1 | 19.6 |
| Ferry movements | 0 | 1 | 10.5 |

## TABLE 4.4.1.2

## SUMMARY OF EXISTING AND FUTURE VESSEL MOVEMENTS AT FIVE LOCATIONS IN THE MARINE RSA

| Location of Cross Section[1] | | Vessel Movements by Vessel Type in 2012 (#/yr) | | | | | | | | | Project-Related Vessel Movements[10] (#/yr) | | | Project-Related Tanker Contribution to 2012 Vessel Traffic (%)[11] | Project-Related Tanker and Tug Contribution to 2012 Vessel Traffic (%)[11] | Estimated Increase in Non-Project Vessel Movements by 2030 (#/yr)[12] | Estimated Total Vessel Movements in 2030 (#/yr)[13] | Project-Related Tanker Contribution to Total Projected Future Vessel Traffic (%)[14] | Project-Related Tanker and Tug Contribution to Total Projected Future Vessel Traffic (%)[14] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Name | Description | Tanker[2] | Cargo/Carrier[3] | Tug[4] | Service[5] | Passenger[6] | Fishing[7] | Other[8] | Unknown[9] | Total | Tanker | Tug | Total | | | | | | |
| Burrard Inlet[15] | North-south across Burrard Inlet just west of the Westridge Marine Terminal | 263 | 108 | 5,631 | 473 | 68 | 25 | 261 | 29 | 6,858 | 720 | 2,160 | 2,880 | 9.5 | 29.6 | 1,401 | 11,139 | 6.5 | 25.9 |
| English Bay | North-south from Point Atkinson in West Vancouver to Point Grey area in Vancouver | 384 | 3,170 | 5,755 | 682 | 477 | 192 | 1,244 | 337 | 12,241 | 720 | 720 | 1,440 | 5.6 | 10.5 | 2,453 | 16,134 | 4.5 | 8.9 |
| Strait of Georgia | Northeast across southern Strait of Georgia, from Delta near Tsawwassen to Active Pass area | 385 | 5,301 | 3,237 | 1,316 | 5,634 | 459 | 672 | 590 | 17,594 | 720 | 720 | 1,440 | 3.9 | 7.6 | 3,450 | 22,484 | 3.2 | 6.4 |

## TABLE 4.4.1.2

## SUMMARY OF EXISTING AND FUTURE VESSEL MOVEMENTS AT FIVE LOCATIONS IN THE MARINE RSA (continued)

| Location of Cross Section[1] | | Vessel Movements by Vessel Type in 2012 (#/yr) | | | | | | | | | Project-Related Vessel Movements[10] (#/yr) | | | Project-Related Tanker Contribution to 2012 Vessel Traffic (%)[11] | Project-Related Tanker and Tug Contribution to 2012 Vessel Traffic (%)[11] | Estimated Increase in Non-Project Vessel Movements by 2030 (#/yr)[12] | Estimated Total Vessel Movements in 2030 (#/yr)[13] | Project-Related Tanker Contribution to Total Projected Future Vessel Traffic (%)[14] | Project-Related Tanker and Tug Contribution to Total Projected Future Vessel Traffic (%)[14] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Name | Description | Tanker[2] | Cargo/Carrier[3] | Tug[4] | Service[5] | Passenger[6] | Fishing[7] | Other[8] | Unknown[9] | Total | Tanker | Tug | Total | | | | | | |
| Haro Strait | Northeast from Victoria area east to San Juan Island | 391 | 4,506 | 975 | 850 | 506 | 300 | 907 | 461 | 8,896 | 720 | 720 | 1,440 | 7.5 | 13.9 | 1,777 | 12,113 | 5.9 | 11.9 |
| Juan de Fuca Strait | Southeast from Victoria to Port Angeles area | 1,197 | 7,695 | 2,294 | 2,189 | 2,146 | 742 | 1,409 | 831 | 18,503 | 720 | 720 | 1,440 | 3.7 | 7.2 | 3,762 | 23,705 | 3.0 | 6.1 |

**Source:** ,TERMPOL 3.2 (Volume 8C, TR 8C-2)

**Notes:**
1 Cross sections were placed across the shipping lanes to characterize the movements of vessels in the area that may be travelling in or adjacent to the shipping lanes.
2 Tanker traffic includes all chemical and petroleum products.
3 Cargo/carrier includes bulk carriers and general cargo carriers.
4 Tug traffic includes all tug movements, such as tugs engaged in towing and barging activities and harbour assist tugs.
5 Service vessels include: law enforcement/patrol vessels, military vessels, pilot vessels, pollution control vessels, research/survey vessels, dredges, and others.
6 Passenger includes ferries and cruise ships. While cruise ships operate in the summer months, most ferry services are year round. Strait of Georgia passenger vessel movements may be biased due to placement of the cross section parallel to major ferry routes and may include more than one instance per ferry crossing. Due to the fact that the passenger vessels category combines ferry and cruise ship traffic, ferry movements were estimated as 1% per annum from 2012 to 2030.
7 Fishing: only fishing vessels greater than 24 m in length and 150 gross tonnes are required to call in to VTS. Smaller vessel movements are not captured.
8 'Other' category may include pleasure craft greater than 30 m in length (required to call into VTS).
9 'Unknown' category is likely to include private recreational vessels and all vessels smaller than 30 m that are not required to call into VTS.
10 Tanker numbers calculated as: 30 vessels/month ×12 months/yr × 2 transits/vessel (inbound + outbound). Tug numbers calculated assuming 3 escort tugs for outbound tankers in Burrard Inlet and 1 escort tug for outbound tankers along the remainder of the shipping lanes. Tug numbers include outbound trip (*i.e.,* while escorting tanker) and inbound trip (*i.e.,* returning to point of origin).

# TABLE 4.4.1.2

## SUMMARY OF EXISTING AND FUTURE VESSEL MOVEMENTS AT FIVE LOCATIONS IN THE MARINE RSA (continued)

11 Calculated as: Project-related vessel movements/yr / (TMEP vessel movements/yr + 2012 total vessel movements).

12 Calculated using projected growth rates from Table 4.4.1.1.

13 Includes Project-related vessel movements.

14 Calculated as: TMEP vessel movements/yr / 2030 total vessel movements.

15 Some traffic east of Second Narrows in Burrard Inlet is associated with Westridge Marine Terminal; however, Pacific Coast Terminals and other terminals operate east of Westridge Marine Terminal in Port Moody. Therefore, existing commercial and tanker traffic and projected growth in this cross-section is not entirely Project-related.

Future marine vessel movements in the Marine RSA were projected to have a growth rate of 2 per cent per annum through to 2030 for marine tankers, including oil tankers, chemical tankers and LNG carriers. Cargo carriers and container ships were projected to grow at 1 per cent per annum through to 2030. The projected growth rate for all other marine vessels (*e.g.*, tugs, barges, government vessels, passenger vessels and all other vessels) was 1 per cent per annum over the same time period, with the exception of fishing vessels, which were projected to have a 0 per cent growth rate (TERMPOL 3.2, TR 8C-2, Volume 8C). The growth of commercial marine vessel traffic in the Marine RSA is the result of development of the marine industry in the region. For example, several existing marine terminals are proposing to undergo considerable expansion to increase their shipping capacity, which will add to the commercial marine traffic in the Marine RSA.

Discussions between Trans Mountain and other bulk terminals in Burrard Inlet were held to discuss the potential increase in local vessel traffic from marine terminal developments east of the Second Narrows, around the Westridge Marine Terminal. In order to navigate through Burrard Inlet into the Strait of Georgia, deep draft marine vessels must request that the CN Rail Bridge be raised to allow transit through the Second Narrows. An increase in traffic in this area will also increase the frequency of the need to raise the rail bridge. As of 2013, at least one other marine terminal located east of the Second Narrows plans to increase vessel calls projecting out to 2018.

Developments in the Marine RSA which have planned marine terminal components or expansions include a number of proposed projects that fall under the jurisdiction of PMV. If approved, these developments are expected to contribute to the increase in commercial marine vessel traffic in Burrard Inlet, the Strait of Georgia, Haro Strait and Juan de Fuca Strait. These include the following proposed projects.

- 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 containers (TEUs), 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 2013b).

- Fraser Surrey Docks on the Fraser River is proposing a development of a direct transfer coal facility to handle up to 4 million metric tonnes of coal per year by 2014. The coal will be transferred to the terminal by rail and loaded onto barges which will be towed to a storage facility on Texada Island, before transfer to bulk carriers for overseas export. At full capacity, an estimated 640 barge tows per year or two tows a day will transit from FSD north across the Strait of Georgia to Texada Island (Det Norske Veritas 2012). The project is currently under review by PMV (PMV 2013).

- Neptune Terminals in Burrard Inlet has received a project permit from PMV to expand its coal handling capacity up to 18.5 million metric tonnes per year, which is expected to result in approximately one additional ship per week calling on the terminal following project completion (PMV 2013a).

- Richardson International Limited has received a project permit from PMV to expand their grain storage capacity at their Vancouver marine terminal by adding a new storage facility. The project is expected to take two years to complete. The increased grain storage capacity will increase the annual capacity of the terminal to handle from 3 million to 5 million metric tonnes of grains and oilseeds (PMV 2013a). No estimates of future growth in associated vessel traffic have been released as of 2013.

- Westshore Terminals in Delta recently completed an upgrade to its facilities that increased throughput capacity for coal exports to 33 million tonnes, and anticipates an increase in coal shipments to reach the new capacity over the next few years (Kirby 2013).

Additionally, proposed coal terminal expansions in Washington State will contribute to marine vessel traffic in Juan de Fuca Strait, if approved. As of 2013, two proposed coal terminals are undergoing review by state authorities, including the following.

- Gateway Pacific Terminal is a terminal proposed at Cherry Point, near Bellingham, Washington. The terminal will have the capacity to ship up to 60 million metric tonnes annually of dry bulk commodities, mostly coal. Most of the coal barges calling at the Gateway Pacific Terminal are expected to use Rosario Strait between the Strait of Georgia and Juan de Fuca Strait, with occasional use of Haro Strait. The project is under environmental review by the Washington Department of Ecology (Washington State Department of Ecology 2013c).

- Millennium Bulk Terminals is a coal terminal proposed in Longview, Washington. The completed terminal will have the capacity to ship up to 44 million metric tonnes of coal annually. The project is under environmental review by the Washington Department of Ecology (Washington State Department of Ecology 2013c).

In addition to reasonably foreseeable marine industry developments, proposed parks and other recreational areas in the Marine RSA that include marine components may also contribute to future increases in marine use by recreational and tourism users and, therefore, are considered in the cumulative effects assessment. Notably, the Southern Strait of Georgia National Marine Conservation Area is proposed for the Southern Gulf Islands and nearshore areas of southeast Vancouver Island. The proposed area includes the current Gulf Islands National Park Reserve with considerable expansion of the marine areas from Gabriola Island in the north to the middle of Haro Strait in the south, including nearshore areas of Vancouver Island out to the shipping lanes and the international border. The current national park reserve is a draw for both residents and visitors to BC. The proposed NMCA is currently in the public consultation phase of a feasibility assessment by the provincial and federal governments (Parks Canada 2013b).

#### *4.4.1.5 Identify Potential Cumulative Effects*

The potential cumulative effects of marine transportation depend on many factors, including:

- the source of the disturbance;
- resilience of the receptor or indicator of interest; and

- the way in which disturbances from multiple vessel passages interact in time and space.

The level of detail provided in the analysis reflects the extent to which a cumulative effect on an environmental or socio-economic 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 receptor or indicator of interest. Most residual effects were assessed qualitatively since the residual effect or indicator to be assessed did not lend itself to a quantitative assessment and given that the Marine RSA is heavily used for marine traffic under current conditions. A quantitative approach using GIS or predictive models (*e.g.,* air emissions analysis) was used to inform the assessment of marine acoustic environment and marine air emissions.

*4.4.1.6 Environmental Protection 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 by 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) (*e.g.*, the use of additional escort tugs for navigational safety in Juan de Fuca Strait).

No additional mitigation measures beyond those listed in Section 5.0 of this marine transportation assessment were deemed warranted.

*4.4.1.7 Determination of Significance*

The overall cumulative effects on an element and the contribution of the effects of the Project-related marine vessel traffic to these cumulative effects (*i.e.,* cumulative effects of the Project) are described for each applicable element or indicator. The significance of the contribution of the effects of the Project-related marine vessel traffic 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 4.3.1 and summarized in Table 4.3.1.2 with the exception of spatial boundaries, which are discussed in Sections 4.3.2 to 4.3.12.

All significance assessment criteria (*e.g.,* temporal context, magnitude, *etc*.) are considered by the assessment team for each cumulative environmental or socio-economic effect.

*4.4.1.8 Cumulative Effects Assessment*

Those environmental and socio-economic effects in which adverse residual effects are predicted and are analyzed in the cumulative effects assessment are:

- physical elements such as marine air emissions and marine acoustic environment;
- biological elements such as marine fish and fish habitat, marine mammals, marine birds and marine species at risk; and
- socio-economic elements such as traditional marine resource use and MCTRU.

The potential and likely residual effects associated with increased Project-related marine vessel traffic on each element are identified in the following subsections along with the identification of existing activities or reasonably foreseeable developments acting in combination with the Project, as well as the cumulative effect.

An evaluation of the significance of the contribution of Project-related marine vessel traffic to cumulative effects was conducted. Details of the significance evaluation are also discussed in each of the following subsections.

### *4.4.2 Marine Air Emissions*

#### *4.4.2.1 Reasonably Foreseeable Developments*

Table 4.4.1.2 summarizes the current level of marine traffic within the Marine RSA as well as the anticipated marine traffic attributed to the Project and other reasonably foreseeable marine traffic. A description of existing and anticipated activities is provided in Section 4.4.1.4.

#### *4.4.2.2 Potential Cumulative Effects*

The potential and likely environmental residual effects associated with the increase in Project-related marine vessel traffic on marine air emission indicators were identified in Section 4.3 and are listed in Table 4.4.2.1 along with the identification of existing activities and reasonably foreseeable marine traffic that could act in combination with the increase in Project-related marine vessel traffic. There is no detailed inventory information available with respect to major foreseeable developments or urban emissions in the Lower Fraser Valley or in marine traffic that would permit a future scenario to be modelled. Therefore, a qualitative assessment was completed.

**TABLE 4.4.2.1**

**POTENTIAL RESIDUAL EFFECTS OF PROJECT-RELATED MARINE TRAFFIC ON AIR EMISSIONS CONSIDERED FOR THE CUMULATIVE EFFECTS ASSESSMENT**

| Potential Residual Project Effect on Indicator | Spatial Boundary[1] | Temporal Boundary | Potential Cumulative Effect | Existing Activities/Reasonably Foreseeable Activities with Residual Effects Acting in Combination with Project-Related Marine Vessel Traffic |
|---|---|---|---|---|
| 1. Combined Project effects on CACs | RSA | Operation | Project contribution to cumulative increase in CAC emissions | • Existing marine traffic<br>• Reasonably foreseeable marine traffic within the RSA listed in Table 4.4.1.2. |
| 2. Combined Project effects on VOCs | RSA | Operation | Project contribution to cumulative increase in VOC emissions | • Existing marine traffic<br>• Reasonably foreseeable marine traffic within the RSA listed in Table 4.4.1.2. |
| 3. Combined Project effect on formation of secondary PM and ozone | LFV | Operation | Project contribution to cumulative increase information of secondary PM and ozone emissions | • Existing marine traffic<br>• Reasonably foreseeable marine traffic within the RSA listed in Table 4.4.1.2. |
| 4. Combined Project effect on visibility | LFV | Operation | Project contribution to cumulative increase in decreased visibility during operations | • Existing marine traffic<br>• Reasonably foreseeable marine traffic within the RSA listed in Table 4.4.1.2. |

**Note:** 1 RSA = Air Quality RSA; LFV = Lower Fraser Valley Photochemical Model Domain

#### *4.4.2.3 Significance Evaluation of Potential Cumulative Effects*

Table 4.4.2.2 provides a summary of the significance evaluation of the contribution of Project-related marine vessel traffic to potential cumulative effects on the air emission indicators. The rationale used to evaluate the significance of each of the cumulative effects is provided below.

**TABLE 4.4.2.2**

**SIGNIFICANCE EVALUATION OF THE CONTRIBUTION OF PROJECT-RELATED MARINE TRAFFIC TO CUMULATIVE EFFECTS ON AIR EMISSIONS**

| Potential Cumulative Effects | | Impact Balance | Spatial Boundary[1] | Temporal Context | | | Magnitude | Probability | Confidence | Significance[2] |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Duration | Frequency | Reversibility | | | | |
| **1** | **Marine Air Emissions Indicator – Primary Emissions of CACs** | | | | | | | | | |
| 1(a) | Project contribution to cumulative increase in CAC emissions | Negative | RSA | Long-term | Periodic | Short-term | Low | High | Moderate | Not significant |
| **2** | **Marine Air Emissions Indicator – Primary Emissions of VOCs** | | | | | | | | | |
| 2(a) | Project contribution to cumulative increase in VOC emissions | Negative | RSA | Long-term | Periodic | Short-term | Low | High | Moderate | Not significant |
| **3** | **Marine Air Emissions Indicator – Formation of Secondary PM and Ozone** | | | | | | | | | |
| 3(a) | Project contribution to cumulative increase in formation of secondary PM and ozone emissions | Negative | LFV | Long-term | Periodic | Short-term | Low | High | Moderate | Not significant |
| **4** | **Marine Air Emissions Indicator – Visibility** | | | | | | | | | |
| 4(a) | Project contribution to cumulative increase in decreased visibility during operations | Negative | LFV | Long-term | Periodic | Short-term | Low | High | Moderate | Not significant |
| **5** | **Combined Cumulative Effects on Marine Air Emissions** | | | | | | | | | |
| 5(a) | Project contribution to combined cumulative effects on marine air emissions indicators (1[a], 2[a], 3[a] and 4[a]) | Negative | LFV | Long-term | Periodic | Short-term | Low | High | Moderate | Not significant |

**Notes:** 1 RSA = Marine Air Quality RSA; LFV = Lower Fraser Valley Photochemical Model Domain

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.

#### 4.4.2.3.1 Air Emissions Indicator – Criteria Air Contaminants

Existing sources of air emissions in the Marine Air Quality RSA include marine vessels emissions arising from shipping, cruise ships, tankers, cargo ships, tugs, container ships, and smaller recreational and commercial boats.

The Project will act in combination with existing activities and reasonably foreseeable developments in the Marine Air Quality RSA to increase shipping-related air emissions. Trans Mountain has limited ability to influence third party vessel owners and operators. On March 26, 2010, the IMO officially designated the North American ECA.

For this area, all vessels within 200 nautical miles of the coast must burn low-sulphur fuel or achieve an equivalent emission reduction with exhaust gas after-treatment or other methods as follows:

- starting August 2012, the maximum fuel sulphur limit was 1 per cent;
- beginning January 2015, the maximum sulphur limit will be lowered to 0.1 per cent; and
- beginning in 2016, $NO_x$ after-treatment emission control requirements become applicable for newly manufactured engines.

Port Metro Vancouver has joined the Northwest Ports Clean Air Strategy (formed in 2007) with the Ports of Seattle and Tacoma, and identified measures to reduce landside and marine air emissions (PMV 2013). Specifically to reduce marine emissions by year 2010, all ocean-going vessels should use distillate fuels with <0.5 per cent sulphur in their auxiliary engines during hoteling (at anchor) and <1.5 per cent sulphur in distillate fuel or equivalent particulate matter reduction measures for the main engines or diesel electric engines, when hoteling. In 2012, 40 per cent of the ocean-going vessels visiting PMV were complying with the IMO target. No PMV performance results were reported for the $NO_x$ reduction measures; however, IMO Tier III marine engine requirements for new ships with engines over 130 kW output power must not exceed 3.4 g/kWh, which is an 80 per cent reduction relative to Tier I marine engines built after year 2000.

For reasons described more fully in Section 4.4.1.4, the Project is unlikely to act in combination with most reasonably foreseeable marine vessel traffic 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 of emissions from the increase in Project-related marine vessel traffic.

Project contribution to a cumulative increase in CAC emissions from combustion of distillate fuels in the main and auxiliary engines within the Marine Air Quality RSA during normal operations activities is considered to have a negative impact balance, is reversible immediately and of low magnitude (Table 4.4.2.2 point 1[a]). A summary of the rationale for all of the significance criteria of combined cumulative effects on increased VOC emissions is provided below.

- **Spatial Boundary** - Marine Air Quality RSA – Project contribution to cumulative increases in CAC emissions from the tanker engines would dissipate within the Air Quality RSA.
- **Duration** - long-term – emissions of CACs and subsequent changes to ambient ground-level concentrations are expected to occur for the life of the Project, and are thereforerated as long-term.
- **Frequency** - periodic – emissions of CACs will occur upon vessels transiting through the Marine Air Quality RSA, which is expected to occur intermittently and repeatedly with one to two vessels per day.
- **Reversibility** - long-term – Project contribution to cumulative effects will reverse shortly after shipping activities stop; however, Project life is more than 10 years.

- **Magnitude** - low – Project contribution to an increase in CAC emissions is expected to be low.
- **Probability** - high – Project emissions and those from other marine vessel traffic will occur on an ongoing basis.
- **Confidence** - moderate – residual effects assessment is based on a good understanding of cause-effect relationships between the Project and air emissions; however, vessel-specific data are limited.

#### 4.4.2.3.2 Air Emissions Indicator –Volatile Organic Compounds

Project contribution to a cumulative increase in VOC emissions from combustion of distillate fuels in the main and auxiliary engines and fugitive emissions from the tanker hold within the Marine Air Quality RSA during normal operations activities is considered to have a negative impact balance, is reversible in the long term and of low magnitude (Table 4.4.2.2 point 2[a]). A summary of the rationale for all of the significance criteria of the Project contribution to cumulative effects on increased VOC emissions is provided below.

- **Spatial Boundary** - Marine Air Quality RSA – Project contribution to cumulative increases in VOC emissions from the tanker engines and fugitives from the tanker hold would dissipate within the Air Quality RSA.
- **Duration** - long-term – emissions of VOCs and subsequent changes to ambient ground-level concentrations are expected to occur for the life of the Project, and therefore are rated as long-term.
- **Frequency** - periodic – emissions of CACs will occur upon vessels transiting through the Marine Air Quality RSA, which is expected to occur intermittently and repeatedly with one to two vessels per day.
- **Reversibility** - long-term - Project contribution to cumulative effects will reverse shortly after shipping activities stop; however, Project life is more than 10 years.
- **Magnitude** - low – Project contribution to an increase in VOC emissions is expected to be low.
- **Probability** - high – Project emissions and those from other marine vessel traffic will occur on an ongoing basis.
- **Confidence** - moderate – residual effects assessment is based on a good understanding of cause-effect relationships between the Project and air emissions; however, vessel-specific data are limited.

#### 4.4.2.3.3 Air Emissions Indicator – Formation of Secondary PM and Ozone

The Project's contribution to an increase in ambient ground-level concentrations of secondary PM and ozone is considered to have a negative impact balance. As shown in Table 4.4.2.2 point 3(a), the increase in ambient ground-level concentrations of secondary PM and ozone is confined to the photochemical model domain or LFV. Some of the Project's 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 long-term in duration, reversible in the long-term and the magnitude is expected to be low. The probability of this occurring is high, and confidence in the residual effects assessment is moderate. 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 PM 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 PM and ozone are expected to occur for the life of the Project and are therefore rated as long-term.
- **Frequency** - periodic – formation of secondary PM and ozone would result from intermittent but repeated release of pre-cursor emissions.
- **Reversibility** - long-term - Project contribution to cumulative effects will reverse shortly after shipping activities stop; however, Project life is more than 10 years.
- **Magnitude** - low – the increase in ambient ground-level concentrations of secondary PM and ozone is expected to be small relative to existing concentrations and regulatory limits; therefore, the magnitude of effect is rated as low.
- **Probability** - high – an increase in Project-related marine vessel traffic will result in pre-cursor emissions, which will react to form secondary PM and ozone.
- **Confidence**: - moderate – residual effects assessment is based on a good understanding of cause-effect relationships between Project pre-cursor emissions and resultant ambient PM and ozone concentrations via atmospheric reactions; however, vessel-specific data are limited.

#### 4.4.2.3.4 Air Emissions Indicator –Visibility

Reduced visibility is considered to have a negative impact balance. As shown in Table 4.4.2.2 point 4(a), the increase in reduced visibility is confined to the LFV. Some of the Project's marine emissions will contribute chemical pre-cursors that could lead to the periodic formation of aerosols when tanker traffic travels through the Marine Air Quality RSA. The change will be long-term in duration, reversible in the long term, and the magnitude is expected to be low. The probability of this occurring is high and confidence in the residual effects assessment is moderate. As shown in Table 4.3.3.3 point 4(a), the reduced visibility is confined to the LFV. A summary of the rationale for all of the significance criteria is provided below.

- **Spatial Boundary** - LFV – changes to visibility are expected to occur within the LFV.
- **Duration** - long-term – emissions of pre-cursors causing light absorption are expected to occur for the life of the Project, and therefore, the duration of effect is rated as being long-term.
- **Frequency** - periodic – light absorption and reduced visibility due to intermittent release of pre-cursor emissions will occur intermittently and repeatedly.

- **Reversibility** - long-term - emissions of pre-cursors will cease and any increases in ambient ground-level concentrations of secondary PM and ozone will reverse shortly after tankers exit the Marine Air Quality RSA but emissions are expected to occur in the Marine Air Quality RSA for the life of the Project which is more than 10 years.
- **Magnitude** - low – the change in light extinction and visibility is expected to be small relative to existing conditions, and in the absence of regulatory limits, the magnitude of effect is rated as being low.
- **Probability** - high – an increase in Project-related marine vessel traffic will result in an increase of pre-cursor emissions and secondary species, which will scatter light and reduce visibility.
- **Confidence** - moderate – residual effects assessment is based on a good understanding of cause-effect relationships between Project pre-cursor emissions and light absorption; however, vessel-specific data are limited.

#### 4.4.2.3.5 Combined Cumulative Effects on Air Emissions

The Project will contribute to an increase in air emissions in the Marine Air Quality RSA along the shipping lanes in combination with existing vessels and the projected increase in marine traffic. Project contribution to a cumulative increase in emissions and decrease in visibility within the Marine Air Quality RSA and LFV is considered to have a negative impact balance, is reversible in the long term, and of low magnitude (Table 4.4.3, point 5[a]). A summary of the rationale for all of the significance criteria of the Project contribution to combined cumulative effects on marine air emissions is provided below.

- **Spatial Boundary** - Marine Air Quality RSA (or LFV) – Project contribution to combined cumulative effects from marine air emissions would dissipate within the Marine Air Quality RSA or LFV (for secondary formation products).
- **Duration** - long-term – the events causing Project contribution to combined cumulative effects from marine air emissions are from normal operations.
- **Frequency** - periodic – the events causing Project contribution to cumulative increases in air emissions will occur intermittently and repeatedly over the assessment period.
- **Reversibility** - long-term - Project contribution to cumulative effects will reverse shortly after shipping activities stop; however, Project life is more than 10 years.
- **Magnitude** - low – Project contribution to cumulative effects from marine air emissions is expected to be low.
- **Probability** - high – Project emissions and those from other marine vessel traffic will occur on an ongoing basis.
- **Confidence** - moderate – cumulative effects assessment is based on a good understanding of cause-effect relationships between the Project and air emissions; however, vessel-specific data are limited.

#### 4.4.2.4 Potential US Effects

Project effects on air emissions in US waters are expected to be similar to Canadian waters. The same vessels will travel through both Canadian and US waters and will emit the same emissions along the shipping lanes. Residual effects on land (*i.e.,* the Olympic Peninsula) may be similar to residual effects at the coastline along shipping lanes in Canadian waters. The dispersion climate and important factors such as wind direction will materially affect the extent and magnitude of the predicted impacts and effects.

#### 4.4.2.5 Summary

As identified in Table 4.4.2.2, 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 Marine Air Quality RSA will be not significant.

### 4.4.3 Marine Acoustic Environment

#### 4.4.3.1 Reasonably Foreseeable Developments

Table 4.4.1.2 summarizes the current level of marine traffic within the Marine RSA as well as the anticipated marine traffic attributed to the Project and other reasonably foreseeable marine traffic. A description of existing and anticipated activities is provided in Section 4.4.1.4.

#### 4.4.3.2 Potential Cumulative Effects

The potential and likely environmental residual effects associated with increased Project-related marine vessel traffic on the marine acoustic environment indicator were identified in Section 4.3.5 and are listed in Table 4.4.3.1 along with the associated existing and reasonably foreseeable regional marine traffic that could act in combination with the effects of increased Project-related marine vessel traffic to cause a cumulative effect on the marine acoustic environment.

**TABLE 4.4.3.1**

**POTENTIAL RESIDUAL EFFECTS OF PROJECT-RELATED MARINE TRAFFIC ON MARINE ACOUSTIC ENVIRONMENT CONSIDERED FOR THE CUMULATIVE EFFECTS ASSESSMENT**

| Potential Residual Effect on Marine Acoustic Environment Indicator | Spatial Boundary[1] | Temporal Boundary | Potential Cumulative Effect | Existing Activities/Reasonably Foreseeable Activities with Residual Effects Acting in Combination with Project-Related Marine Vessel Traffic |
|---|---|---|---|---|
| 1. Combined Project effects on atmospheric sound levels. | RSA | Operations | Project contribution to cumulative atmospheric sound levels. | • Existing marine vessel traffic within the Marine RSA (Table 4.4.1.2).<br>• Reasonably foreseeable marine vessel traffic within the Marine RSA (Table 4.4.1.2). |

**Note:** 1 RSA = Marine RSA.

#### 4.4.3.3 Significance Evaluation of Potential Cumulative Effects

Table 4.4.3.2 provides a summary of the significance evaluation of the contribution of the effects of Project-related marine vessel traffic to potential cumulative effects on the marine acoustic environment indicator. The rationale used to evaluate the significance of each of the cumulative effects is provided below.

**TABLE 4.4.3.2**

**SIGNIFICANCE EVALUATION OF THE CONTRIBUTION OF PROJECT-RELATED MARINE TRAFFIC TO CUMULATIVE EFFECTS ON MARINE ACOUSTIC ENVIRONMENT**

| Potential Cumulative Effects | | Impact Balance | Spatial Boundary[1] | Temporal Context | | | Magnitude | Probability | Confidence | Significance[2] |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Duration | Frequency | Reversibility | | | | |
| **1.** | **Marine Acoustic Environment Indicator – Atmospheric Sound Levels** | | | | | | | | | |
| 1(a) | Project contribution to cumulative atmospheric sound levels. | Negative | RSA | Long-term | Periodic | Immediate | Low to medium | High | Moderate | Not significant |
| **2.** | **Combined Cumulative Effects on Marine Acoustic Environment** | | | | | | | | | |
| 2(a) | Project contribution to combined cumulative effects on marine acoustic environment indicator (1[a]). | Negative | RSA | Long-term | Periodic | Immediate | Low to medium | High | Moderate | 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.

### 4.4.3.3.1 Marine Acoustic Environment Indicator – Atmospheric Sound Levels

The primary effect evaluated in Section 4.3.5.6 was the potential change in day/night atmospheric sound levels due to increased vessel traffic in the shipping lanes. Individual noise events from shipping would increase due to the tankers and associated tugs, resulting in increased average sound levels over the time periods indicated. The analysis was based on pass-by events, where a combination of tanker and tugs was taken as a single event or 'trip'.

Projected future traffic summarized in Table 4.4.1.2 lists the total numbers for vessel movements based on the number of individual ships. As the marine acoustic environment assessment uses the number of events, not the number of individual vessels as the basis for the analysis, the cumulative effect of changes to atmospheric sound levels from future vessel traffic can be discussed by looking at the relative changes that may occur.

Increased Project-related marine vessel traffic day/night sound levels were estimated to increase by between 0 to 1 dBA and singular sound level events could increase sufficiently in Burrard Inlet to be noticeable, resulting in a combined magnitude rating of low to medium for the effects on existing sound levels. Table 4.4.1.1 indicates there is approximately a 20 per cent increase of non-Project related vessel movements along the shipping lanes in the absence of the Project. Atmospheric sound from singular sound level events from other future vessel traffic (*i.e.*, the 2030 case not including Project-related traffic) may change within a day or night period when Project-related marine vessels are active, proportionally to the amount of increased traffic. When combined with Project-related marine traffic, the total increase in vessel traffic is not expected to result in substantially different sound levels as demonstrated in Table 4.3.5.4 of Section 4.3.5. Therefore, the magnitude of the Project's contribution to cumulative effects on atmospheric sound levels is expected to be low to medium (Table 4.4.3.2, point 1[a]), consistent with the results of Section 4.3.5.

A summary of the rationale for all of the significance criteria is provided below.

- **Spatial Boundary** - Marine RSA – the Project's contribution to cumulative effects is assessed within the regional context of the Marine RSA.
- **Duration** - long-term – the sound emissions and singular sound level events from Project-related marine vessels contributing to cumulative effects on sound levels will occur for the duration of operation of the Project-related marine vessel traffic.
- **Frequency** - periodic – sound level increases from Project-related marine vessel pass-bys, anchors or horns contributing to cumulative effects on sound levels will occur intermittently but repeatedly over the duration of operation of the Project-related marine vessel traffic.
- **Reversibility** - immediate – day/night noise levels return to ambient shortly after pass-bys of Project-related marine vessels.
- **Magnitude** - low to medium – the Project's contribution to cumulative effects on atmospheric sound levels from Project vessel pass-bys are expected to be detectable but remain within the BC OGC Guideline PSL values. When combined with future marine traffic, the total increase in vessel traffic is not expected to result in substantially different sound levels.
- **Probability** - high – the Project and other future vessels will generate sound and more vessel passages will occur.
- **Confidence** - moderate – the confidence in the evaluation of the combined cumulative effects is based on data relevant to the Project area as well as good understanding of noise propagation.

#### 4.4.3.3.2 Combined Cumulative Effects on Marine Acoustic Environment

Atmospheric sound levels are the only marine acoustic environment indicator likely to be affected by increased Project-related vessel traffic, therefore, combined cumulative effects on marine acoustic environment are the same as cumulative effects on atmospheric sound levels (see subsection above and Table 4.4.3.2, point 2[a]).

### *4.4.3.4 Potential United States Effects*

The Project's contribution to cumulative sound levels in US waters, specifically the various shoreline areas in US waters are expected to be similar to those in Canadian waters at the same distances from the shipping lanes. No differences in acoustic environment conditions in the US and Canadian portions of the Marine RSA were identified that would change the nature of the cumulative effects assessment.

### *4.4.3.5 Summary*

As identified in Table 4.4.3.2, 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, it is concluded that the Project's contribution to cumulative effects on the acoustic environment within the Marine RSA will be not significant.

### 4.4.4 Marine Fish and Fish Habitat

#### 4.4.4.1 Reasonably Foreseeable Developments

Table 4.4.1.2 summarizes the current level of marine traffic within the Marine RSA as well as the anticipated marine traffic attributed to the Project and other reasonably foreseeable marine traffic. A description of existing and anticipated activities is provided in Section 4.4.1.4.

#### 4.4.4.2 Potential Cumulative Effects

The potential and likely environmental residual effects associated with increased Project-related marine vessel traffic on marine fish and fish habitat indicators were identified in Section 4.3.6 and are listed in Table 4.4.4.1 along with the associated existing and reasonably foreseeable regional marine traffic that could act in combination with the effects of increased Project-related marine vessel traffic to cause a cumulative effect on marine fish and fish habitat. Residual effects on the Pacific salmon and Pacific herring indicators (*i.e.*, injury or mortality due to vessel wake) are considered unlikely (see Section 4.3.6) and are, therefore, not considered in the context of cumulative effects.

**TABLE 4.4.4.1**

**POTENTIAL RESIDUAL EFFECTS OF PROJECT-RELATED MARINE TRAFFIC ON MARINE FISH AND FISH HABITAT CONSIDERED FOR THE CUMULATIVE EFFECTS ASSESSMENT**

| Potential Residual Effect on Marine Fish and Fish Habitat Indicator | Spatial Boundary[1] | Temporal Boundary | Potential Cumulative Effect | Existing Activities/Reasonably Foreseeable Activities with Residual Effects Acting in Combination with Project-Related Marine Vessel Traffic |
|---|---|---|---|---|
| 1. Combined Project effects on intertidal habitat. | RSA | Operations | Project contribution to cumulative disturbance to intertidal habitat. | • Existing marine vessel traffic within the Marine RSA (Table 4.4.1.2).<br>• Reasonably foreseeable marine vessel traffic within the Marine RSA (Table 4.4.1.2). |

**Note:** 1 RSA = Marine RSA

#### 4.4.4.3 Significance Evaluation of Potential Cumulative Effects

Table 4.4.4.2 provides a summary of the significance evaluation of the contribution of the effects of Project-related marine vessel traffic to potential cumulative effects on the marine fish and fish habitat indicator. The rationale used to evaluate the significance of each of the cumulative effects is provided below.

**TABLE 4.4.4.2**

**SIGNIFICANCE EVALUATION OF THE CONTRIBUTION OF PROJECT-RELATED MARINE TRAFFIC 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 disturbance to intertidal habitat. | Negative | RSA | Long-term | Periodic | Immediate | Low | High | High | Not significant |
| **2.** | **Combined Cumulative Effects on Marine Fish and Fish Habitat** | | | | | | | | | |
| 2(a) | Project contribution to combined cumulative effects on marine fish and fish habitat indicator (1[a]). | Negative | RSA | Long-term | Periodic | Immediate | 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.

#### 4.4.4.3.1 Marine Fish and Fish Habitat Indicator – Intertidal Habitat

Intertidal habitats within the Marine RSA are constantly exposed to natural wind-generated waves. In general, wave heights are greater during the winter months when storm events are more frequent and at locations with greater fetch (*i.e.*, distance to nearest landmass). Local landscape and seascape features such as headlands, embayments, bathymetric contours, shoreline slope, intertidal and subtidal substrates, and currents also influence site-specific wave heights. Although there is limited data available on wave heights within the Marine RSA, regional buoy data indicates that average significant wave heights range from as low as 0.06 m in Saanich Inlet (Patricia Bay buoy) to as high as 2.66 m on the west coast of Vancouver Island (La Perouse Bank buoy; DFO 2013a).

Due to the large number of vessels that transit the shipping lanes and adjacent waters, intertidal habitats throughout the Marine RSA are routinely exposed to wake waves generated by passing vessels. The height of a wake wave at the shoreline depends on a number of factors, including vessel size, vessel speed, hull shape, vessel distance from shore, bathymetry, shoreline slope, and shoreline substrate. In general, large vessels traveling at high speeds produce the largest wake waves; however, smaller vessels such as pleasure craft often travel at high speeds close to shore and are capable of producing larger waves that interact with intertidal habitats.

Due to the average channel width of 22 to 28 km in the Strait of Georgia and Juan de Fuca Strait (Thompson 1981) and the relatively rapid rate at which wake waves decrease in height away from transiting Project-related tankers and tugs, wakes are not expected to be detectable from existing wave conditions along most of the shoreline in the Marine RSA. In Burrard Inlet, Haro Strait and near the southern end of Vancouver Island where the shipping lanes pass within 2 km of land, wake waves from Project-related vessels are predicted to be less than 0.1 m in height at the shoreline (see Section 4.3.6.5). In these areas, wake waves from existing vessel traffic, Project-related vessel traffic, and reasonably foreseeable future vessel traffic may act cumulatively to affect intertidal habitats. In 2012, approximately 6,900 vessel movements were recorded in Burrard Inlet and 8,900 movements were recorded in Haro Strait (Table 4.4.1.2).

If approved, the Project would add up to approximately 2,880 vessel movements in Burrard Inlet and 1,440 movements in Haro Strait, which would represent 29.6 per cent and 13.9 per cent of the total traffic in these areas (Table 4.4.1.2). Based on the anticipated growth rates presented in Table 4.4.1.2, the total number of annual vessel movements in Burrard Inlet and Haro Strait are predicted to increase by approximately 1,401 and 1,777, respectively, by the year 2030. The Project's contribution to total vessel traffic would then be 25.9 per cent in Burrard Inlet and 11.9 per cent in Haro Strait (Table 4.4.1.2).

Wake waves have the potential to disturb intertidal habitats, primarily through the erosion of fine-grained sediments. Large waves can also dislodge sessile marine organisms (*e.g.*, algae and invertebrates), leading to reduced habitat complexity and productivity. These effects are more likely to occur in soft-sediment habitats that are sheltered from wind-driven waves. As discussed in Section 4.3.6.5, most shoreline habitats within the Marine RSA are dominated by rocky substrates. These habitats are routinely exposed to natural waves that can be considerably larger than wake waves produced by passing vessels. As a result, marine organisms inhabiting the intertidal zone are adapted to the physical forces imparted by incoming waves, and are unlikely to be affected by wake waves that are within the range of natural wave heights. Although the heights of wake waves from existing vessel traffic and reasonably foreseeable future vessel traffic have not been calculated, it is expected that other large, deep draft vessels transiting the shipping lanes will produce similar wake waves. Smaller, faster vessels such as recreational fishing boats and pleasure craft may produce larger wake waves, but these would still be within the range of natural wave heights.

While the combination of existing vessel traffic, Project-related vessel traffic and reasonably foreseeable vessel traffic will increase the frequency of wake waves interacting with the shoreline, wake heights are predicted to be within the range of natural wave conditions and are unlikely to result in any measurable changes to the biophysical characteristics of intertidal habitats. With one inbound and one outbound transit per day, the Project's contribution to the cumulative effect will be periodic over the life of the Project. Wake waves from Project-related vessels will be detectable at the shoreline for only several minutes per day, and any temporary disturbance to intertidal habitats (*e.g.*, localized re-suspension of sediment) will be reversible within minutes following the passing of the vessel. Considering the large number of vessels that currently transit the shipping lanes and adjacent waters, the Project's contribution to the cumulative effect of disturbance to intertidal habitats is predicted to be of low magnitude (Table 4.4.4.2, point 1[a]). A summary of the rationale for all of the significance criteria is provided below.

- **Spatial Boundary** - Marine RSA – the Project's contribution to potential cumulative effects on intertidal habitat could extend to the Marine RSA.
- **Duration** - long-term – wake waves from Project-related vessels will occur throughout the operations phase.
- **Frequency** - periodic – on average, wake waves from Project-related vessels will be generated twice per day during one inbound and one outbound transit.
- **Reversibility** - immediate – the temporary disturbance of intertidal habitats by vessel wake will not be detectable within minutes following each passing vessel.

- **Magnitude** - low – while Project-related vessel traffic will account for an estimated 25.9 per cent and 11.9 per cent of total vessel traffic in Burrard Inlet and Haro Strait by 2030, the predicted wake wave heights are well within the range of natural wave conditions and are not expected to result in measurable changes to the biophysical characteristics of intertidal habitats.
- **Probability** - high – vessel wake from Project-related vessels will be detectable along shorelines within the Marine RSA and will act cumulatively with wake waves from existing and future vessel traffic.
- **Confidence** - high – based on a good understanding of the wave heights generated by Project-related vessels, a reasonable understanding of the natural wave conditions within the Marine RSA, a good understanding of the shoreline types within the Marine RSA, and a good understanding of the sensitivity of intertidal biota to wave exposure.

#### 4.4.4.3.2 Combined Cumulative Effects on Marine Fish and Fish Habitat

Intertidal habitat is the only marine fish and fish habitat indicator likely to be affected by increased Project-related vessel traffic, therefore, combined cumulative effects on marine fish and fish habitat are the same as cumulative effects on intertidal habitat (see subsection above and Table 4.4.4.2, point 2[a]).

#### *4.4.4.4 Potential United States Effects*

Cumulative effects of vessel wake on intertidal habitats in US waters are expected to be very similar to those described for Canadian waters. In the US, only about 10 km of shoreline falls within 2 km of the shipping lanes (the area within which wake waves from Project-related vessels are expected to be detectable), and this area is limited to the west side of the San Juan Islands in Haro Strait. Shoreline habitat types and natural wave conditions are very similar on the east and west sides of Haro Strait and all vessels transiting this area will generate wake waves that interact with Canadian and US intertidal habitats in a similar fashion. Therefore, the significance evaluation for cumulative disturbance to intertidal habitats due to vessel wake (Table 4.4.4.2) applies to both Canadian and US waters.

#### *4.4.4.5 Summary*

As identified in Table 4.4.4.2, 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, it is concluded that the Project's contribution to cumulative effects on marine fish and fish habitat within the Marine RSA will be not significant.

### *4.4.5 Marine Mammals*

#### *4.4.5.1 Reasonably Foreseeable Developments*

Table 4.4.1.2 summarizes the current level of marine traffic within the Marine RSA as well as the anticipated marine traffic attributed to the Project and other reasonably foreseeable marine traffic. A description of existing and anticipated activities is provided in Section 4.4.1.4.

#### *4.4.5.2 Potential Cumulative Effects*

The potential and likely environmental residual effects associated with increased Project-related marine vessel traffic on marine mammals are identified for each indicator in Section 4.3.7. The assessed combined effect of those potential residual effects on each of the marine mammal indicators is listed in Table 4.4.5.1 along with the associated existing and reasonably foreseeable regional marine traffic that could act in combination with the effects of increased Project-related marine vessel traffic to cause a cumulative effect on marine mammals.

**TABLE 4.4.5.1**

**POTENTIAL RESIDUAL EFFECTS OF PROJECT-RELATED MARINE TRAFFIC ON MARINE MAMMALS CONSIDERED FOR THE CUMULATIVE EFFECTS ASSESSMENT**

| Potential Residual Effect on Marine Mammal Indicator | Spatial Boundary[1] | Temporal Boundary | Potential Cumulative Effect | Existing Activities/Reasonably Foreseeable Activities with Residual Effects Acting in Combination with Project-Related Marine Vessel Traffic |
|---|---|---|---|---|
| 1. Combined Project effects on southern resident killer whale. | RSA | Operations | Project contribution to cumulative increase in sensory disturbance due to underwater noise. | • Existing marine vessel traffic within the Marine RSA (Table 4.4.1.2).<br>• Reasonably foreseeable marine vessel traffic within the Marine RSA (Table 4.4.1.2). |
| 2. Combined Project effects on humpback whale. | RSA | Operations | Project contribution to cumulative increase in sensory disturbance due to underwater noise. | • Existing marine vessel traffic within the Marine RSA (Table 4.4.1.2).<br>• Reasonably foreseeable marine vessel traffic within the Marine RSA (Table 4.4.1.2). |
| 3. Combined Project effects on Steller sea lion. | RSA | Operations | Project contribution to cumulative increase in sensory disturbance due to underwater noise. | • Existing marine vessel traffic within the Marine RSA (Table 4.4.1.2).<br>• Reasonably foreseeable marine vessel traffic within the Marine RSA (Table 4.4.1.2). |

**Note:** 1 RSA = Marine RSA.

Marine mammals may be affected by increased sensory disturbance due to the cumulative effects of underwater noise from existing marine vessel traffic acting in combination with noise from the increase in Project-related and reasonably foreseeable marine vessel traffic within the Marine RSA. Residual effects associated with permanent or temporary auditory injury (PTS or TTS) due to underwater noise from marine vessel traffic are considered unlikely (see Section 4.3.7). Cumulative broadband SELs associated with Project-related vessels are not predicted to exceed the Southall *et al.* (2007) PTS-onset thresholds for pinnipeds or cetaceans (*i.e.,* 203 and 215 dB re: 1 $\mu Pa^2$-s, respectively) under any of the four modelled scenarios (*i.e.*, Strait of Georgia, Haro Strait, Juan de Fuca Strait and North of Cape Flattery) (see Appendix A of the Marine Resources – Marine Transportation Technical Report (Volume 8B, TR 8B-1). For TTS, cumulative SELs are only predicted to exceed the Southall *et al.* thresholds at distances of less than 30 and 15 m from the vessel's propeller (*i.e.,* for pinnipeds and cetaceans, respectively; see Table 4.3.7.7). Threshold values for continuous noises capable of causing PTS or TTS are not addressed by the NOAA criteria (NOAA Fisheries 2013).

Although the SPLs and cumulative broadband SELs from existing and reasonably foreseeable future vessel traffic are not known, it is generally expected that other large, deep draft vessels transiting the shipping lanes will produce similar sound levels to Project-related vessels. Smaller, faster vessels such as recreational fishing boats and pleasure craft will also contribute to underwater noise, and noise from all vessels may act additively to increase overall underwater ambient sound levels in the marine environment. However, based on acoustic modelling done for the Project, SPLs higher than 130 dB re: 1 μPa are expected to attenuate quickly with distance from the vessels (see Table 8 in Appendix A of the Marine Resources – Marine Transportation Technical Report (Volume 8B, TR 8B-1). It is unlikely that the potential interaction of existing, Project-related, and reasonably foreseeable future vessel traffic noise (*i.e.,* during close vessel passes) will lead to underwater sound levels capable of causing PTS or TTS for distances that exceed much beyond (if at all) those predicted for residual effects (*i.e.,* within 30 m of the tug or tanker propellers). As noted for residual effects, it is also unlikely that a marine mammal would approach this close to the vessels' operating propellers, and exposure to cumulative SELs capable of causing PTT or TTS is considered similarly unlikely.

Based on the above, no permanent or temporary auditory injury to marine mammals is expected as the result of the combination of underwater noise from existing vessel traffic and the increase in Project-related and reasonably foreseeable vessel traffic. The potential for PTS and TTS is, therefore, not considered further in the context of cumulative effects. The assessed combined Project residual effects on the marine mammals indicators listed in Table 4.4.5.1; therefore include only the potential for cumulative effects of sensory disturbance due to underwater noise.

#### *4.4.5.3 Significance Evaluation of Potential Cumulative Effects*

Table 4.4.5.2 provides a summary of the significance evaluation of the contribution of Project-related marine vessel traffic to potential cumulative effects on the marine mammals indicators. The rationale used to evaluate the significance of each of the cumulative effects is provided below. The assessment follows a qualitative approach (*i.e.,* based primarily on professional judgment) due to a lack of quantitative measures of underwater noise levels associated with existing and reasonably foreseeable marine vessel traffic in the Marine RSA and current levels of sensory disturbance to marine mammal species within the Marine RSA.

**TABLE 4.4.5.2**

**SIGNIFICANCE EVALUATION OF THE CONTRIBUTION OF PROJECT-RELATED MARINE TRAFFIC TO CUMULATIVE EFFECTS ON MARINE MAMMALS**

| Potential Cumulative Effects | Impact Balance | Spatial Boundary[1] | Temporal Context | | | Magnitude | Probability | Confidence | Significance[2] |
|---|---|---|---|---|---|---|---|---|---|
| | | | Duration | Frequency | Reversibility | | | | |
| **1. Marine Mammals Indicator – Southern Resident Killer Whale** | | | | | | | | | |
| 1(a) Project contribution to cumulative increase in sensory disturbance due to underwater noise. | Negative | RSA | Long-term | Periodic | Immediate | High | High | Low | Significant[3] |
| **2. Marine Mammals Indicator – Humpback Whale** | | | | | | | | | |
| 2(a) Project contribution to cumulative increase in sensory disturbance due to underwater noise. | Negative | RSA | Long-term | Periodic | Immediate | Medium | High | Low | Not Significant |

**TABLE 4.4.5.2**

**SIGNIFICANCE EVALUATION OF THE CONTRIBUTION OF PROJECT-RELATED MARINE TRAFFIC TO CUMULATIVE EFFECTS ON MARINE MAMMALS (continued)**

| Potential Cumulative Effects | Impact Balance | Spatial Boundary[1] | Temporal Context | | | Magnitude | Probability | Confidence | Significance[2] |
|---|---|---|---|---|---|---|---|---|---|
| | | | Duration | Frequency | Reversibility | | | | |
| **3. Marine Mammals Indicator – Steller Sea Lion** | | | | | | | | | |
| 3(a) Project contribution to cumulative increase in sensory disturbance due to underwater noise. | Negative | RSA | Long-term | Periodic | Immediate | Low | High | High | Not Significant |
| **4. Combined Cumulative Effects on Marine Mammals** | | | | | | | | | |
| 4(a) Project contribution to combined cumulative effects on marine mammals indicators (1[a], 2[a] and 3[a]). | Negative | RSA | Long-term | Periodic | Immediate | High | High | Low | Not Significant to 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.

3 Refer to the discussion on Southern Resident Killer Whales below for the rationale for the evaluation.

The Project's contribution to cumulative effects of underwater noise is considered in the context of the contribution of existing marine transportation activities and reasonably foreseeable projects to overall ambient underwater noise levels in the Marine RSA. The potential for increase in underwater ambient noise levels and sensory disturbance from overall growth in marine traffic (including effects from Project-related and reasonably foreseeable future vessels) is much greater in Burrard Inlet compared to other areas of the shipping lanes. By the year 2030 and accounting for projected future growth (Table 4.4.1.2), the Project contribution to total vessel traffic would be 25.9 per cent in Burrard Inlet, 8.9 per cent in English Bay, 6.4 per cent in the Strait of Georgia, 11.9 per cent in Haro Strait, and 6.1 per cent in Juan de Fuca Strait (Table 4.4.1.2). These numbers account for Project contribution to tug and tanker traffic.

### 4.4.5.3.1 Marine Mammals Indicator – Southern Resident Killer Whale

The following subsection provides the evaluation of significance of the potential cumulative effect and Project contribution to cumulative effect on the southern resident killer whale indicator.

**Sensory Disturbance of Southern Resident Killer Whales Due to Underwater Noise Resulting from the Cumulative Effects of Existing Marine Vessel Traffic and the Increase in Project-Related and Reasonably Foreseeable Marine Vessel Traffic**

As discussed in the assessment of residual effects (see Section 4.3.7.6), based on available scientific knowledge, it is concluded that past and current activities (including all forms of mortality, high contaminant loads, reduced prey, and sensory and physical disturbance) have resulted in significant adverse cumulative effects to the southern resident killer whale population. The recent historical decline of the southern resident killer whale population and its current status (*i.e.,* Endangered) support this conclusion. However, given the current state of knowledge, and the ability of threats to interact with one another, it is not possible to completely partition how each threat may be affecting the population.

While the Endangered status of southern resident killer whales is assumed to represent a currently-existing significant adverse cumulative effect, there are currently no quantitative Canadian thresholds with respect to assessing sensory disturbance for marine mammals associated with underwater noise, nor are there recommended Canadian standards or guidelines with respect to what would be appropriate ambient SPLs or SELs for southern resident killer whale critical habitat. Trans Mountain has little direct control over the operating practices of the tankers or tugs, as Project-related vessels are owned and operated by a third party. Operation of Project-related vessels and other marine traffic in Canadian waters is authorized and regulated through the *Canada Shipping Act, 2001* and related legislation, and regulations are administered by Transport Canada and the CCG. Despite operating legally, the Project will contribute additional underwater noise that could affect the southern resident killer whale population and this noise will act cumulatively with noise from existing and reasonably foreseeable marine vessel traffic. As such, even though the Project contribution to overall underwater noise represents only one component of current and future marine transportation sources for underwater noise, the Project's contribution to potential cumulative effects of sensory disturbance is determined to be significant for southern resident killer whales.

A summary of the rationale for all of the significance criteria is provided below (Table 4.4.5.2, point 1[a]).

- **Spatial Boundary** - Marine RSA – the Project's contribution to cumulative increase in sensory disturbance due to underwater noise on southern resident killer whales will be concentrated along the shipping lanes in the Marine RSA and will decrease with distance from the sound source (*i.e.*, tankers and tugs).
- **Duration** - long-term – the Project's contribution to increased tanker transits and the associated production of underwater noise along the shipping lanes will be initiated during the operations phase and will extend for the life of the Project.
- **Frequency** - periodic – Project-related marine vessel traffic will increase by approximately 30 Aframax tanker calls to the Westridge Marine Terminal per month (*i.e.,* an additional 720 tanker transits each year). It will take Project-related vessels approximately 12 hours to complete one transit of the Marine RSA, and on average, there will be two transits every 24 hours. Southern resident killer whale exposure to Project-related vessels will likely be limited to a maximum of two exposures per transit per day (*i.e.,* periodic).
- **Reversibility** - immediate – the Project's contribution to underwater noise in the Marine RSA will exceed NOAA thresholds for sensory disturbance at any given location for approximately half an hour per transit, and any temporary disturbance to individual southern resident killer whales at this location will likely be reversible shortly thereafter (*i.e.,* in less than 2 days).
- **Magnitude** - high – the Project's contribution to underwater noise within the Marine RSA will exceed NOAA's regulatory standards for sensory disturbance.

While there are no Canadian regulatory standards with respect to this effect, the NOAA thresholds are used as commonly-applied environmental standards. Southern resident killer whales within 4 to 7 km of the shipping lanes are expected to be exposed to noise from Project-related vessel traffic capable of causing sensory disturbance. This effect will occur throughout the Canadian designated critical habitat for this endangered population. For these population status reasons, the magnitude for southern resident killer whales is rated as high.

- **Probability** - high – underwater noise produced by Project-related vessels is expected to exceed the current NOAA standards for sensory disturbance within 4 to 7 km of the transiting vessels and will act cumulatively with noise from existing and reasonably foreseeable future vessel traffic. As such, there is a high probability that southern resident killer whales in the Marine RSA will experience some degree of sensory disturbance as a result of cumulative effects associated with increased Project-related marine vessel traffic.
- **Confidence** - low – there is no precedent (*e.g.,* other project EAs) for attempting to assess significance of the effects of sensory disturbance from underwater noise associated with marine shipping on southern resident killer whales. Things that are known with certainty concerning this population are its small size, recent population trends, Endangered status, and relative importance of this area (*i.e.,* critical habitat). Recent ambient noise measurement studies have been conducted in the Marine RSA and results are available in the literature (Williams *et al.* 2013; see also Appendix A of the Marine Resources – Marine Transportation Technical Report of Volume 8B, TR 8B-1). Project-related vessel source levels and ambient conditions were not directly measured and underwater noise associated with reasonably foreseeable future traffic is unknown; however, the vessel source levels from the literature are deemed appropriate surrogates and acoustic modeling used in the residual effects assessment followed standard practices. Disturbance from vessels and underwater noise have been shown through numerous studies to alter behaviour, cause compensatory responses, and interfere with normal activity patterns, but the greatest source of uncertainty is the linkage of sensory disturbance effects to population-level consequences and the degree to which such effects can be attributed to underwater noise from Project-related vessels and other ships and boats.

#### 4.4.5.3.2 Marine Mammals Indicator – Humpback Whale

The following subsection provides the evaluation of significance of the potential cumulative effect and Project contribution to cumulative effect on the humpback whale indicator.

**Sensory Disturbance of Humpback Whales Due to Underwater Noise Resulting from the Cumulative Effects of Existing Marine Vessel Traffic and the Increase in Project-Related and Reasonably Foreseeable Marine Vessel Traffic**

As discussed in the assessment of residual effects (see Section 4.3.7.6), while the acoustic environment in many areas of the humpback whale's range may currently exceed environmental standards for sensory disturbance, the North Pacific population is not only stable, but has been growing at an annual rate of approximately 4.9 per cent since 1993 (Cascadia Research 2008). Unlike southern resident killer whales, DFO has identified critical habitat for humpback whales in other areas of BC, and humpback whales in Canada belong to a much larger population (*i.e.,* 2008 estimate of 18,302 individuals in the North Pacific) (Cascadia Research 2008). Based on photo-identification studies (from 1992 to 2006) and a minimum number alive (MNA) estimate of the 2006 BC humpback whale population size of 1,620 individuals, 208 humpback whales have been identified in the southwest Vancouver Island critical habitat area; this represents approximately 13 per cent of the BC coast-wide MNA (DFO 2010b).

The increase in Project-related vessel traffic will contribute additional underwater noise to the Marine RSA and this noise will act cumulatively with noise from existing and reasonably foreseeable marine vessel traffic. However, the Project contribution to overall underwater noise represents only one component of current and future marine transportation sources for underwater noise. The Project contribution to cumulative effects will affect a relatively small, localized component of the overall North Pacific (or Canadian) humpback whale population, and only during periods of the year when they are present in the Marine RSA. As such, while the assessment recognizes the importance of maintaining functional acoustic habitats for humpback whales or any marine mammal species, the Project's contribution to potential cumulative effects of sensory disturbance is determined to be adverse, but not significant for humpback whales.

A summary of the rationale for all of the significance criteria is provided below (Table 4.4.5.2, point 2[a]).

- **Spatial Boundary** - Marine RSA – the Project's contribution to cumulative increase in sensory disturbance due to underwater noise on humpback whales will be concentrated along the shipping lanes in the Marine RSA and will decrease with distance from the sound source (*i.e.,* tankers and tugs).
- **Duration** - long-term – the Project's contribution to increased tanker transits and the associated production of underwater noise along the shipping lanes will be initiated during the operations phase and will extend for the life of the Project.
- **Frequency** - periodic – Project-related marine vessel traffic will increase by approximately 30 Aframax tanker calls to the Westridge Marine Terminal per month (*i.e.,* an additional 720 tanker transits each year). It will take Project-related vessels approximately 12 hours to complete one transit of the Marine RSA, and on average, there will be two transits every 24 hours. Humpback whale exposure to Project-related vessels will likely be limited to a maximum of one exposure per transit per day during the months when humpback whales are present in the Marine RSA.
- **Reversibility** - immediate – the Project's contribution to underwater noise in the Marine RSA will exceed NOAA thresholds for sensory disturbance at any given location for approximately half an hour per transit, and any temporary disturbance to individual humpback whales at this location will likely be reversible shortly thereafter (*i.e.,* in less than 2 days).
- **Magnitude** - medium – the Project's contribution to underwater noise within the Marine RSA will exceed NOAA's regulatory standards for sensory disturbance. While there are no Canadian regulatory standards with respect to this effect, the NOAA thresholds are used as commonly-applied environmental standards. Humpback whales within 4 to 7 km of the shipping lanes are expected to be

exposed to noise from Project-related vessel traffic capable of causing sensory disturbance. The Marine RSA overlaps a small portion of the proposed Canadian critical habitat for this species and only a small proportion of the much larger North Pacific population of humpback whales occurs seasonally in the Marine RSA. For these population status reasons, the magnitude for humpback whales is rated as medium.

- **Probability** - high – underwater noise produced by Project-related vessels is expected to exceed the current NOAA standards for sensory disturbance within 4 to 7 km of the transiting vessels and will act cumulatively with noise from existing and reasonably foreseeable future vessel traffic. As such, there is a high probability that humpback whales in the Marine RSA will experience some degree of sensory disturbance as a result of cumulative effects associated with increased Project-related marine vessel traffic.

- **Confidence** - low – Recent ambient noise measurement studies have been conducted in the Marine RSA and results are available in the literature (Williams *et al.* 2013; see also Appendix A of the Marine Resources – Marine Transportation Technical Report (Volume 8B, TR 8B-1). Project-related vessel source levels and ambient conditions were not directly measured and underwater noise associated with reasonably foreseeable future traffic is unknown; however, the vessel source levels from the literature are deemed appropriate surrogates and acoustic modeling used in the residual effects assessment followed standard practices. Disturbance from vessels and underwater noise have been shown through numerous studies to alter behaviour, cause compensatory responses, and interfere with normal activity patterns, but the greatest source of uncertainty is the linkage of sensory disturbance effects to population-level consequences and the degree to which such effects can be attributed to underwater noise from Project-related vessels and other ships and boats. The primary rationale for the difference in significance determination between humpback whales and southern resident killer whales is the marked difference in status, population size, distribution, and relative use and importance of the Marine RSA.

#### 4.4.5.3.3 Marine Mammals Indicator – Steller Sea Lion

The following subsection provides the evaluation of significance of the potential cumulative effect and Project contribution to cumulative effect on the Steller sea lion indicator.

**Sensory Disturbance of Steller Sea Lion Due to Underwater Noise Resulting from the Cumulative Effects of Existing Marine Vessel Traffic and the Increase in Project-Related and Reasonably Foreseeable Marine Vessel Traffic**

The increase in Project-related vessel traffic will contribute additional underwater noise to the Marine RSA and this noise will act cumulatively with noise from existing and reasonably foreseeable marine vessel traffic. The Project contribution to overall underwater noise will be most detectable directly along the shipping lane during a vessel transit. However, as discussed in the assessment of residual effects (see Section 4.3.7.6), Steller sea lions in the Marine RSA are expected for the most part to be habituated to regular traffic movements along the shipping lanes and a large part of the acoustic energy produced by Project-related (and other large commercial vessels) is expected to be inaudible to sea lions and within the predicted range of current ambient conditions. While individuals in the water are expected to move away from vessels, large-scale disturbance around the haulouts is not expected, and individuals are likely to recover from any direct effects of sensory disturbance immediately. There are no rookeries, critical habitat or DFO-identified important areas for pinnipeds in the Marine RSA and the DFO Steller Sea Lion Management Plan lists acoustic disturbance when in aquatic habitat as low concern (DFO 2010a). As such, while the assessment recognizes the importance of maintaining functional acoustic habitats for Steller sea lions and all marine mammal species, the Project's contribution to potential cumulative effects of sensory disturbance on Steller sea lions is determined to be not significant.

A summary of the rationale for all of the significance criteria is provided below.

- **Spatial Boundary** - Marine RSA – the Project's contribution to cumulative increase in sensory disturbance due to underwater noise on Steller sea lions will be concentrated along the shipping lanes in the Marine RSA and will decrease with distance from the sound source (*i.e.,* tankers and tugs).

- **Duration** - long-term – the Project's contribution to increased tanker transits and the associated production of underwater noise along the shipping lanes will be initiated during the operations phase and will extend for the life of the Project.

- **Frequency** - periodic – Project-related marine vessel traffic will increase by approximately 30 Aframax tanker calls to the Westridge Marine Terminal per month (*i.e.,* an additional 720 tanker transits each year). It will take Project-related vessels approximately 12 hours to complete one transit of the Marine RSA, and on average, there will be two transits every 24 hours. Steller sea lion exposure to Project-related vessels will likely be limited to a maximum of one exposure per transit per day.

- **Reversibility** - immediate – the Project's contribution to underwater noise in the Marine RSA will exceed NOAA thresholds for sensory disturbance at any given location for approximately half an hour per transit, and any temporary disturbance to individual Steller sea lions at this location will likely be reversible shortly thereafter (*i.e.,* in less than 2 days).

- **Magnitude** - low – the Project's contribution to underwater noise within the Marine RSA will exceed NOAA's regulatory standards for sensory disturbance. While there are no Canadian regulatory standards with respect to this effect, the NOAA thresholds are used as commonly-applied environmental standards. Steller sea lions within 4 to 7 km of the shipping lanes are expected to be exposed to noise from Project-related vessel traffic capable of causing sensory disturbance. However, the Project contribution to introduced underwater noise (relative to Steller sea lion hearing) is expected to mostly be within the range of current ambient conditions. Steller sea lions in the Marine RSA are expected for the most part to be habituated to regular traffic movements along the shipping lanes. There are no rookeries, critical habitat or DFO identified important areas for pinnipeds in the Marine RSA and little if any detectable effects are predicted as a result of the increase over current traffic conditions, which will remain concentrated along the shipping lanes. For these species-specific and population status reasons, the magnitude for Steller sea lions is rated as low.

- **Probability** - high – underwater noise produced by Project-related vessels is expected to exceed the current NOAA standards for sensory disturbance within 4 to 7 km of the transiting vessels and will act cumulatively with noise from existing and reasonably foreseeable future vessel traffic. As such, there is a high probability that Steller sea lions in the Marine RSA will experience some degree of sensory disturbance as a result of cumulative effects associated with increased Project-related marine vessel traffic. However, the NOAA thresholds do not factor in species-specific hearing abilities, and based on audiogram-weighted analyses, Project-related vessels will for the most part be undetectable to Steller sea lions outside of current ambient conditions.

- **Confidence** - high – pinnipeds in water and away from rookeries are known to be fairly tolerant of even close vessel approaches and the Marine RSA does not include any habitat identified as being of particular importance to Steller sea lions. The DFO Steller Sea Lion Management Plan lists acoustic disturbance when in aquatic habitat as low concern (DFO 2010a).

#### 4.4.5.3.4 Combined Cumulative Effects on Marine Mammals

The evaluation of the Project's contribution to the combined cumulative effects of sensory disturbance due to increased Project-related marine vessel traffic on the marine mammals element considers collectively the assessment of the likely potential cumulative effects on the following indicators: southern resident killer whale, humpback whale, and Steller sea lion. The assessment of these indicator species for the selected effects is considered to adequately represent the Project's contribution to the combined cumulative effects on all marine mammals within the Marine RSA.

A summary of the assessment conclusions for combined cumulative effects is provided below and presented in Table 4.4.5.2 (point 4[a]). Where two indicators had different criterion conclusions, the more conservative assessment was carried forward to the combined effects assessment.

- **Spatial Boundary** - Marine RSA – the Project's contribution to cumulative increase in sensory disturbance due to underwater noise on marine mammals will be concentrated along the shipping lanes in the Marine RSA and will decrease with distance from the sound source (*i.e.*, tankers and tugs).

- **Duration** - long-term – the Project's contribution to increased tanker transits and the associated production of underwater noise along the shipping lanes will be initiated during the operations phase and will extend for the life of the Project.

- **Frequency** - periodic – Project-related marine vessel traffic will increase by approximately 30 Aframax tanker calls to the Westridge Marine Terminal per month (*i.e.*, an additional 720 tanker transits each year). It will take Project-related vessels approximately 12 hours to complete one transit of the Marine RSA, and on average, there will be two transits every 24 hours. Marine mammal exposure to Project-related vessels will likely be limited to a maximum of one exposure per transit per day.

- **Reversibilit** - immediate – the Project's contribution to underwater noise in the Marine RSA will exceed NOAA thresholds for sensory disturbance at any given location for approximately half an hour per transit, and any temporary disturbance to individual marine mammals will likely be reversible shortly thereafter (*i.e.*, in less than 2 days).

- **Magnitude** - high – the Project's contribution to underwater noise within the Marine RSA will exceed NOAA's regulatory standards for sensory disturbance. While there are no Canadian regulatory standards with respect to this effect, the NOAA thresholds are used as commonly-applied environmental standards. Marine mammals within 4 to 7 km of the shipping lanes are expected to be exposed to noise from Project-related vessel traffic capable of causing sensory disturbance.
- **Probability** - high – underwater noise produced by Project-related vessels is expected to exceed the current NOAA standards for sensory disturbance within 4 to 7 km of the transiting vessels and will act cumulatively with noise from existing and reasonably foreseeable future vessel traffic. As such, there is a high probability that marine mammals in the Marine RSA will experience some degree of sensory disturbance as a result of cumulative effects associated with increased Project-related marine vessel traffic.
- **Confidence** - low - disturbance from vessels and underwater noise have been shown through numerous studies to alter behaviour, cause compensatory responses, and interfere with normal activity patterns, but the greatest source of uncertainty is the linkage of sensory disturbance effects to population-level consequences and the degree to which such effects can be attributed to underwater noise from Project-related vessels and other existing and future marine vessel traffic.

Given that past and current activities are considered to have caused significant adverse effects on the southern resident killer whale population, the Project's contribution to cumulative effects associated with the increase in Project-related marine vessel activity on this species was considered to be significant. The Project's contribution to cumulative effects on humpback whale and Steller sea lion populations in the Marine RSA are considered to be not significant.

PMV is in the midst of developing a program to look at the current levels of underwater noise in the Strait of Georgia and surrounding waters and to consider options for reducing potential environmental effects of noise from marine traffic on marine mammals. This program will be a collaborative effort, led by PMV, and supported by TC, DFO, and the CCG. It will involve the Chamber of Shipping and the PPA as key stakeholders, as well as other major marine shipping industry representatives. The program will involve the deployment of a network of hydrophones in the Strait of Georgia and Haro Strait that will be used to measure the acoustic signatures of vessels and to monitor the activities of southern resident killer whales and other cetaceans. Data collected through the program will contribute to the development of mitigation measures aimed at reducing acoustic disturbance to marine mammals. PMV is expected to release more details on the program in early 2014.

Trans Mountain is strongly supportive of this regionally-based collaborative industry-government approach to developing viable solutions that could be applied to the marine transportation industry as a whole. Trans Mountain met with PMV in late 2013 and expressed its interest in contributing in a meaningful capacity to the development and implementation of the proposed program. Trans Mountain is also willing to support the outcomes (*i.e.*, research findings and recommended mitigations) that result from the PMV program or a similar government-industry effort. Trans Mountain will be furthering conversation with PMV in early 2014 to establish how to best support and participate in current and future endeavours on this topic.

#### *4.4.5.4 Potential United States Effects*

No differences in the indicators or acoustic conditions in the US and Canadian portions of the Marine RSA were identified that would change the nature of the effects assessment. Therefore, the effects are expected to be similar in Canadian and US waters.

#### *4.4.5.5 Summary*

As identified in Table 4.4.5.2, given the current endangered status of the southern resident killer whale population, the Project's contribution to cumulative effects associated with increased Project-related marine vessel traffic on marine mammals are considered to be significant.

### ***4.4.6 Marine Birds***

#### *4.4.6.1 Reasonably Foreseeable Developments*

Table 4.4.1.2 summarizes the current level of marine traffic within the Marine RSA, the anticipated marine traffic attributed to the Project, and other reasonably foreseeable marine traffic. A description of existing and anticipated activities is provided in Section 4.4.1.4.

#### *4.4.6.2 Potential Cumulative Effects*

The potential and likely environmental residual effects associated with the increase in Project-related marine vessel traffic on marine birds are identified for each indicator in Section 4.3.8. The assessed combined effect of those potential residual effects on each of the marine bird indicators is listed in Table 4.4.6.1 along with the associated existing and reasonably foreseeable regional marine traffic that could act in combination with the effects of increased Project-related marine vessel traffic to cause a cumulative effect on marine birds.

Marine birds are likely to be affected by sensory disturbances from Project-related marine shipping activities that disrupt marine bird foraging behaviours and can cause birds to flush from preferred or important feeding habitats. Repeated vessel disturbances, such as those which may affect some species of marine birds within the transportation route, can eventually cause a level of stress, especially during the sensitive breeding season when energetic costs are high. The consequent alterations in behaviour are indirect effects that have implications for their energy budgets and survivorship. Marine birds are present in the shipping lanes throughout the year, with various species using these habitats for migration, overwintering, moulting and foraging during the breeding period. The effect of Project-related sensory disturbances will be localized and recurrent with the regular transiting of two vessels per day within the shipping lanes. Individual encounters will be temporary and not expected to be detrimental to the viability, stability and overall well-being of the diverse populations of marine birds.

The current context of marine traffic can be represented as the total number recorded in 2012, ranging from 6,858 vessels (Burrard Inlet) to 18,503 vessels (Juan de Fuca Strait), depending on the location along the shipping lanes (Table 4.4.1.2), and also includes English Bay, Strait of Georgia and Haro Strait. The Project's projected percent contribution to existing traffic is highest in Burrard Inlet (25.9 per cent) and Haro Strait (11.9 per cent), and is lowest in Juan de Fuca Strait (6.1 per cent). The total number of vessels from the present time to the year 2030 in Burrard Inlet increases from 6,858 to 11,139 (38 per cent), and in Haro Strait from 8,896 to

12,113 vessels (27 per cent). The potential for the increase in noise and visual disturbances from overall traffic is much greater in Burrard Inlet, which also includes effects from Project-related vessels, compared to other components of the shipping lanes.

**TABLE 4.4.6.1**

**POTENTIAL RESIDUAL EFFECTS OF PROJECT-RELATED MARINE TRAFFIC ON MARINE BIRDS CONSIDERED FOR THE CUMULATIVE EFFECTS ASSESSMENT**

| Potential Residual Effect on Marine Bird Indicator | Spatial Boundary[1] | Temporal Boundary | Potential Cumulative Effect | Existing Activities/Reasonably Foreseeable Activities with Residual Effects Acting in Combination with Project-Related Marine Vessel Traffic |
|---|---|---|---|---|
| 1. Combined Project effects on fork-tailed storm-petrel. | RSA | Operations | Project contribution to the cumulative increase in behavioural alteration or sensory disturbance. | • Existing marine vessel traffic within the Marine RSA (Table 4.4.1.2).<br>• Reasonably foreseeable marine vessel traffic within the Marine RSA (Table 4.4.1.2). |
| 2. Combined Project effects on Cassin's auklet. | RSA | Operations | Project contribution to the cumulative increase in behavioural alteration or sensory disturbance. | • Existing marine vessel traffic within the Marine RSA (Table 4.4.1.2).<br>• Reasonably foreseeable marine vessel traffic within the Marine RSA (Table 4.4.1.2). |
| 3. Combined Project effects on surf scoter. | RSA | Operations | Project contribution to the cumulative increase in behavioural alteration or sensory disturbance. | • Existing marine vessel traffic within the Marine RSA (Table 4.4.1.2).<br>• Reasonably foreseeable marine vessel traffic within the Marine RSA (Table 4.4.1.2). |
| 4. Combined Project effects on pelagic cormorant. | RSA | Operations | Project contribution to the cumulative increase in behavioural alteration or sensory disturbance. | • Existing marine vessel traffic within the Marine RSA (Table 4.4.1.2).<br>• Reasonably foreseeable marine vessel traffic within the Marine RSA (Table 4.4.1.2). |
| 5. Combined Project effects on glaucous-winged gull. | RSA | Operations | Project contribution to the cumulative increase in behavioural alteration or sensory disturbance. | • Existing marine vessel traffic within the Marine RSA (Table 4.4.1.2).<br>• Reasonably foreseeable marine vessel traffic within the Marine RSA (Table 4.4.1.2). |

**Note:** 1 RSA = Marine RSA

### *4.4.6.3 Significance Evaluation of Potential Cumulative Effects*

Table 4.4.6.2 provides a summary of the significance evaluation of the contribution of Project-related marine vessel traffic to potential cumulative effects on the marine bird indicators. The rationale used to evaluate the significance of each of the cumulative effects is provided below. The assessment follows a qualitative approach due to a lack of quantitative measures of thresholds of disturbance to marine bird species within the Marine RSA. The evaluation of significance was based primarily on professional judgment, which is the product of a strong body of knowledge about indicator species life-history in the Marine RSA and experience gained on environmental assessments of other similar marine transportation projects in BC.

**TABLE 4.4.6.2**

**SIGNIFICANCE EVALUATION OF THE CONTRIBUTION OF PROJECT-RELATED MARINE TRAFFIC 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 Birds Indicator – Fork-tailed Storm-Petrel** | | | | | | | | | |
| 1(a) Project contribution to the cumulative increase in behavioural alteration or sensory disturbance. | Negative | RSA | Long-term | Periodic | Short-term | Low | High | High | Not significant |
| **2. Marine Birds Indicator – Cassin's auklet** | | | | | | | | | |
| 2(a) Project contribution to the cumulative increase in behavioural alteration or sensory disturbance. | Negative | RSA | Long-term | Periodic | Short-term | Medium | High | High | Not significant |
| **3. Marine Birds Indicator – Surf Scoter** | | | | | | | | | |
| 3(a) Project contribution to the cumulative increase in behavioural alteration or sensory disturbance. | Negative | RSA | Long-term | Periodic | Short-term | Medium | High | High | Not significant |
| **4. Marine Birds Indicator – Pelagic Cormorant** | | | | | | | | | |
| 4(a) Project contribution to the cumulative increase in behavioural alteration or sensory disturbance. | Negative | RSA | Long-term | Periodic | Short-term | Medium | High | High | Not significant |
| **5. Marine Birds Indicator – Glaucous-winged Gull** | | | | | | | | | |
| 5(a) Project contribution to the cumulative increase in behavioural alteration or sensory disturbance. | Negative | RSA | Long-term | Periodic | Short-term | Low | High | High | Not significant |
| **6. Combined Cumulative Effects on Marine Birds** | | | | | | | | | |
| 6(a) Project contribution to combined cumulative effects on marine birds indicators (1[a], 2[a], 3[a], 4[a] and 5[a]). | Negative | RSA | Long-term | Periodic | Short-term | Medium | 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.

### 4.4.6.3.1 Marine Bird Indicator – Fork-Tailed Storm-Petrel

The fork-tailed storm-petrel is a pelagic species spending most of its life in open waters on the continental shelf and beyond, making irregular visits to the Marine RSA during the breeding season and during long-distance flights to forage. Observations of individuals within the Marine RSA primarily take place during summer and fall seasons, somewhat distant from the shipping lanes. The fork-tailed storm-petrel rarely lands, soaring low over waves, capturing prey from the water's surface. Therefore, there is a lower likelihood of sensory disturbance responses that might characterize surface or diving foragers, such as flushing from moving vessels in close proximity due to in-air and underwater noise. The Project's contribution to cumulative effects with respect to the fork-tailed storm-petrel is primarily of concern in the area of overlap with the species distribution which is greatest in the western passages of the shipping lanes from Haro Strait to the 12 nautical mile boundary of the territorial sea. This is where the contribution of Project-related vessel movements to overall vessel traffic is approximately 6 to 12 per cent (Table 4.4.1.2). Sensory disturbance (*i.e.*, vessel-related in-air noise and activity) is considered to have a negative impact balance through marine bird avoidance of important habitats. The potential periodic disturbances will affect a small number of individuals that intermittently use the Marine RSA, but are unlikely to have more than a marginal to low adverse effect to the regional population, considering the wide-ranging and highly pelagic nature of this species. The physical presence of vessels and vessel-generated noise is anticipated to result in localized, repetitive, temporary disturbances. The recovery (return to normal behaviours) of individuals or groups of birds from vessel disturbances may be interrupted and somewhat delayed by the subsequent disturbances from other vessel and marine activities. The effects from sensory disturbances (stress, changes in energy budgets over time and reduced fitness) could be more persistent than the immediate recovery that might be expected after isolated disturbance events, given the frequency of overall vessel movements along the shipping lanes. Consequently, taking into account the high volume of vessel traffic within the Marine RSA, and with the professional judgment of the assessment team, the Project's contribution to cumulative effects on fork-tailed storm-petrel is considered to have a high probability of being long-term in duration with a low magnitude and short-term reversibility (Table 4.4.6.2, point 1[a]). A summary of the rationale for all of the significance criteria is provided below.

- **Spatial Boundary** - Marine RSA – the Project's contribution to cumulative effects is assessed within the regional context of the Marine RSA with consideration for the highly pelagic, wide-ranging and agile flight behaviour of fork-tailed storm-petrels.
- **Duration** - long-term – the event causing sensory disturbance to fork-tailed storm-petrel is the contribution of Project-related vessels to cumulative effects during operations for the life of the Project.
- **Frequency** - periodic – the Project's contribution to the cumulative effects on fork-tailed storm-petrels is intermittent but repeated sensory disturbance, with regular transits potentially twice per day, for the life of the Project.
- **Reversibility** - short-term – the reversibility of the event of the Project's contribution to the cumulative effect of vessel-related sensory disturbances to fork-tailed storm-petrel will be short-term considering the potential for other subsequent vessel disturbances after the passage of Project-related marine vessels.
- **Magnitude** - low – the Project's contribution to cumulative effects will be detectable at the individual level, but marginal to negligible on the population level with consideration for the context of existing and anticipated high volume vessel traffic within the Marine RSA, the highly pelagic nature of the species, and the relatively lower contribution of Project-related vessels to cumulative effects in this western portion of the shipping lanes.
- **Probability** - high – the Project is likely to contribute to the cumulative effect of sensory disturbances to fork-tailed storm-petrel.

- **Confidence** - high – based on a good understanding by the assessment team of cause-effect relationships between the Project activities and fork-tailed storm-petrel, and data pertinent to the coastal region.

#### 4.4.6.3.2 Marine Bird Indicator – Cassin's Auklet

Cassin's auklets breed at colonies within the western portion of the Marine RSA near Juan de Fuca Strait. During the non-breeding season, they spend most of their time at sea upwellings and on the continental shelf. Recent literature documents the sensitivities of these and other alcid species to various sources of disturbance (Carney and Sydeman 1999, 2000). Considering the sensitive nature of auklets, the cumulative effects of the increased Project-related and reasonably foreseeable future vessel traffic may potentially result in a minimal adverse impact on the population. Auklets are unlikely to become habituated to marine shipping activities. Outside the breeding season, large groups resting on the water surface or diving to forage are vulnerable to disturbances and exhibit flushing and other stress responses when disrupted. The events relevant to the Cassin's auklet primarily take place in narrow and physically sheltered passages during the breeding season, and where their foraging range in open waters overlaps the shipping lanes from the Strait of Georgia to the 12 nautical mile territorial boundary, in which the percent contribution to overall traffic is approximately 6 to 12 per cent (Table 4.4.1.2). Taking into account the existing vessel traffic within the Marine RSA, and the professional judgment of the assessment team, the increased Project-related and reasonably foreseeable future vessel traffic is anticipated to result in regular, temporary disturbances, resulting in cumulative effects of medium magnitude. Sensory disturbance (*i.e.*, vessel-related in-air noise and the avoidance of important habitats) is considered to have a negative impact balance. The recovery of individuals or groups of auklets from vessel disturbances may be interrupted and subsequently delayed by subsequent disturbances from other vessel activity. Auklets, as a group, are more sensitive to various types of human disturbance than other bird species groups, therefore, direct and indirect effects (stress, changes in energy budgets over time and reduced fitness) could be more persistent. The Project's contribution to cumulative effects on Cassin's auklet is determined to have a high probability of being long-term in duration with a medium magnitude and short-term reversibility (Table 4.4.6.2, point 2[a]). A summary of the rationale for all of the significance criteria is provided below.

- **Spatial Boundary** - Marine RSA – the Project's contribution to cumulative effects is assessed within the regional context of the Marine RSA with consideration for the wide-ranging and seasonal changes in behaviour and habitat use of Cassin's auklet.

- **Duration** - long-term – the event causing sensory disturbance to Cassin's auklet is the contribution of Project-related vessels to cumulative effects during operations for the life of the Project.

- **Frequency** - periodic – the Project's contribution to the cumulative effect on Cassin's Auklet is intermittent but repeated sensory disturbance, with regular transits potentially twice per day, for the life of the Project.

- **Reversibility** - short-term – the reversibility of the event of the Project's contribution to the cumulative effect of vessel-related sensory disturbances to Cassin's auklet will be short-term considering the potential for other subsequent vessel disturbances after the passage of Project-related marine vessels.

- **Magnitude** - medium – the Project's contribution to cumulative effects will be detectable at the individual level but low to medium on the population level with consideration for the context of existing and anticipated high-volume large-vessel traffic within the Marine RSA, the seasonal sensitivity of the species during breeding, their seasonal tendency to forage in large aggregations, and the relatively lower contribution of Project-related vessels to cumulative effects in this western component of the shipping lanes.
- **Probability** - high – the Project is likely to contribute to the cumulative effect of sensory disturbances to Cassin's auklet.
- **Confidence** - high – based on a good understanding by the assessment team of cause-effect relationships between the Project activities and Cassin's auklet, and data pertinent to the coastal region.

#### 4.4.6.3.3 Marine Bird Indicator – Surf Scoter

Surf scoters are seasonally present within the Marine RSA and effects would be limited to wintering, migrating and moulting periods (late summer to late spring). During these periods, large foraging aggregations of surf scoters are present in nearshore areas, while smaller groups are found in open waters. The presence of vessels and vessel-generated noise is anticipated to result in regular, temporary disturbances, primarily in narrower portions of the shipping lanes, such as in Haro Strait. Depending on the time of year, these disturbances could adversely affect large numbers of surf scoters (*e.g.*, thousands in spring when foraging on Pacific herring spawn) or when energetic costs are already high for individuals (during moulting periods). However, birds are expected to move away from vessels and resume normal behaviors and activities within a relatively short time frame, depending on the potential for subsequent disturbance events. The increase in Project-related large vessel traffic will continue over the long-term; however, it is unlikely that there would be substantial adverse effects to the relatively large regional population of surf scoters. The cumulative effect of sensory disturbance (*i.e.*, the avoidance of important habitats) is considered to have a negative impact balance. The Project's contribution to cumulative effects that is relevant to the surf scoter takes place primarily in nearshore and sheltered passages of the shipping lanes from Burrard Inlet to the 12 nautical mile boundary of the territorial sea. The percent contribution of the Project to overall traffic in these areas will range from approximately 6 to 26 per cent (Table 4.4.1.2). The recovery of individuals or groups of birds from vessel disturbances may be interrupted by subsequent disturbances due to other marine vessel activity. The effects (stress, changes in energy budgets over time and reduced fitness) could last longer than the immediate recovery expected after isolated events, given the frequency of vessel movements in the shipping lanes. Consequently, the professional judgment of the assessment team has determined that the Project's contribution to cumulative effects on surf scoter will have a high probability of being long-term in duration with a low magnitude and an short-term reversibility (Table 4.4.6.2, point 3[a]). A summary of the rationale for all of the significance criteria is provided below.

- **Spatial Boundary** - Marine RSA – the Project's contribution to cumulative effects is assessed within the regional context of the Marine RSA with consideration for the seasonal presence and nearshore congregational foraging behaviour of surf scoters.

- **Duration** - long-term – the event causing sensory disturbance to surf scoters is the contribution of Project-related vessels to cumulative effects during operations for the life of the Project.
- **Frequency** - periodic – the Project's contribution to the cumulative effect on surf scoter is intermittent but repeated sensory disturbance, with regular transits potentially twice per day, for the life of the Project.
- **Reversibility** - short-term – the reversibility of the event of the Project's contribution to the cumulative effect of vessel-related sensory disturbances to surf scoter will be short-term considering the context of other subsequent vessel disturbances after the passage of Project-related marine vessels.
- **Magnitude** - medium – the Project's contribution to cumulative effects will be detectable at the individual level, but marginal to negligible on the population level with consideration for the context of high-volume vessel traffic existing and anticipated within the Marine RSA, and the potential for large aggregations of birds during overwintering moulting and overwintering seasons in channels and nearshore habitats.
- **Probability** - high – the Project is likely to contribute to the cumulative effect of sensory disturbances to surf scoters.
- **Confidence** - high – based on a good understanding by the assessment team of cause-effect relationships between the Project activities and surf scoters, and data pertinent to the coastal region.

#### 4.4.6.3.4 Marine Bird Indicator – Pelagic Cormorant

The regional population of pelagic cormorants is abundant year-round and habitat use is primarily focused in nearshore areas. This species has one of the largest flushing distances among marine birds (*i.e.,* low disturbance threshold). The Project's contribution to cumulative effects that is relevant to the pelagic cormorant takes place in the nearshore and narrow passages from Burrard Inlet to the 12 nautical mile boundary of the territorial sea where the Project's contribution to overall vessel traffic ranges from 6 to 26 per cent (Table 4.4.1.2). Many of these areas have cormorant breeding colonies, including Burrard Inlet, where marine activity will be the highest in the shipping lanes. The recovery from vessel disturbance for individuals or groups of cormorants, primarily in narrow channels, may be somewhat delayed by the potential for continuous subsequent disturbances from other marine activity. The effects could be more persistent given the proximity of the shipping lanes to birds at shorelines and marine structures. Although the sensitivity of pelagic cormorants to human disturbances is well documented (Carney and Sydeman 1999, 2000), they sometimes use marine and commercial structures for perching and resting. Habituation to the presence and activity of marine traffic has not previously been assessed in the Marine RSA. It is unlikely that there will be cumulative effects at the scale of the relatively abundant regional population of pelagic cormorants. Consequently, considering the existing high volume of large vessel traffic within the Marine RSA, and the professional judgment of the assessment team, the Project's contribution to cumulative effects on pelagic cormorant is considered to have a high probability of being long-term in duration with a medium magnitude and short-term reversibility (Table 4.4.6.2, point 4[a]). Sensory disturbance (*i.e.*, vessel-related in-air noise) is considered to have a negative impact balance through the avoidance of important habitats. A summary of the rationale for all of the significance criteria is provided below.

- **Spatial Boundary** - Marine RSA – the Project's contribution to cumulative effects are assessed within the Marine RSA with consideration for the sensitivity of pelagic cormorant, weather conditions and the location of local breeding colonies.
- **Duration** - long-term – the event causing sensory disturbance to pelagic cormorant is the contribution of Project-related vessels to cumulative effects during operations for the life of the Project.
- **Frequency** - periodic – the Project's contribution to the cumulative effect on pelagic cormorant is intermittent but repeated sensory disturbance, with regular transits potentially twice per day, for the life of the Project.
- **Reversibility** - short-term – the reversibility of the event of the Project's contribution to the cumulative effect of vessel-related sensory disturbances to pelagic cormorant will be short-term considering the potential for other subsequent vessel disturbances after the passage of Project-related marine vessels
- **Magnitude** - medium – the Project's contribution to cumulative effects will be detectable at the individual level but low to moderate on the population level with consideration for the context of existing and anticipated high-volume vessel traffic within the Marine Birds LSA, the sensitive foraging and breeding behaviour of the species, and the relatively moderate contribution of Project-related vessels to cumulative effects in narrower channels of the shipping lanes, especially in Burrard Inlet.
- **Probability** - high – the Project is likely to contribute to the cumulative effects of sensory disturbances to pelagic cormorant.
- **Confidence** - high – based on a good understanding by the assessment team of cause-effect relationships between the Project activities and pelagic cormorants, and data pertinent to the coastal region.

#### 4.4.6.3.5 Marine Bird Indicator – Glaucous-Winged Gull

Glaucous-winged gulls are abundant and ever-present within the Marine RSA. Although generally an inshore species, it does forage at sea as far as the continental shelf. The Project's contribution to cumulative effects that is relevant to the glaucous-winged gulls takes place primarily in nearshore and sheltered passages of the shipping lanes and from Burrard Inlet to the 12 nautical mile boundary of the territorial sea. Glaucous-winged gulls breed at colonies located on islets near the shipping lanes, including in Burrard Inlet. One active breeding colony is located within 1 km of the Westridge Marine Terminal. The percent contribution of the Project to overall traffic ranges from approximately 6 to 26 per cent throughout the full extent of shipping lanes; however, the largest contribution is in Burrard Inlet (Table 4.4.1.2). While the increase in large vessel traffic due to the Project is likely to be long-term in duration, it is unlikely that any associated effects will be detectable at the scale of the regionally high-density population of glaucous-winged gulls. Habituation to the current presence and activity of marine vessels is likely; however, birds are most sensitive to disturbances during the breeding season (Carney and Sydeman 1999, 2000) and the additional traffic is likely to contribute increased disturbance effects on seasonal colonial breeders. The recovery of individuals or groups of birds from vessel disturbance may be somewhat delayed by subsequent disturbances from other marine activity. The adverse effects, primarily at breeding colonies, could be more pronounced in these narrow channel areas. Considering gulls are well-adapted to human-influenced environments, adverse effects are less likely for glaucous-winged gulls than other species outside of the breeding season; however, there is a lack of information and studies to document the species-specific threshold of continuous disturbances for birds that commonly use these areas. Consequently, considering the existing high volume of large vessel traffic within the Marine RSA, and the professional judgment of the assessment team, the Project's contribution to cumulative effects on glaucous-winged gulls is considered to have a high probability of being long-term in duration with a low magnitude and short-term reversibility (Table 4.4.6.2, point 5[a]). A summary of the rationale for all of the significance criteria is provided below.

- **Spatial Boundary** - Marine RSA – the Project's contribution to cumulative effects are assessed within the Marine RSA with consideration for the seasonal sensitivity of local breeding colonies of glaucous-winged gulls.
- **Duration** - long-term – the event causing sensory disturbance to glaucous-winged gulls is the contribution of Project-related vessels to cumulative effects during operations for the life of the Project.
- **Frequency** - periodic – the Project's contribution to the cumulative effect on glaucous-winged gulls is intermittent but repeated sensory disturbance, with regular transits potentially twice per day, for the life of the Project.
- **Reversibility** - short-term – the reversibility of the event of the Project's contribution to the cumulative effects of vessel-related sensory disturbances to glaucous-winged gull will be short-term considering the potential for other subsequent vessel disturbances after the passage of Project-related marine vessels.
- **Magnitude** - low – the Project's contribution to cumulative effects will be detectable at the individual level, but low on the population level with consideration for the context of existing and anticipated high-volume large-vessel traffic within the Marine RSA, the sensitivity of local breeding colonies, especially in Burrard Inlet, and the relatively moderate contribution of Project-related vessels to cumulative effects in narrower channels of the shipping lanes, most apparent in Burrard Inlet.
- **Probability** - high – the Project is likely to contribute to the cumulative effect of 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 marine birds, and data pertinent to the coastal region.

#### 4.4.6.3.6 Combined Cumulative Effects on Marine Birds

The evaluation of the Project's contribution to the cumulative effect of increased sensory disturbance to marine birds considers collectively the likelihood of potential residual effects on the following indicator species: fork-tailed storm-petrel; Cassin's auklet; surf scoter; pelagic cormorant; glaucous-winged gull; and the larger diverse assemblage of marine bird species they represent. Increased Project-related marine vessel traffic may act cumulatively with existing and reasonably foreseeable future vessel traffic to adversely affect marine birds in the Marine Birds LSA and Marine RSA, as described above for the marine birds indicator species. The Marine RSA is one of the busiest waterways on the Pacific Coast and the assessment of combined effects has been considered in this context. Effects are considered within a setting of predicted future high-volume vessel activity within the Marine RSA, the Project's modest contribution to that activity, and standards set within an existing regulatory framework. The impact balance is considered negative. The implementation of mitigation measures will reduce the severity of cumulative effects arising from the Project and reasonably foreseeable increases in vessel traffic. There is a high probability that the combined cumulative effect of the Project on marine birds is long-term in duration, of medium magnitude and reversible in the short-term (Table 4.4.6.2, point 6[a]). A summary of the rationale for all of the significance criteria is provided below.

- **Spatial Boundary** - Marine RSA – the Project's contribution to cumulative effects to marine birds from sensory disturbance is assessed within the regional context of existing and projected future marine activities in the Marine RSA interacting with Project-related activities.
- **Duration** - long-term – the event causing the Project's contribution to cumulative effects on marine birds will be initiated during operations and continue for the life of the Project.
- **Frequency** - periodic – the Project's contribution to the cumulative effect on marine birds is intermittent but repeated sensory disturbance, with regular transits potentially twice per day, for the life of the Project.
- **Reversibility** - short-term – the reversibility of the event of Project's contribution to the cumulative effect of vessel-related sensory disturbances to marine birds will be short-term considering the potential for other subsequent vessel disturbances after the passage of Project-related marine vessels.
- **Magnitude** - medium – the Project's contribution to cumulative effects will be detectable at the individual level and may have low to moderate effects on the populations of some sensitive colonial breeding species in narrow channel areas with consideration for the context of high volume large vessel traffic that currently exists within the Marine RSA and the relatively moderate contribution of Project-related vessels to cumulative effects.
- **Probability** - high – the Project is likely to contribute to the cumulative adverse effects to varying degrees, and under some conditions, on marine birds.
- **Confidence** - high – based on a good understanding by the assessment team on pathways of effect between the increased Project-related vessel activities and marine birds, and with baseline data relevant to the coastal region.

#### *4.4.6.4 Potential United States Effects*

During various seasons, seabirds cross terrestrial/marine ecological and political boundaries regularly to forage, stage during migration, overwinter in large congregations and breed, often in large colonies. Individual birds and seabird populations are exposed to similar environmental conditions in open water or intertidal habitats, from vessel activity or natural wave conditions in the US and Canadian portions of the Marine RSA. The same types of effects from shipping assessed in Canadian waters are expected to be present in US waters since the marine bird species compositions and the volume of large marine vessel traffic is similar or greater in US waters. However, federal and state management policies may be slightly different than provincial policies. Considering the jurisdiction of agencies does not cross the land-sea boundary in the same manner as the seabirds they are managing, these management efforts are often facilitated by multi-agency communication and collaboration. The cumulative effects from marine vessel traffic on marine birds are expected to be similar in Canadian and US waters.

#### *4.4.6.5 Summary*

As identified in Table 4.4.6.2, there are no situations where there is a high probability of occurrence of the Project's contribution to a permanent or long-term cumulative effect of high magnitude that cannot be technically or economically mitigated. Consequently, it is concluded that the Project's contribution to cumulative effects on marine birds within the Marine RSA will be not significant.

### ***4.4.7 Marine Species at Risk***

Potential cumulative effects of the increased Project-related marine vessel traffic on marine species at risk are assessed through the use of indicators in Section 4.4.4, Section 4.4.5 and Section 4.4.6. Therefore, although not all marine species at risk are discussed explicitly under each indicator, the Project's contribution to potential cumulative effects was assessed in consideration of all species at risk. Since the cumulative effects assessment considers only likely residual effects, low probability potential effects to fish, bird and mammal species were not assessed for cumulative effects. For a discussion on how indicators were selected to ensure consideration of species at risk, the reader is referred to Section 4.3.9.

### ***4.4.8 Traditional Marine Resource Use***

This subsection discusses how existing marine traffic and reasonably foreseeable marine traffic within the Marine RSA may interface with increased Project-related marine vessel traffic to cumulatively affect traditional marine resource use indicators including subsistence activities and sites, and cultural sites.

#### *4.4.8.1 Reasonably Foreseeable Developments*

Table 4.4.1.2 summarizes the current level of marine traffic within the Marine RSA as well as the anticipated marine traffic attributed to the Project and other reasonably foreseeable marine traffic. A description of existing and anticipated activities is provided in Section 4.4.1.4.

#### *4.4.8.2 Potential Cumulative Effects*

The potential and likely socio-economic residual effects associated with increased Project-related marine vessel traffic on traditional marine resource use indicators were identified in Section 4.3.10 and are listed in Table 4.4.8.1 along with the associated existing and reasonably foreseeable regional marine traffic that could act in combination with the effects of increased Project-related marine vessel traffic to cause a cumulative effect on TMRU.

The significance evaluation considers the effect of Project-related marine vessel traffic as a proportion of the total amount of existing and future marine vessel traffic. The potential cumulative effects for each indicator are then discussed in the context of the total foreseeable increased marine vessel traffic in the region.

**TABLE 4.4.8.1**

**POTENTIAL RESIDUAL EFFECTS OF PROJECT-RELATED MARINE TRAFFIC ON TRADITIONAL MARINE RESOURCE USE CONSIDERED FOR THE CUMULATIVE EFFECTS ASSESSMENT**

| Potential Residual Effect on TMRU Indicator | Spatial Boundary[1] | Temporal Boundary | Potential Cumulative Effect | Existing Activities/Reasonably Foreseeable Activities with Residual Effects Acting in Combination with Project-Related Marine Vessel Traffic |
|---|---|---|---|---|
| 1. Combined effects on subsistence activities and sites. | RSA | Operations | Project contribution to cumulative effects on subsistence activities and sites. | • Existing marine traffic within the Marine RSA (Table 4.4.1.2).<br>• Reasonably foreseeable marine traffic within the RSA listed in Table 4.4.1.2. |
| 2. Combined effects on cultural sites. | RSA | Operations | Project contribution to cumulative effects on cultural sites. | • Existing marine traffic within the Marine RSA (Table 4.4.1.2).<br>• Reasonably foreseeable marine traffic within the RSA listed in Table 4.4.1.2. |

**Note:** 1 RSA = Marine RSA

### *4.4.8.3 Significance Evaluation of Potential Cumulative Effects*

The combined Project effects on subsistence activities and sites as well as on cultural sites from Table 4.3.10.4 were assessed in terms of the Project contribution to cumulative effects in each indicator category. Table 4.4.8.2 provides a summary of the significance evaluation of the contribution of Project-related marine vessel traffic to the potential cumulative effects. The rationale used to evaluate the significance of each of the cumulative effects is provided below.

**TABLE 4.4.8.2**

**SIGNIFICANCE EVALUATION OF THE CONTRIBUTION OF PROJECT-RELATED MARINE TRAFFIC TO CUMULATIVE EFFECTS ON TRADITIONAL MARINE RESOURCE USE**

| Potential Cumulative Effects | Impact Balance | Spatial Boundary[1] | Temporal Context: Duration | Temporal Context: Frequency | Temporal Context: Reversibility | Magnitude | Probability | Confidence | Significance[2] |
|---|---|---|---|---|---|---|---|---|---|
| **1. Traditional Marine Resource Use Indicator – Subsistence Activities and Sites** | | | | | | | | | |
| 1(a) Project contribution to cumulative effects on subsistence activities and sites. | Negative | RSA | Long-term | Periodic | Short to long-term | Low to high | High | High | Significant |

**TABLE 4.4.8.2**

**SIGNIFICANCE EVALUATION OF THE CONTRIBUTION OF PROJECT-RELATED MARINE TRAFFIC TO CUMULATIVE EFFECTS ON TRADITIONAL MARINE RESOURCE USE (continued)**

| Potential Cumulative Effects | Impact Balance | Spatial Boundary[1] | Temporal Context: Duration | Temporal Context: Frequency | Temporal Context: Reversibility | Magnitude | Probability | Confidence | Significance[2] |
|---|---|---|---|---|---|---|---|---|---|
| **2. Traditional Marine Resource Use Indicator – Cultural Sites** | | | | | | | | | |
| 2(a) Project contribution to cumulative effects on cultural sites. | Negative | RSA | Long-term | Continuous | Long-term | Medium | High | High | Not significant |
| **3. Combined Cumulative Effects on Traditional Marine Resource Use** | | | | | | | | | |
| 3(a) Combined Project contribution to cumulative effects on traditional marine resource use indicators (1[a] and 2[a]). | Negative | RSA | Long-term | Continuous | Long-term | High | High | High | Significant |

**Notes:** 1 RSA = Marine RSA

2 **Significant Contribution to a Cumulative Socio-Economic Effect:** The Project's contribution to a cumulative socio-economic effect is considered significant if the contribution is predicted to be:

- high magnitude, high probability, short to medium-term reversibility and regional, provincial or national in extent that cannot be technically or economically mitigated; or
- high magnitude, high probability, long-term or permanent reversibility and any spatial boundary that cannot be technically or economically mitigated.

### 4.4.8.3.1 Traditional Marine Resource Use Indicator – Subsistence Activities and Sites

As noted Section 4.3.10.5, all components of the marine environment are understood to support the marine resource base and habitat conditions essential to the practice of traditional activities. As such, the potential cumulative effects on subsistence activities and sites are assessed in consideration of all pertinent biophysical resources known or assumed to be of importance to Aboriginal communities for traditional use, as well as in consideration of the existing high volume of large vessel traffic within the Marine RSA. As described in Section 4.3.7.6, southern resident killer whales within 4 to 7 km of the shipping lanes are expected to be disturbed by vessel traffic and this effect will occur throughout the Canadian designated critical habitat for this endangered population. The assessment of marine mammals has determined the magnitude of this effect on southern resident killer whales is expected to be high; this determination takes into consideration past and current activities resulting in a currently existing significant adverse cumulative effect on this population. While future harvesting of the southern resident killer whale population is unlikely given the recent historical decline of this population (as described in Section 4.3.10.6), significant changes in the availability of a single traditionally harvested resource may also be reflected throughout the broader ecological system and the availability of marine resources overall. Effects to subsistence activities and sites are not expected to be of high magnitude except for effects relating to southern resident killer whale. The overall contribution of the Project to cumulative effects on the subsistence activities and sites indicator is of low to high magnitude, reversible in the short-term to long-term and of high probability (Table 4.4.8.2, point 1[a]).

A summary of the rationale for all of the significance criteria is provided below.

- **Spatial Boundary** - Marine RSA – the Project's contribution to cumulative change in subsistence activities and sites is assessed within the regional context of the Marine RSA to include wide-ranging marine species.
- **Duration** - long-term – the contribution of Project-related vessels to cumulative effects on traditionally harvested marine resources will extend for the operational life of the Project.
- **Frequency** - periodic – the Project's contribution to the cumulative effect on subsistence activities and sites will occur whenever a Project-related tanker is in transit.
- **Reversibility** - short to long-term – the Project's contribution to cumulative effects on subsistence activities such as delays or disruptions are expected to extend throughout the operational life of the Project; however, disturbances to marine resources will be short-term considering the context of other subsequent vessel disturbances after the passage of Project-related marine vessels.
- **Magnitude** - low to high – the cumulative effects assessment results for marine fish and fish habitat, marine mammals and marine birds indicates that contribution of Project-related vessels to cumulative effects on marine resources may be detectable and is dependent on each target species' sensitivities, with the exception of the southern resident killer whale population, whereby cumulative changes are beyond environmental and regulatory standards.
- **Probability** - high – the Project's contribution to cumulative effects on subsistence sites and activities is considered to be likely.
- **Confidence** - high – there is a good understanding of general cause-effect relationships that result in the Project contribution to cumulative effects on subsistence activities and sites.

#### 4.4.8.3.2 Traditional Marine Resource Use Indicator – Cultural Sites

The Project contribution to cumulative effects on the cultural sites indicator consists of increased sensory disturbance to marine users and negative user perspectives of increased Project-related marine vessel traffic (Table 4.4.8.2, point 2[a]). If approved, future developments such as those described in Section 4.4.1.4 and Project-related marine vessel traffic will add to the existing marine vessel traffic in the Marine RSA. Increased marine vessel traffic is likely to increase congestion in areas that are geographically constrained and already experience high marine traffic volumes. Increased marine vessel traffic in such areas may potentially cause some traditional marine users to avoid these areas or to alter their preferred routes due to sensory disturbance from transiting marine vessels. Mitigation measures for the potential residual effects of increased Project-related marine vessel traffic on cultural site use are proposed in Table 4.3.10.3 in Section 4.3.

A detailed assessment discussion of this cumulative effect, including an explanation of the rationale of the significance criteria related to the marine recreational use indicator of MCRTU, is provided in Section 4.4.9.3, which includes traditional marine resource users.

#### 4.4.8.3.3 Combined Cumulative Effects on Traditional Marine Resource Use

The potential effects of the Project (*i.e.*, combined Project effects on subsistence activities and sites, and cultural sites) are anticipated to act in combination with other existing marine vessels and reasonably foreseeable developments to affect traditional marine resource use in the Marine RSA. The impact balance of the combined cumulative effects is considered negative, though the implementation of mitigation measures described in Table 4.3.10.3 in Section 4.3 will reduce the severity of cumulative effects associated specifically with the Project and other reasonably foreseeable developments. The overall contribution of the Project to the cumulative effects on traditional marine resource use is of high magnitude given the cumulative effects assessment of marine mammals, reversible in the long-term and of high probability (Table 4.4.8.2, point 3[a]). A summary of the rationale for all the significance criteria is provided below. Effects are considered in the context of existing high-volume vessel activity within the Marine RSA, the existing regulatory framework and the relatively moderate contribution of Project-related vessels to cumulative effects.

- **Spatial Boundary** - Marine RSA – the Project's contribution to cumulative combined effects on traditional marine resource use indicators are assessed within the regional context of existing activities and reasonable foreseeable marine developments and activities in the Marine RSA interacting with Project-related activities.
- **Duration** - long-term – the presence of Project-related marine vessels will extend through the operational life of the Project.
- **Frequency** - continuous - Project-related marine vessels will be present in the Marine RSA continually over the assessment period.
- **Reversibility** - long-term – the Project contribution to cumulative change for all traditional marine resource use indicators is expected to extend throughout the operational life of the Project.
- **Magnitude** - high – the effects on marine resources are beyond environmental and regulatory standards.
- **Probability** - high – the Project contribution to cumulative effects on traditional marine resource use indicators is likely.
- **Confidence** - high – there is a good understanding of general cause-effect relationships that result in the Project contribution to cumulative effects on traditional marine resource use indicators.

### *4.4.8.4 Potential United States Effects*

The potential cumulative effects evaluated in this assessment are considered to apply equally in Canadian and US waters, primarily due to the location of the shipping lanes being along the international boundary throughout much of the Marine RSA.

#### *4.4.8.5 Summary*

As identified in Table 4.4.8.2, the Project's contribution to adverse cumulative effects on traditional marine resource use within the Marine RSA is considered not significant, with the exception of the Project's contribution to cumulative effects on the southern resident killer whale population, which is considered to be significant (see Section 4.3.7).

### *4.4.9 Marine Commercial, Recreational and Tourism Use*

This subsection discusses how existing marine traffic and reasonably foreseeable marine traffic within the Marine RSA may interface with additional Project marine traffic to cumulatively affect MCRTU indicators including commercial fisheries and aquaculture, marine transportation, marine recreational use and marine tourism use.

#### *4.4.9.1 Reasonably Foreseeable Developments*

Table 4.4.1.2 summarizes the current level of marine traffic within the Marine RSA as well as the anticipated marine traffic attributed to the Project and other reasonably foreseeable marine traffic. A description of existing and anticipated activities is provided in Section 4.4.1.4.

#### *4.4.9.2 Potential Cumulative Effects*

The potential and likely socio-economic residual effects associated with increased Project-related marine vessel traffic on MCRTU indicators were identified in Section 4.3.11 and are listed in Table 4.4.9.1 along with the associated existing and reasonably foreseeable regional marine traffic that could act in combination with the effects of increased Project-related marine vessel traffic to cause a cumulative effect on MCRTU.

The significance evaluation considers the effect of Project-related marine vessel traffic as a proportion of the total amount of existing and future marine vessel traffic. The potential cumulative effects for each indicator are then discussed in the context of the total foreseeable increased marine vessel traffic in the region.

**TABLE 4.4.9.1**

**POTENTIAL RESIDUAL EFFECTS OF PROJECT-RELATED MARINE TRAFFIC ON MARINE COMMERCIAL, RECREATIONAL AND TOURISM USE CONSIDERED FOR THE CUMULATIVE EFFECTS ASSESSMENT**

| Potential Residual Effect on MCRTU Indicator | Spatial Boundary[1] | Temporal Boundary | Potential Cumulative Effect | Existing Activities/Reasonably Foreseeable Activities with Residual Effects Acting in Combination with Project-Related Marine Vessel Traffic |
|---|---|---|---|---|
| 1. Combined Project effects on commercial fisheries and aquaculture. | LSA to RSA | Operations | Project contribution to cumulative effects on commercial fishing. | • Existing marine traffic.<br>• Reasonably foreseeable marine traffic within the RSA listed in Table 4.4.1.2. |
| 2. Combined Project effects on marine transportation. | LSA to RSA | Operations | Project contribution to cumulative effects on marine transportation. | • Existing marine traffic.<br>• Reasonably foreseeable marine traffic within the RSA listed in Table 4.4.1.2. |

**TABLE 4.4.9.1**

**POTENTIAL RESIDUAL EFFECTS OF PROJECT-RELATED MARINE TRAFFIC ON MARINE COMMERCIAL, RECREATIONAL AND TOURISM USE CONSIDERED FOR THE CUMULATIVE EFFECTS ASSESSMENT (continued)**

| Potential Residual Effect on MCRTU Indicator | Spatial Boundary[1] | Temporal Boundary | Potential Cumulative Effect | Existing Activities/Reasonably Foreseeable Activities with Residual Effects Acting in Combination with Project-Related Marine Vessel Traffic |
|---|---|---|---|---|
| 3. Combined Project effects on marine recreational use. | LSA to RSA | Operations | Project contribution to cumulative effects on marine recreational use. | • Existing marine traffic.<br>• Reasonably foreseeable marine traffic within the RSA listed in Table 4.4.1.2. |
| 4. Combined Project effects on marine tourism use. | LSA to RSA | Operations | Project contribution to cumulative effects on marine tourism use. | • Existing marine traffic.<br>• Reasonably foreseeable marine traffic within the RSA listed in Table 4.4.1.2. |

**Note:** 1 RSA = Marine RSA

### *4.4.9.3 Significance Evaluation of Potential Cumulative Effects*

The combined Project effects on marine transportation, marine recreational use and marine tourism use from Table 4.3.11.3 were assessed in terms of the Project contribution to cumulative effects in each indicator category. Table 4.4.9.2 provides a summary of the significance evaluation of the contribution of Project-related marine vessel traffic to the potential cumulative effects. The rationale used to evaluate the significance of each of the cumulative effects is provided below.

**TABLE 4.4.9.2**

**SIGNIFICANCE EVALUATION OF THE CONTRIBUTION OF PROJECT-RELATED MARINE TRAFFIC TO CUMULATIVE EFFECTS ON MCRTU**

| Potential Cumulative Effects | Impact Balance | Spatial Boundary[1] | Temporal Context | | | Magnitude | Probability | Confidence | Significance[2] |
|---|---|---|---|---|---|---|---|---|---|
| | | | Duration | Frequency | Reversibility | | | | |
| **1. MCRTU Indicator – Commercial Fisheries and Aquaculture** | | | | | | | | | |
| 1(a) Project contribution to cumulative effects on commercial fishing. | Negative | LSA to RSA | Long-term | Periodic | Long-term | Low to medium | High | High | Not significant |
| **2. MCRTU Indicator – Marine Transportation** | | | | | | | | | |
| 2(a) Project contribution to cumulative effects on marine transportation. | Negative | LSA to RSA | Long-term | Periodic | Long-term | Low to medium | High | High | Not significant |

**TABLE 4.4.9.2**

**SIGNIFICANCE EVALUATION OF THE CONTRIBUTION OF PROJECT-RELATED MARINE TRAFFIC TO CUMULATIVE EFFECTS ON MCRTU (continued)**

| Potential Cumulative Effects | Impact Balance | Spatial Boundary[1] | Temporal Context | | | Magnitude | Probability | Confidence | Significance[2] |
|---|---|---|---|---|---|---|---|---|---|
| | | | Duration | Frequency | Reversibility | | | | |
| **3. MCRTU Indicator – Marine Recreational Use** | | | | | | | | | |
| 3(a) Project contribution to cumulative effects on marine recreational use. | Negative | LSA to RSA | Long-term | Periodic to continuous | Long-term | Low to medium | High | High | Not significant |
| **4. MCRTU Indicator – Marine Tourism Use** | | | | | | | | | |
| 4(a) Project contribution to cumulative effects on marine tourism use. | Negative | LSA to RSA | Long-term | Periodic | Long-term | Low to medium | High | High | Not significant |
| **5. Combined Cumulative Effects on MCRTU** | | | | | | | | | |
| 5(a) Combined Project contribution to cumulative effects on MCRTU indicators (1[a], 2[a] 3[a], and 4[a]). | Negative | LSA to RSA | Long-term | Periodic | Long-term | Low to medium | High | High | Not significant |

**Notes:** 1 RSA = Marine RSA

2 **Significant Contribution to a Cumulative Socio-Economic Effect:** The Project's contribution to a cumulative socio-economic effect is considered significant if the contribution is predicted to be:

- high magnitude, high probability, short to medium-term reversibility and regional, provincial or national in extent that cannot be technically or economically mitigated; or
- high magnitude, high probability, long-term or permanent reversibility and any spatial boundary that cannot be technically or economically mitigated.

#### 4.4.9.3.1 Marine Commercial, Recreational and Tourism Use Indicator – Commercial Fisheries and Aquaculture

Commercial fishing takes place throughout the Marine RSA, including areas of Burrard Inlet, the southern Strait of Georgia, Boundary Pass, Haro Strait and Juan de Fuca Strait. Commercial fishing vessels employ a variety of fishing techniques for a large number of key targeted species and species groups, including salmon, herring, groundfish, crab, shrimp and prawn. Desktop analysis determined that no active aquaculture operations are present within the Marine LSA in Canadian waters; it was determined that the effects of vessel wake from Project-related marine vessels on fish and fish habitat would be negligible at a distance of approximately 2 km.

Existing activities that affect commercial fishing in the Marine RSA include any use that displaces fishing activities. Fishing vessels can be physically displaced by the presence of other vessels or marine infrastructure, or fishing may be prohibited in areas that are reserved for other types of use. Marine shipping activities of deep draft vessels (including Project-related marine vessels) may affect commercial fishing activities if fishing is taking place within the designated shipping lanes, or if fishing vessels use the shipping lanes on route to fishing grounds or processing facilities.

Preferred fishing areas coincide with the designated shipping lanes in many areas of the Marine RSA. Fishing grounds are likely to have existed for many years prior to the imposition of the shipping lanes. In addition, fishers may specifically target shipping lanes or other frequently used routes because such areas may not be fished regularly and, therefore, can be de facto recovery areas for target species. For example, conflicts between crab fishers and ferry operators have recently been documented near both Prince Rupert and Mayne Island, where crab traps have become entangled in ferry propellers (Vancouver Sun 2010).

Commercial fishing vessels may choose to fish in the shipping lanes during fishery openings; for example, fishery openings for species such as roe herring or salmon can be very brief and may occur only once in a fishing season, with fishing vessels sometimes congregating for the duration of the opening over a key fishing area (CCG 2013b, DFO 2012d, DFO 2013l).

The Project contribution to the cumulative effects on commercial fishing is most likely to occur in areas where productive fishing grounds coincide with the designated shipping lanes in the Marine RSA. Several locations along the shipping lanes are highly productive undersea banks that are important fishing locations for many fisheries, including Sturgeon Bank and Roberts Bank in the southern Strait of Georgia, Constance Bank south of Victoria in Juan de Fuca Strait, and Swiftsure Bank near the western entrance to Juan de Fuca Strait. Preferred fishing locations depend upon the species being fished, and many of these fishing "hotspots" are situated along or near the shipping lanes. Another example occurs near Stuart Island around the shipping lanes in Haro Strait which is higher effort area for the prawn trap fishery. A final example is the salmon gillnet fishery which can occur in short and intense openings around the mouth of the Fraser River, in the Roberts Bank area of the shipping lanes outside Tsawwassen (CCG 2013a). Smaller marine vessels including many fishing vessels are not required to register with the CCG Marine Communications and Traffic Services, and these vessels may also not be fully visible on ship's radar, making them difficult to detect by large ships in poor weather (CCG 2013a).

The impact balance of the Project contribution to cumulative effects on the commercial fishing indicator is considered to be negative. The spatial boundary ranges from the Marine LSA to the Marine RSA. Although fishing vessels will only be directly affected by Project-related marine vessels in the area of the shipping lanes (Marine LSA), the cumulative effect of the increase in marine vessel traffic may be that displaced fishing vessels select other fishing areas, which could increase fishing effort in other areas of the Marine RSA. The duration is considered to be long-term, extending through the operational life of the Project. The frequency of the Project contribution is considered to be periodic. Project-related marine vessels will be transiting daily through the Marine RSA, with the potential to contribute to the combined effects on fishing activities intermittently and repeatedly over the operational life of the Project.

The reversibility of the Project contribution to cumulative effects on commercial fishing is considered to be long-term, since the residual effects attributable to the Project-related increase in vessel traffic will occur for the operational life of the Project. The magnitude of the Project contribution to the cumulative effect is low to medium. The Project contribution to cumulative effects on commercial fishing activities may cause commercial fishing vessels be temporarily inconvenienced by the presence of Project-related marine vessels (low), but delays may have business implications for some commercial fishing operators at select times (medium). The overall probability of a Project contribution to cumulative change in commercial fishing activities is considered to be high, for some operators (Table 4.4.9.2, point 1[a]). A summary of the rationale for all of the significance criteria is provided below.

- **Spatial Boundary** - Marine LSA to RSA - the Project contribution to cumulative effects on commercial fishing could occur at any point along the shipping lanes

(LSA), and may cause displacement of vessels to other regions of the Marine RSA.

- **Duration** - long-term - the event causing the cumulative change in commercial fishing (*i.e.* presence of Project-related marine vessels) will begin during the operations phase and extend for the operational life of the Project.
- **Frequency** - periodic –the Project contribution to the cumulative effects on commercial fishing activities have the potential to occur intermittently but repeatedly over the operational life of the Project.
- **Reversibility** - long-term – the Project contribution to cumulative effects on commercial fishing is expected to extend throughout the operational life of the Project.
- **Magnitude** - low to medium - the Project contribution to cumulative effects on commercial fishing activities may cause commercial fishing vessels be temporarily inconvenienced by the presence of Project-related marine vessels (low), but delays may have business implications for some commercial fishing operators at select times (medium).
- **Probability** - high – it is likely that the Project contribution to the cumulative effects on commercial fishing vessels, as characterized, will occur for some operators.
- **Confidence** - high - there is a good understanding of general cause-effect relationships that characterize the Project contribution to cumulative change in commercial fishing.

#### 4.4.9.3.2 Marine Commercial, Recreational and Tourism Use Indicator – Marine Transportation

Marine transportation use in the Marine RSA includes: deep draft marine vessels for long distance shipping of goods; (*i.e.*, cargo carriers, container ships and tankers); passenger vessels such as cruise ships and passenger ferries, and tugs engaged in barging activities. Marine terminals import and export goods including automobiles, bulk products (*i.e.*, raw material commodities such as chemicals and petroleum products) break-bulk products (*e.g.*, forest products); and intermodal containers with consumer goods (PMV 2013a).

A large portion of the current commercial vessel movements in areas of the Marine RSA consists of tug traffic, while assisting ships, engaging in short sea (*i.e.*, short distance) shipping activities, or in transit. In eastern Burrard Inlet, tug traffic comprises 82 per cent of the total current marine vessel movements. Cargo and container ships make up significant portions of the total vessel movements in the Strait of Georgia (30 per cent), Haro Strait (50 per cent), and other areas. Ferry movements are responsible for a large proportion of the total vessel activity in the Strait of Georgia (32 per cent) (refer to Table 4.4.1.2).The Project contribution to the cumulative effects on marine transportation is considered to be most likely to occur in Burrard Inlet in the area of the Second Narrows. Table 4.4.1.2 shows the annual number of Project-related marine tanker movements to be 720, assuming an average increase of 30 vessels per month above the current vessel traffic associated with the Westridge Marine Terminal, which accounts for both inbound and outbound tankers calling at Westridge Marine Terminal. The increase constitutes an increase of 9.5 per cent in eastern Burrard Inlet, not counting the associated increase in escort tugs that will be required (Table 4.4.1.2). The total Project-related contribution to marine vessel traffic in Burrard Inlet is estimated to be 29.6 per cent, including escort tugs (Table 4.4.1.2).

Assuming daily transits of Project-related marine vessels, the CN Rail Bridge will need to be raised twice daily to accommodate Project-related vessels. The PMV requirement for all other vessels to remain clear of the shipping channels while deep draft vessels are in transit will also apply twice daily, on average. Marine traffic requiring access to areas east of the Second Narrows and rail traffic both have the potential to be delayed by the increase in Project-related marine vessel traffic. The demand for anchorages may also increase if commercial vessels miss the appropriate tidal window for transiting through Burrard Inlet. Including Westridge Marine Terminal, six active marine terminals are located east of the Second Narrows in Burrard InletThe use of the CN Rail Bridge will further increase in frequency if capacities are increased at other marine terminals in the eastern portions of Burrard Inlet. .

The relative contribution of Project-related marine vessels (tankers and escort tugs) to total vessel traffic in other areas of the Marine RSA is lower, ranging from 7.2 per cent to 13.9 per cent, due to the increased traffic from other ports and terminals in Canada and the US (Table 4.4.1.2). If approved, future developments such as those described in Section 4.4.1.4 and Project-related marine vessel traffic will add to the existing marine vessel traffic in the Marine RSA. Increased marine vessel traffic from all sources is likely to increase congestion in areas that are constrained geographically and already experience high marine traffic volumes. Mitigation measures for the potential residual effects of increased Project-related marine vessel traffic on marine transportation are proposed in Table 4.3.11.2.

The impact balance of the Project contribution to cumulative effects on the marine transportation indicator is considered to be negative. The spatial boundary where these effects are considered to be likely is the Marine LSA to the Marine RSA; since the zone of influence of Project-related marine vessels could overlap with other future traffic and extend beyond the Marine LSA. The duration of the Project contribution to cumulative effects on marine transportation is considered to be long-term, extending through the operational life of the Project.

The Project contribution to cumulative effects on marine transportation is considered to be periodic in frequency. Project-related marine vessels will be transiting through the Marine RSA twice daily over the operational life of the Project. The reversibility of the Project contribution to cumulative effects on marine transportation is considered to be long-term, since the effect on marine transportation and rail traffic will potentially occur for the operational life of the Project.

The magnitude is low to medium. Although the Project contribution to cumulative change in marine transportation use may be perceived only as a nuisance to some users (low), the activities of other commercial marine users may be interrupted as a result of interactions with Project-related marine vessel traffic which could have business implications (medium) (Table 4.4.9.2, point 2[a]).

The Project contribution to cumulative change in marine transportation use is considered to be likely, due to the navigational constraints present in Burrard Inlet, the requirement for raising the lift span of the CN Rail Bridge to allow vessel transits, the PMV Clear Narrows requirement for deep draft vessel transits and the location of other active marine terminals east of the Second Narrows which also experience regular vessel calls. Confidence in the significance evaluation is high, and is based on a good understanding of data from within the RSA. A summary of the rationale for all of the significance criteria is provided below.

- **Spatial Boundary** - Marine LSA to RSA – the Project contribution to cumulative effects on marine transportation use since the zone of influence of Project-related marine vessels could overlap with other future traffic and contribute to cumulative effects extending beyond the Marine LSA.
- **Duration** - long-term – the presence of Project-related marine vessels will extend for the operational life of the Project.
- **Frequency** - periodic – the Project contribution to the cumulative effect on marine transportation will occur whenever a Project-related tanker is in transit.
- **Reversibility** - long-term – the Project contribution to cumulative effects on marine transportation such as delays or disruptions are expected to extend throughout the operational life of the Project.
- **Magnitude** - low to medium - the Project contribution to cumulative effects on marine transportation activities may contribute to commercial vessels to be temporarily inconvenienced by the presence of Project-related marine vessels (low), but delays may have business implications for some commercial operators at select times (medium).
- **Probability** - high – the Project contribution to cumulative effects on marine transportation is considered to be likely.
- **Confidence** - high – there is a good understanding of general cause-effect relationships that result in the Project contribution to cumulative effects on marine transportation use.

#### 4.4.9.3.3 Marine Commercial, Recreational and Tourism Use Indicator – Marine Recreational Use

Marine recreational use in the Marine RSA includes: kayaking; boating; fishing; and scuba diving. Many easily accessible areas within the Marine RSA are popular destinations for both residents and visitors, including Indian Arm and False Creek in the Lower Mainland and marine areas around Victoria on Vancouver Island. In the southern Strait of Georgia, fishers and boaters use the strait to access destinations in the Gulf Islands, Vancouver Island and other locations. Recreational fishing occurs all over the Marine RSA, in particular for salmon, halibut, rockfish and crab. Marinas and yacht clubs are located in communities throughout the Marine RSA. Most recreational activities including boating, kayaking and diving take place in accessible nearshore areas which are outside of the shipping lanes. Fishing may be the most likely recreational activity to occur in or near the shipping lanes, due to the overlap with key fishing grounds at several locations in the Marine RSA.

The Project contribution to the cumulative effects on marine recreational use is likely to affect recreational vessel traffic in Burrard Inlet, where concern has been noted at marinas east of the Second Narrows regarding the increased frequency of CN Rail Bridge openings and related “Clear Narrows” procedures that will be attributable to the Project. In other areas of the Marine RSA that are near the shipping lanes such as Juan de Fuca Strait south of Victoria, recreational users may experience sensory disturbance due to noise, odour or other irritants associated with passage of large marine vessels. A further potential residual effect that was considered to have a high probability of occurrence is negative user perspectives of the Project. This effect addresses feedback from stakeholders and other sources about the negative perspective on the increased presence of oil tankers in the Marine RSA. The effect is applicable to recreational users.

If approved, future developments such as those described in Section 4.4.1.4 and Project-related marine vessel traffic will add to the existing marine vessel traffic in the Marine RSA. Increased marine vessel traffic is likely to increase congestion in areas that are constrained geographically and already experience high marine traffic volumes. Increased marine vessel traffic in such areas may cause recreational users to avoid the area or delay travel, ultimately affecting the quality of the recreational experience.

The impact balance of the Project contribution to cumulative effects on the marine recreational use indicator is considered to be negative. The spatial boundary considered to range from the Marine LSA to the Marine RSA. Recreational vessels are only likely to be directly affected by Project-related marine vessels in the immediate vicinity of the shipping lanes (LSA); however, the negative perspective of the Project is not contingent on the proximity of Project-related marine vessel traffic. The duration is considered to be long-term, extending through the operational life of the Project. The frequency is considered to be periodic to continuous. The Project contribution to the cumulative effects on marine recreational users will occur intermittently, however, repeatedly over the life of the Project. The overall presence of Project-related marine vessels in the Marine RSA may be viewed as continuously affecting negative user perspectives.

The reversibility of the Project contribution to cumulative effects on marine recreational use is considered to be long-term, since the increased Project-related marine vessel traffic will occur for the operational life of the Project. The magnitude is low to medium. Although the effect of one daily tanker transit on a recreational user at a specific location in the shipping lanes is not considered to be significant in the context of the total daily marine vessel traffic (Table 4.4.9.2, point 3[a]), the Project contribution to cumulative effects on marine recreational use will be detectable by marine recreational users. In most cases the Project contribution to effects are likely to represent only an inconvenience to those affected (low), however, if marine recreational users alter preferred routes the magnitude may be considered to be medium.

The overall probability of the Project contribution to cumulative effects on marine recreational users is considered to be high. Sensory disturbance to recreational users is likely, and may contribute to some users avoiding areas near the shipping lanes. Confidence in the significance evaluation is high and is based on a good understanding of data from within the RSA.

A summary of the rationale for all of the significance criteria is provided below.

- **Spatial Boundary** - Marine LSA to RSA – the event causing the Project contribution to cumulative effects on marine recreational use (*i.e.,* presence of Project-related marine vessels) could occur at any point in the shipping lanes in the Marine LSA. Contributions to potential effects related to alteration of movement patterns could occur at any point in the Marine RSA and may also affect the distribution of vessels in areas of the Marine RSA.

- **Duration** - long-term – the event causing the the Project's contribution to cumulative effects on marine recreational use (*i.e.,* presence of Project-related marine vessels) will extend for the operational life of the Project.

- **Frequency** - periodic to continuous – the Project contribution to the cumulative effects on marine recreational users will occur intermittently, however, repeatedly over the life of the Project. The overall presence of Project-related marine vessels in the Marine RSA may be viewed as continuously contributing to negative user perspectives some marine users.

- **Reversibility** - long-term – the Project contribution to cumulative effects on marine recreational use is expected to extend throughout the operational life of the Project.
- **Magnitude** - low to medium – the Project contribution to cumulative effects on marine recreational use will be detectable by marine recreational users. In most cases the effects are likely to represent only an inconvenience to those affected (low), however, if marine recreational users alter their preferred routes or activities the magnitude may be considered to be medium.
- **Probability** - high – the Project contribution to cumulative effects on marine recreational use is likely.
- **Confidence** - high – there is a good understanding of general cause-effect relationships that result in the Project contribution to cumulative effects on marine recreational use.

#### 4.4.9.3.4 Marine Commercial, Recreational and Tourism Use Indicator – Marine Tourism Use

Marine tourism uses of the Marine RSA are diverse, and include: cruise ships; yacht charters; fishing charter companies; and whale-watching. Cruise terminals in Vancouver and Victoria are points of call for the Alaska cruise industry. Cruise ships are required to use the shipping lanes and also must use the services of a marine pilot in BC coastal waters. Small vessels are also involved in marine tourism. Commercial sportfishing guides take clients fishing for salmon, halibut and other fish and invertebrates around the Vancouver area, the Gulf Islands and Juan de Fuca Strait. Whale-watching operators operate throughout the Strait of Georgia, and spend the most time around the southern Gulf Islands and the US San Juan Islands where killer whales are most likely to be present (Towers pers. comm.). Other tourism operations include day cruises in Burrard Inlet and other areas of the Marine RSA, and yacht charters. Passenger ferries are considered to be commercial marine operators in this assessment, but also can be considered as a marine tourism use.

The Project contribution to cumulative effects on the marine tourism use indicator is related to the increased sensory disturbance to marine tourism users as well as existing marine vessel movement patterns.

If approved, future developments such as those described in Section 4.4.1.4 and Project-related marine vessel traffic will add to the existing marine vessel traffic in the Marine RSA. Increased marine vessel traffic is likely to increase congestion in areas that are constrained geographically and already experience high marine traffic volumes. Increased marine vessel traffic in such areas may potentially cause some smaller tourism users to avoid these areas or alter their preferred routes due to sensory disturbance from transiting marine vessels. Mitigation measures for the potential residual effects of increased Project-related marine vessel traffic on marine recreational use are proposed in Table 4.3.11.3 in Section 4.3.

The impact balance of the Project contribution to cumulative effects to marine tourism users is considered to be negative. The spatial boundary is the Marine LSA to RSA, since the zone of influence of Project-related marine vessels could overlap with other future traffic and extend beyond the Marine LSA. Marine tourism vessels are only likely to be directly affected by Project-related marine vessels in the area of the shipping lanes. The duration is considered to be long-term, extending through the operational life of the Project. The frequency is considered to be periodic. Project-related marine vessel traffic is likely to affect marine tourism users intermittently and repeatedly over the operational life of the Project.

The reversibility of the Project contribution to cumulative effects on marine tourism use is long-term, because the Project-specific effects will occur for the operational life of the Project. The magnitude is low to medium. The Project may contribute to commercial tourism operators being temporarily inconvenienced by the presence of Project-related marine vessels (low), but contributions to vessel delays or required alternation of marine routes may have business implications for some commercial tour operators at select times (medium).

The overall probability of the Project contribution to cumulative effects on marine tourism use is considered to be high. Generally, the potential for a Project contribution to cumulative effects on marine tourism users is considered likely to occur and thus of high probability. Confidence in the significance evaluation is high, and is based on a good understanding of data from within the RSA (Table 4.4.4.2, point 4[a]). A summary of the rationale for all of the significance criteria is provided below.

- **Spatial Boundary** - Marine LSA to RSA – Project contribution to sensory disturbance (*e.g.*, visual effects, noise, and air quality) from increased large marine vessel traffic could occur at any point in the shipping lanes in the Marine LSA. Contribution to potential effects related to alteration of movement patterns could occur at any point in the Marine RSA and may also affect the distribution of vessels in areas of the Marine RSA.

- **Duration** - long-term – the event causing the Project contribution to cumulative effects on in marine tourism use (*i.e.*, presence of *Proj*ect-related marine vessels) will extend for the operational life of the Project.

- **Frequency** - periodic – Project-related marine vessels will be transiting through the Marine RSA intermittently but repeatedly over the operational life of the Project.

- **Reversibility** - long-term – the Project contribution to cumulative effects on marine tourism use is expected to extend throughout the operational life of the Project.

- **Magnitude** - low to medium - the Project contribution to cumulative effects on marine tourism activities may cause commercial tourism operators to be temporarily inconvenienced by the presence of Project-related marine vessels (low), but delays or required alteration of marine routes may have business implications for some commercial tourism operators at select times (medium).

- **Probability** - high – a Project contribution to cumulative effects on marine tourism use is likely.

- **Confidence** - high – there is a good understanding of general cause-effect relationships that result in the Project contribution to cumulative effects on marine tourism use.

#### 4.4.9.3.5 Combined Cumulative Effects on Marine Commercial, Recreational and Tourism Use

The potential effects of the Project (*i.e.*, combined Project effects on marine transportation, marine recreation use and marine tourism use) are anticipated to act in combination with other existing marine vessels and projected future increases in vessel traffic to affect MCRTU in the Marine RSA. The impact balance of the Project's contribution to the combined cumulative effects is considered negative, though the implementation of mitigation measures described in Table 4.3.11.2 in Section 4.3 will reduce the severity of cumulative effects associated specifically with the Project and other reasonably foreseeable developments. The overall contribution of the Project to the cumulative effects on MCRTU is of low to medium magnitude, reversible in the long-term and high probability (Table 4.4.9.2, point 4[a]). A summary of the rationale for all the significance criteria is provided below.

- **Spatial Boundary** - Marine RSA - the Project's contribution to cumulative effects is assessed within the regional context of the Marine RSA.
- **Duration** - long-term – the presence of Project-related marine vessels will extend through the operational life of the Project.
- **Frequency** - periodic – Project-related marine vessels will be transiting through the Marine RSA intermittently, but repeatedly over the operational life of the Project.
- **Reversibility** - long-term – the Project contribution to cumulative change in all MCRTU indicators is expected to extend throughout the operational life of the Project.
- **Magnitude** - low to medium – the Project contribution to cumulative effects on MCTRU indicators due to increased Project-related marine vessel traffic is detectable but in most cases does not contribute more than that of an inconvenience or nuisance (low); however, contribution to cumulative effects resulting in delays or alteration of marine routes may have business implications for some commercial operators at select times (medium).
- **Probability** - high – the Project contribution to cumulative effects on MCRTU indicators is likely.
- **Confidence** - high – there is a good understanding of general cause-effect relationships that result in the Project contribution to cumulative effects in MCRTU indicators.

### *4.4.9.4 Potential United States Effects*

The potential cumulative effects evaluated in this assessment are considered to apply equally in Canadian and US waters, primarily due to the location of the shipping lanes being along the international boundary throughout much of the Marine RSA.

### *4.4.9.5 Summary*

As identified in Table 4.4.11.3, there are no situations where the Project's contribution to cumulative socio-economic effects will be significant. Consequently, the Project's contribution to adverse cumulative effects on MCRTU within the Marine RSA will be not significant.

### *4.4.10 Human Health Risk Assessment*

This subsection outlines the nature of potential health risks to people within the screening level HHRA LSA associated with short-term and long-term exposures to the chemical emissions from the increased Project-related marine vessel traffic in combination with chemical exposures associated with existing activities as well as all other reasonably foreseeable developments within the Marine Air Quality RSA (referred to as the "combined chemical exposures" for the purposes of this subsection). The HHRA evaluated the potential health risks to people associated with more than 100 chemicals, including CACs, metals, PAHs, petroleum hydrocarbons (PHCs), sulphur-containing chemicals and VOCs. The HHRA was completed using a series of conservative assumptions reflecting 'worst-case' circumstances, which collectively contributed to an exposure event being strictly hypothetical in nature, with a low probability of occurrence. In particular, the HHRA assumed that people would be found on both a short-term and long-term basis at the location within the HHRA LSA corresponding to the MPOI. The MPOI refers to the location at which the highest ground-level air concentrations of each of the COPC would be expected to occur, and at which the exposures received by the people within the HHRA LSA would be greatest. The choice of the MPOI location was meant to ensure that any potential impacts that could result from exposure to the chemical emissions associated with the Project on the health of the people, regardless of where they might be found, would not be underestimated. The decision to use the MPOI to represent the location at which people would be found was made by default; that is, consideration was not given as to whether or not the MPOI location was suitable for a permanent residence and/or for residents to obtain their entire complement of locally grown or harvested foodstuffs, including garden vegetables, beef, chicken, dairy, eggs, game meat, fish, beach-foods and wild plants, from the local area.

#### *4.4.10.1 Reasonably Foreseeable Developments*

Table 4.4.1.2 summarizes the current level of marine traffic within the Marine RSA as well as the anticipated marine traffic attributed to the Project and other reasonably foreseeable marine traffic. A description of existing and anticipated activities is provided in Section 4.4.1.4.

#### *4.4.10.2 Potential Cumulative Effects*

Consistent with the Project effects assessment (Section 4.3.12), the assessment indicators for the cumulative effects assessment are people within the HHRA LSA whose health might be adversely impacted as a result of the combined chemical exposures. The assessment indicators included both permanent residents living within the HHRA LSA, as well as area users who might frequent the area for recreation or other purposes. The permanent residents were separated into Aboriginal peoples and non-Aboriginal peoples, with the latter residents further separated into urban and non-urban dwellers. Additional details are available in Section 4.3.12.1.

The results of the HHRA revealed that, despite the conservative assumptions employed, with very few exceptions, the maximum predicted levels of exposure to the COPC (acting either singly or in combination) remained below the levels of exposure that would be expected to cause health effects. In the majority of cases, the exposure levels were well below those associated with health effects. The exceedances revealed by the HHRA were very few in number and in virtually all cases were modest in magnitude. The high degree of conservatism incorporated into both the exposure estimates and the exposure limits used for comparison as part of the HHRA must be considered in the interpretation of the exceedances. Based on the weight of evidence, it is unlikely that people would experience health effects from exposure to the potential increase in marine vessel traffic under the cumulative effects assessment. A detailed quantitative HHRA will be completed to expand on the findings and conclusions of the screening level HHRA; the report discussing the detailed HHRA will be submitted to the NEB in early 2014.

### *4.4.11 Summary of the Assessment of Potential Cumulative Effects*

The cumulative environmental and socio-economic effects associated with the Project are similar to those routinely encountered during existing marine transportation operations associated with the Project.

The potential cumulative environmental and socio-economic effects associated with the Project were identified through: engagement with Aboriginal communities, government agencies, other stakeholders and the general public; a review of existing literature; and the professional judgment of the assessment team. These potential cumulative effects were related to environmental and socio-economic elements including:

- physical elements such as marine air emissions and marine acoustic environment;
- biological elements such as marine fish and fish habitat, marine mammals, marine birds, and marine species at risk; and
- socio-economic elements such as traditional marine resource use, marine commercial, recreational and tourism use, and human health.

As per the NEB Filing Manual (2013c), a cumulative effects assessment of GHG emissions is not required for the Project. No likely residual effects were identified in association with the Project for marine sediment or water quality and, consequently, a cumulative effects assessment was not warranted for this element.

Accidental events, such as the venting of an over-pressurized tanker, were considered to have a low probability of occurrence and, therefore, they were not assessed for cumulative effects.

For the purposes of the marine transportation assessment, since Trans Mountain does not have any direct control over the actions of vessel owners and operators, mitigation is considered to include existing legislation and shipping standards that are monitored by federal and international authorities (*e.g.*, PMV, PPA, CCG, Transport Canada, USCG and IMO).

Through the implementation of the mitigation measures, the residual cumulative effects associated with the increase in marine transportation on the environmental and socio-economic elements were considered to be not significant in all cases except one. Given that past and current activities are considered to have caused significant adverse effects on the southern resident killer whale population, the Project's contribution to cumulative effects associated with the increased Project-related marine vessel traffic on this species is considered to be significant.

## 4.5 Supplemental Studies

### *4.5.1 Introduction*

A comprehensive assessment of potential environmental and socio-economic effects was conducted in 2012 and 2013 to complete the following objectives for normal operations of the marine transportation in accordance with the NEB's direction from their *List of Issues* (July 29, 2013) (NEB 2013a).

- Characterise the environmental and human use setting for the proposed increase in Project-related marine vessel traffic, including the following elements:
  - marine sediment and water quality;
  - marine fish and fish habitat;
  - marine birds;
  - marine species at risk;
  - traditional marine resource use;
  - MCRTU; and
  - human health risk assessment.
- Identify sensitive or unique features through consultation.
- Identify environmental mitigation measures (including existing marine transportation industry regulations and standards) to avoid or reduce potential effects.
- Assess the potential environmental and socio-economic effects (including the Project's contribution to cumulative effects) that might be caused by or otherwise affect the Project.

The environmental and socio-economic program was designed to support the highest standards of environmental and socio-economic assessment in recognition of the large scale and many environments the Project is located in.

Due to the timelines involved in collecting knowledge through consultation and facilitating studies such as TMRU studies, an update to the information is proposed to refine and augment site-specific environmental and socio-economic information gathering. A description of these updates and other detailed plans that are proposed are provided in Sections 4.5.2 and 4.5.3.

The objective of the updates is to confirm our current predictions based on desktop review, literature reviews, professional judgment and 60 years of operation of tankers associated with the Westridge Marine Terminal.

For clarity, no supplemental studies relating to the following elements are anticipated:

- marine sediment and water quality;
- marine air emissions;
- marine GHG emissions;
- marine acoustic environment;
- marine fish and fish habitat;
- marine mammals;

- marine birds;
- marine species at risk; and
- MCRTU.

As consultation and engagement continues, the information will be reviewed for any potential changes to the settings, effects assessments and significance conclusions. A supplemental filing based on the updated consultation and engagement activities may be submitted, if deemed warranted.

### *4.5.2 Traditional Marine Resource Use*

TMRU studies for increased Project-related marine vessel traffic were initiated in 2013 for the Project and are ongoing. The initiation of community directed TMRU studies (using third-party consultants) was discussed with Aboriginal communities based on an indicated interest in participating in these studies, their proximity to the Project or their assertion of traditional and cultural rights of the land and waters. Trans Mountain continues to provide funding to assist Aboriginal communities that elected to conduct their own community-directed TMRU studies.

TMRU studies are intended to describe the current use of land and water by Aboriginal communities for traditional purposes and the spatial and temporal extent of use (*i.e.*, frequency, duration and seasonal aspects) potentially affected by the Project, in addition to identification of issues and concerns relating to traditional marine resource use. The methodology for ongoing TMRU studies as well as the qualifications of the personnel designing and conducting the studies is described in the Traditional Marine Resource Use – Marine Transportation Technical Report (Volume 8B, TR 8B-5).

On August 29, 2013, Esquimalt Nation elected to conduct a TERA-facilitated TMRU study. The TMRU study included a map review and community interviews that focused on the Crown lands and waters within the asserted traditional territory of Esquimalt Nation crossed by the Marine RSA. The results of Esquimalt Nation TMRU study completed to date for the Project are provided in the Traditional Marine Resource Use – Marine Transportation Technical Report (Volume 8B, TR 8B-5). Each phase of the TERA-facilitated TMRU study is described in further detail in the following subsections. TERA has implemented proper record keeping practices for information obtained during the TMRU study to ensure that study results are accessible for future reference and confidential information is protected.

Trans Mountain provided funding to assist Aboriginal communities that elected to conduct their own independent, community-led TMRU studies (*i.e.*, third-party). These communities often engaged other consultants to provide technical support and assistance with their TMRU studies for the Project. The following communities have elected to conduct independent, community-led TMRU studies:

- Cowichan Tribes;
- Halalt First Nation;
- Hwlitsum First Nation;
- Lyackson First Nation;
- Pacheedaht First Nation;

- Penelakut First Nation;
- Semiahmoo First Nation; and
- Stz'uminus First Nation.

To date, preliminary interests specific to the ESA have been identified to Trans Mountain by by Esquimalt Nation, Semiahmoo First Nation and by Cowichan Nation Alliance on behalf of Penelakut First Nation, Halalt First Nation, Hwlitsum First Nation, Stz'uminus First Nation and Cowichan Tribes. These interests and the progress of each participating community's TMRU study at the time of application filing is described in detail in the Traditional Marine Resource Use - Marine Transportation Technical Report (Volume 8B, TR 8B-5).. Additional TMRU study work with participating Aboriginal communities is scheduled for completion prior to construction of the Project. Information gathered during ongoing TMRU studies will be considered for incorporation into Project planning under the guidance of existing marine transport regulations and mitigation recommendations made to date. The results of these ongoing engagement efforts will be provided to the NEB.

Katzie First Nation, Kwikwetlem First Nation, Musqueam Indian Band, Malahat First Nation, Pauquachin First Nation, Scia'new Indian Band, Squamish Nation, Tsartlip First Nation, Tsawout First Nation, Tsawwassen First Nation, Tseycum First Nation and Tsleil Waututh Nation have also identified a potential interest in the Project. To date, Trans Mountain has shared Project information and invited each of these communities to participate in the development of a TMRU study and identification of interests. Trans Mountain will continue to support the participation of Katzie First Nation, Kwikwetlem First Nation, Musqueam Indian Band, Squamish Nation and Tsleil-Waututh Nation in Project activities and interest in a TMRU study will be determined by each individual community.

A detailed summary of Trans Mountain's engagement activities with each potentially affected Aboriginal community is provided in Volume 3B and Appendix A of Volume 3B.

#### *4.5.3 Update to the Environmental and Socio Economic Assessment*

An update to Section 4.0 will be provided to the NEB in Q2 2014. The update will contain the following information.

- An update to consultation and engagement conducted pertaining to Section 4.0, since the cut-off for consultation and engagement information for submission of the application.
- An update to the environmental and socio-economic setting (Section 4.2), effects assessment, including any new mitigation (Section 4.3) and cumulative effects assessment (Section 4.4) based on additional TMRU study information collected as well as consultation and engagement conducted as necessary.

After initiation of the marine air and GHG emissions, marine acoustic environment and marine mammals modelling, and as a result of the quantitative risk assessment, Trans Mountain decided to consider the use of additional tug escort as a navigational safety measure to reduce the risk of an accidental spill from a laden Project-related tanker. Tug escort would be added for the entire route between the Westridge Marine Terminal and Buoy J, as identified in Figure 5.4.2 and discussed in more detail in Section 5.4.2.1. Marine air and GHG emissions, marine acoustic environment and marine mammals modelling numbers will be updated based on extended escort tug usage. Modeling results will be provided to the NEB in a supplemental filing in Q2 2014. Based on the professional judgment of the assessment team, the addition of the escort tug is not likely to change any of the significance conclusions presented for marine air and GHG emissions, marine acoustic environment and marine mammals.

Development of HHRA for marine transportation proceeded step-wise, beginning with the screening (preliminary) level HHRA that was completed for the filing of the application. The second step of the process will be the completion and submission of the comprehensive HHRA to the NEB in early 2014.

The screening level HHRA and the comprehensive HHRA represent either end of the scale of complexity in human health risk assessment. The screening level HHRA due, in part, to its more simplistic nature is associated with a higher level of uncertainty than its comprehensive counterpart. However, this uncertainty is accommodated through the use of assumptions based on existing literature and scientific data as well as the professional judgment and experience of the assessment team. Using this approach, any health risks identified by the screening level HHRA are unlikely to be understated, but may be considerably overstated. The increased detail and complexity of the comprehensive HHRA will serve reduce the uncertainty associated with the screening level HHRA.

## 4.6 Conclusion

This marine transportation component of the ESA was completed in support of the proposed TMEP. The pipeline and facilities component of the ESA is found in Volumes 5A and 5B.

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

As a result of the Project, marine traffic volume calling at the Westridge Marine Terminal will increase. The expanded system will be capable of serving 34 Aframax class vessels per month, with actual demand driven by market conditions. The maximum size of vessels (Aframax class) served at the terminal will not change as part 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.

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 *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 2013c), and pertinent issues and concerns identified through consultation and engagement with Aboriginal communities, landowners, regulatory authorities, stakeholders and the general public. The ESA also considers 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 2013b), effectively determining the scope of the ESA and the factors to be assessed.

In addition, the ESA addresses the NEB's *List of Issues* (July 29, 2013) for the Project (NEB 2013a) provided below. Issue 5 of this list specifically informed the marine transportation ESA.

- "The need for the proposed project;

- the economic feasibility of the proposed project;
- the potential commercial impacts of the proposed project;
- 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;
- 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);
- the appropriateness of the general route and land requirements for the proposed project;
- the suitability of the design of the proposed project;
- the terms and conditions to be included in any approval the Board may issue;
- potential impacts of the project on Aboriginal interests;
- potential impacts of the project on landowners and land use;
- contingency planning for spills, accidents or malfunctions, during construction and operation of the project;
- safety and security during construction of the proposed project and operation of the project, including emergency response planning and third-party damage prevention; and
- the NEB 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 4.1. In summary, the ESA includes a description of the following:

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

Table 4.6.1 provides the companies that assisted with the preparation of Section 4.0.

**TABLE 4.6.1**

**PROJECT TEAM**

| Application Component | Team |
|---|---|
| Overview of Marine Transportation and Shipping Activities | Trans Mountain |
| Air Emissions and Greenhouse Gas Emissions Assessment<br>Noise Impact Assessment | Rowan Williams Davies and Irwin Inc. (RWDI) |
| Marine Resources Assessment (Marine Fish and Marine Mammals)<br>Marine Bird Assessment<br>Marine Sediment and Water Quality Assessment<br>Species At Risk Assessment<br>Accidents and Malfunctions Assessment | Stantec Consulting Ltd. (Stantec) |
| Traditional Marine Resource Use Assessment | TERA |
| Human Health Risk Assessment for Normal Operations | Intrinsik |
| Marine Commercial, Recreational and Tourism Use Assessment | Vista Strategy<br>TERA |

Environmental and socio-economic elements potentially interacting with the increased Project-related marine vessel traffic include marine sediment and water quality, marine air emissions, marine GHG emissions, marine acoustic environment, marine fish and fish habitat, marine mammals, marine birds, marine species at risk, traditional marine resource use, marine commercial, recreational, and tourism use, and human health risk assessment. The description of the environmental and socio-economic setting of the marine transportation component of the Project (current state of the biophysical and socio-economic environment) in the vicinity of the marine shipping lanes was compared against the Project description to assess potential environmental and socio-economic effects of increased Project-related marine vessel traffic. For this assessment, one or more indicators were selected and used 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.

Most of the environmental and socio-economic issues have been identified through engagement with Aboriginal communities, regulatory authorities, stakeholders and the general public, as well as through literature reviews and the professional experience of the assessment team. Most of the associated potential effects on environmental and socio-economic indicators arising from the Project can be readily mitigated by industry standards and federal legislation for marine vessel traffic in Juan de Fuca Strait, Haro Strait, Georgia Strait, and Burrard Inlet.

Most of the potential environmental and socio-economic residual effects that could arise from increased Project-related marine vessel traffic are considered to be long-term in duration (*i.e.*, lasting for the operational life of the Project), generally of low to medium magnitude and periodic or accidental in nature. There are no situations that would result in a significant environmental or socio-economic effect, as defined in Section 4.3, except the following:

- the potential effect of sensory disturbance of southern resident killer whales, which is determined to be high magnitude, high probability and significant but immediately reversible; and
- the potential effects of the Project on TMRU as it relates to southern resident killer whales.

The Project may act cumulatively with existing activities and reasonably foreseeable developments in the vicinity of the marine shipping lanes including other current or likely marine vessel traffic in the element-specific RSA (*i.e.*, Marine RSA or Marine Air Emissions RSA). Cumulative effects associated with the Project were evaluated conservatively using assumptions relevant to the element under consideration. Most of the cumulative effects within the element-specific RSAs are anticipated to be long-term in duration and generally of low to medium magnitude. There are no situations that would result in a significant cumulative environmental or socio-economic effect, as defined in Section 4.4, except the following:

- the potential Project contribution to the cumulative effect of sensory disturbance of southern resident killer whales, which is determined to be high magnitude, high probability and significant but immediately reversible; and
- the potential Project contribution to cumulative effects on TMRU as it relates to southern resident killer whales.

Industry and regulatory standards anticipate and address many of the Project's potential effects on the biophysical and socio-economic environment. Though Trans Mountain has little direct control over the actions of the vessel owners and operators, mitigation measures have been developed to further reduce the severity of some potential environmental and socio-economic residual effects (*e.g.*, Trans Mountain would be interested in acting as an active participant in a joint industry-government advisory group that would be charged with determining and/or developing effective mitigation measures to reduce potential effects of underwater noise on marine mammals in the region). The implementation of the proposed mitigation measures and adherence by vessel owners and operators to marine shipping regulations will reduce the severity of the adverse residual environmental and socio-economic effects associated with increased Project-related marine vessel traffic.

# 5.0 RISK ASSESSMENT AND SPILL MANAGEMENT

## 5.1 Purpose and Background

A spill of oil into the marine environment, arising from an incident involving a Project-related tanker, is a key concern for Trans Mountain, Aboriginal communities, government agencies, the public, and the maritime community. Trans Mountain recognizes that an unmitigated oil spill from a tanker could have immediate to long-term effects on the biophysical and human environment of the West Coast of BC.

Given the existing measures in place to prevent shipping and tanker accidents and tanker-related oil spills, Trans Mountain expects that a Project-related spill from a tanker will continue to be an unlikely event. Regardless, Trans Mountain is committed to continuing to work with Aboriginal communities, the public, pipeline shippers, parties in the maritime community, regulatory authorities and others to ensure that spill prevention, emergency preparedness and response measures are reviewed in a systematic and risk-based manner as part of continual improvement and as a commitment to tanker and shipping safety in this region. Such risk-based measures have been evaluated and improvements have been identified with respect to the Project-related increase in marine transportation, which will ensure that any increase in risk as a result of the Project is mitigated to the extent possible and comparable with the current level of risk of a tanker-related oil spill in this region.

Although Trans Mountain is not directly responsible for the operation of tankers and barges calling at the Westridge Marine Terminal, it is an active member in the maritime community and works with maritime agencies to promote best practices and facilitate improvements focusing on the safety, efficiency, and environmental standards of tanker traffic in the Salish Sea. Trans Mountain is a shareholder of WCMRC and works closely with WCMRC and other members to ensure that WCMRC remains capable of responding to any hydrocarbon spills from vessels transferring product or transporting it within their area of jurisdiction.

The purpose of Section 5.0 is to provide an overview of the probability and consequences of an oil spill from a tanker on the biophysical and human environments, and is organized in the following way:

Section 5.2 provides a summary of the quantitative risk assessment conducted by Det Norske Veritas (DNV) (TERMPOL 3.15, Volume 8C, TR 8C-12). The risk assessment considered regional traffic growth, navigational hazards, vessel construction, and risk controls provided under the existing safety regime. Based on an assessment of the tanker transit route the report identified potential locations for accidents. The report quantified the probability of oil spill incidents and the potential consequence of these incidents in terms of spill volume. These probabilities and consequences were combined to define credible worst case and mean case risks based on spill volume.

Section 5.3 is also a summary of the DNV quantitative risk assessment but focuses on spill prevention measures. This section provides a summary of the risk controls that are currently in place and included in the risk assessment. DNV found that existing risk controls are considered to be state of the art compared to other coastal sailing routes worldwide and in line with global best practices. However, to mitigate the effect of increased tanker traffic a number of enhancements are recommended which, if implemented, will raise the level of care and safety in the Salish Sea to well above globally accepted shipping standards. The primary recommendations include extending tug escorts for laden tankers throughout Strait of Georgia and Juan de Fuca Strait and implementing a moving exclusion zone around laden tankers.

Section 5.4 provides a summary of technical reports that describe the fate and behavior of oil spilled in the marine environment. This section includes a discussion of oil properties in general as well as the results of weathering tests conducted for Trans Mountain on diluted bitumen. Results from these tests along with spill volumes and potential locations identified in the DNV risk assessment were used to conduct stochastic modelling for selected locations. Stochastic modelling generates a probability map for oil exposure for the study area. A different map is generated for each combination of spill volume, location, and season. The stochastic modelling was implemented by executing the spill model, for the specific release, every six hours over a full calendar year, to capture the effects of tides, winds, estuarine flow and forcing from the open Pacific. The resulting probability maps do not provide information on a specific spill, but indicate the area that is at risk. An actual spill would only affect a small part of this area, but all parts are at risk. Section 5.4 concludes with a discussion of the results of testing conducted for Trans Mountain on recovery techniques for diluted bitumen.

Section 5.5 provides a summary of oil spill response capacity in the Salish Sea. Trans Mountain engaged WCMRC to review the risk assessment and fate and behavior studies and to describe enhancements to the existing planning standards that would better accommodate the tanker traffic resulting from the Project. The WCRMC study includes an equipment plan that serves as a practical example of how response capacity could be enhanced.

Section 5.6 discusses potential environmental and socio-economic effects of credible worst case and smaller oil spills described in Section 5.4

Section 5.7 provides an assessment of the spill response enhancements presented in Section 5.5. In this case the results for a single spill event at Arachne Reef in the Turn Point Special Operating Area are compared with and without spill response mitigation to assess the effectiveness of the enhanced response capacity described in Section 5.5.

Pursuant to the CEA Act, 2012 s. 19 (1) (a), the NEB's List of Issues for the Project, and the NEB's Filing Requirements Related to the Potential Environmental and Socio-Economic Effects of Increase Marine Shipping Activities, Trans Mountain Project (10 September 2013), Trans Mountain is required to consider the environmental effects of potential malfunctions and accidents that might occur related to the Project. Section 4.0 provided an assessment of higher probability and lower consequence potential accidents and malfunctions, excluding the credible worst case and smaller oil spills. Section 5.0 provides an assessment of a lower probability, high consequence incidents resulting in the unplanned release of oil from several locations along the shipping route. Assessments of credible worst case and smaller spill scenarios at the Westridge Marine Terminal are provided in Volume 7, Section 8.0. Together, these sections meet the NEB and CEA Act, 2012 requirements for the consideration of accidents and malfunctions.

## 5.2 Probability of an Oil Spill from a Tanker in a Marine Environment

The existing Westridge Marine Terminal typically loads five tankers and two or three barges per month. With approval of the Project only the number of tankers is expected to increase with the typical number of tanker loadings increasing up to 34 Aframax tankers per month (Table 2.2.1). An increase in barge traffic as a result of the Project is not expected. As a result of the increase in tanker traffic, the probability of an oil spill will increase. The following sub-sections describe the historical information about oil spills from tankers into the marine environment and discuss the incremental risk of a spill from an oil tanker once the Project is operating.

### *5.2.1 Historical Casualty Data*

As part of the TERMPOL process, Trans Mountain contracted DNV to complete a survey of the available historical casualty data related to marine vessel incidents worldwide and oil spills resulting from those incidents. The complete study is provided in Volume 8C (TERMPOL 3.8, TR 8C-6) and a summary of the results of the study is provided in this section.

#### *5.2.1.1 Background*

Det Norske Veritas used data on the following types of incidents related to marine transportation in the casualty data survey:

- collisions and grounding, referred to as wrecking/stranding in the survey;
- fire/explosion; and
- foundering and contact (*i.e.*, an equipment or electrical malfunction resulting in a loss of power).

Det Norske Veritas used multiple sources of data including:

- IHS Fairplay database of worldwide casualty data;
- oil spills recorded by the International Tanker Owners Pollution Federation Limited;
- incidents in Canadian waters collected and published by the Transportation Safety Board of Canada and the CCG;
- incidents on the West Coast of Canada reported in the PPA incident database; and
- incidents in US waters published by the US Department of Homeland Security.

The results of the casualty study provide estimates of incident frequencies per year, where the information is available; however, the casualty data provided does not describe other relevant factors such as weather, local navigational conditions, and other vessel traffic.

#### *5.2.1.2 Global Trend in Maritime Shipping Safety*

Det Norske Veritas notes that the global safety record in the marine industry has improved continuously over the past 40 years due to regulatory changes and improved safety procedures taken from the lessons learned from past incidents. In addition, the shift from single-hulled to double-hulled tanker design since 1990 has significantly reduced the number of oil spills from tankers.

Det Norske Veritas reviewed recent studies on the effect of double-hulled tankers compared to single-hulled tankers and concluded that a double-hulled tanker design plays an important role in reducing the number of oil spills that could result from a tanker incident such as a collision or grounding. However, if the double hull of the tanker were fully breached, one of the studies referenced by DNV concluded that the incident would result in the same spill volume from a double-hulled *vs*. a single-hulled tanker given the same cargo tank volume and the same oil type. The benefit of the double-hulled tanker design appears to be the decrease in incidents resulting in a full breach of a double-hulled tanker.

DNV illustrates the positive outcome resulting from a double hull *vs.* single hull design by comparing the groundings of the Exxon Valdez in 1989 and the HS Elektra in 2009. The single hull Exxon Valdez spilled 37,000 tonnes of oil in the Prince William Sound, Alaska, as a result of a hard grounding on Bligh Reef. In comparison, when the double-hulled HS Elektra hit an uncharted rock close to the Chilean Coast in 2009, the collision did not result in any release of cargo oil.

While improved navigational management and safety procedures have resulted in fewer collisions and groundings of marine vessels, and in particular for oil tankers, the double hull design of oil tankers has resulted in fewer releases of oil when a collision or grounding occurs.

#### *5.2.1.3 Global Oil Tanker Incidents and Oil Spills*

DNV indicates that the global safety record for oil tankers has improved in step with the global safety record for the maritime industry. Based on the available data, DNV shows that the worldwide incident frequency involving oil tankers is among the lowest of all marine vessels for the period 2002 to 2011 and that only a fraction of the incidents reported for oil tankers resulted in the release of oil. As well, DNV shows that, despite the steady increase in the volume of oil being transported globally, the number of oil spills has decreased in the period 1970 to 2012.

DNV cautions that the global incident data for oil tankers is not directly comparable to the Salish Sea region because the global data does not take into consideration local weather conditions, the navigability of the sailing route, as well as local risk controls implemented that would reduce the likelihood for an incident. However, the global incident data for oil tankers between 2002 to 2011 supports the conclusion that the global safety record for the marine industry continues to improve, in particular for oil tankers. DNV indicated that the change from a single hull to double hull design of tankers, the segregation of oil cargo tanks, improved reliability of machinery, improved navigational aids, and improved risk management are all factors contributing to the reduction of oil spill incidents worldwide.

#### *5.2.1.4 Shipping Incidents in Canadian Waters*

Det Norske Veritas collected data from the Transportation Safety Board on shipping incidents in Canadian waters, including the East (Maritimes and Newfoundland regions), Central (Laurentian and Central regions), West, and Arctic Regions. The most recent incident data from the Transportation Safety Board was for the period 2002 to 2011.

Det Norske Veritas indicated that shipping incidents reported in Canadian waters totalled 285 in 2011, which was a 5 per cent decline from 2010 and a 22 per cent reduction compared to the 2006 to 2010 average of 364 incidents. Overall there has been a downward trend in the number of shipping incidents in Canadian waters since 2002, in keeping with the international trend of improved maritime safety.

The vessel type involved in incidents in Canadian waters most frequently reported is fishing vessels. DNV noted since 2002, 45 per cent of vessels involved in shipping incidents in Canadian waters were fishing vessels. With respect to oil tankers, in 2011, DNV notes there were 11 tankers involved in incidents in Canadian waters, the lowest number of all vessel types. No records could be found of any of these incidents resulting in an oil spill.

#### *5.2.1.5 Shipping Incidents and Oil Spills on the West Coast of Canada*

Of the 285 shipping incidents in Canadian waters in 2011, DNV reported that 31 per cent of these occurred on the West Coast (89), which was the highest concentration of incidents reported compared to other regions in Canada, likely due to the size of the region and number of vessels. In keeping with global trends, all regions in Canada reported a drop in the number of incidents in 2011, compared to the 2002 to 2010 average. With respect to the West Coast, there were 89 incidents in 2011 and an average of 119 incidents from 2002 to 2010. Of particular note, DNV indicated that the majority of incidents on the West Coast involved fishing vessels, tugs, and barges, not oil tankers.

During the 2002 to 2011 period, there was one incident on the West Coast involving an oil tanker and DNV indicates that this incident did not lead to damage of the tanker's hull or a release of oil to the marine environment.

Det Norske Veritas notes that there is no traffic density data correlated to the Transportation Safety Board data, therefore it is impossible to derive incident frequencies. However, the data published by the Transportation Safety Board gives an indication of the low number of vessel incidents on the West Coast, particularly for oil tankers.

The PPA collects incident data for the types of vessels for which they license pilots, which includes the types of oil tankers calling at the Westridge Marine Terminal. From 1993 to 2012, the PPA data reports 6 incidents with tankers, with an average of 0.3 incidents per year within the region that is the PPA's jurisdiction. DNV emphasized that the type of incidents reported by the PPA varied in severity from minor incidents, such as breaking a fender, to more serious incidents, such as collision or grounding. DNV noted that the PPA's data does not report the environmental consequence of any incidentsand therefore the portion of the reported incidents that might have resulted in an oil spill is unknown.

Det Norske Veritas noted that the majority of the incidents reported to the PPA database for all vessels including oil tankers were the result of contact damage (*i.e.,* contact with the dock while berthing). DNV noted that, on average for the period 1993 to 2012, over 60 per cent of incidents reported involved contact damage and other dock-related incidents.

With respect to oil spills on the West Coast, DNV accessed the most recent and available CCG statistics, which were for the period 2001 to 2009. DNV notes there is no updated data available for 2010 to 2012. Of particular interest, DNV noted that during the 2001 to 2009 period there were no oil spill accidents from tankers on the West Coast.

#### *5.2.1.6 Shipping Incidents in the US Salish Sea*

Det Norske Veritas accessed casualty data on incidents in US waters within North America from the Department of Homeland Security's Homeport database. DNV notes that the data is reliable for the period 2006 to 2010; some data before 2006 appears to be missing so the data is questionable, while some incidents reported after 2010 are still under investigation.

Det Norske Veritas notes that the 2006 to 2010 data from the US suggests an increase in the number of all types of vessel incidents on the US West Coast, likely due to the increase in traffic volume.

With respect to tankers in the US waters of the Salish Sea region, DNV noted that the annual number of incidents ranged from eight in 2006 to three in 2007/2008. Most of these incidents occurred in the vicinity of terminals at Cherry Point and Anacortes, Washington. DNV indicated since the data reported covers only five years and the number of vessels is relatively low in the US waters of the Salish Sea, the validity of frequency estimates is low. The data does suggest;

however, that the existing navigational risk controls have had a positive effect on the level of navigational safety in the Salish Sea region, where TMEP-related tankers would transit.

#### *5.2.1.7 Conclusion*

The data investigated by DNV from a number of different sources confirms that globally, there has been an increase in marine safety and subsequent decline in the number of marine vessel incidents, in particular those related to oil tankers and those incidents resulting in the release of oil in a marine environment.

With respect to accidental oil spills from tankers transiting the West Coast there were no reported spills from oil tankers in the 2001-2009 period of CCG collecting this type of data. The low number of incidents involving oil tankers on the West Coast may suggest the current scheme to manage navigation and marine traffic on the West Coast is effective.

### *5.2.2 Probability of a Spill in the Marine Environment Related to the Project*

To understand the incremental risk related to the increase in oil tanker traffic created by TMEP, Trans Mountain contracted DNV to conduct a quantitative risk assessment. The quantitative risk assessment is one of the studies carried out for the TERMPOL process and the entire study is provided in TERMPOL 3.15, Volume 8C, TR 8C-12. A summary of the results of the risk assessment is provided in this section.

Det Norske Veritas evaluated the existing marine and shipping network of the Burrard Inlet and Salish Sea to identify:

- the possible types of incidents that could result in an oil spill from a laden tanker;
- the navigational hazards along the route a laden oil tanker would transit between the Westridge Marine Terminal and the Pacific Ocean;
- the navigational risk controls currently that are in use in the Salish Sea region and which have been effective at reducing the frequency of navigational incidents;
- the possible types of incidents that could result in an oil spill from a laden tanker;
- the hypothetical accident locations along the previously mentioned tanker route that could result in an oil spill from a laden tanker;
- the potential for enhanced navigational risk controls to reduce the probability of an oil spill from a laden tanker; and
- the probability and consequences of a credible worst case and smaller accidental oil spill (*i.e.,* a “mean-case” oil spill) from a laden tanker.

Based on an examination of casualty data and TERMPOL requirements, DNV selected five accidents types that could result in an accidental oil spill from a laden oil tanker:

- collision;
- powered grounding;
- drift grounding;
- structural failure; and
- fire/explosion.

As a result of the navigational hazard assessment, DNV defined a study area that included the route a laden oil tanker would transit from the Westridge Marine Terminal to the Pacific Ocean as well as directly adjacent areas, and divided the study area into twelve segments. DNV estimated both the accident and the frequency an accident might result in an accidental oil spill by a laden oil tanker from the Westridge Marine Terminal for each segment, taking into consideration these factors:

- existing and future marine traffic density;
- navigational difficulty;
- existing and proposed additional navigational risk controls; and
- meteorological and oceanographic conditions along the shipping route.

Det Norske Veritas considered existing navigational risk controls that are currently used in the study area to effectively manage marine vessel traffic and reduce the frequency of marine vessel incidents. The existing navigational risk controls DNV considered, and which were previously described in Section 1.4.3, in the quantitative risk assessment included:

- traffic separation scheme and one-way traffic;
- communication systems and oversight such as MCTS;
- mandatory pilotage for oil tankers;
- ship vetting procedures; and
- escort tugs, both tethered and non-tethered.

Det Norske Veritas also recommended two additional navigational risk controls to address the Project-related increase in tanker traffic. The additional navigational risk controls are described in greater detail in Section 5.4.2 and include:

- additional tug escort for laden oil tankers, including both tethered and non-tethered tugs; and
- a moving safety zone around laden oil tankers.

### *5.2.3 Volume of a Spill in the Marine Environment Related to the Project*

To determine the risk of oil spills resulting from Project tankers DNV applied the probability of oil spill accidents, discussed above, to an estimate the consequences discussed here. For the purpose of DNV's analysis the quantification of consequences was limited to oil spill volume.

Expected oil spill volumes were derived from a ship damage model based on International Marine Organization Resolution for Marine Environmental Protection Program methods (IMO 2013c) for collision and grounding events. DNV applied a Monte Carlo simulation to this model to calculate the extent of uncontrolled outflow volume from a partially laden Aframax tanker. The results of the simulation provide a cumulative probability of outflow volume for an oil cargo spill accident. DNV recommended that a credible worst case spill be based on the $90^{th}$ percentile volume, this is shown along with the mean ($50^{th}$ percentile spill volume) in Table 5.2.1.

**TABLE 5.2.1**

**SIZE OF POSSIBLE ACCIDENTAL CARGO OIL SPILLS FROM A PROJECT-RELATED TANKER**

| Cases | Volume of Oil Spilled |
|---|---|
| Credible worst-case spill | 16,500 $m^3$/104,000 bbl |
| Mean-case spill | 8,250 $m^3$/52,000 bbl |

**Source:** TERMPOL 3.15 (Volume 8C, TR 8C-12)

It is important to note that the credible worst-case spill does not reflect the complete loss of the contents of an oil tanker. DNV noted that, given the current design of an oil tanker with a double hull and segregated cargo compartments, the complete loss of the contents of a tanker leaving the Westridge Marine Terminal (*i.e.*, an Aframax vessel filled to 85 per cent capacity) is so unlikely that it is not a credible event for the purposes of the quantitative risk assessment.

### *5.2.4 Potential Locations for a Spill in the Marine Environment Related to the Project*

As part of the quantitative risk assessment DNV completed a hazard identification exercise to identify locations where there is a higher degree of navigation complexity and probability of an incident due to a navigation issue involving collision or grounding of the tanker due to vessel traffic and/or the narrowness of the passage. The locations along the tanker route identified in the hazard identification exercise are summarized in Table 5.2.2. Five of the eight locations were modelled to develop hypothetical spill scenarios. One of the modelled locations is at the Westridge Marine Terminal and the results of modelling at this location are provided in Volume 7, Section 8.0, leaving four locations which are discussed in this Section 5. Three locations in Table 5.2.2 were not modelled for the reasons provided in the table.

## TABLE 5.2.2

## POSSIBLE LOCATIONS FOR AN ACCIDENT INVOLVING A PROJECT-RELATED TANKER

| ID[1] | Possible location of Accident with Possibility of Oil Spill | Representative Hypothetical Incident | Identified Hypothetical Spill Scenario (Latitude/Longitude: North/West) |
|---|---|---|---|
| A | Westridge Terminal[2] | Oil spill from loading operation or flow line damage. | 160 $m^3$ spill at berth with 20% escaping the pre-deployed oil spill boom (Lat/Long: 49.29150/ -122.95050) |
| B | English Bay | Possible collision with ships at anchor in English Bay and traffic from Fraser river is low probability | Not considered as viable spill location due to relatively low frequency for an accidental oil cargo spill |
| C | Roberts Bank | Possible collision with crossing traffic from Fraser river and other crossing traffic is low probability | Not considered as viable spill location due to relatively low frequency for an accidental oil cargo spill |
| D | Strait of Georgia (main ferry route crossing) | Possible collision with crossing traffic from Fraser River and ferries is a low probability event, but considered because of higher number of crossings per day | Collision (Lat/Long: 48.94303/ -123.21739) |
| E | Arachne Reef (Turn Point Special Operating Area)[3] | Possible powered grounding is a low probability event due to pilots and tethered tug but this location is rated with greatest level of navigation complexity for the entire passage. Location also has high environmental values. | Powered grounding (Lat/Long: 48.6850/ -123.2930) |
| F | Brotchie Pilot Boarding Area | Possible collision with other vessel is a low probability event. | Similar to Location G. Chose Location G. |
| G | Juan de Fuca Strait – (south of Race Rocks) | Possible collision with crossing traffic from Puget Sound and Rosario Strait or grounding at Race Rock is a low probability event, but considered because not all vessels in this location would have pilot onboard. | Collision (Lat/Long: 48.25257/ -123.52687) |
| H | Buoy J | Possible collision between vessels approaching the confluence of the traffic separation scheme (TSS) at the entrance to Juan de Fuca Strait. It is a low probability event due to high oversight by MCTS and well established TSS. | Collision (Lat/Long: 48.49401/ -124.99440) |

**Notes:** All in-transit hypothetical spill locations have been modelled for both credible worst case (16,500 $m^3$) and smaller spill size (8,250 $m^3$)

1 These identifiers correspond to the locations outlined in Figure 5.5.2

2 The hypothetical spill at the Westridge Marine Terminal is described in Volume 7A

3 The hypothetical spill at Arachne Reef in the Turn Point Special Operating Area is the hypothetical scenario described in Section 5.7.

**Source:** TERMPOL 3.15 (Volume 8C, TR 8C-12)

### 5.2.5 *Risk of a Spill in the Marine Environment Related to the Project*

Det Norske Veritas's quantitative risk assessment illustrates the risk of an accidental oil spill without the Project proceeding, with predicted 2018 marine traffic volumes and with the current navigational safety regime in Table 5.2.3.

**TABLE 5.2.3**

**RISK OF ACCIDENTAL CARGO OIL SPILL IN 2018, ASSUMING NO PROJECT AND CURRENT NAVIGATION SAFETY MEASURES**

| Spill Size | Oil Spill Volume ($m^3$/bbl) | Return Period[1] in Years |
|---|---|---|
| Credible worst-case | 16,500 $m^3$/104,000 bbl | 1 in 3,093 years |
| Mean-case | 8,250 $m^3$/52,000 bbl | 1 in 619 years |
| Any | > 0 $m^3$/0 bbl | 1 in 309 years |

**Source:** TERMPOL 3.15 (Volume 8C, TR 8C-12)

Det Norske Veritas's quantitative risk assessment also illustrates the risk of an accidental cargo oil spill from a Project-related Aframax tanker in 2018 with the current navigation safety measures in place and no additional mitigation undertaken (Table 5.2.4). Without additional navigation safety measures, the probability of an accidental oil spill from a Project-related tanker would increase substantially.

**TABLE 5.2.4**

**RISK OF ACCIDENTAL CARGO OIL SPILL FROM A PROJECT-RELATED TANKER WITHOUT ADDITIONAL NAVIGATION SAFETY MEASURES**

| Spill Size | Oil Spill Volume ($m^3$/bbl) | Return Period[1] in Years |
|---|---|---|
| Credible worst-case | 16,500 $m^3$/104,000 bbl | 1 in 456 years |
| Mean-case | 8,250 $m^3$/52,000 bbl | 1 in 91 years |
| Any | > 0 $m^3$/0 bbl | 1 in 46 years |

**Source:** TERMPOL 3.15 (Volume 8C, TR 8C-12)

In order to reduce the probability of an accident occurring that would result in a spill from a Project-related tanker, Trans Mountain is seeking endorsement from Transport Canada for additional measures to improve navigational safety outlined in Section 5.4.2. If the additional navigation safety controls are implemented, the probability of an oil spill from a Project-related Aframax tanker in 2018 will be substantially reduced, as summarized in Table 5.2.5 and further described in Section 5.4.2. Trans Mountain will require all Project-related tankers to have enhanced tug escort for the entire transit between the Westridge Marine Terminal and the Pacific Ocean.

[1] A *return period* is a calculated estimate of the probability of an event. This term is used as part of a quantitative risk assessment. A return period is mathematically the inverse of an annual frequency. It means that an accident whose annual frequency is 0.01 is likely to happen once every 100 years. Its return period is 100 years. The lower the probability is the higher the return period will be.

**TABLE 5.2.5**

**RISK OF ACCIDENTAL CARGO OIL SPILL FROM A PROJECT-RELATED TANKER WITH ADDITIONAL NAVIGATION SAFETY MEASURES**

| Spill Size | Oil Spill Volume $m^3$/bbl | Return Period in Years |
|---|---|---|
| Credible worst-case | 16,500 $m^3$/104,000 bbl | 1 in 2,366 years |
| Mean-case | 8,250 $m^3$/52,000 bbl | 1 in 473 years |
| Any | > 0 $m^3$/0 bbl | 1 in 237 years |

**Source:** TERMPOL 3.15 (Volume 8C, TR 8C-12)

## 5.3 Oil Spill Prevention

### *5.3.1 Existing Risk Controls*

Det Norske Veritas found that within the study area marine navigation is well managed and important risk controls have been established for all traffic and for oil tankers in particular. DNV acknowledges that the existing risk controls for the route a Project-related tanker would transit are considered to be state of the art compared to other coastal sailing routes worldwide. These controls are in line with global best practices. The risk control measures in place today include:

- inspection of vessels under Port State Control;
- screening of vessels by charterer and terminal operator;
- aids to Navigation;
- Traffic Separation Scheme;
- oversight by VTS;
- mandatory pilotage;
- mandatory use of modern navigation equipment Electronic Chart Display and Information System, AIS, Radar;
- mandatory use of escort tugs; and
- mandatory participation in spill response regime.

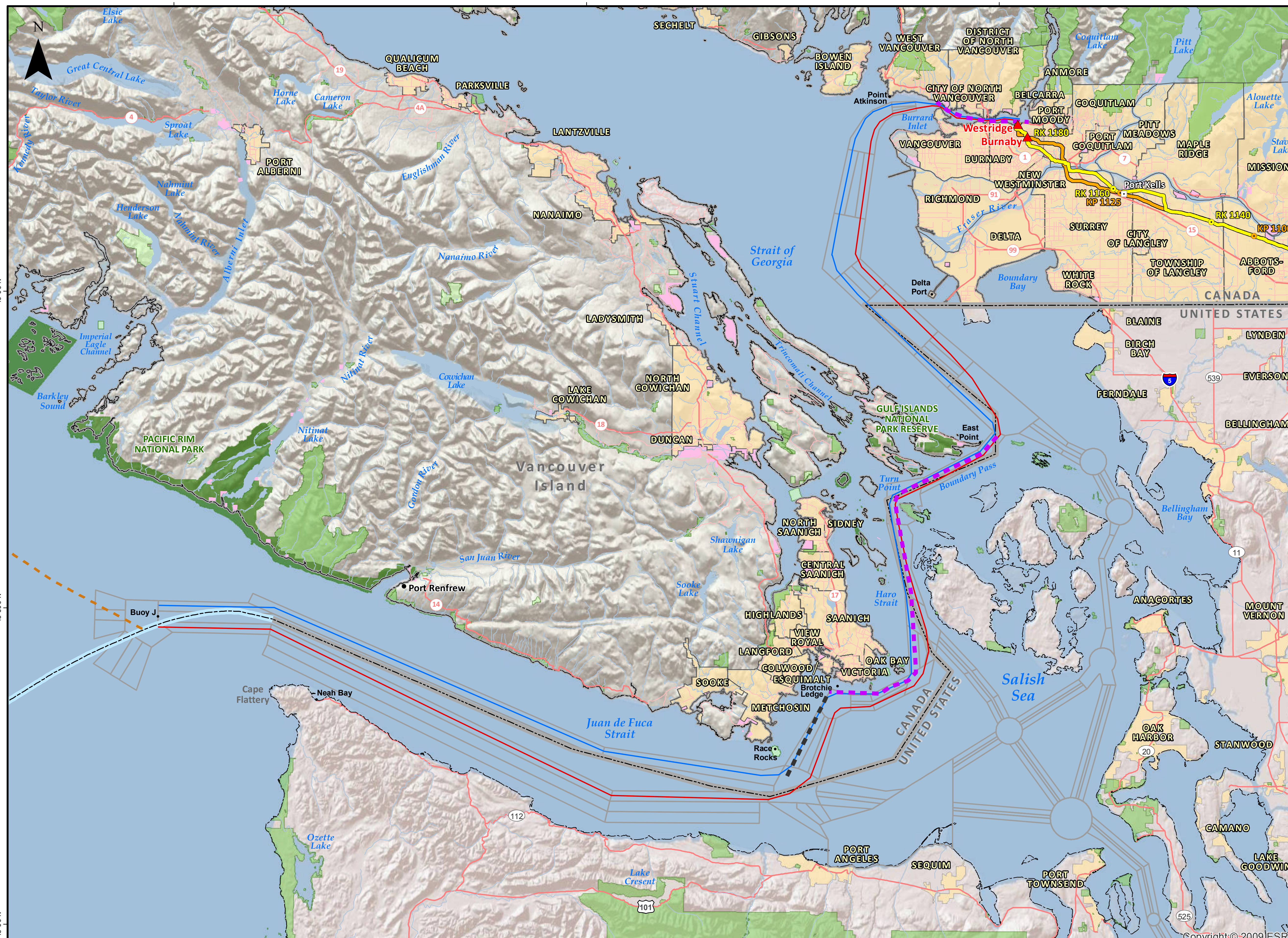
To offset the effect of increased Project-related tanker traffic, a number of enhancements are recommended which, if implemented, will raise the level of care and safety in the study area to well above globally accepted shipping standards. The primary recommendations include extending tug escorts for laden Project-related tankers throughout Strait of Georgia and Juan de Fuca Strait and implementing a Moving Safety Zone around laden tankers. In addition to these preventative measures Trans Mountain is proposing significant improvements to the oil spill response regime for the area, which will be further modified in accordance with any future Canadian Federal regulations and standards.

The regulatory framework, roles and responsibilities for navigational safety in Canada were described in detail in Section 1.4.

To summarize the key messages in Section 1.4, prevention of spills from oil tankers in the marine environment in Canadian waters emphasizes ensuring navigational safety through a regulatory framework that focuses on:

- **Vessel design and specifications** - All large oil tankers transiting Canadian waters must be of double-hulled design (Government of Canada 2013). A double hull is a type of tanker construction where the bottom and sides of a vessel have two complete layers of watertight hull surface, creating a space between the outer hull and the inner hull (TERMPOL 3.9 Ship Specifications, Volume 8C, TR 8C-7). For an uncontrolled release of oil from a tanker to occur, both layers would need to be breached. As noted in the summary of TERMPOL 3.8 Casualty Data (Volume 8C, TR 8C-6) in Section 5.2.1, a double-hulled tanker design decreases the frequency of tanker accidents that would result in an accidental release of cargo oil.
- **Vessel screening, vetting, and inspection** - Transport Canada participates in an international program that identifies Ships of Particular Interest, and bans them from entering Canadian waters. This program, combined with Canada's Port State Control program, has been highly effective in preventing sub-standard ships from entering Canadian waters. Regular aerial surveillance is a widely recognized and effective deterrent that reduces oil discharges in Canadian waters because potential polluters are aware that Canada has heightened surveillance, for which purpose Transport Canada undertakes the National Aerial Surveillance Program. Upon arrival in Canadian waters, Transport Canada inspects all foreign vessels and again on an annual basis thereafter. Trans Mountain maintains a Tanker Acceptance Standard against which all tankers nominated by pipeline shippers are evaluated and either accepted or rejected at the Westridge Marine Terminal. Pipeline shippers also have their own tanker screening and selection process, which is intended to ensure that tankers nominated to the Westridge Marine Terminal meet international regulations and Trans Mountain's Tanker Acceptance Standard.
- **Vessel operations and movements within the Canadian waters** - Tankers follow established shipping routes with separation schemes, protocols, and communication procedures to minimize the probability of a collision with another vessel or with navigational hazards (Section 1.4.3). In addition, the PPA has established mandatory pilotage requirements for inbound and outbound traffic to the Westridge Marine Terminal and PMV and the PPA have established mandatory tug escort requirements for tankers from the Westridge Marine Terminal (Figure 5.3.1). Tethered escort means escort tugs are physically attached to the oil tanker and can exert enough force to prevent the oil tanker from grounding in the event of a mechanical failure of the oil tanker's equipment. Untethered escort tugs navigate with the outbound oil tanker but are not physically attached to it. In the event the oil tanker experiences a mechanical failure, an untethered escort tug can connect a line and exert enough force to prevent the tanker from grounding but the response time is greater (DNV 2013); the current locations where a tug is tethered have been selected based on similar programs conducted by PMV and PPA that considered areas where immediate response to a failure of the ship systems may be required

- **Training -** To maintain their high level marine navigational safety, tankers need employ trained, qualified and competent officers and crew. In keeping with STCW Transport Canada develops and updates regulations, examinations and training standards for the certification of seafarers, including medical fitness; issues Certificates of Competency to seafarers after they have successfully fulfilled the requirements and passed examinations for the certificate; and keeps complete records of all seafarers who are candidates for or holders of these certificates. Foreign vessels are required to meet similar standards in crew training and competency. The certificates of seafarers serving on the tankers are verified during Transport Canada inspections. Pilots require training and experience to be certified by the PPA and also undertake refresher training on ship handling practices.




TRANS MOUNTAIN

**FIGURE 5.3.1**

# CURRENT TUG ESCORT FOR LADEN OIL TANKERS LEAVING WESTRIDGE MARINE TERMINAL

## TRANS MOUNTAIN EXPANSION PROJECT

- Reference Kilometre Post (RK)
- Kilometre Post (KP)
- Trans Mountain Pipeline (TMPL)
- Trans Mountain Expansion Project Proposed Pipeline Corridor
- Terminal
- Existing Pump Station
- Highway
- Road
- 12 Nautical Mile Limit (Territorial Sea)
- Escorted Tug Route
- Tethered Tug Route
- Limit of Exclusive Economic Zone (EEZ)
- International Boundary
- Marine Vessel Outbound Shipping Lane
- Marine Vessel Inbound Shipping Lane
- Traffic Separation Scheme
- City / Town / District Municipality
- Indian Reserve / Métis Settlement
- National Park
- Provincial / State Park
- Protected Area/Natural Area/ Provincial Recreation Area/Wilderness Provincial Park/Conservancy Area



Projection: 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: BC Forests, Lands and Natural Resource Operations, 2012 & ESRI, 2005; Geopolitical Boundaries: IHS Inc., 2011, BC FLNRO, 2007 & ESRI, 2005, Natural Resources Canada, 2012; First Nation Lands: Government of Canada, 2013 & IHS Inc., 2011; Hydrology: IHS Inc., 2004, United States National Imagery and Mapping Agency, 2000, Natural Resouces Canada, 2010; Parks and Protected Areas: Natural Resources Canada, 2013, BC FLNRO, 2008; CHS: provided by KMC, 2013; Marine Shipping Lanes: Moffatt and Nichol, 2013; Hillshade: TERA, derived from Geobase; US Hillshade: ESRI, 2009.

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| MAP NUMBER | | PAGE |
|---|---|---|
| 201310_MAP_TERA_MR_00469_REV0 | | SHEET 1 OF 1 |
| DATE: December 2013 | TERA REF.: 7894 | REVISION: 0 |
| SCALE: 1:650,000 | PAGE SIZE: 11x17 | DISCIPLINE: MR |
| DRAWN: TGG | CHECKED: CAS | DESIGN: LM |

0 5 10 15 20 25 km

ALL LOCATIONS APPROXIMATE

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As described in Section 1.4, many parties share accountability for ensuring navigational safety of vessels within Canadian waters. Based on the results presented in TERMPOL 3.8 Casualty Data (Volume 8C, TR 8C-6), the existing navigational management and safety regime in the Salish Sea region has served Canada well in preventing incidents and possible cargo oil spills from laden oil tankers as a result of these incidents.

### *5.3.2 Proposed Improvements*

Trans Mountain continues to work with other members of the maritime community on various initiatives to improve safety, including for example, a recent PMV-led process to improve safety and efficiency of transit through the Second Narrows MRA.

Trans Mountain has been in consultation with DNV, various maritime authorities such as Transport Canada and PMV, the PPA, BCCPA, COSBC, WCMRC, tug providers, and others in the maritime community to identify potential improvements to existing navigational safety controls related to the predicted increase in tanker traffic as a result of the Project. As a result of these consultations and considering the recommendations of DNV's quantitative risk assessment, the possibility of drift grounding (*i.e.,* a tanker losing power and drifting on to a rocky shore) or collision with another vessel were identified as key areas of navigation where additional mitigation would result in a significant improvement to navigational safety.

Although DNV acknowledges that the existing risk controls for the sailing route are considered to be state of the art compared to other coastal sailing routes worldwide their quantitative risk assessment identified two measures that, if implemented, nearly eliminate the change in overall oil cargo spill risk resulting from the Project. Trans Mountain proposes and seeks endorsement from Transport Canada and the TERMPOL Review Committee for these measures to be implemented to significantly reduce the risk of an accidental oil spill from a Project-related tanker.

#### *5.3.2.1 Additional Dedicated Tug Escort*

Figure 5.3.1 shows two portions of the established shipping routes where tug escorts are not provided for an oil tanker. A vessel suffering a loss of power today would depend of tugs of opportunity for assistance in these areas. Tugs of opportunity are defined as those tugs that might happen to be in the vicinity of an incident and available to assist.

As noted in Table 5.3.1, allocating a dedicated escort tug to a tanker in such areas would significantly reduce the overall probability of an incident resulting in an oil spill from a laden tanker as there would be no question of whether or not a tug would be available to assist in the event of an incident. Trans Mountain therefore proposes to require an increase in the existing level of tug escort for laden Project-tankers during their entire passage from the Westridge Marine Terminal to the Pacific Ocean, outside of the PPA and PMV's geographical jurisdiction (Figure 5.3.2). This new requirement would be included in Trans Mountain's Tanker Acceptance Criteria.

Tug operators based in Vancouver have indicated to Trans Mountain that escort tugs with sufficient capability to control a laden oil tanker under conditions prevailing in the study area are now and will continue to be available for this service. Trans Mountain also commissioned an assessment to determine desired capabilities of tugs that might provide this service, especially through Juan de Fuca Strait (Volume 8C, TR 8C-12, S3), An Evaluation of Local Escort and Rescue Tug Capabilities in Juan de Fuca Strait [Robert Allan Ltd. 2013]). Trans Mountain shall continue to work with local tug operators to support continuous improvement initiatives in tug escort training and technology.

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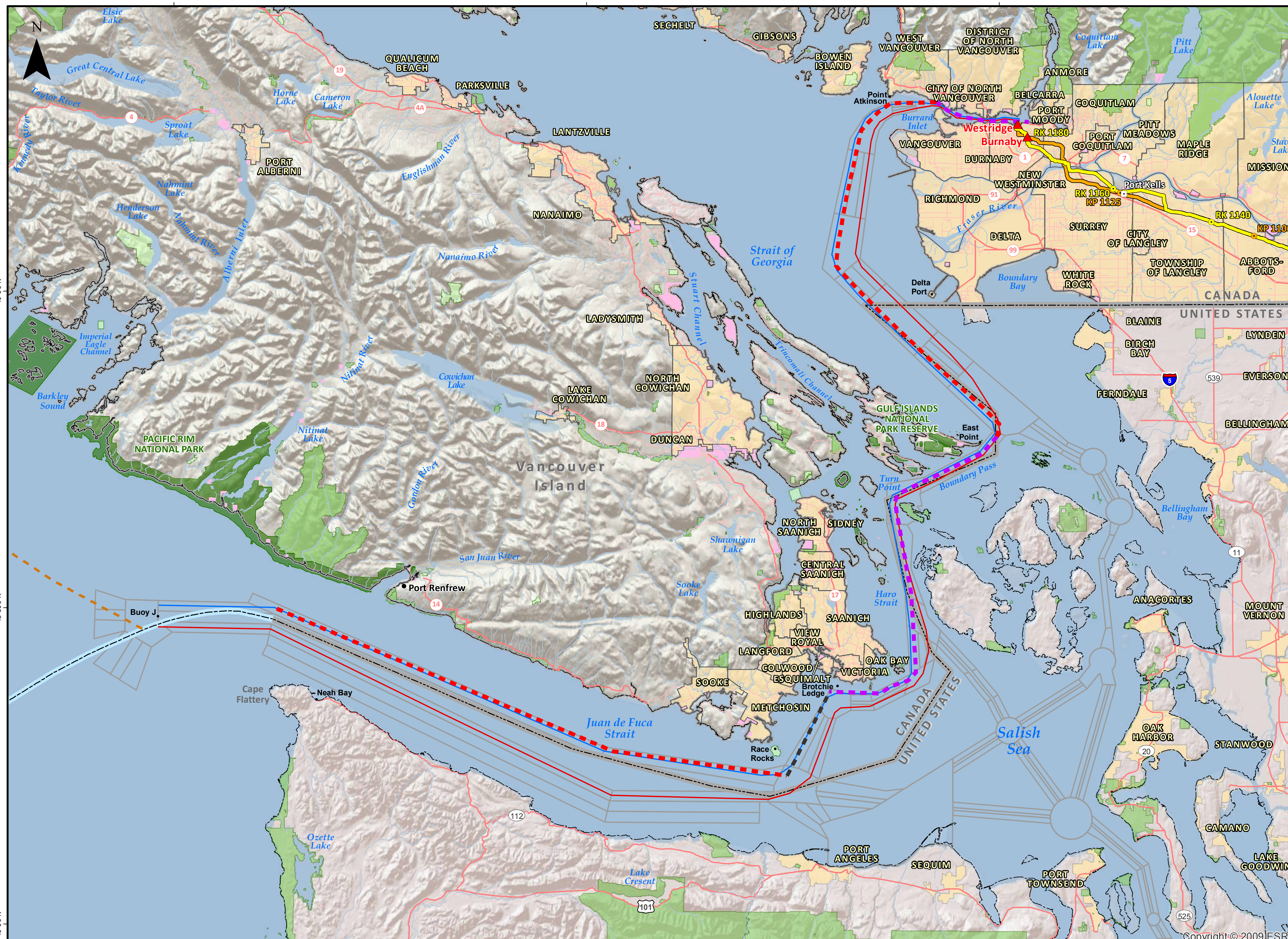
**FIGURE 5.3.2**

# PROPOSED ADDITIONAL TUG ESCORT FOR LADEN OIL TANKERS LEAVING WESTRIDGE MARINE TERMINAL

## TRANS MOUNTAIN EXPANSION PROJECT

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- Escorted Tug Route
- Tethered Tug Route
- Proposed Additional Tug Route
- Limit of Exclusive Economic Zone (EEZ)
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- Marine Vessel Outbound Shipping Lane
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- City / Town / District Municipality
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- Provincial / State Park
- Protected Area/Natural Area/ Provincial Recreation Area/Wilderness Provincial Park/Conservancy Area



Projection: UTM Zone 10N.
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0 5 10 15 20 25 km

ALL LOCATIONS APPROXIMATE

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#### *5.3.2.2 Moving Safety Zone*

Within Canadian waters users of shipping lanes and users crossing the shipping lanes are required to follow the established mandatory routes shown on navigation charts issued by the Canadian Hydrographic Service (CHS) and also abide by the International Rules for Prevention of Collisions at Sea. The regulation for all non-pleasure vessels over 350 gross tons and pleasure vessels over 500 gross tons to have a pilot onboard east of Victoria is an extremely important measure to prevent marine vessel collisions. Furthermore, the separation of opposing streams of traffic and regulating the flow of traffic at crossing points have reduced the incidence of encounters and the possibility of collision.

The research carried out by DNV for the TERMPOL studies and Trans Mountain's experience suggests that the existing marine transportation management protocols implemented in the jointly managed Canada/US waterways in the Salish Sea region have played a key role in ensuring safety, efficiency, the protection of the environment, and are in keeping with the intent of SOLAS.

An important part of the assessment carried out by DNV on behalf of Trans Mountain was to ascertain what, if any, additional operating procedures could be implemented to improve navigational safety and reduce the probability of a collision or grounding of a laden tanker.

Det Norske Veritas identified that adopting a Moving Safety Zone (MSZ) around laden tankers outbound from the Westridge Marine Terminal would substantially reduce the probability of a vessel collision. A MSZ is defined by Transport Canada as "a defined area, which for safety and environmental purposes access is limited to persons, ships or objects authorized by the Coast Guard. Such a zone may be stationary and described by fixed limits, or it may be described as an area around a ship or object in transit" (Transport Canada 1991).

An MSZ around laden oil tankers has been used successfully in other jurisdictions to reduce the occurrence of vessel collisions. For example:

- In many parts of Europe and Asia, such as in the North Sea and in the approaches to Japanese ports, tanker traffic is further separated from the other shipping traffic navigating within Traffic Separation Schemes and in some cases they are subject to additional regulations.
- In the approaches to Southampton, rules have been established whereby a moving prohibited zone is immediately established around all large vessels once they are underway (Southampton Vessel Traffic Services 2013).
- Under certain circumstances the USCG establishes moving security zones around tankers and other specially designated vessels.

As a result of the TERMPOL studies, and in keeping with examples from other jurisdictions, Trans Mountain is seeking endorsement and support of the Joint Coordinating Group of the CVTS to implement a MSZ. The MSZ would be consistent with safety zones described by Transport Canada (Transport Canada 1991) and the USCG (USCG 2013) and would be established around all laden oil tankers in excess of 40,000 tonnes DWT size, whenever such vessels are underway and are within a VTS zone.

Trans Mountain recommends that the MSZ be implemented in addition to the existing navigational measures previously described that have already proven effective at preventing collisions between marine vessels.

Table 5.3.1 shows the benefit of these two proposed navigational safety measures in reducing the probability of a credible worst-case scenario oil spill from a Project-related tanker.

**TABLE 5.3.1**

**PROBABILITY OF CREDIBLE WORST CASE OIL SPILL RELATED TO TRANS MOUNTAIN TANKER SHOWING EFFECTS OF ADDITIONAL NAVIGATIONAL SAFETY CONTROLS**

| | **2018 (*i.e.*, no Project)** | **2018 + Project (*i.e.*, no additional navigational safety controls)** | **Project + Additional Tug Escort of Project Tankers** | **Project + Tug Escorts And Moving Safety Zone** |
|---|---|---|---|---|
| Combined return period in years for all accident categories | 1 in 3,093 years | 1 in 456 years | 1 in 1,326 years | 1 in 2,366 years |

#### *5.3.2.3 Conclusion*

In its assessment DNV noted that implementing the extra risk controls described in the previous sections would raise the level of care and safety in the study area to well above globally accepted shipping standards.

The quantitative risk assessment carried out by DNV demonstrated that, with the implementation of additional tug escort and the establishment of an MSZ to prevent collisions, the probability of an oil spill from a laden tanker from the Westridge Marine Terminal would improve from a 1-in-456-year probability to a 1-in-2,366-year probability for a credible worst-case oil spill from a Project-related tanker (Table 5.2.4). Provided the proposed additional navigational controls were implemented as a result of the Project, the risk of a credible worst-case oil spill resulting from the Project-related increase in tanker traffic would be about the same as it is today, without the Project.

As noted previously, Trans Mountain is updating its Tanker Acceptance Criteria with the requirement for additional tug escort. As well, Trans Mountain is seeking endorsement for the MSZ from the Joint Coordinating Group of the CVTS. Lastly, Trans Mountain is seeking endorsement from Transport Canada for both of the proposed additional navigational control measures, which would be implemented if the Project were approved and prior to the operation of the Project.

## 5.4 Fate and Behaviour of an Oil Spill in a Marine Environment

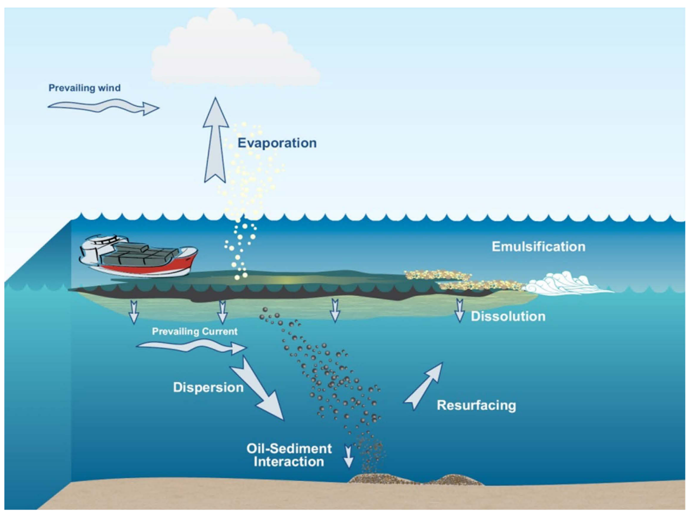
Section 5.4 describes the characteristics of oil spilled in a marine environment, beginning with a general description of these characteristics and gradually narrowing to a discussion of the results of a study and modeling of scenarios of a Project-related spill of diluted bitumen in the marine environment.

### *5.4.1 Properties and Weathering of Oil Spilled in a Marine Environment*

The following overview of the fate and behaviour of marine oil spills is informed with information from the International Tanker Owners Pollution Federation (ITOPF; www.itopf.com).

#### *5.4.1.1 Fate and Behaviour of Oil Spilled in a Marine Environment*

As soon as oil is spilled, it starts to spread out over the sea surface, initially as a single slick. The speed at which this takes place depends on the buoyancy of the oil causing it to spread, and its viscosity, attenuating the motion of the oil. Fluid, low viscosity oil spreads more quickly than oil with a high viscosity. Nevertheless, oil slicks quickly spread to cover extensive areas of the sea surface. Spreading is rarely uniform and large variations in the thickness of the oil are typical. The rate at which the oil spreads is also determined by the prevailing conditions such as temperature, water currents, tidal streams and wind speeds. After a few hours the slick will begin to break up and, because of winds, wave action and water turbulence, will then generally form narrow bands or windrows, which may be parallel to the wind direction, but are also deformed because of small-scale motions in the surface water. The more severe the conditions, the more rapid the spreading and breaking up of the oil. The oil movement on the surface while undergoing a number of chemical and physical changes is collectively termed weathering (Figure 5.4.1). The various oil weathering processes are described in the following paragraphs.




**Source:** Modified from itopf.com

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KINDER MORGAN CANADA
FIGURE 5.4.1
OIL WEATHERING PROCESSES

**Figure 5.4.1 Oil Weathering Processes**

The product (*i.e.*, crude oils, aviation fuel, etc.) contains a variety of discrete components each of which has a distinct vapour pressure, boiling point and molecular weight (*i.e.*, hydrocarbons with more lighter and low boiling point products have a higher evaporation rate). The evaporation rate from heavier products is attenuated by the slow rate at which the lighter fractions can diffuse up to the surface of the slick, even for relatively thin slicks

#### 5.4.1.1.1 Evaporation

The product (*i.e.*, crude oils, aviation fuel, etc.) contains a variety of discrete components each of which has a distinct vapour pressure, boiling point and molecular weight (*i.e.*, hydrocarbons with more lighter and low boiling point products have a higher evaporation rate). The evaporation rate from heavier products is attenuated by the slow rate at which the lighter fractions can diffuse up to the surface of the slick, even for relatively thin slicks.

The evaporation rate is also a function of the area or horizontal extent of the spill (*i.e.*, the larger the spill is, the higher is the evaporation rate). Finally, the evaporation rate is generally greater during strong winds compared to calm conditions.

#### 5.4.1.1.2 Vertical Dispersion and Resurfacing

Breaking waves drive small droplets of the oil into the water column. Oil disperses most quickly if the oil is light and of low viscosity and if the sea is very rough. Depending on the natural turbulence in the water and the size and density of the droplets, the dispersed oil will generally stay suspended in the water column and will be prevented from resurfacing as long as the dispersing mechanism, breaking surface waves, remain active. When wind and waves die down, the dispersed oil will generally rise to the surface. The dispersion process is a function of wind speed, wave height, fraction of waves that are breaking, and the size of the droplets.

The size of the droplets is a criterion for a droplet to stay inside the water column because of natural turbulence. It is often seen that droplets larger than 70 microns will resurface in less time than it takes for the surface spill to move.

Since the surface slick moves according to both surface currents and a wind leeway, the oil on the surface and the dispersed oil in the water column do not travel together, but becomes spatially separated, especially during periods of strong winds. Oil that was dispersed and then rises to the surface undergoes evaporation, which is a loss for the dispersed oil fraction, but a gain for the evaporated fraction.

#### 5.4.1.1.3 Emulsification

An emulsion is formed when two liquids combine, with one ending up suspended in the other. Emulsification of crude oils refers to the process whereby sea water droplets become suspended in the oil. This occurs by physical mixing promoted by turbulence at the sea surface. The emulsion thus formed is usually very viscous and more persistent than the original oil and is often referred to as “chocolate mousse” because of its appearance. The formation of these emulsions causes the volume of the oil-water mixture to increase to between three and four times the original oil volume. This slows and delays other processes that would allow the oil to dissipate.

Oils with asphaltene content greater than 7 per cent tend to form stable emulsions which may persist for many months after the initial spill has occurred. Those oils containing a lower per centage of asphaltenes are less likely to form emulsions and are more likely to disperse. Emulsions may separate into oil and water again if heated by sunlight under calm conditions or when stranded on shorelines. The emulsification process will often lead to an increased quantity of oil-water mixture to be dealt with during an oil spill response.

#### 5.4.1.1.4 Sediment Interaction

Some heavy refined products have densities greater than 1.0 g/cm$^3$ (density of freshwater) and so will sink in fresh or brackish water. Crude oils (even those considered as "heavy") are normally less dense than freshwater and seawater, which has a density of approximately 1.025 g/cm$^3$. However in interaction with suspended matter (particles of sediment or organic matter) already in the water, these particles could adhere to the weathered oil forming oil-suspended particulate matter aggregates (OSAs) which are generally sufficiently dense that they sink. Shallow waters are often laden with suspended solids providing favourable conditions for OSA formation, although the sediment must generally be fine-grained and of moderately high concentration. The energy for the formation of these aggregates is generally derived from breaking waves, but turbulent flow in a river could also facilitate formation of these aggregates.

Oil stranded on sandy shorelines often becomes mixed with sand and other sediments. If this mixture is subsequently washed off the beach back into the sea it may then sink. In addition, if the oil catches fire or is ignited after it has been spilled, the residues that sometimes form can be sufficiently dense to sink.

#### 5.4.1.1.5 Dissolution

Water soluble compounds in oil may dissolve into the surrounding water. This depends on the composition and state of the oil, and occurs most quickly when the oil is finely dispersed in the water column. Components that are most soluble in seawater are the light aromatic hydrocarbons compounds such as benzene and toluene. However, these compounds are also those first to be lost through evaporation, a process that is 10 to 100 times faster than dissolution.

#### 5.4.1.1.6 Formation of Tarballs

Tarballs are often formed following a spill. They tend to collect on shorelines and have a solid outer crust surrounding a softer, less weathered interior. Their sizes extend from a few millimetres to several centimetres, and they begin to form as the lighter fractions evaporate and the relative per centage of asphaltene in the slick increases. Oxidation can form an outer protective coating of heavy compounds that result in the increased persistence of the tar balls.

#### 5.4.1.1.7 Beach/Shore Contact

A potential issue of concern is the extent to which oil would come into contact with intertidal sand and mud flats and adversely affect benthic invertebrates and bio-films. In addition to entering beach and mud flat sediment via the shore contact process, oil could become stranded as water levels fell below the level of the beach or sand flat cell.

Each segment of shoreline can retain a certain maximum volume of any oil spilled into the sea. A number of properties determine the amount of oil left on a shoreline including the adhesion properties or "stickiness" of stranded oil.

Low energy shorelines almost always have an extremely fine subsurface substrate (sand or mud), even though the surface veneer is coarse pebble, cobble or boulder. This will have limited oil penetration due to the fine nature of the substrate. Coarse (pebble, cobble, boulder), high-energy shorelines may be coarse to considerable depths, increasing permeability and potential stranded oil retention.

The retention values of the affected shoreline are important planning items to consider if oil spill response activities are taking place.

#### 5.4.1.1.8 Oil Grouping and Persistence

The processes of spreading, evaporation, dispersion, emulsification and dissolution are most important during the early stages of a spill whilst oxidation, sedimentation and biodegradation are more important later on and determine the ultimate fate of the oil. To understand how different oils change over time whilst at sea, one needs to know how these weathering processes interact.

Studies show that the main properties affecting the fate of spilled oil at sea are specific gravity (its density relative to pure water); distillation characteristics (its volatility); viscosity (its resistance to flow); and pour point (the temperature below which it will not flow). In addition the wax and asphaltene content influence the likelihood that the oil will mix with water to form a water-in-oil emulsion. Oils that form stable oil-in-water emulsions persist longer at the water surface. The resin and asphaltene content determine the likelihood of tar-ball formation.

Oil persistence is often used to classify oils for transportation and allocate resources during an oil spill response. In simple terms less persistent oils once spilled are expected to remain in the environment for lesser time that higher persistence oils. This has led to the terms persistent and non-persistent oils within the shipping, oil response and insurance industries.

Some simple grouping has been developed based on oil type according to their density - generally, oils with a lower density will be less persistent. However some light oils can behave more like heavy ones due to the presence of waxes.

Group I oils (non-persistent) tend to dissipate completely through evaporation within a few hours and do not normally form emulsions. Group II and III oils can lose up to 40 per cent by volume through evaporation but, because of their tendency to form viscous emulsions, there is an initial volume increase as well as a curtailment of natural dispersion, particularly in the case of Group III oils. Group IV oils are very persistent due to their lack of volatile material and high viscosity, which preclude both evaporation and dispersion (Table 5.4.1).

**TABLE 5.4.1**

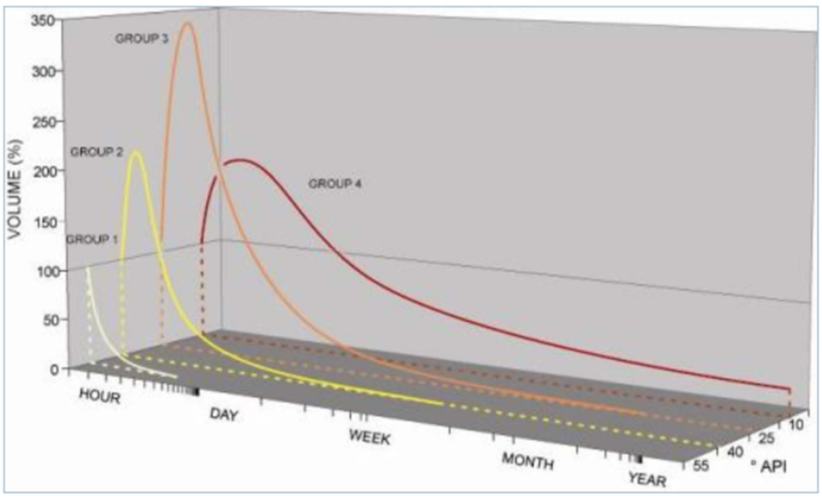
**GROUP I TO IV OILS**

| Group | Density | Examples |
|---|---|---|
| Group I | less than 0.8 | Gasoline, Kerosene |
| Group II | 0.8 to 0.85 | Gas Oil, Abu Dhabi Crude |
| Group III | 0.85 to 0.95 | Arabian Light Crude, North Sea Crude Oils (*e.g.*, Forties), diluted bitumen shipped on TMPL and from the Westridge Marine Terminal |
| Group IV | greater than 0.95 | Heavy Fuel, Venezuelan Crude Oils |

**Source:** Government of United States 2013

There is often mention of a fifth classification, termed Group V that is meant to collectively classify oils whose density is higher than that of freshwater, and even of a density higher than that of seawater and thus liable to sink once spilled to the sea.

Figure 5.4.2 provides a simple empirical model based upon the properties of different oil types. This uses the four main groups described above and shows the expected rate at which the volume of oil at the sea surface decreases. It is apparent from the graph that for most oils once the competing process of emulsification has been taken into account there would be an increase in volume in the short term. Response organizations must take the emulsification phenomenon into account when developing response plans and defining equipment requirements.




**Source:** ITOPF 2013

**FIGURE 5.4.2**

**VOLUME OF OIL AND WATER-IN-OIL EMULSION REMAINING ON THE SEA SURFACE, AS A PERCENTAGE OF THE ORIGINAL VOLUME SPILLED**

**Figure 5.4.2 Volume of Oil and Water-in-oil Emulsion Remaining on the Sea Surface, as a Percentage of the Original Volume Spilled**

### 5.4.1.1.9 Summary

Typically, once released into the marine environment oil begins to "weather" and after a period of time can submerge or begin to sink. When released into water, lighter components of hydrocarbons will begin to evaporate, some will dissolve into the water column, and the remainder will float as long as the density of the remaining oil is less than the density of the water into which it was released. Wave action can cause water-in-oil emulsions, which will drive the mixture towards neutral buoyancy. Adhesion to bottom sediment (*e.g.*, beaches, riverbeds) or other sinking material can cause the oil to be submerged. The question then, especially for product like diluted bitumen, which although typically rated as a Group III product displays heavier oil behaviour when weathered, is about the weathering process and the mechanisms that can cause it to submerge or sink.

### *5.4.2 Hydrocarbon Properties of Product Shipped on TMPL*

The TMPL system after the Project is in operation would have the capability to transport a variety of oil products, including both light and heavy crude oils, and those oils often termed as diluted bitumen. Bitumen is the oil product from oil sands deposits.

The main difference between oil sands deposits and those from the rest of the Western Canadian Sedimentary Basin is that oil sands formed nearer to the surface. As a result, oil sands deposits were subject to more microbial activity. Most of the lighter fractions in these deposits, characterized by fewer carbon atoms in their molecules, lower densities and higher vapour pressures, were digested by microbes. What remains are the heavier fractions that result in the denser, more viscous crude oil known as bitumen.

Once sand and water have been removed the remaining bitumen is too dense and viscous to meet pipeline specifications so it is mixed with diluent. Typical diluents are natural gas condensate (light oil recovered from natural gas production) and synthetic crude oil (partially refined bitumen). In effect the diluent is added to replace the light hydrocarbons lost from microbial degradation of the oil sands. Adding diluent creates a stable homogeneous mixture that behaves in a similar manner to other natural crude oils.

The CAPP describes diluted bitumen as a bitumen blend consisting of diluent that has a density of less than 800 kg/m$^3$. If it has a density greater than or equal to 800 kg/m$^3$, the diluent is presumed to be synthetic crude oil, and the blend is called synbit (CAPP 2013).

Diluted bitumen is expected to form a large proportion of the crude oil shipped from the Westridge Marine Terminal once the Project is in operation.

Table 5.4.2 describes the characteristics of the hydrocarbon products that may typically be transported on the TMPL and shipped by tanker from the Westridge Marine Terminal.

**TABLE 5.4.2**

**CRUDE COMPARISON (FROM SEPTEMBER 1, 2011 TO SEPTEMBER 1, 2013)**

| | Light Sour | Light Sweet | Synthetic | High TAN Dilbit[1] | Dilbit[1] | Synbit[2] | Dilsynbit[3] |
|---|---|---|---|---|---|---|---|
| **Basic Analysis** | | | | | | | |
| Density (kg/m$^3$) | 829.5 ± 6.8 | 828.7 ± 3.9 | 844.9 ± 18.4 | 874.2 ± 48.4 | 928.0 ± 5.2 | 931.9 ± 6.1 | 933.2 ± 6.8 |
| Gravity (deg. API) | 39.0 ± 1.4 | 39.1 ± 0.8 | 35.9 ± 3.6 | 30.7 ± 9.0 | 20.9 ± 0.9 | 20.2 ± 1.0 | 20.0 ± 1.1 |
| Viscosity centistokes (cSt) @ 5 deg.C | 10.6 | 12.1 | 10.7 | Blended to meet < 350 cSt at Reference Temperature | | | |
| Viscosity cSt @ 10 deg. C | 8.0 | 8.0 | 8.9 | | | | |
| Viscosity cSt @ 15 deg. C | 6.9 | 6.4 | 7.5 | | | | |
| Reid Vapour Pressure (kPa) | 68.9 | 74.9 | 31.7 | 62.9 | 51.7 | 20 | 62.7 |
| Sulphur (wt%) | 0.69 ± 0.18 | 0.42 ± 0.07 | 0.29 ± 0.12 | 2.08 ± 1.78 | 3.78 ± 0.08 | 3.42 ± 0.38 | 3.11 ± 0.70 |
| Hydrogen Sulphide (ppm) | < 250 | < 10 | < 1 | < 10 | < 10 | < 10 | < 10 |
| MCR (wt%) | 2.13 ± 0.44 | 1.92 ± 0.18 | 0.94 ± 0.89 | 6.06 ± 4.55 | 10.42 ± 0.30 | 8.93 ± 1.55 | 11.50 ± 1.47 |

## TABLE 5.4.2

## CRUDE COMPARISON (FROM SEPTEMBER 1, 2011 TO SEPTEMBER 1, 2013) (continued)

| | Light Sour | Light Sweet | Synthetic | High TAN Dilbit[1] | Dilbit[1] | Synbit[2] | Dilsynbit[3] |
|---|---|---|---|---|---|---|---|
| **Basic Analysis** | | | | | | | |
| Sediment (ppmw) | - | - | - | 136 ± 113 | 123 ± 92 | 92 ± 38 | 378 ± 341 |
| TAN (mgKOH/g) | - | - | - | 1.72 ± 0.09 | 0.98 ± 0.08 | 1.20 ± 0.24 | 0.75 ± 0.27 |
| Salt (ptb) | - | - | - | 6.2 ± 1.7 | 10.4 ± 2.3 | 7.5 ± 3.2 | 10.7 ± 1.9 |
| Nickel (mg/L) | 5.6 ± 2.6 | 4.2 ± 0.7 | 1.4 ± 2.9 | 48.0 ± 33.5 | 65.8 ± 3.6 | 59.2 ± 7.4 | 54.7 ± 12.4 |
| Vanadium (mg/L) | 14.9 ± 7.9 | 8.3 ± 2.4 | 2.7 ± 6.3 | 129.1 ± 92.3 | 172.0 ± 12.8 | 159.5 ± 15.8 | 129.6 ± 45.5 |
| Olefins (wt%) | - | ND | ND | ND | ND | ND | ND |
| **Light Ends (vol%)** | | | | | | | |
| Butanes | 4.07 ± 1.10 | 3.98 ± 0.68 | 3.13 ± 1.09 | 2.38 ± 1.78 | 0.91 ± 0.27 | 0.73 ± 0.27 | 1.16 ± 0.46 |
| Pentanes | 2.80 ± 0.45 | 3.16 ± 0.70 | 2.93 ± 0.81 | 5.81 ± 2.86 | 6.19 ± 1.10 | 3.75 ± 2.65 | 5.82 ± 1.09 |
| Hexanes | 5.70 ± 0.38 | 5.43 ± 0.53 | 4.75 ± 1.02 | 6.18 ± 0.89 | 5.46 ± 0.50 | 3.67 ± 1.91 | 5.48 ± 0.48 |
| Heptanes | 7.72 ± 0.50 | 6.87 ± 0.55 | 5.32 ± 1.77 | 5.66 ± 1.49 | 3.51 ± 0.50 | 2.64 ± 0.89 | 3.62 ± 0.60 |
| Octanes | 7.68 ± 0.84 | 6.93 ± 0.74 | 5.60 ± 1.58 | 4.77 ± 2.41 | 2.29 ± 0.55 | 2.33 ± 0.51 | 2.74 ± 0.86 |
| Nonanes | 6.04 ± 0.89 | 5.46 ± 0.62 | 4.38 ± 1.21 | 3.33 ± 2.20 | 1.42 ± 0.42 | 1.85 ± 0.66 | 1.78 ± 0.69 |
| Decanes | 3.00 ± 0.54 | 2.54 ± 0.34 | 2.12 ± 0.51 | 1.55 ± 1.03 | 0.70 ± 0.22 | 0.99 ± 0.39 | 0.86 ± 0.32 |
| **BTEX (vol%)** | | | | | | | |
| Benzene | 0.36 ± 0.07 | 0.24 ± 0.03 | 0.22 ± 0.04 | 0.27 ± 0.05 | 0.24 ± 0.03 | 0.15 ± 0.10 | 0.20 ± 0.06 |
| Toluene | 1.10 ± 0.15 | 0.74 ± 0.11 | 0.63 ± 0.17 | 0.64 ± 0.16 | 0.42 ± 0.09 | 0.29 ± 0.15 | 0.37 ± 0.10 |
| Ethyl Benzene | 0.26 ± 0.03 | 0.24 ± 0.02 | 0.21 ± 0.04 | 0.15 ± 0.09 | 0.06 ± 0.02 | 0.07 ± 0.03 | 0.08 ± 0.04 |
| Xylenes | 1.43 ± 0.22 | 1.00 ± 0.13 | 0.82 ± 0.22 | 0.70 ± 0.34 | 0.35 ± 0.10 | 0.33 ± 0.10 | 0.35 ± 0.11 |
| **Distillation (deg. C)** | | | | | | | |
| 5% Mass Recovered | 52.2 ± 13.78 | 45.9 ± 15.30 | 79.0 ± 29.07 | 43.0 ± 9.85 | 46.9 ± 10.56 | 83.6 ± 41.61 | 46.1 ± 9.46 |
| 10% Mass Recovered | 85.5 ± 9.09 | 88.1 ± 8.70 | 121.9 ± 27.54 | 80.2 ± 16.19 | 91.2 ± 18.39 | 135.2 ± 51.87 | 93.4 ± 23.50 |
| 20% Mass Recovered | 125.0 ± 14.82 | 129.9 ± 8.45 | 176.5 ± 39.25 | 184.1 ± 58.65 | 244.4 ± 19.80 | 247.6 ± 14.75 | 243.6 ± 40.89 |
| 30% Mass Recovered | 172.1 ± 13.87 | 183.1 ± 11.36 | 225.1 ± 34.23 | 286.8 ± 78.88 | 334.0 ± 13.44 | 317.7 ± 18.06 | 356.3 ± 29.83 |
| 40% Mass Recovered | 223.4 ± 13.64 | 241.7 ± 13.77 | 270.7 ± 23.81 | 359.1 ± 86.29 | 407.1 ± 12.95 | 377.1 ± 31.17 | 421.5 ± 19.49 |
| 50% Mass Recovered | 278.5 ± 11.80 | 298.1 ± 15.66 | 313.1 ± 15.50 | 426.2 ± 93.01 | 475.1 ± 14.85 | 435.9 ± 41.16 | 478.4 ± 15.05 |
| 60% Mass Recovered | 334.7 ± 11.27 | 355.7 ± 20.66 | 356.7 ± 17.47 | 502.0 ± 103.98 | 551.4 ± 19.04 | 503.1 ± 52.22 | 538.5 ± 21.26 |
| 70% Mass Recovered | 398.7 ± 10.90 | 419.3 ± 25.15 | 402.9 ± 29.16 | 580.2 ± 112.62 | 633.2 ± 20.38 | 586.1 ± 58.31 | 605.3 ± 33.58 |
| 80% Mass Recovered | 468.4 ± 12.20 | 492.8 ± 41.00 | 455.9 ± 53.70 | 599.0 ± 114.00 | 700.3 ± 16.47 | 662.3 ± 41.15 | 667.8 ± 33.97 |
| 90% Mass Recovered | 567.3 ± 23.96 | 564.4 ± 20.77 | 488.1 ± 44.43 | 562.8 ± 34.51 | - | 705.1 ± 9.13 | 703.2 ± 19.40 |
| 95% Mass Recovered | 628.8 ± 14.41 | 638.1 ± 32.27 | 529.9 ± 62.41 | 635.9 ± 45.89 | - | - | - |
| 99% Mass Recovered | 699.0 ± 8.66 | 704.4 ± 15.20 | 567.1 ± 8.88 | - | - | - | - |

**Source:** Crude Quality Inc. 2013; Format is: Average ± std. dev.

**Notes:** 1 Diluted bitumen

2 Synthetic bitumen

3 Diluted synthetic bitumen

Diluted bitumen falls into an oil group classification noted as Group III hydrocarbons (Government of the United States 2013). That is, the specific gravity of the diluted bitumen is equal to or greater than 0.85 and less than 0.95. Table 5.4.3 provides a point of comparison between the physical properties of diluted bitumen and those of other crude and fuel oils with ranges of specific gravities that overlap with the Group III category. Diluted bitumen and these other commodities have been transported throughout the world and the general behaviour of these oils are quite comparable with respect to fate and weathering and spill countermeasures.

**TABLE 5.4.3**

**RANGES OF PROPERTIES FOR GROUP III AND IV OILS (HEAVY CRUDE AND DILBIT RANGE HIGHLIGHTED)**

| Property | Units | Light Crude | Heavy Crude/ Dilbit | Intermediate Fuel Oil | Bunker C | Crude Oil Emulsion |
|---|---|---|---|---|---|---|
| Specific Gravity | | 780 to 880 | 880 to 1000 | 940 to 990 | 960 to 1040 | 950 to 1000 |
| API Gravity | | 30 to 50 | 10 to 30 | 10 to 20 | 5 to 15 | 10 to 15 |
| Viscosity | mPas at 15°C | 5 to 50 | 50 to 50,000 | 1,000 to 15,000 | 10,000 to 50,000 | 20,000 to 100,000 |
| Flash point | 15°C | -30 to 30 | -30 to 60 | 80 to 100 | >100 | >80 |
| Solubility in Water | ppm | 10 to 50 | 5 to 30 | 10 to 30 | 1 to 5 | - |
| Pour Point | °C | -40 to 30 | -40 to 30 | -10 to 10 | 5 to 20 | >50 |
| Interfacial Tension | mN/m at 15°C | 10 to 30 | 15 to 30 | 25 to 30 | 25 to 35 | NR |
| Distillation Fractions (% distilled at:) | 100 °C | 2 to 15% | 1 to 10% | - | | NR |
| | 200 °C | 15 to 40% | 2 to 25% | 2 to 5% | 2 to 5% | NR |
| | 300 °C | 30 to 60% | 15 to 45% | 15 to 25% | 5 to 15% | NR |
| | 400 °C | 45 to 85% | 25 to 75% | 30 to 40% | 15 to 25% | NR |
| | residual | 15 to 55% | 25 to 75% | 60 to 70% | 75 to 80% | NR |

**Source:** Modified from Fingas (2001)

Table 5.4.4 summarizes the density ranges typical of the five product streams that are representative of the majority of the anticipated throughput of TMPL after the Project is in operation.

**TABLE 5.4.4**

**CRUDE COMPARISON (FROM SEPTEMBER 1, 2011 TO SEPTEMBER 1, 2013)**

| | Access Western Blend (AWB) | Cold Lake (CL) | Statoil Cheecham Blend (SCB) | Surmont Heavy Blend (SHB) | Albian Heavy Synthetic (AHS) |
|---|---|---|---|---|---|
| Density (kg/m3) | 923.6 ± 5.3 | 928.0 ± 5.2 | 928.1 ± 5.2 | 931.9 ± 6.1 | 933.2 ± 6.8 |
| Gravity (o API) | 21.6 ± 0.9 | 20.9 ± 0.9 | 20.8 ± 0.9 | 20.2 ± 1.0 | 20.0 ± 1.1 |

**Source:** Crudemonitor.ca; Format is: Average ± std. deviation

In addition to the density of diluted bitumen, other chemical properties are of significance with respect to fate and behaviour, and environmental risk. Tables 5.4.5 and 5.4.6 respectively present the light ends and BTEX compositions of representative diluted bitumen. BTEX is the collective name for the volative, single-ringed aromatic compounds found in crude oil. The behaviour of the four compounds is somewhat similar when released to the environment and thus, they are usually considered as a group.

**TABLE 5.4.5**

**COMPARISON OF THE LIGHT END COMPONENTS OF REPRESENTATIVE CRUDES (FROM SEPTEMBER 1, 2011 TO SEPTEMBER 1, 2013)**

| Light Ends (vol %) | | | | | |
|---|---|---|---|---|---|
| | **Access Western Blend (AWB)** | **Cold Lake (CL)** | **Statoil Cheecham Blend (SCB)** | **Surmont Heavy Blend (SHB)** | **Albian Heavy Synthetic (AHS)** |
| Butanes | 0.64 ± 0.18 | 0.91 ± 0.27 | 0.94 ± 0.28 | 0.73 ± 0.27 | 1.16 ± 0.46 |
| Pentanes | 8.52 ± 1.34 | 6.19 ± 1.10 | 5.71 ± 1.54 | 3.75 ± 2.65 | 5.82 ± 1.09 |
| Hexanes | 6.86 ± 0.55 | 5.46 ± 0.50 | 5.36 ± 0.52 | 3.67 ± 1.91 | 5.48 ± 0.48 |
| Heptanes | 4.32 ± 0.65 | 3.51 ± 0.50 | 3.61 ± 0.61 | 2.64 ± 0.89 | 3.62 ± 0.60 |
| Octanes | 2.40 ± 0.58 | 2.29 ± 0.55 | 2.83 ± 1.41 | 2.33 ± 0.51 | 2.74 ± 0.86 |
| Nonanes | 1.16 ± 0.33 | 1.42 ± 0.42 | 1.94 ± 1.24 | 1.85 ± 0.66 | 1.78 ± 0.69 |
| Decanes | 0.53 ± 0.15 | 0.70 ± 0.22 | 0.98 ± 0.63 | 0.99 ± 0.39 | 0.86 ± 0.32 |

**Source:** Crudemonitor.ca Format is: Average ± std. dev.

**TABLE 5.4.6**

**BTEX COMPARISON OF REPRESENTATIVE CRUDES (FROM SEPTEMBER 1, 2011 TO SEPTEMBER 1, 2013)**

| BTEX (vol %) | | | | | |
|---|---|---|---|---|---|
| | **Access Western Blend (AWB)** | **Cold Lake (CL)** | **Statoil Cheecham Blend (SCB)** | **Surmont Heavy Blend (SHB)** | **Albian Heavy Synthetic (AHS)** |
| Benzene | 0.30 ± 0.04 | 0.24 ± 0.03 | 0.21 ± 0.07 | 0.15 ± 0.10 | 0.20 ± 0.06 |
| Toluene | 0.51 ± 0.10 | 0.42 ± 0.09 | 0.38 ± 0.10 | 0.29 ± 0.15 | 0.37 ± 0.10 |
| Ethyl Benzene | 0.06 ± 0.02 | 0.06 ± 0.02 | 0.08 ± 0.04 | 0.07 ± 0.03 | 0.08 ± 0.04 |
| Xylenes | 0.37 ± 0.09 | 0.35 ± 0.10 | 0.38 ± 0.13 | 0.33 ± 0.10 | 0.35 ± 0.11 |

**Source:** Crudemonitor.ca Format is: Average ± std. dev.

### *5.4.3 Weathering of Diluted Bitumen*

In May 2013, Trans Mountain conducted applied research on the fate and behaviour of diluted bitumen in a marine environment (*i.e.,* the Gainford Study, Volume 8C, TR 8C-12, S7). The Gainford Study included a weathering test of diluted bitumen spilled in a marine environment over a 10-day period. The tests were attended by a wide range of regulators and other agencies that were invited to attend. The Gainford study and other tests have shown that, like other crude oils, while the density increases as the lighter components evaporate, the rate at which this occurs diminishes as the density and viscosity of the oil increases. Although the relative density of the diluted bitumen observed in the Gainford Study reached that of fresh water, it took eight to ten days for this to happen. No evidence of sunken or submerged diluted bitumen was observed during the Gainford Study.

The fate of hydrocarbon releases and factors that affect released oil were discussed in general terms in Section 5.4.1. This section describes the key elements and observations pertaining to representative oils and considers some of those properties that have the potential to influence their fate and behaviour in the marine environment. Section 5.4.4 provides a detailed discussion of the results of oil spill simulations carried out at a number of selected locations using the credible worse case oil volume as well as smaller oil volumes.

#### *5.4.3.1 The Gainford Study Results*

Although several detailed studies have been completed that characterize the fate and behaviour of heavy crude oil made from Alberta oil sands, most are laboratory and bench-scale tests. Trans Mountain undertook an initiative to expand upon this knowledge through larger, meso-scale tests of diluted Alberta oil sands bitumen. The initiative is referred to as the Gainford Study (Volume 8C, TR 8C-12, S7).

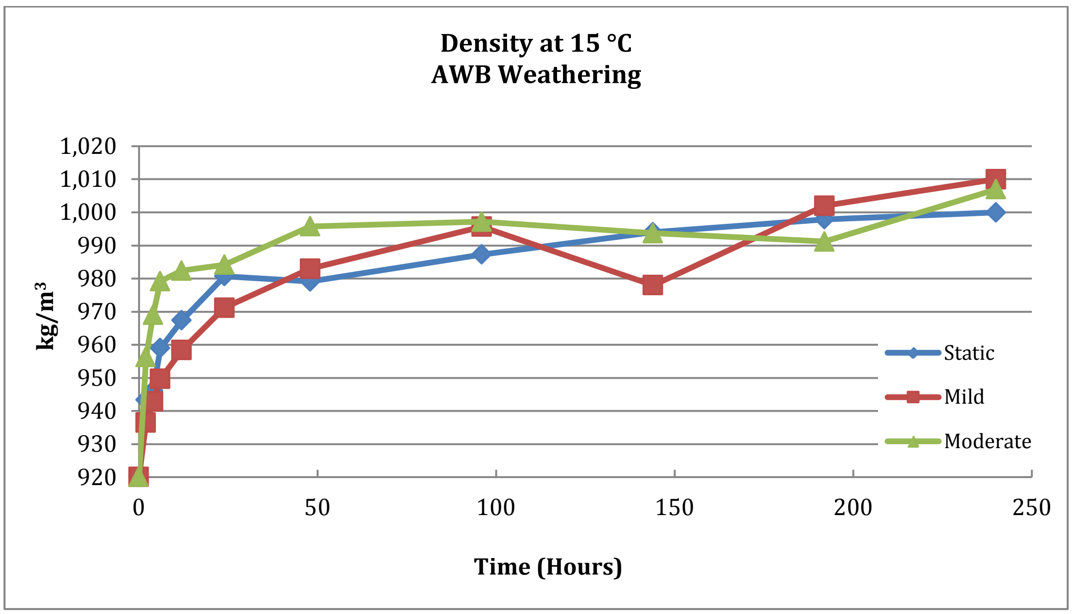
Larger tank tests allowed for simulated wave and current conditions that may be more typical of the marine setting of Burrard Inlet, the export point for diluted bitumen from the TMPL. Induced wave and wind energy on the meso-scale test tanks provide a mechanism to assess shifts in weathering rates as weathering energy increases. Increased energy from wind and waves in a marine setting can be analogous to the increased energy in freshwater system in which increased current speeds and turbulence result in faster weathering rates.

The Gainford Study employed a series of dedicated tanks where Trans Mountain could observe the 10-day behaviour of two types of diluted bitumen: Cold Lake Winter Blend (CLWB) and Access Western Blend (AWB) (Gainford Study, Volume 8C, TR 8C-12, S7). Wind and wave generating devices were used to simulate environmental conditions for the study. Salt was added to the water to achieve a salinity of 20 parts per thousand (ppt) to simulate the brackish waters of Burrard Inlet. Water temperature averaged about 15°C. Oil was applied to achieve approximately 1 cm slick thickness at the moment released (prior to evaporation or weathering processes).

Weathering processes result in changes to the physical and chemical properties of the remaining oil. For the two products tested, the most significant changes noted from the 10-day weathering events, were in density (key factor in floating *vs*. non-floating weathered oil), viscosity (key factor in weathered oil penetration into pore spaces and affects pump ability to recover spilled oil), water uptake and emulsification (affects density, viscosity, and potentially oil recovery systems), and chemistry (light ends). Both AWB and CLWB exhibit water uptake within the weathered oil matrix, although not as a stable, uniform emulsion but rather as a mechanically mixed and unstable oil-water combination. Water content analyses, conducted following procedures for whole oil, showed no systematic uptake or pattern for either product during the weathering process. Given the unstable character of water in oil, sampling and sample processing may result in very different oil-water mixtures at the time of analyses; hence, no conclusions are drawn for those tests other than to note that the maximum water contents measured, above 40 per cent, were noted in samples from three tanks with moderate and mild agitation and after one to three days of weathering. Visual observations of the surface of the oil in the various tanks showed that a crust, or armouring, formed as the oil weathered. There was little evidence of small droplets (natural dispersion) into the water column. Instead, the oil tended to form relatively continuous floating patches on the tank surface. In the end, the behaviour of both products proved to be no different than what might be expected of other heavy crudes when exposed to similar conditions.

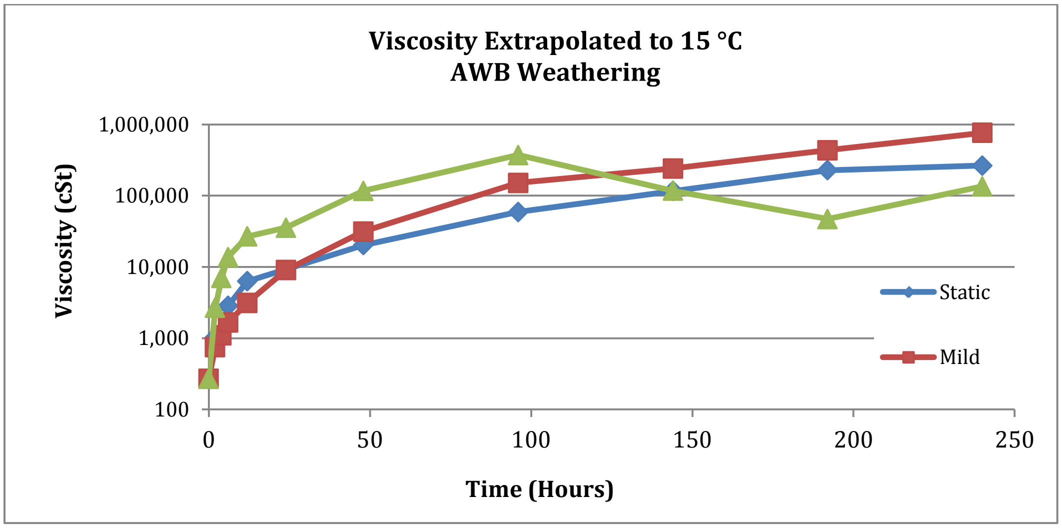
### *5.4.3.2 Physical Properties of Weathered AWB Diluted Bitumen*

The increased density of AWB during weathering was more pronounced with moderate agitation, whereas oil under static conditions and mild agitation had comparable change (Figure 5.4.3). In all cases absolute densities (at 15°C) reached or slightly exceeded 1000 kg/m$^3$ (freshwater equivalent), but only after eight to ten days of weathering. The increase in AWB pour point and in viscosity as it weathered was pronounced in the first 48 hours, with the latter ranging 108 to over 60,000 centistokes (cSt) within that timeframe (Figure 5.4.4). Loss of a portion of lighter hydrocarbons combined with water inclusion into oil, much as may occur with most heavy crudes, are key factors defining the weathered oil properties.




**Source:** Gainford Study Report (Volume 8C, TR 8C-12, S7)

**Figure 5.4.3 AWB - Absolute Density**

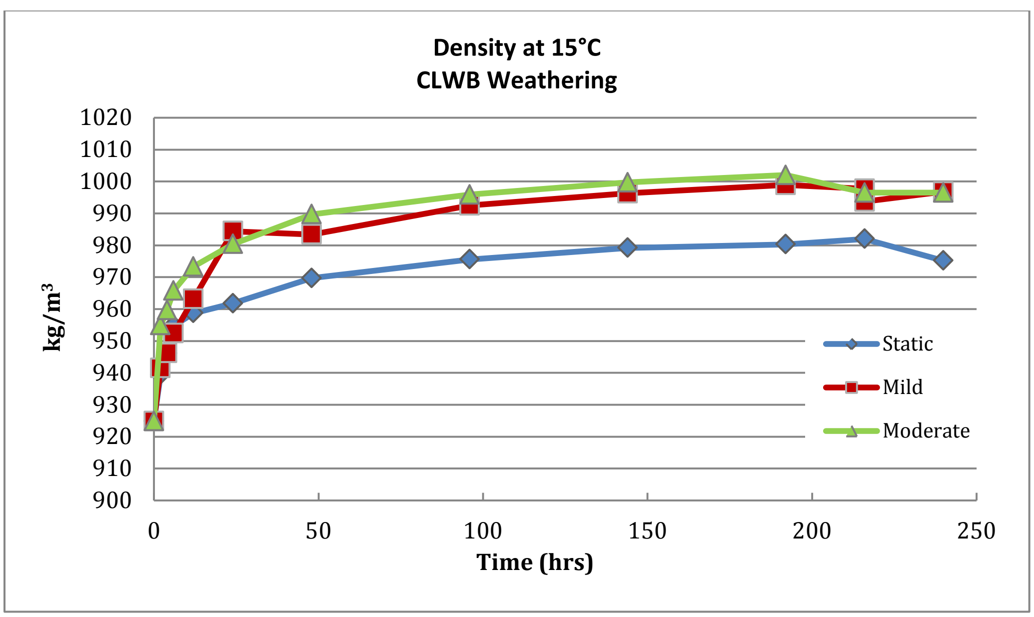



**Source:** Gainford Study Report (Volume 8C, TR 8C-12, S7)

**Figure 5.4.4 AWB Viscosity**

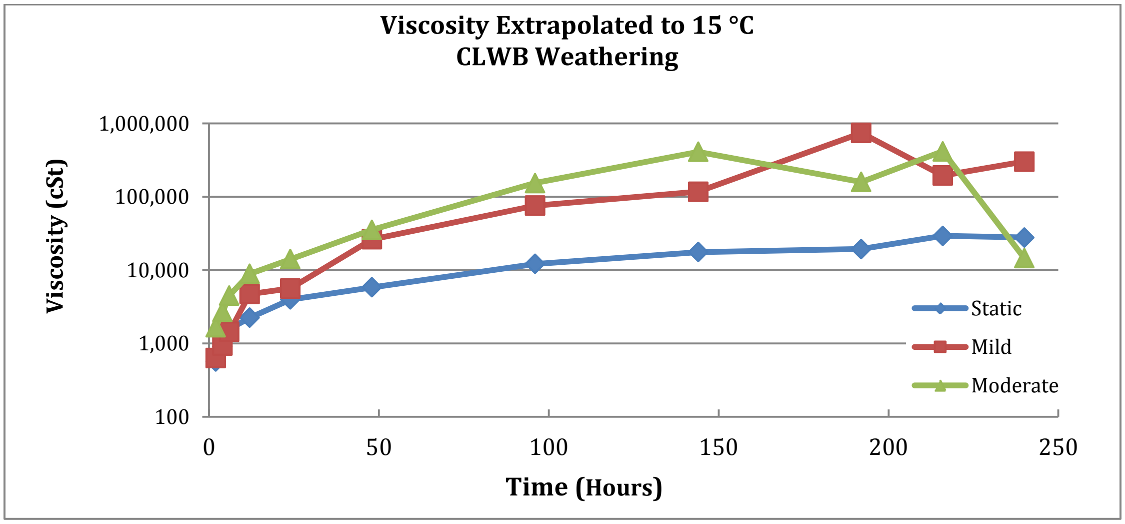
### *5.4.3.3 Physical Properties of Weathered CLWB*

The increase in density of weathered CLWB was more pronounced in the first 24 hours under moderate agitation (Figure 5.4.5) but oils in static and mild agitation tanks achieved similar densities after that time. In all cases absolute densities (at 15°C) never exceeded 1000 (freshwater equivalent) with the exception of a single measurement at 8 days for the CLWB under moderate agitation. Viscosity increased to over 10,000 cSt within the first 48 hours, although increases in viscosity were much less pronounced in the static tank (Figure 5.4.6)




**Source:** Gainford Study Report (Volume 8C, TR 8C-12, S7)

**Figure 5.4.5 CLWB Absolute Density**

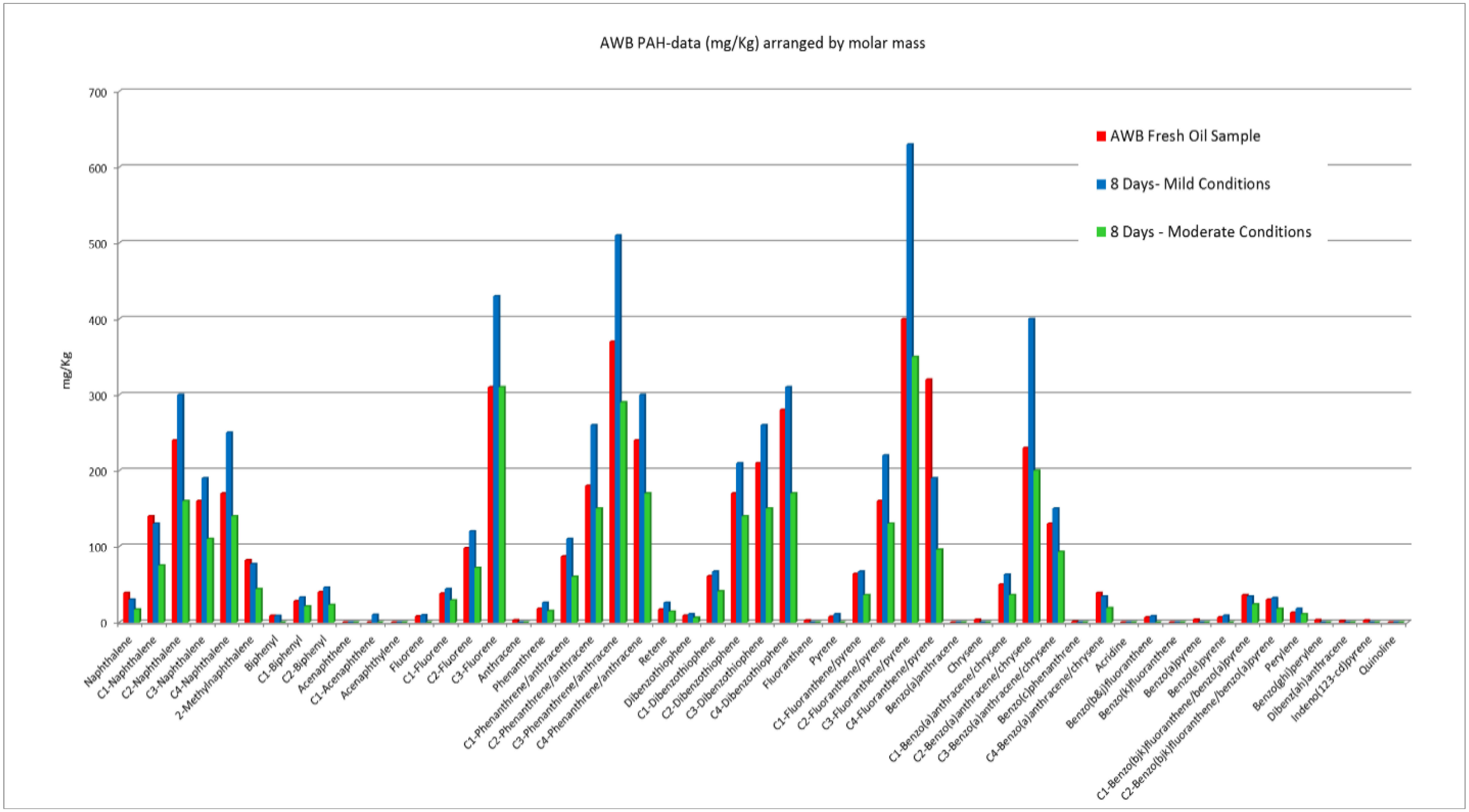



**Source:** Gainford Study Report (Volume 8C, TR 8C-12, S7)

**Figure 5.4.6 CLWB Viscosity**

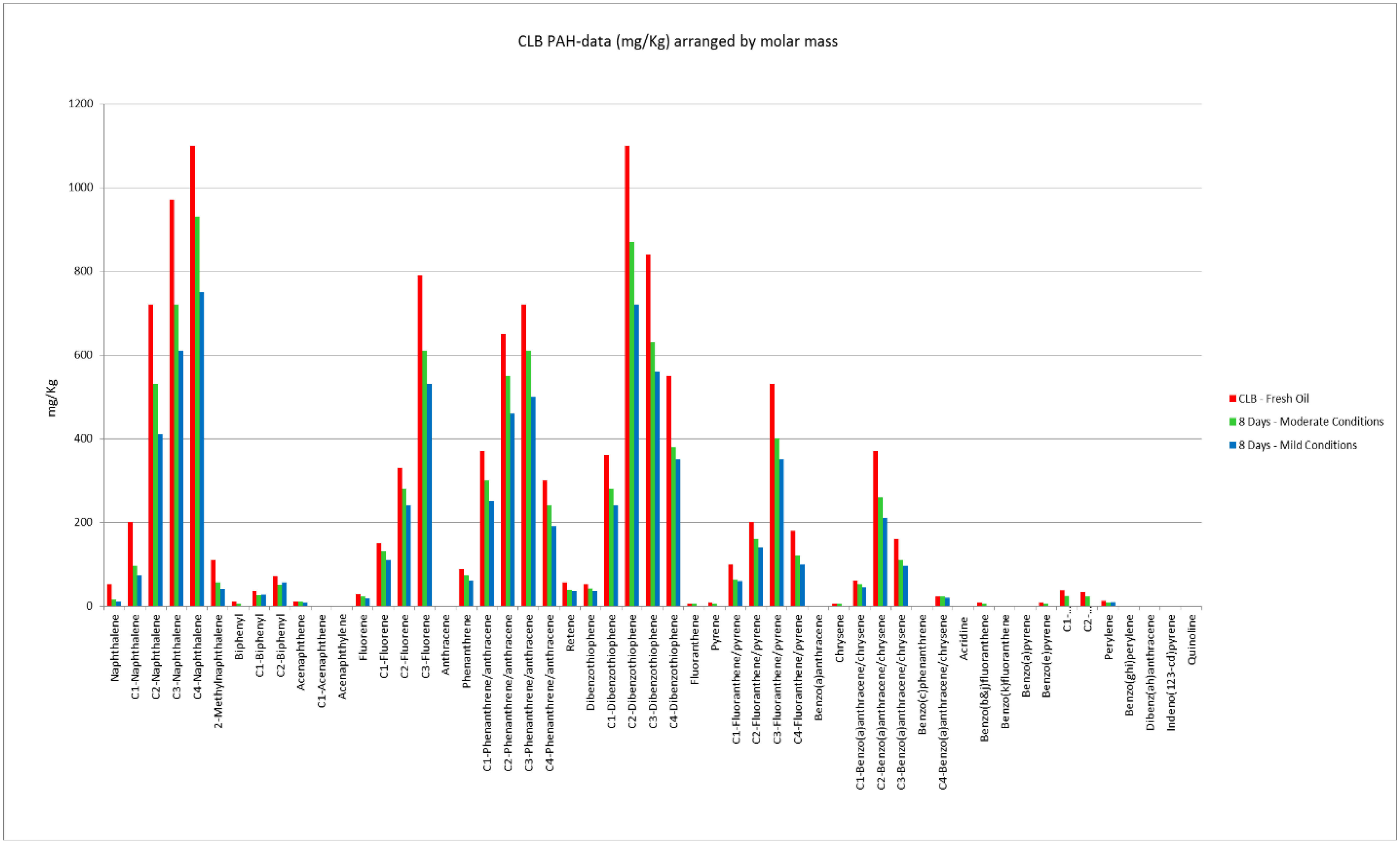
### *5.4.3.4 Chemical Properties of Weathered AWB and CLWB Diluted Bitumen*

Oil chemistry, including light ends (*i.e.*, C1-C30) and PAH analyses, were analyzed to characterize the originating (fresh oil) diluted bitumen and to assess hydrocarbon content and degradation patterns. Figures 5.4.7 and 5.4.8 show PAH data for weathered and fresh AWB oil samples. Figures 5.4.9 and 5.4.10 show relative weight concentration of C1 through C30 compounds in fresh and weathered AWB and CLWB, respectively, and compares changes in these compounds with different levels of induced turbulence. (see Volume 8C, TR 8C-12, S7 or full details).



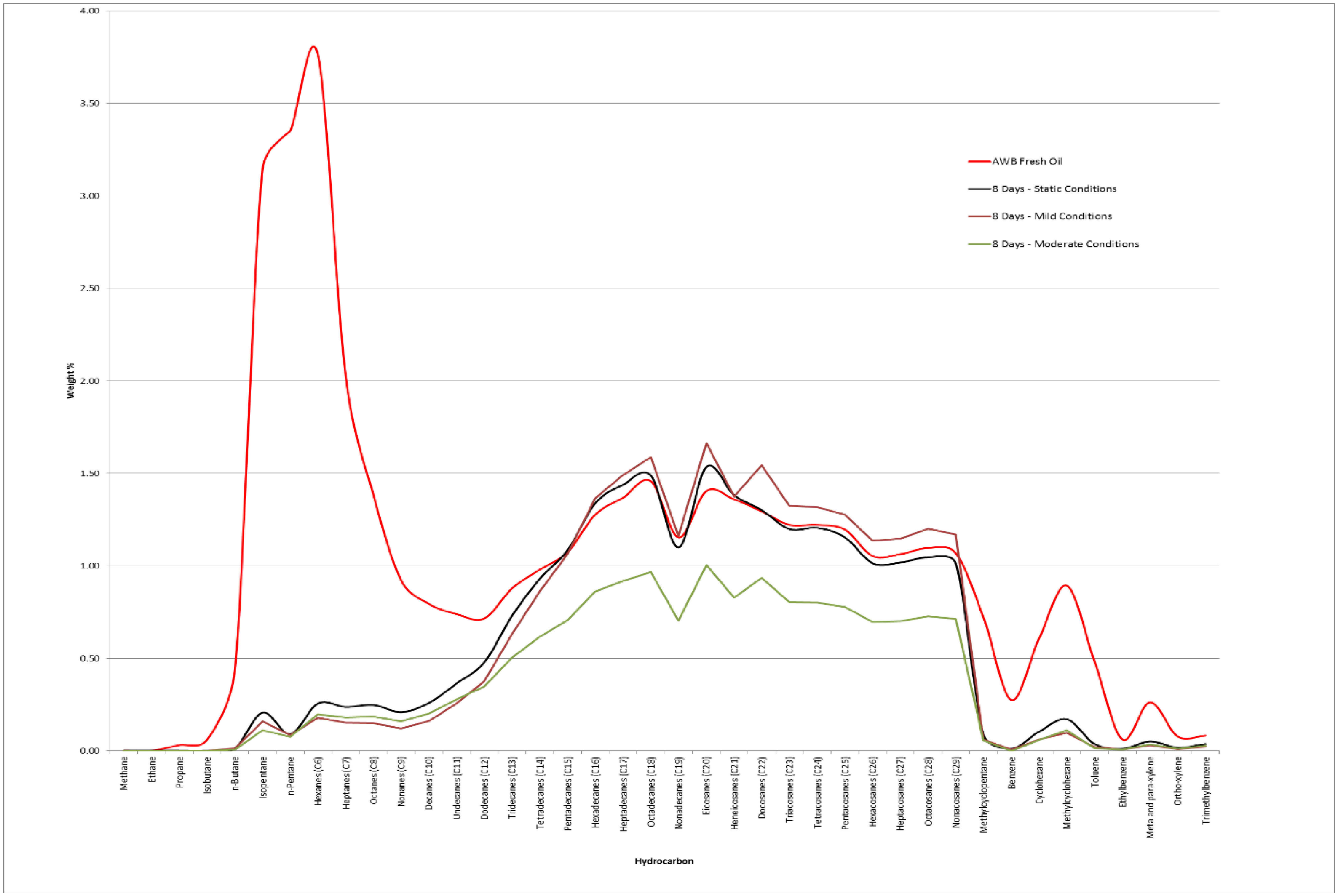

**Source:** Gainford Study Report (Volume 8C, TR 8C-12, S7)

## Figure 5.4.7 Oil Chemistry Data - AWB



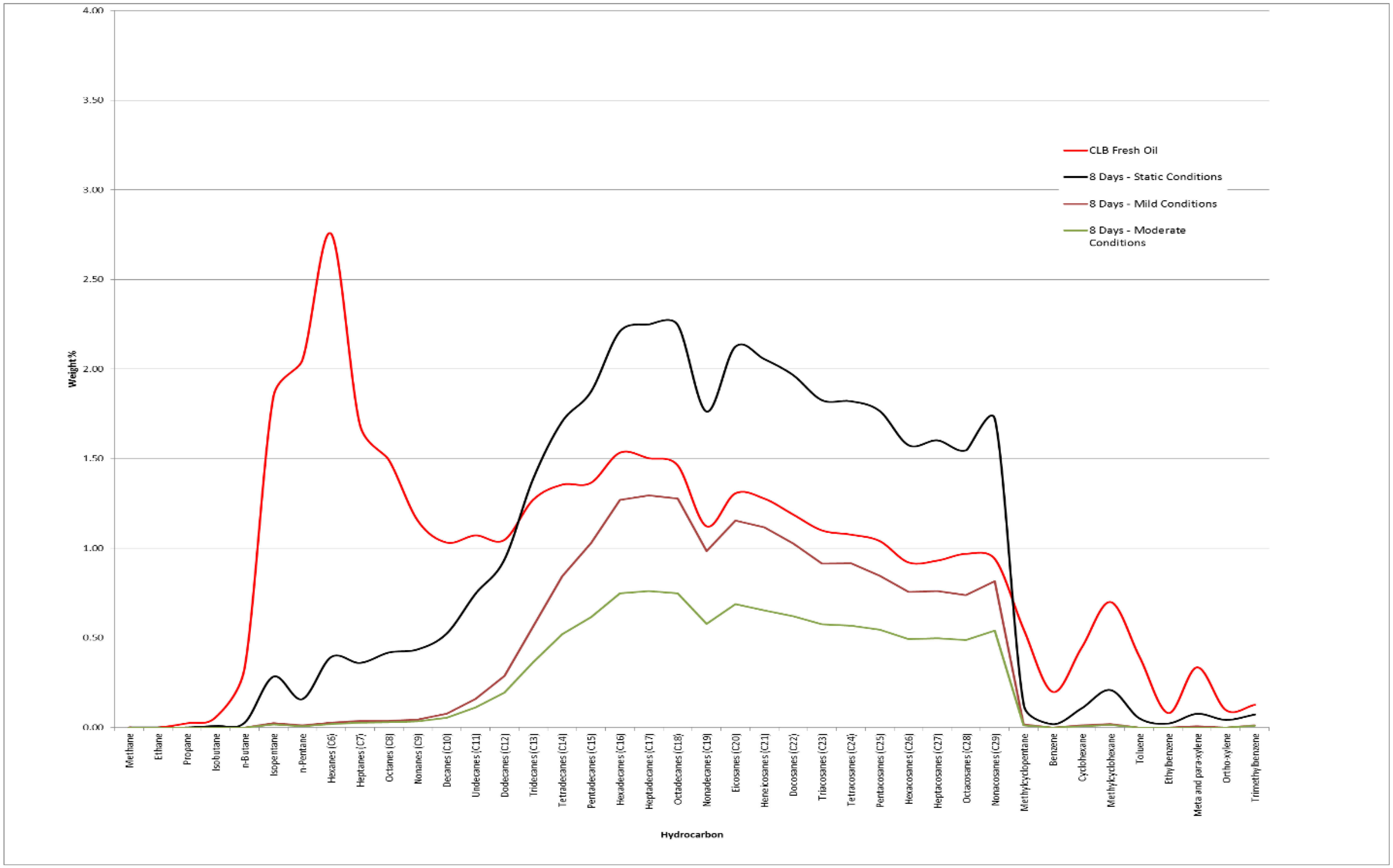

**Source:** Gainford Study Report (Volume 8C, TR 8C-12, S7)

**Figure 5.4.8 Oil Chemistry Data – CLWB**




**Source:** Gainford Study Report (Volume 8C, TR 8C-12, S7)

**Figure 5.4.9 Light Ends (C1 – C30) AWB**




**Source:** Gainford Study Report (Volume 8C, TR 8C-12, S7)

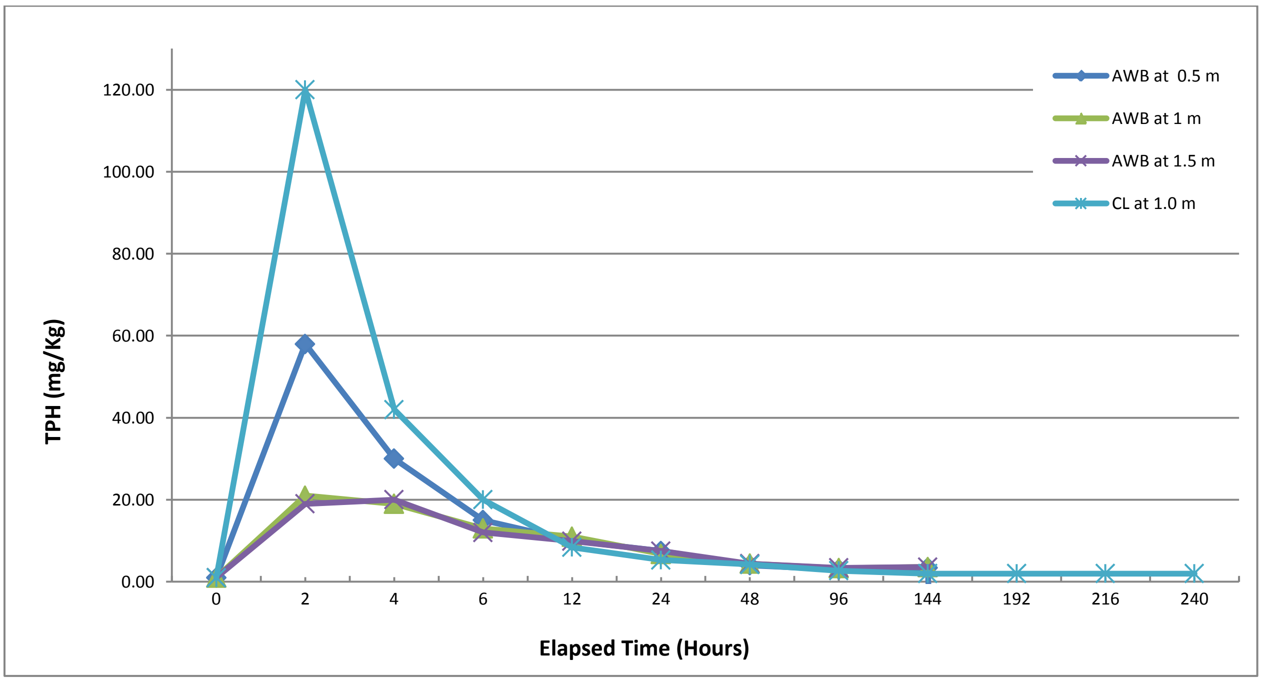
**Figure 5.4.10 Light Ends (C1-C30) CLWB**

#### *5.4.3.5 Oil Distribution in the Water Column*

Oil distribution and partitioning into the water column are provided through total petroleum hydrocarbons (TPH) and BTEX analyses of water samples at specific depths below the water surface (Volume 8C, TR 8C-12, S7). Chemical analyses of the weathered oils and of the water column showed that concentrations of BTEX diminished rapidly within 48 hours and that TPH in the water column only exceeded the detection limit (2 mg/L) during the first 48 hours in tanks with moderate surface agitation, despite the artificial confinement imposed by tanks relative to what may be expected in an open, natural setting

#### *5.4.3.6 TPH the Water Column*

TPH measured in the water columns of the AWB and CLWB tanks were in nearly all cases below detection thresholds (<2 mg/L) with the exception of tanks with moderate agitation (S3-AWB and S9A-CLWB). The highest TPH values measured were 120mg/L at 1m below the water surface from the CLWB and 60 mg/L at 50 cm below the water surface for AWB (Figure 5.4.11). By approximately 12 hours, all TPH values, regardless of depth in the water column or oil type, were near 10 mg/L in the tanks with moderate agitation. This pattern demonstrates that the lower molecular weight fractions of TPH tend to be more soluble in water and weather (*e.g.,* volatilize) faster.




**Source:** Gainford Study Report (Volume 8C, TR 8C-12, S7)

**Figure 5.4.11 TPH in Water Column Samples - AWB and CLWB Weathering Under Moderate Conditions**

#### *5.4.3.7 BTEX in the Water Column*

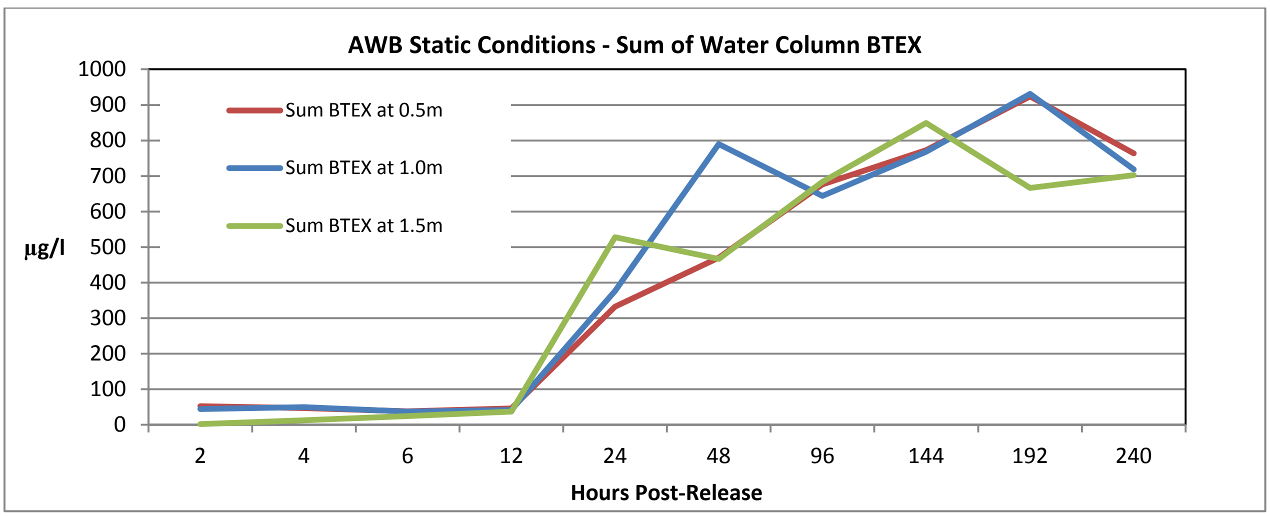
Most crude oil contains BTEX usually from about 0.5 per cent to 5 per cent or more. The CLWB and AWB contain approximately 1 per cent BTEX in the fresh oil samples, consistent with other crude oils. Gasoline can contain up to 40 per cent BTEX. BTEX compounds are volatile and rapidly volatilize producing a net loss of BTEX compounds.

Single-ringed aromatics are also soluble in water at low levels and readily partition out of the heavy crude. In the study of both CLWB and AWB, the BTEX compounds partitioned into the water column evenly at all depths examined (Figure 5.4.12) but behaved somewhat differently overall under different wind and wave conditions. BTEX in both AWB and CLWB behaved very similarly. In the static tests, dissolution of BTEX in the water column increased at 12 to 24 hours with maximum concentrations reaching approximately 900 µg/L (∑ BTEX) at approximately six days (Figure 5.4.12). There was little evidence of a net loss of BTEX in the static water leading up to ten days.

In mild wind and wave conditions, BTEX began to partition into the water column immediately reaching maximum ∑ BTEX concentrations of 1,200 µg/L (CLWB) to 1,500 µg/L (AWB) in 48 hours (Figure 5.4.13). Net loss of BTEX to volatilization was apparent at 48 hours with water concentrations dropping to less than 200 µg/L by eight days. Under moderate wind and wave conditions, (∑ BTEX reached similar, but slightly higher values, and it reached these values almost immediately. (Figure 5.3.14)

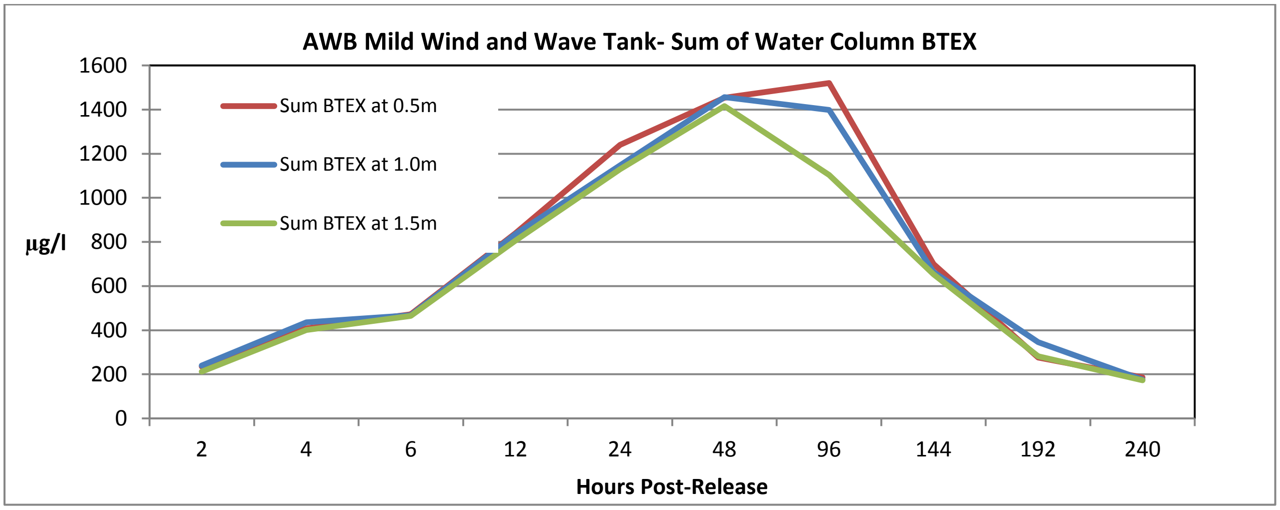
In moderate wind and wave conditions, CLWB ∑BTEX reached 3,000 µg/L almost immediately followed by a net loss to <100 µg/L in 4 days (Figure 5.4.15). The AWB ∑BTEX reached maximum concentrations of approximately 1,700 µg/L after four hours followed by a slightly slower net loss to <200 µg/L after 4 days. It is possible that the CLWB tanks located outdoors resulted in more rapid net loss of BTEX compounds. The higher maximum concentration of BTEX in CLWB could have been the result of a smaller tank.

In general, the results are expected, following the trend of more rapid and complete dissolution with mixing, as well as more rapid net loss.



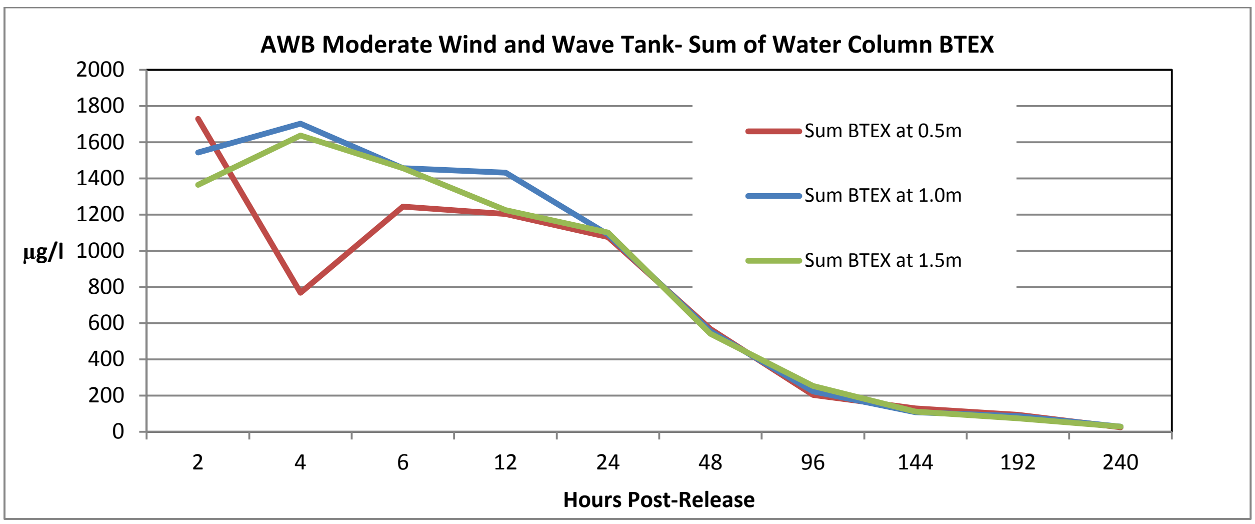

**Source:** Gainford Study Report (Volume 8C, TR 8C-12, S7)

**Figure 5.4.12 AWB Static Conditions - Sum of Water Column BTEX**



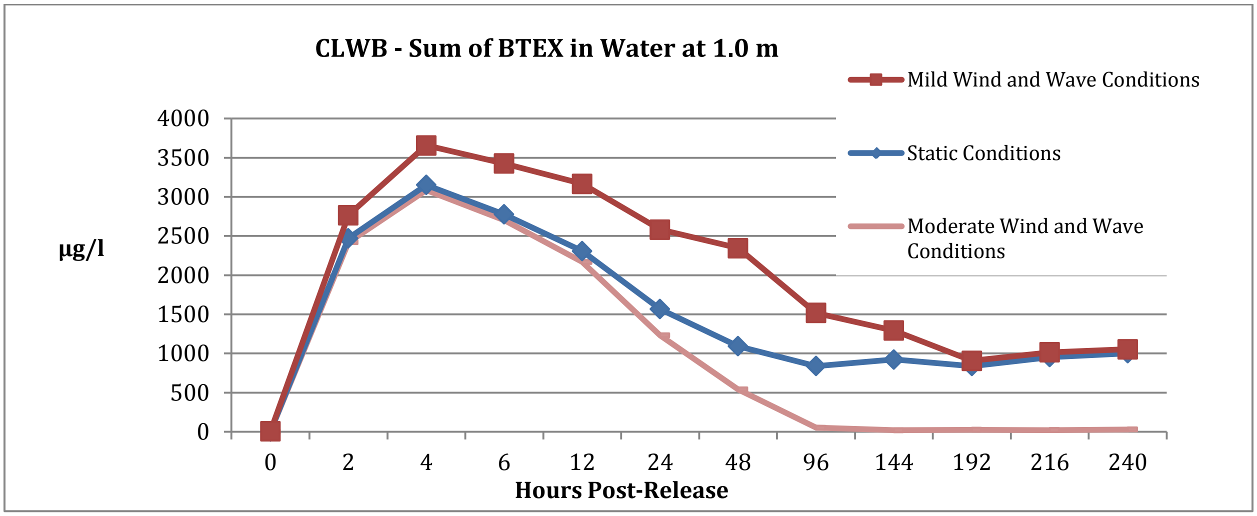

**Source:** Gainford Study Report (Volume 8C, TR 8C-12, S7)

**Figure 5.4.13 AWB Mild Wind and Wave Tank- Sum of Water Column BTEX**




**Source:** Gainford Study Report (Volume 8C, TR 8C-12, S7)

**Figure 5.4.14 AWB Moderate Wind and Wave Tank- Sum of Water Column BTEX**




**Source:** Gainford Study Report (Volume 8C, TR 8C-12, S7)

**Figure 5.4.15 BTEX in Water Column Samples – CLWB Tanks**

### *5.4.4 Fate and Behaviour of Accidental Project-Related Diluted Bitumen Spills*

The fate and behaviour of Project-related spills is discussed in terms of properties of the product (*i.e.*, diluted bitumen), spill behaviour including weathering, and considerations with respect to mitigation. Since general oil properties and weathering have been discussed earlier in Section 5.4.3, this section will concentrate on the particular characteristics of the diluted bitumen proposed for this Project. The description of fate and behaviour was prepared by EBA Engineering Consultants Ltd. operating as EBA, A Tetra Tech Company (EBA), based on their proprietary modeling and the results of the Gainford Study conducted to simulate the weathering of spilled diluted bitumen in a marine environment.

Trans Mountain selected CLWB as a representative product for the purposes of modeling hypothetical spill scenarios since its properties are comparable to other diluted bitumen products transported on the TMPL system and shipped from the Westridge Marine Terminal. CLWB is now, and is expected to continue to be, a major contributor to the total quantity of diluted bitumen shipped on the TMPL system and from the Westridge Marine Terminal. Therefore there is a reasonable probability that in the event of an accidental oil spill, the spilled oil could be CLWB. In addition, the following factors were taken into consideration in selecting CLWB as a representative product for the purposes of spill modeling:

- More research on fate and behaviour has been completed with CLWB than other blends.
- The diluent in CLWB is condensate (a hydrocarbon product derived from natural gas production, that can be described as a light oil, similar in some respects to a crude gasoline). The CLWB contains a relatively large fraction of diluent in order to achieve specifications for viscosity and density under winter shipping conditions. As the condensate is rich in lighter hydrocarbons that are both volatile and relatively water soluble, the CLWB represents a diluted bitumen product that has a relatively high potential to cause acute toxicity to aquatic life (through dissolution of lighter hydrocarbons in water), or to cause

irritation or injury to human receptors (through inhalation of volatile hydrocarbons). CLWB is expected to weather to a state resembling a summer dilbit blend with less condensate within a day.

- The choice of condensate as a diluent is conservative with respect to alternative diluents (such as synthetic oil) that are less water soluble and volatile. The potential for light-end hydrocarbons contained in the CLWB to volatilize, dissolve or be biodegraded in the hours and days following an oil spill leads to a greater potential for the weathering oil to achieve a density that could sink, either through interaction with suspended sediment particles (*i.e.*, as an oil mineral aggregate), or directly if the density of the weathered oil were to exceed the density of the ambient water.

#### *5.4.4.1 Properties of CLWB used for Modeling*

To support the discussion of diluted bitumen properties and behaviour in the marine environment, it is worth describing briefly the properties of the CLWB product used for modeling of the spill scenarios.

The Canada Wide Standard for Petroleum Hydrocarbons (CCME 2008) describes a method of characterizing hydrocarbons from a toxicity point of view, using four fractions, F1 to F4, where each fraction (or pseudo-component) represents a range of carbon atoms in the molecule. F1 is the $C_6$ to $C_{10}$ band, for example. Sub-categories of aromatics and aliphatics are also recognized in the CWS. Based on these considerations, a pseudo-component description with greater resolution (smaller ranges of carbon numbers in each fraction) was developed by the environmental assessment team for this Project. Table 5.4.7 is the pseudo-component description a CLWB sample, using the pseudo-component categories adopted for this Project (Sample BG5490, collected February 19, 2013 at the Westridge Marine Terminal).

**TABLE 5.4.7**

**PROPERTIES OF CLWB**

| Pseudo-component | Description | Concentration (g/kg) | Molar Fraction | Molecular Weight (g/mol) | Vapour Pressure (Pa) | Solubility in Water (mol/m$^3$) | Density (@ 20 or 25 °C) (g/cm$^3$) | Boiling Point (°C) |
|---|---|---|---|---|---|---|---|---|
| VOL | Volatiles | 72 | 0.255 | 70.8 | 9.98E+04 | 2.28E+00 | 612 | 29 |
| AR1 | Benzene | 2 | 0.006 | 78.1 | 1.27E+04 | 2.28E+01 | 867 | 80 |
| AR2 | TEX | 8 | 0.020 | 99.0 | 2.47E+03 | 2.05E+00 | 860 | 125 |
| AR3 | Aromatics > C8-C10 | 3 | 0.006 | 120 | 1.27E+03 | 3.90E-01 | 866 | 150 |
| AR4 | Aromatics > C10-C12 | 4 | 0.008 | 130 | 4.14E+00 | 2.35E-01 | 888 | 200 |
| AR5 | Aromatics > C12-C16 | 22 | 0.037 | 150 | 8.72E-03 | 1.10E-01 | 1156 | 260 |
| AR6 | Aromatics > C16-C21 | 47 | 0.062 | 190 | 2.13E-05 | 3.10E-02 | 1235 | 320 |
| AR7 | Aromatics > C21-C34 | 120 | 0.125 | 240 | 9.16E-08 | 3.17E-03 | 1216 | 340 |
| AL1 | Aliphatics > C6-C8 | 55 | 0.137 | 100 | 6.38E+03 | 1.42E-01 | 695 | 96 |

**TABLE 5.4.7**

**PROPERTIES OF CLWB (continued)**

| Pseudo-component | Description | Concentration (g/kg) | Molar Fraction | Molecular Weight (g/mol) | Vapour Pressure (Pa) | Solubility in Water (mol/m$^3$) | Density (@ 20 or 25 °C) (g/cm$^3$) | Boiling Point (°C) |
|---|---|---|---|---|---|---|---|---|
| AL2 | Aliphatics > C8-C10 | 20 | 0.038 | 130 | 6.38E+02 | 1.45E-02 | 721 | 150 |
| AL3 | Aliphatics > C10-C12 | 16 | 0.025 | 160 | 6.38E+01 | 1.48E-03 | 740 | 200 |
| AL4 | Aliphatics > C12-C16 | 40 | 0.050 | 200 | 4.86E+00 | 5.51E-05 | 765 | 260 |
| AL5 | Aliphatics > C16-C21 | 46 | 0.043 | 270 | 1.11E-01 | 2.70E-07 | 781 | 320 |
| AL6 | Aliphatics > C21-C34 | 60 | 0.038 | 390 | 2.59E-06 | 6.31E-12 | 800 | 467 |
| RES1 | F4 (> C34-C50) | 110 | 0.048 | 570 | 1.00E-10 | 5.25E-15 | 998 | --- |
| RES2 | Resins | 295 | 0.089 | 825 | 1.00E-10 | 9.55E-08 | 1008 | Na |
| RES3 | Asphaltenes | 80 | 0.013 | 1599 | 1.00E-10 | 3.24E-16 | 1166 | Na |

*5.4.4.2 Characteristics of the Shipping Route*

#### 5.4.4.2.1 Configuration

The shipping route, Figure 1.3.1, was previously described in Section 2.2. As was discussed in greater detail in Section 5.2, the hypothetical locations where an oil spill from a Project-related tanker could occur were described in Table 5.2.2 and are mapped on Figure 5.5.2. These hypothetical locations were used by EBA to model the fate and behaviour of hypothetical accidental oil spills from a Project-related tanker.

An accidental oil spill from a Project-related tanker in transit would spread and move away from the spill site, depending on local currents, driven by winds, tides and estuarine circulation. The waters between Vancouver Island and the mainland and the interconnecting channels form a deep, topographically complex and strongly tidal estuarine system. Freshwater from the Fraser River, as well as other rivers draining into these waters, provide a driving force for a strong estuarine circulation, which leads to a seaward set to currents along the bulk of the shipping route. This estuarine circulation persists out onto the continental shelf, aided by additional fresh water from the Columbia River.

#### 5.4.4.2.2 Meteorology

The descriptions of winds provided hereinafter are informed by the general discussions in Thomson (1981) and two Environment Canada publications (Lange 1998 and 2003), as well as the data that is included in this section. In general, large-scale wind patterns in the Project area (as depicted in Figure 1.3.1) are the result of the relative positions of the Aleutian Low, which is located over the Gulf of Alaska and the Aleutian Islands, and the North Pacific High, located between Hawaii and California. The counter-clockwise circulation around the Low and the clockwise circulation around the High produce a general westerly upper-level flow onto the Southern Coast of BC.

At the surface, the two major pressure systems, the Aleutian Low and the North Pacific High, drive a general circulation characterized by south-easterly winds in the winter, and north-westerly winds in the summer. Additionally, migratory low and high-pressure systems move through the area, producing day-to-day changes in weather and wind patterns. Low pressure systems can develop offshore, more frequently during the winter, either originating from the Gulf of Alaska or as rapidly forming Coastal Lows, referred to as "Coastal Bombs" (Murty *et al.*, 1983) because of their short time scale and high intensity winds. Ahead of these systems, strong south-easterly winds and rain are produced. Often, as the cold front passes, a second band of winds occur, originating from the west or northwest. These north-westerly winds can be particularly strong in spring and occasionally in summer as high pressure begins to rebuild and winds are funnelled down the Strait of Georgia (EC 1999). Often, there are few indicators of the onset of these winds.

On occasion during the winter, outflows occur as cold arctic air deepens over the interior of BC and flows through the Coastal Mountain passes, out over coastal waters. Such events can produce very strong localized winds, particularly through Howe Sound, but are generally infrequent events on the South Coast.

Typically during the summer, the presence of high pressure off the coast and a thermal low over the interior produce a general north-westerly flow. Winds are typically light and are replaced by strengthening onshore winds later in the day as a result of land-sea heating differences. These onshore winds produce inflow winds through Juan de Fuca Strait and Howe Sound.

Thunderstorms are infrequent in the study area, but form with very strong winds and dissipate quickly.

Wind patterns in this coastal region are complicated due to the mountains and coastal topography and the land-sea contrast. Topography heavily influences the winds by restricting and steering horizontal movement and can lead to hazardous conditions in passes or channels and in the vicinity of headlands and islands. During the passage of a storm, a particular location may experience rapid changes in wind direction and wind speed.

#### 5.4.4.2.3 Oceanography

Patterns of currents and waves differ to various degrees from one area to another, due to the complexity of the physiographic, oceanographic and hydrographic settings. Currents are driven by the interaction of freshwater drainage from land, precipitation, the salty waters that originate from the Pacific Ocean, tidal fluctuations, winds and other physical processes. The general description of circulation and wave climate provided in this document is based on Waldichuk (1957), Thomson (1981), Labrecque *et al.* (1994), Masson (2005). Water level and its fluctuations vary from one location to another as a result of the complex processes that are involved in the tidal wave propagation. Added to the tidal fluctuations in water level is storm surge, the difference in elevation between the observed water level and the predicted tidal water level resulting from disturbances propagating in from the open ocean, usually coupled with air pressure gradients. The specific information about water level at various locations provided herein is based on tide books and hydrographic charts published by the CHS.

Wave fields in the study area depend on local wind patterns as well as the degree and direction of exposure to wave attacks. Swell propagating from the Pacific Ocean also plays a major role in governing the wave climate in Juan de Fuca Strait and the Pacific Ocean off the West Coast of Vancouver Island.

### *5.4.4.3 The Modelling System*

EBA's proprietary oil spill model SPILLCALC was used for the simulations described here. SPILLCALC is a stand-alone model, but relies on other models and observational data bases. For this Project, the main models used were:

- a three-dimensional hydrodynamic model, H3D;
- a wave model, SWAN; and
- a spill simulation model, SPILLCALC.

The Technical Report (Modelling the Fate and Behaviour of Marine Oil Spills for the Trans Mountain Expansion Project, contained in Volume 8B, TR 8C-12, S9) provides a more complete description of these models. The relevant features of these models are summarized in the following paragraphs.

#### 5.4.4.3.1 HYDRODYNAMIC MODEL: H3D

Although the dominant currents affecting an oil spill are the surface currents, the best way to obtain realistic currents is to use a three-dimensional model. In this way, processes such as wind-driven currents, river plumes and large-scale estuarine circulation are correctly included in the calculation of surface currents. Surface currents for the oil spill simulations were hindcast using a proprietary three-dimensional hydrodynamic model, H3D. This model is derived from GF8 (Stronach *et al.*, 1993) developed for Fisheries and Oceans Canada. H3D has been used on several studies along the BC coast. An extensive application of an operational version of this model to the St. Lawrence Estuary is described in Saucier and Chassée (2000).

The following key points provide further information on the hydrodynamic characteristics of the model.

- Tidal constituents from the CHS were used to provide water level data at the oceanic boundary of H3D. Tidal currents at the boundaries are generated by the model, and are the response of the basin to the fluctuating water levels on the boundaries.
- Wind forcing causes both currents and water level differences. Consideration of wind forcing is also important because wind energy has a notable effect on vertical mixing, and therefore scalar distributions. Wind stresses acting at the water surface are derived from wind records collected from coastal Meteorological Service of Canada stations and moored buoys.
- The model incorporates inflows from 50 rivers and creeks throughout the model domain. These inflows contribute mass and momentum to the waterbody. Where available, all input river flows are generated from daily hydrographs of the particular river under consideration.
- In addition to wind, other meteorological data are also needed to compute heat flux into the waterbody and thus its temperature structure. These data are obtained from the Halibut Bank buoy, with the exception of cloud cover, which was obtained from the Vancouver International Airport meteorological station. In the summer, heat input leads to increased temperature stratification. In the winter, when salinity stratification is often minimal, cooling can lead to static

instabilities and overturning in the upper part of the water column. H3D's ability to simulate both summer heating and winter cooling has been rigorously verified in simulations done for freshwater lakes, where adequate temperature data is more routinely available over several years (Zaremba *et al.* 2005).

- Turbulence modelling is important in determining the correct distribution of velocity and scalars such as temperature and salinity.
- The model operates in a time-stepping mode over the period of simulation. The time-step length is variable, depending on the maximum velocity present in the model at that particular time-step.
- The model is initialized with salinity and temperature fields obtained by interpolating observations archived at the Institute of Ocean Sciences. An initial condition of zero velocity is chosen, and the water level is set to mean sea level initially. The model is run in prognostic mode from this initial state, with the tide and wind being ramped up over one day. The first 15 days of the run are discarded, as they are deemed to be contaminated by start-up transients.
- Oceanic boundary conditions for salinity and temperature were available via models maintained by the Alaska Ocean Observing System (AOOS). The southern boundary of this model domain is approximately 450 km south of the mouth of the Juan de Fuca Strait, and the AOOS provides and archives model predictions every 4 hours since early 2011. These data were downloaded and used to provide realistic boundary conditions to H3D.

#### 5.4.4.3.2 Wave Model: SWAN

The oil spill model, SPILLCALC, requires wave conditions as an input to its weathering processes. Wave conditions for the simulation period were hindcast using SWAN version 40.72 (Booij *et al.*, 2006). For consistency with the hydrodynamic inputs, wave conditions were simulated on the same set of computational grids as were used for the hydrodynamic modelling.

SWAN is a third-generation wave model for obtaining realistic estimates of wave parameters in coastal areas, lakes, reservoirs and estuaries from given wind and bottom conditions. SWAN utilizes a finite difference scheme to compute random, short-crested wind generated waves. SWAN incorporates physical processes such as wave propagation, wave generation by wind, whitecapping, shoaling, wave breaking, bottom friction, sub-sea obstacles, wave setup and wave-wave interactions in its computations. It is thus well-suited to computing a wave field as it propagates from the Pacific into the Strait of Georgia, Burrard Inlet and the Fraser estuaries.

For the 1-km grid model, covering the Salish Sea and extending out onto the continental shelf, SWAN used the same computational domain and bathymetry as the corresponding hydrodynamic model. The wind inputs were also the same as those used in H3D. Wave boundary conditions along the southwest and northwest edges of the domain were taken from the La Perouse Bank and South Brooks wave buoys. These buoys do not record wave direction. Therefore, to best agree with the wave directions observed at Neah Bay, boundary waves were assumed always to come from the west.

This model also provided boundary condition data for the other nested models: the 200-m grid model of the central Strait of Georgia, the 125-m grid model of Burrard Inlet and the 50 m × 20 m grid model of the Fraser River.

#### 5.4.4.3.3 SPILLCALC

SPILLCALC is a time-stepping model that computes the motion and weathering of liquid hydrocarbon spills. It can be implemented in one of two different versions: stand-alone and embedded within the hydrodynamic model H3D. The stand-alone version contains interfaces to the output from one or more H3D circulation models. SPILLCALC uses currents from this model to move the spill. Oil released on the water surface is represented as a large number of independent floating particles, referred to as slicklets. Individual slicklets are not intended to be physically meaningful. Instead, the cloud of particles as a whole is the area covered by the spill, and its progress is the spill's dispersion and trajectory. Each slicklet knows its volume and the volume fraction of each pseudo-component, age, the amount on intertidal banks, and whether or not the oil is in the form of a tar ball.

### *5.4.4.4 Oil Weathering Processes*

#### 5.4.4.4.1 Evaporation

In SPILLCALC, there are two mechanisms to specify the evaporation process: first, the fairly standard approach of calculating the mass flux based on wind speed, equilibrium pressure for the constituent and molar concentration of the constituent in the total product. This method is used in ADIO 2, for instance. However, SPILLCALC includes an additional mechanism, the effect of the slow rate of molecular diffusion within diluted bitumen. Molecular diffusion is responsible for bringing the lighter fractions to the evaporating surface, to replace the losses due to evaporation. In general the rate of molecular diffusion through the vertical extent of the slick is slower than the rate of evaporation from the surface, so that in fact the controlling mechanism is the internal diffusion process. SPILLCALC calculates both rates, and the slower of the two is used to calculate the rate of evaporation. The diffusion coefficient used was similar to those reported by Afsahi and Kantzas (2006) for pentane diffusion in Cold Lake bitumen, but was adjusted slightly to values that would reproduce the Gainford Study results (Volume 8C, TR 8C-12, S7). Figure 5.4.15 shows the simulation of the observed density in the Gainford Study static CLWB test. The density of the oil is a relatively sensitive indicator of the amount of evaporation: the faster evaporation occurs, the faster the density will increase. The near-exact reproduction of the time rate of change of density in Figure 5.4.15 is a strong indicator that the observation that CLWB does not readily sink in brackish waters is supported by a reasonable theoretical explanation.

#### 5.4.4.4.2 Vertical Dispersion and Resurfacing

Breaking waves drive small droplets of the oil into the water column. Depending on the natural turbulence in the water and the size and density of the droplets, the dispersed oil will generally stay suspended in the water column and will be prevented from resurfacing as long as the dispersing mechanism, breaking surface waves, remain active. When wind and waves die down, the dispersed oil will generally rise to the surface. The process of vertical dispersion has been implemented in SPILLCALC using equations developed by Delvigne and Sweeney (1988), which are also used to compute dispersion in the NOAA ADIOS2 model. The process of resurfacing was implemented in SPILLCALC using the equations developed by Tkalich and Chan (2002). A unique feature of SPILLCALC is that the wave field was generated by a reliable and widely used wave model SWAN, whereas most spill models estimate waves from wind speed and fetch. The use of SWAN provides much more realistic wave energy for computing vertical dispersion.

#### 5.4.4.4.3 Contact with Shorelines

SPILLCALC uses a shoreline provided by Coastal and Ocean Sciences (Methods for Estimating Shoreline Oil Retention in Volume 8C, TR 8C-12, S11). The shoreline is based on BC and Washington State databases, and includes not only shore location, but also coastline type, and a value for oil retention. Oil retention was calculated based on shore types and the know properties of dilbit, especially it’s relatively high viscosity.

When a slicklet intersects the shoreline, SPILLCALC activates a shore retention algorithm. If there is capacity for that shoreline segment to retain more oil (*i.e.*, if it has not been filled up by a previous encounter with the oil slick), that amount of oil is taken from the slicklet is transferred to the shoreline, up to the minimum of the amount of oil in the slicket, and the capacity of the shoreline segment to hold additional oil.

#### 5.4.4.4.4 Contact with Beach and Intertidal Areas

A potential issue of concern is the extent to which oil would come into contact with intertidal sand and mud flats and adversely affect benthic invertebrates and bio-films. In addition to entering beach and mud flat sediment via the shore contact process, SPILCALC contains an algorithm to simulate stranding of oil as water levels fell below the level of the beach or sand flat cell. The algorithm used was that all the oil on the water surface in a particular cell would be transferred to the sediment on a falling tide, once the water depth dropped below 2 cm. No provision was made to re-float the trapped oil on a rising tide. This procedure is likely to overestimate the amount of oil that is stranded, and hence overestimates the amount of oil trapped in the intertidal.

#### 5.4.4.4.5 Small-Scale Spreading

In addition to the vertical diffusion within the slick, the area covered by the slick plays a major role in the evaporation subroutine. A spreading experiment conducted at the WCMRC facility showed that the lateral spreading of the oil is limited and that a minimum thickness is observed. This minimum thickness is 0.4 mm, as described in the Spreading Observation Memo, Appendix B of the Technical Report (Volume 8C, TR 8C-12, S9). As a result, an effective area was used in the evaporation process, based on the volume of oil in one cell and the minimum thickness it can reach. The ratio of the effective area over the area ranges between 0 and 1. At the beginning of the simulation, the effective area is very close to the cell area, since the oil slick is very concentrated close to its release point. As time goes by, the effective area becomes smaller, representing the patchiness developing in the slick.

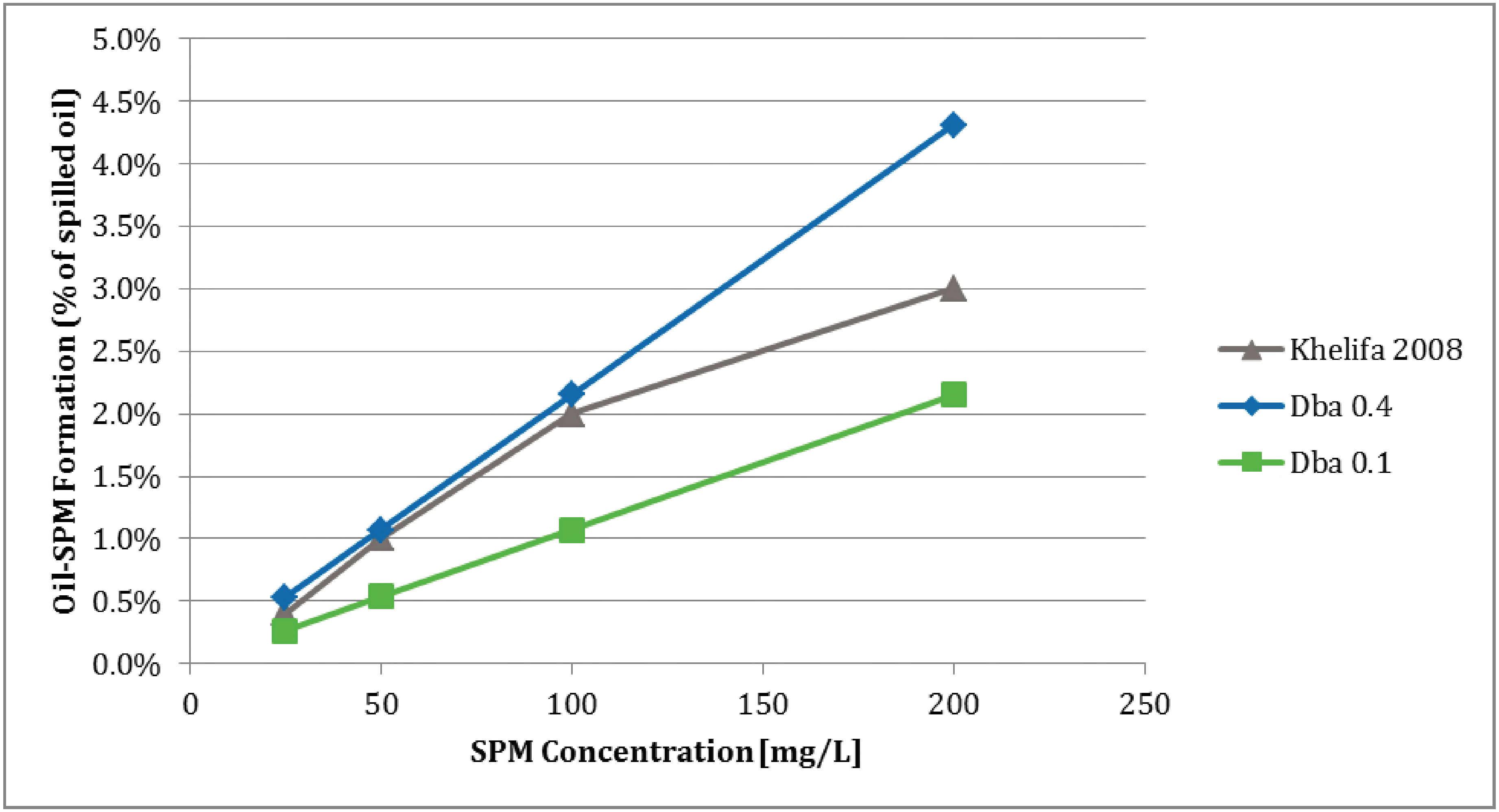
#### 5.4.4.4.6 Oil-Sediment Interaction

The formation of oil-mineral aggregate is another process that can affect the behaviour of an oil slick. In river and estuary areas, where the fine sediment load is usually higher than the one in the ocean, the interaction between oil and fine sediment is crucial in assessing the impact of a spill on the environment.

The method used in the SPILLCALC model follows the same approach as in the NOAA ADIOS2 model. The approach was proposed by J.R. Payne (Payne *et al.* 1987) and incorporates the effect of water turbulence.

The oil spill model, SPILLCALC, uses time-varying wave data computed by SWAN and time-varying sediment concentration computed by H3D to calculate the interaction of oil with sediments, making it difficult to reproduce laboratory conditions.

The calibration and the validation of the SPILLCALC oil-sediment interaction module was conducted using data reported by Khelifa, Fingas and Brown (2008). The rate of energy dissipation in the breaking wave field was used in place of the mechanical agitation energy in the reported s experiments. Good agreement was obtained using the SPILLCALC formulation in a hindcast of these experiments, as shown in Figure 5.4.16.




## NOTES

- Conditions from Khelifa's experiment were reproduced to the best extent into the oil spill model SPILLCALC.

STATUS
ISSUED FOR REVIEW

CLIENT
TRANSMOUNTAIN

eba
A TETRA TECH COMPANY

## TRANS MOUNTAIN OIL SPILL STUDY

**Percentage of Oil-SPM Interaction**

| PROJECT NO. | DWN | CKD | APVD | REV |
|---|---|---|---|---|
| V13203022 | AH | JAS | JAS | 0 |

| OFFICE | DATE |
|---|---|
| EBA-VANC | October 28, 2013 |

**Figure 5.4.16**

#### 5.4.4.4.7 Emulsification

Emulsification is a process whereby oil and water co-mingle and form an emulsion, usually requiring wave energy to mix the two liquids. The emulsification process can be qualitatively seen as the opposite of the vertical dispersion process: during oil emulsification, oil takes up water to form the emulsion, whereas during vertical dispersion, the oil droplets are surrounded and mixed in the water content.

The formation of emulsions can change the properties and characteristics of the oil drastically. Depending on the state of the emulsion (stable, meso-stable or unstable), the volume of spilled material may contain 50 per cent up to 80 per cent of water, thus expanding the volume of the spilled material considerably (Xie *et al.*, 2007).

Formulas for the water uptake and the emulsion stability were proposed by Mackay *et al.* (1980) and Mackay and Zagorsky (1982) respectively. Amongst others, the emulsification has a strong impact on the evaporation process. The inhibition of evaporation rises with increasing water content and slick thickness. SPILLCALC follows the method developed by Ross and Buist (1995): evaporation is assumed to have a linear relationship with the water content.

#### 5.4.4.4.8 Dissolution

Some of the lighter hydrocarbon fractions are soluble in water; they will dissolve in the underlying water column. The solubility of the pseudo-components are given in Table 5.4.7. The potential for dissolution is a function of the pure component solubility, the mole fraction of the hydrocarbon and the mass transfer coefficient. The rate of dissolution is computed according to the equation published by MacKay and Leinonen (1977) and uses their value for a mass transfer coefficient: 2.36 e-6 m/s.

This flux is applied as a loss to the oil slick, in a similar manner to the evaporation process. In order to compute concentrations in the water column of these lighter fractions, some of which are quite toxic, SPILLCALC is operated within the hydrodynamic model H3D. The flux from the oil slick enters the top layer of H3D, and is then acted on by the same processes of advection and diffusion that apply to all the other scalars, such as temperature and salinity. This method is applicable to a three dimensional simulation of the dissolved oil in the water column.

#### 5.4.4.4.9 Bacterial Decay

Despite its toxicity, a considerable fraction of petroleum oil entering marine systems is eliminated by the hydrocarbon-degrading activities of microbial communities, in particular the so-called hydrocarbonoclastic bacteria (HCB). *Alcanivorax borkumensis* is one of the HCB family and is an alkane-degrading marine bacterium which naturally propagates and becomes predominant in crude-oil-containing seawater when nitrogen and phosphorus nutrients are supplemented. They are currently thought to be the world's most important oil-degrading organisms.

The biodegradability of the oil components generally decreases in the following order: n-alkanes, branched-chain alkanes, branched alkenes, low molecular-weight n-alkyl aromatics, mono-aromatics, cyclic alkanes, polycyclic aromatic hydrocarbons (PAHs) and asphaltenes (Atlas 1981).

Uncertainty is present regarding the population size of such bacteria along the tanker route. Since the initial bacteria population is rarely well known, most models having a biodegradation module use a first order bacterial decay process in which the rate of oil biodegraded is proportional to the initial mass and an empirical decay coefficient, *i.e.*, m = m0, exp(-kt). The empirical decay coefficient was selected as being in the same order of magnitude than the first order biodegradation rate constants from field studies (Niu *et al.*, 2011 and Zhu *et al.*, 2004)

#### *5.4.4.5 Four Representative Marine Spill Scenarios*

In order to understand the fate and behaviour of spilled oil, representative scenarios were selected, and then analyzed using EBA's numerical spill modelling system. Representative scenarios were modeled without spill response measures applied to mitigate the effect of an accidental oil spill in order to provide conservative results. Two considerations entered into the selection of representative spills:

- selecting the areas of highest probability of a spill; and
- selecting areas to represent the range of variability in oceanographic and meteorological conditions.

As described in Section 5.2.2, the quantitative risk assessment (Volume 8C, TR 8C-12) examined the risk of an accidental spill from a laden oil tanker carrying product from the Westridge Marine Terminal. Eight locations along the tanker transit route were selected as possible locations for a hypothetical accident involving a Project-related laden oil tanker and resulting in an oil spill. These 8 locations were described in Table 5.2.2 and are further identified in Figure 5.5.2. Five of the eight locations were modelled for the purpose of a hypothetical spill scenario. One of the modelled locations is at the Westridge Marine Terminal and the results of modelling at this location are provide in Volume 7, Section 8.0, leaving four locations that were modelled along the shipping route a Project-related tanker would travel.

Four of the seven possible locations along the tanker transit route listed in Table 5.2.2 were selected for modelling the oil spill behaviour that is likely to be encountered:

- Strait of Georgia (Location D);
- Arachne Reef (Location E);
- Juan de Fuca Strait (south of Race Rocks) (Location G); and
- Buoy J (Location H).

Three locations in along the shipping route (Table 5.2.2) were not modelled as the incident would not likely result in an oil spill.

#### *5.4.4.6 Stochastic Simulations*

Stochastic modelling is widely used to develop an understanding of the likely behaviour of an oil slick without spill response measures applied. Typically, the major driving force for slick motion is wind-driven currents, and it is fairly common to randomly select a number of scenarios, *i.e.*, random sampling of a wind dataset should produce a smaller number of wind events to be modelled, but with the same statistics (means, max, etc.) as the original series. For the simulations conducted to examine the risks associated with the Trans Mountain Expansion Program, it is important to recognize that wind, tide, offshore processes and estuarine flows drive the slick motions. In order to provide a truly random stochastic simulation, many years of numerical model runs would have to be generated before the process of random selection can start. A limitation on these simulations is that high quality boundary condition data, from a large-area model operated by Alaska Fisheries, is only available for the last two years.

Consequently, the approach taken was to simulate a particular period (in this case October 1, 2011 to September 30, 2012), and sample it at 6-hour intervals. That is, every 6 hours, an independent spill is assumed to occur, and its motions and weather are calculated and recorded for a 15-day period. The simulations were segregated into four seasons: winter (January, February and March), Spring (April, May, and June), Summer (July, August, and September) and Fall (October, November and December). For spills starting every six hours, each season contains a compilation of about 360 independent spills. These spills are fully-calculated: motions, weathering, shore contact are all operative. For each season, various statistical summaries were calculated. A complete set of results is presented in the Technical Appendix (Volume 8C, TR 8C-12, S9). For this document, important summary information is presented.

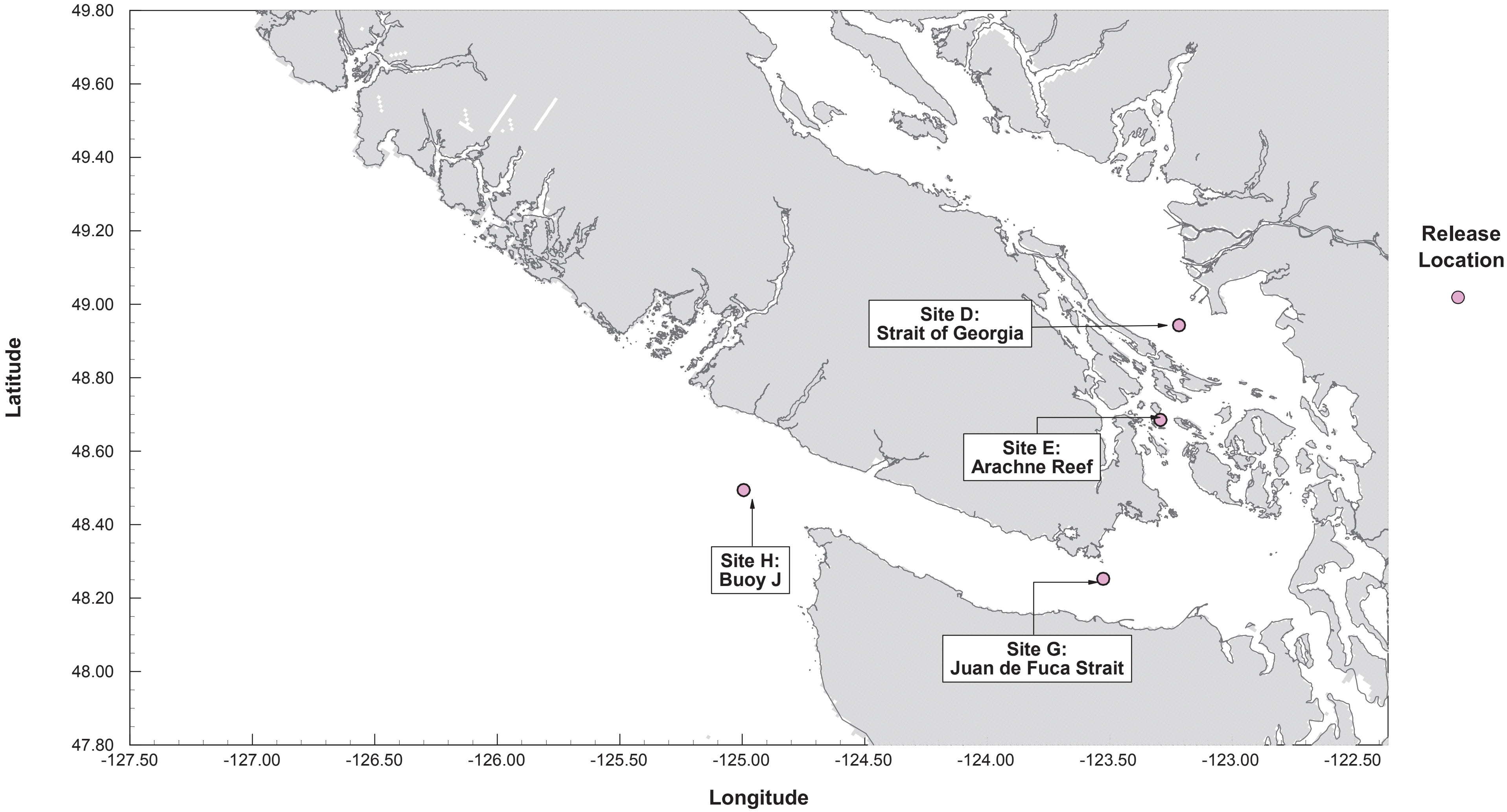
#### *5.4.4.7 Stochastic Results*

Each seasonal stochastic model run consists of a compilation of approximately 360 independent simulations. The simulations are constructed on a spatial grid, with individual cells having dimensions of 500 m × 500 m. An extensive set of data products can be generated for each stochastic simulation, and are provided in the Technical Reference (Appendix 8C, TR 8C-12, S9). In this Section, attention is directed to the following sub-set for spills at each location (Figure 5.4.17):

- Stochastic maps: show the probability that a particular 500 m × 500 m piece of water will be contacted by a spill starting at the modelled release point, expressed as per centage contours.
- Amount of oiled shoreline per spill: expressed in kilometres, and shown on a per-spill (member of the 360 stochastic simulation set) basis.
- Mass balance of the fate of the oil at a particular time after the release started: volume on water, volume evaporated, volume that was retained on shorelines, volume that dissolved, volume that was dispersed, volume that bio-degraded, and volume lost through oil-mineral aggregation.

Seasonal similarities and differences can be identified by comparing the previously described statistical properties over all four seasons for a particular location.

All of the scenarios discussed in this section were modelled without spill response intervention, the effects of the spills modelled here are unmitigated by response efforts. A discussion of spill response capacity is included in Section 5.5 and the results of spill models run with response intervention are discussed in Section 5.7.




## NOTES

- Sites location based on the DNV Memo, dated February 26, 2013.

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## TRANS MOUNTAIN OIL SPILL STUDY

### Spill Locations for the Stochastic Simulations

| PROJECT NO. | DWN | CKD | APVD | REV |
|---|---|---|---|---|
| V13203022 | AH | JAS | JAS | 0 |

OFFICE
EBA-VANC

DATE
October 28, 2013

Figure 5.4.17

V:\V13203022 Trans Mountain\Reports\11-Vol_8\Figures\06-Site_Location\site_location.lay

07 Nov 2013 11:25:57

#### 5.4.4.7.1 Location D, Strait of Georgia

Location D is located in the Strait of Georgia between the Tsawwassen Ferry Terminal and the Southern Gulf Islands, as shown in Figure 5.5.2. This location has been determined to be representative of a collision with crossing traffic from either the Fraser River or BC ferries. As noted in Section 5.2.1, Table 5.2.1, the potential volume of oil spilled in a credible worst case is predicted to be 16,500 $m^3$. The simulated duration of the release is 13 hours: 25 per cent of the volume is released in the first hour, and the balance released at a uniform rate over the next 12 hours.

The general wind pattern at Location D is mainly south-east and north-west winds which rarely exceed 20 m/s.

Figures 5.4.18 and 5.4.19 show the 50 per cent ($P_{50}$) and 90 per cent ($P_{90}$) probability maps at Hour 24, *i.e.*, 24 hours after the start of the incident, and Hour 48. The contours shown on these maps represent the probability that oil from the compilation of spills lies within the given area; they do not represent the area affected by any single spill. In general, a wider range of probabilities is presented in a typical stochastic probability map, but selecting only two contours simplifies the discussion. Presenting the probabilities at shorter duration (6, 12, 24, and 487 hours) is useful when discussing mitigation measures and the response time needed for effective mitigation. These are provided in Volume 8C (TR 8C-12, S9).

Figure 5.4.18, for 24 hours, illustrates the importance of using an adequate hydrodynamic model: the combination of prevailing northwest winds and the influence of the Fraser River are key factors in determining the seasonal variability, which causes the summer $P_{50}$ contours to extend over an area about 50 per cent larger than the winter $P_{50}$ region. As well, northwest winds and the estuarine flow, causing surface water to leave the Strait and flow toward the open Pacific, lead to an elongation of the spill to the southwest in the summer and fall. After 48 hours, the $P_{50}$ contour has moved into Boundary Pass and almost to the top end of Haro Strait. The most striking difference between the situation at 25 hours and at 48 hours, regardless of season, is two- to three-fold increase in the area within a particular probability contour. This comparison illustrates profoundly the benefit to be gained by developing mitigation strategies that are in the field and operational within a very few hours of the start of the incident. Although not shown here, the minimum time to reach a particular location or shoreline is also helpful in developing mitigation strategies.

The length of shoreline oiled is relevant for determining potential ecological damage, and for estimating shoreline clean up resources that would be required in the event of a spill. Figure 5.4.20 illustrates the length of shoreline contacted by oil for each member of the summer simulations. The variability across all the spills within one season is quite remarkable, and illustrates the significant day-to-day changes in winds and currents that can occur in the study area. Basic statistics on shoreline oiling for all seasons are presented in Table 5.4.8.

**TABLE 5.4.8**

**STATISTICS FOR SHORELINE CONTACT FOR A CREDIBLE WORST CASE SPILL AT LOCATION D (NO MITIGATION APPLIED)**

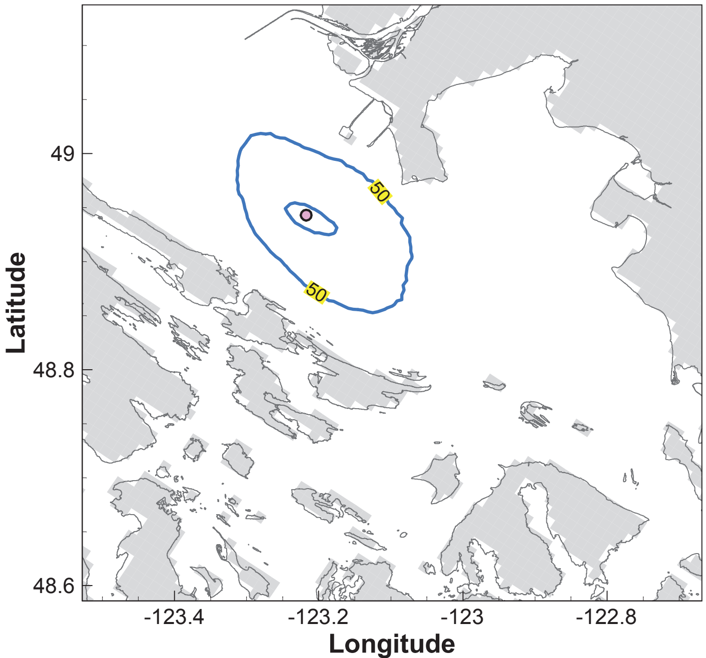
| | Median (km) | Average (km) | Maximum (km) | Minimum (km) |
|---|---|---|---|---|
| Winter | 271 | 263 | 388 | 105 |
| Spring | 296 | 291 | 436 | 97 |
| Summer | 284 | 279 | 414 | 71 |
| Fall | 296 | 293 | 425 | 106 |

The mass balance of the spilled oil provides a good summary of a particular spill, or, when averaged across all spills, a good understanding of spill behaviour for a spill that would occur in a particular season. Figures 5.4.21 and 5.4.22 show the mass balance for the summer spill scenario. Figure 5.4.21 shows the major components: on water, on shore and evaporated, and Figure 5.4.22 shows the minor components: dispersed, bio-degraded, on banks and dissolved. Table 5.4.9 summarizes the mass balance for all four seasons at the end of the 15-day stochastic simulation period. The amount of oil bound up in oil-mineral aggregations was negligible, even for this site, which would be influenced by the Fraser River Plume.

**TABLE 5.4.9**

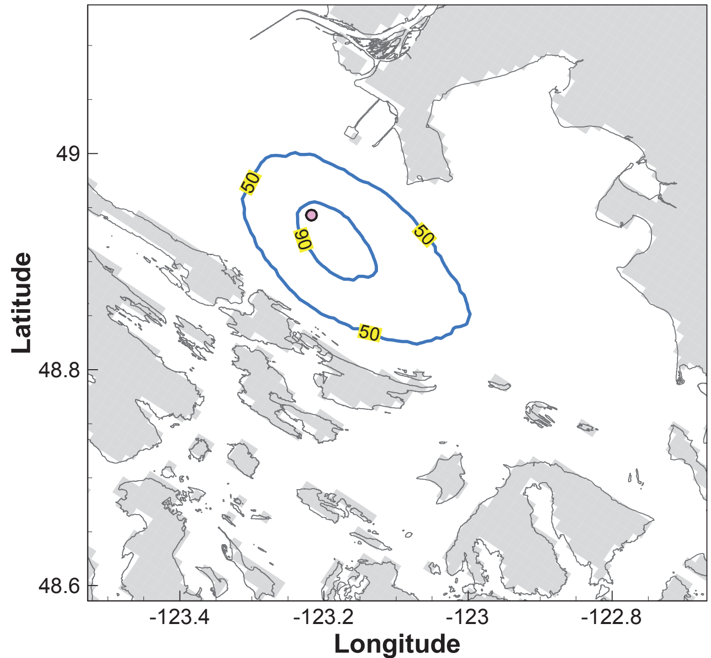
**MASS BALANCE SUMMARY FOR A CREDIBLE WORST CASE SPILL AT LOCATION D (NO MITIGATION APPLIED)**

| Component | Winter | Spring | Summer | Fall | Yearly Average |
|---|---|---|---|---|---|
| On Shore | 63.8 | 67.4 | 66.4 | 66.8 | 66.1 |
| Evaporated | 21.7 | 19.8 | 19.3 | 20.7 | 20.4 |
| On Water | 2.6 | 1.7 | 2.4 | 1.4 | 2.0 |
| Dissolved | 6.7 | 6.8 | 6.7 | 6.9 | 6.8 |
| Biodegraded | 3.2 | 2.8 | 2.7 | 2.8 | 2.9 |
| On Banks | 1.9 | 0.7 | 2.4 | 1.4 | 1.6 |
| Dispersed | 0.1 | 0 | 0 | 0.1 | 0.1 |



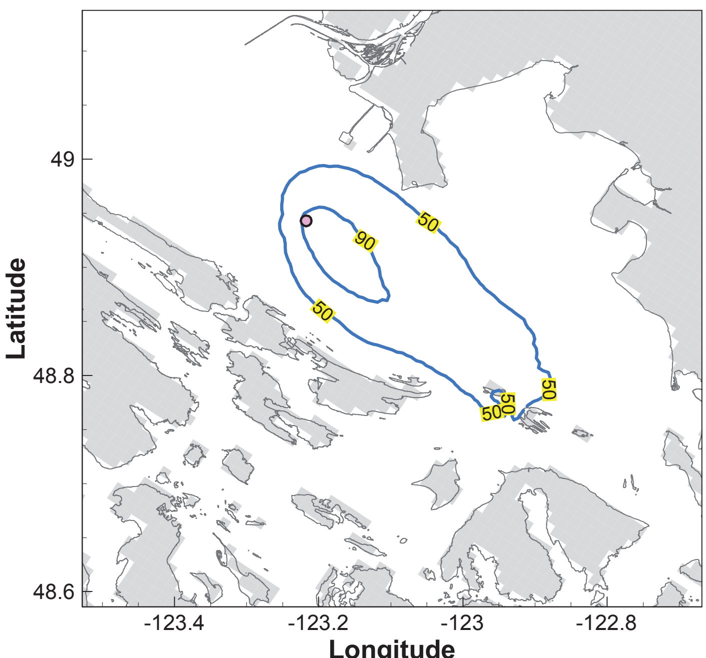

## Winter 2012

| | |
|---|---|
| Area within the $P_{50}$ Contour Line: | 217.5 km$^2$ |
| Area within the $P_{90}$ Contour Line: | 9.8 km$^2$ |
| Average Thickness within the $P_{50}$ Contour Line: | 48 um |
| Average Thickness within the $P_{90}$ Contour Line: | 100 um |
| Average Shore Oiled: | 9.5 km |



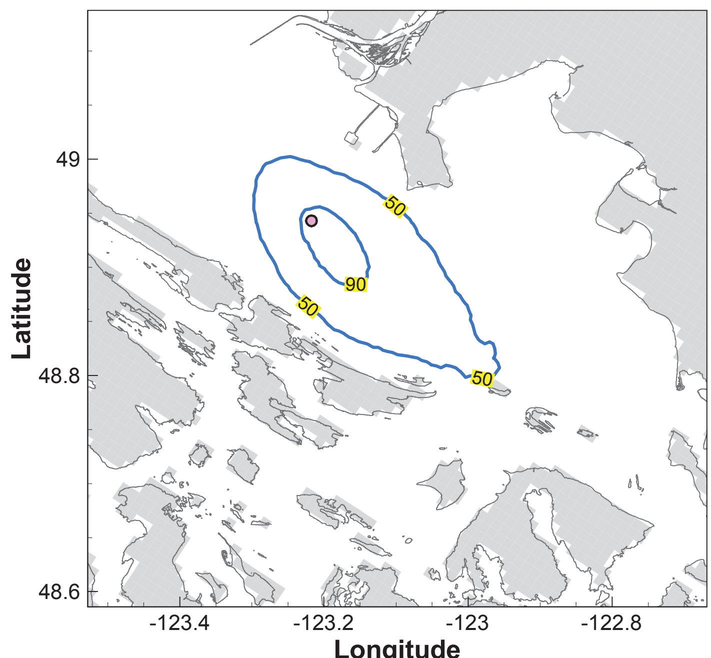

## Spring 2012

| | |
|---|---|
| Area within the $P_{50}$ Contour Line: | 285.0 km$^2$ |
| Area within the $P_{90}$ Contour Line: | 41.8 km$^2$ |
| Average Thickness within the $P_{50}$ Contour Line: | 42 um |
| Average Thickness within the $P_{90}$ Contour Line: | 63 um |
| Average Shore Oiled: | 13 km |




## Summer 2012

| | |
|---|---|
| Area within the $P_{50}$ Contour Line: | 364.2 km$^2$ |
| Area within the $P_{90}$ Contour Line: | 48.8 km$^2$ |
| Average Thickness within the $P_{50}$ Contour Line: | 34 um |
| Average Thickness within the $P_{90}$ Contour Line: | 57 um |
| Average Shore Oiled: | 14.7 km |




## Fall 2011

| | |
|---|---|
| Area within the $P_{50}$ Contour Line: | 308.0 km$^2$ |
| Area within the $P_{90}$ Contour Line: | 36.3 km$^2$ |
| Average Thickness within the $P_{50}$ Contour Line: | 37 um |
| Average Thickness within the $P_{90}$ Contour Line: | 62 um |
| Average Shore Oiled: | 13 km |

**NOTES**

● Release Location

Probability of oil presence is the percentage of simulations in which oil was present at a given location.
- $P_{50}$: after 24 hours, there is 50% or greater probability for the area within the $P_{50}$ contour line to have been contacted.
- $P_{90}$: after 24 hours, there is 90% or greater probability for the area within the $P_{90}$ contour line to have been contacted.

Statistical results for each season based on independent spills occuring every 6 hours for three months.
Tracking time for each spill was 24 hours.
The average thickness is based on a full coverage of each grid cell that contains oil and lies within the contour line.

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**TRANS MOUNTAIN OIL SPILL STUDY**

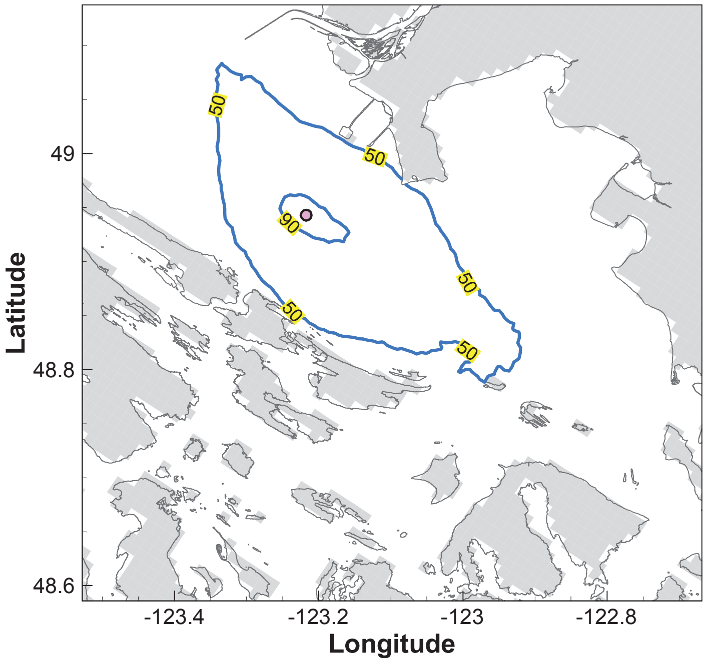
**Stochastic Simulation**
**Site D (16,500 m$^3$)**
**$P_{50}$ and $P_{90}$ after 24 Hours**

| PROJECT NO. | DWN | CKD | APVD | REV |
|---|---|---|---|---|
| V13203022 | DP | JAS | - | 0 |

| OFFICE | DATE |
|---|---|
| EBA-VANC | October 25, 2013 |

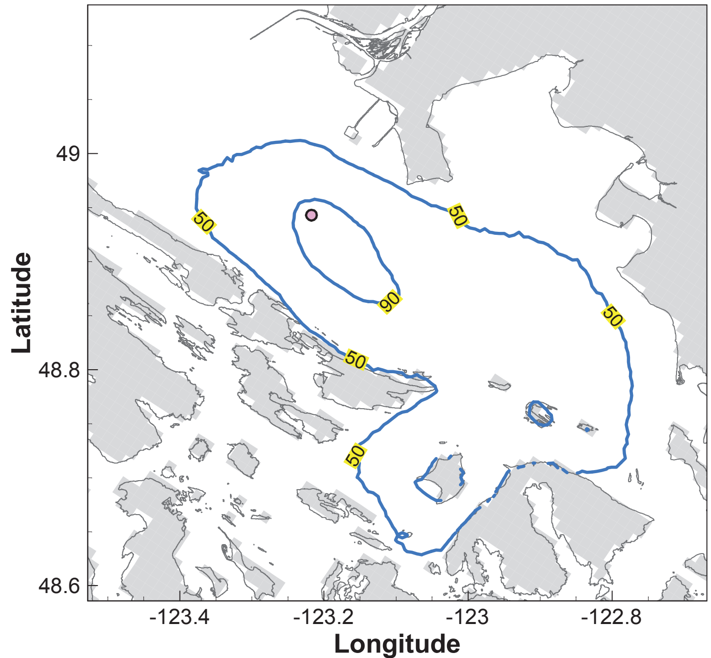
**Figure 5.4.18**

C:\Users\daniel.potts\Documents\Local_work\KinderMorgan\04-SPILLCALC\551-Stochastic_SOG_16500m3\Results_AllSeasons\13-stochastic_map_lines_24h.lay 25 Oct 2013 17:05:30



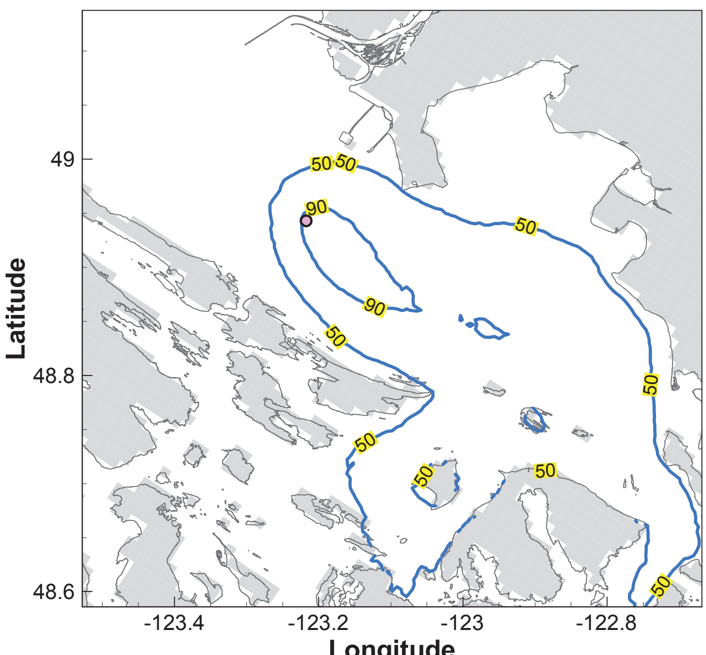

## Winter 2012

| | |
|---|---|
| Area within the $P_{50}$ Contour Line: | 495.2 km$^2$ |
| Area within the $P_{90}$ Contour Line: | 19.8 km$^2$ |
| Average Thickness within the $P_{50}$ Contour Line: | 25 um |
| Average Thickness within the $P_{90}$ Contour Line: | 67 um |
| Average Shore Oiled: | 39 km |



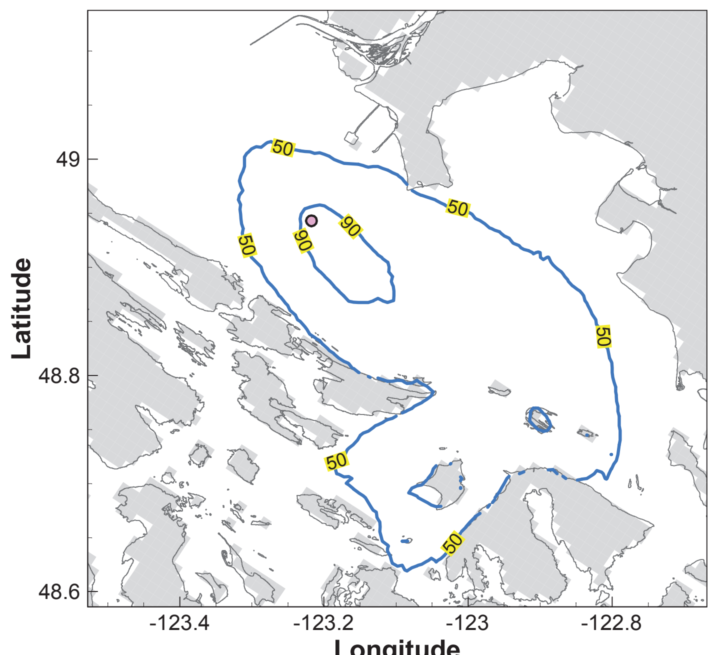

## Spring 2012

| | |
|---|---|
| Area within the $P_{50}$ Contour Line: | 957.5 km$^2$ |
| Area within the $P_{90}$ Contour Line: | 66.8 km$^2$ |
| Average Thickness within the $P_{50}$ Contour Line: | 15 um |
| Average Thickness within the $P_{90}$ Contour Line: | 44 um |
| Average Shore Oiled: | 63 km |




## Summer 2012

| | |
|---|---|
| Area within the $P_{50}$ Contour Line: | 1032.7 km$^2$ |
| Area within the $P_{90}$ Contour Line: | 65.8 km$^2$ |
| Average Thickness within the $P_{50}$ Contour Line: | 15 um |
| Average Thickness within the $P_{90}$ Contour Line: | 46 um |
| Average Shore Oiled: | 77.5 km |




## Fall 2011

| | |
|---|---|
| Area within the $P_{50}$ Contour Line: | 929.7 km$^2$ |
| Area within the $P_{90}$ Contour Line: | 58.8 km$^2$ |
| Average Thickness within the $P_{50}$ Contour Line: | 14 um |
| Average Thickness within the $P_{90}$ Contour Line: | 43 um |
| Average Shore Oiled: | 63 km |

**NOTES**

● Release Location

Probability of oil presence is the percentage of simulations in which oil was present at a given location.
$P_{50}$: after 48 hours, there is 50% or greater probability for the area within the $P_{50}$ contour line to have been contacted.
$P_{90}$: after 48 hours, there is 90% or greater probability for the area within the $P_{90}$ contour line to have been contacted.
Statistical results for each season based on independent spills occuring every 6 hours for three months.
Tracking time for each spill was 48 hours.
The average thickness is based on a full coverage of each grid cell that contains oil and lies within the contour line.

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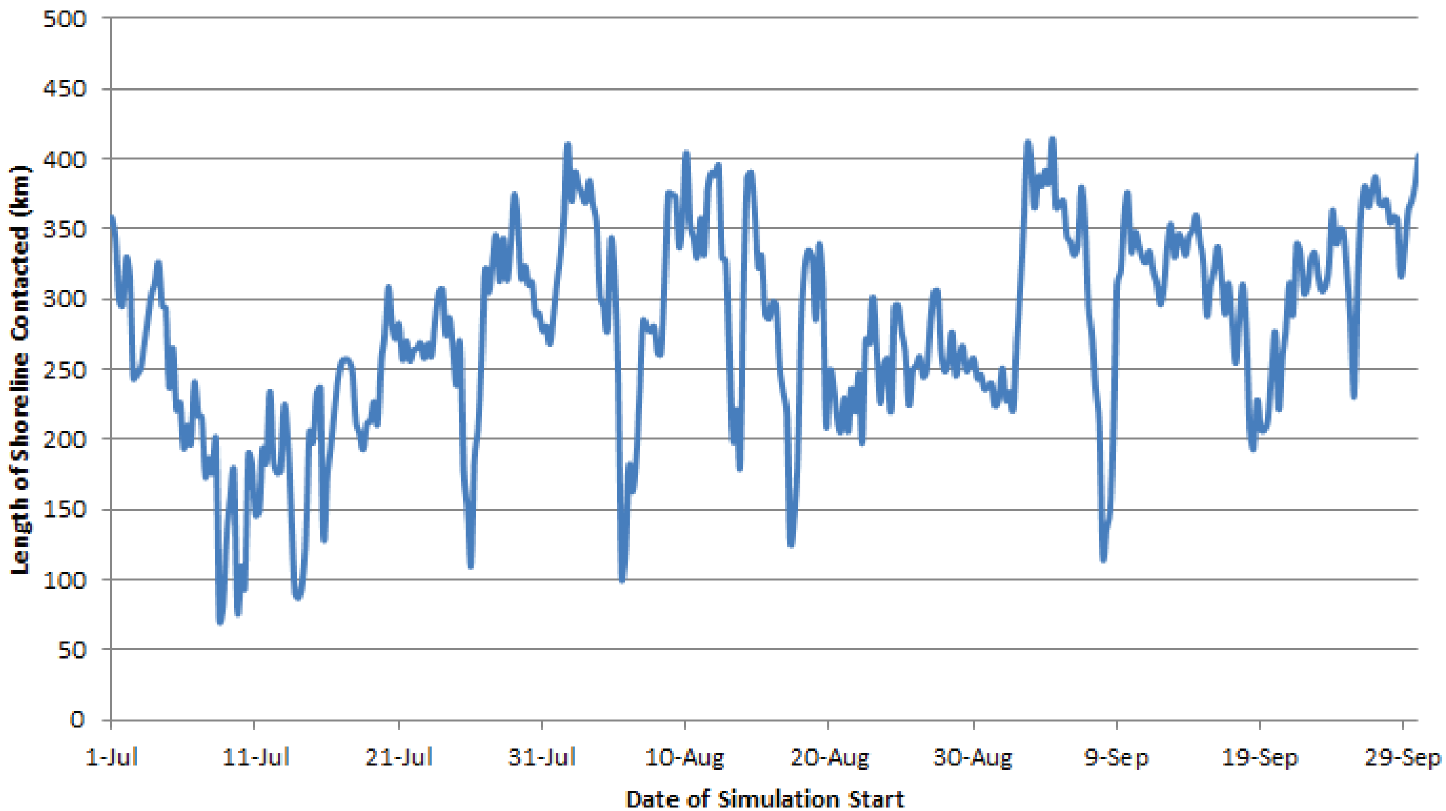
**TRANS MOUNTAIN OIL SPILL STUDY**

**Stochastic Simulation**
**Site D (16,500 m$^3$)**
**$P_{50}$ and $P_{90}$ after 48 Hours**

| PROJECT NO. | DWN | CKD | APVD | REV |
|---|---|---|---|---|
| V13203022 | DP | JAS | - | 0 |

| OFFICE | DATE |
|---|---|
| EBA-VANC | October 25, 2013 |

**Figure 5.4.19**




## NOTES

- Statistical results based on independent spills occuring every 6 hours from July 01 00:00 to September 30 23:00, for a total of 368 independant spills.
- Tracking time for each spill was 15 days.

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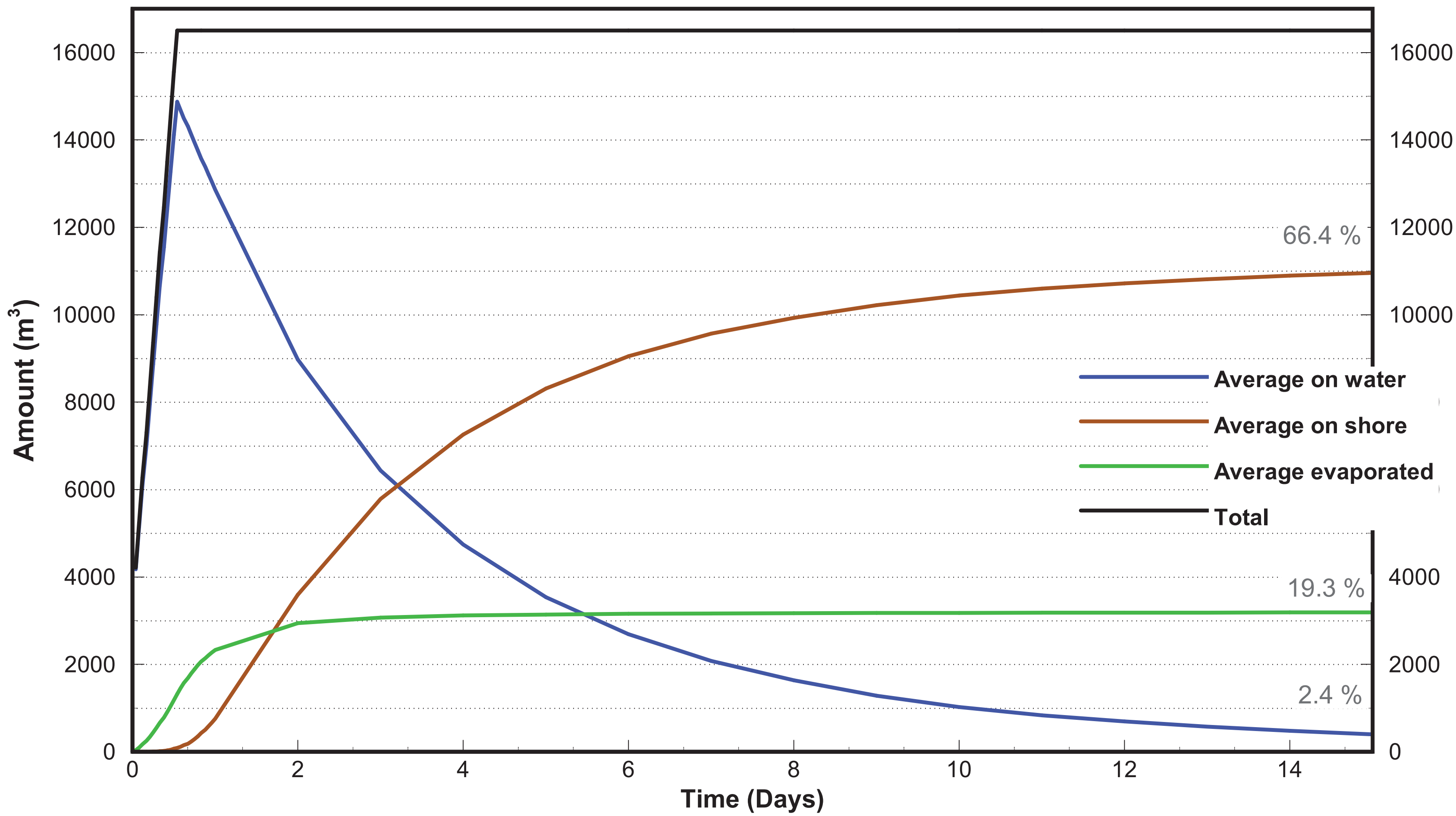
## TRANS MOUNTAIN OIL SPILL STUDY

**Stochastic Simulation**
**Summer 2012, Site D (16,500 $m^3$)**
**Length of Shoreline Contacted**

| PROJECT NO. | DWN | CKD | APVD | REV |
|---|---|---|---|---|
| V13203022 | AH | JAS | - | 0 |

| OFFICE | DATE |
|---|---|
| EBA-VANC | October 15, 2013 |

**Figure 5.4.20**




## NOTES

- Statistical results based on independent spills occuring every 6 hours from July 01 00:00 to Septeber 30 23:00.

- Tracking time for each spill was 15 days.

- The major components of the mass balance are shown above.

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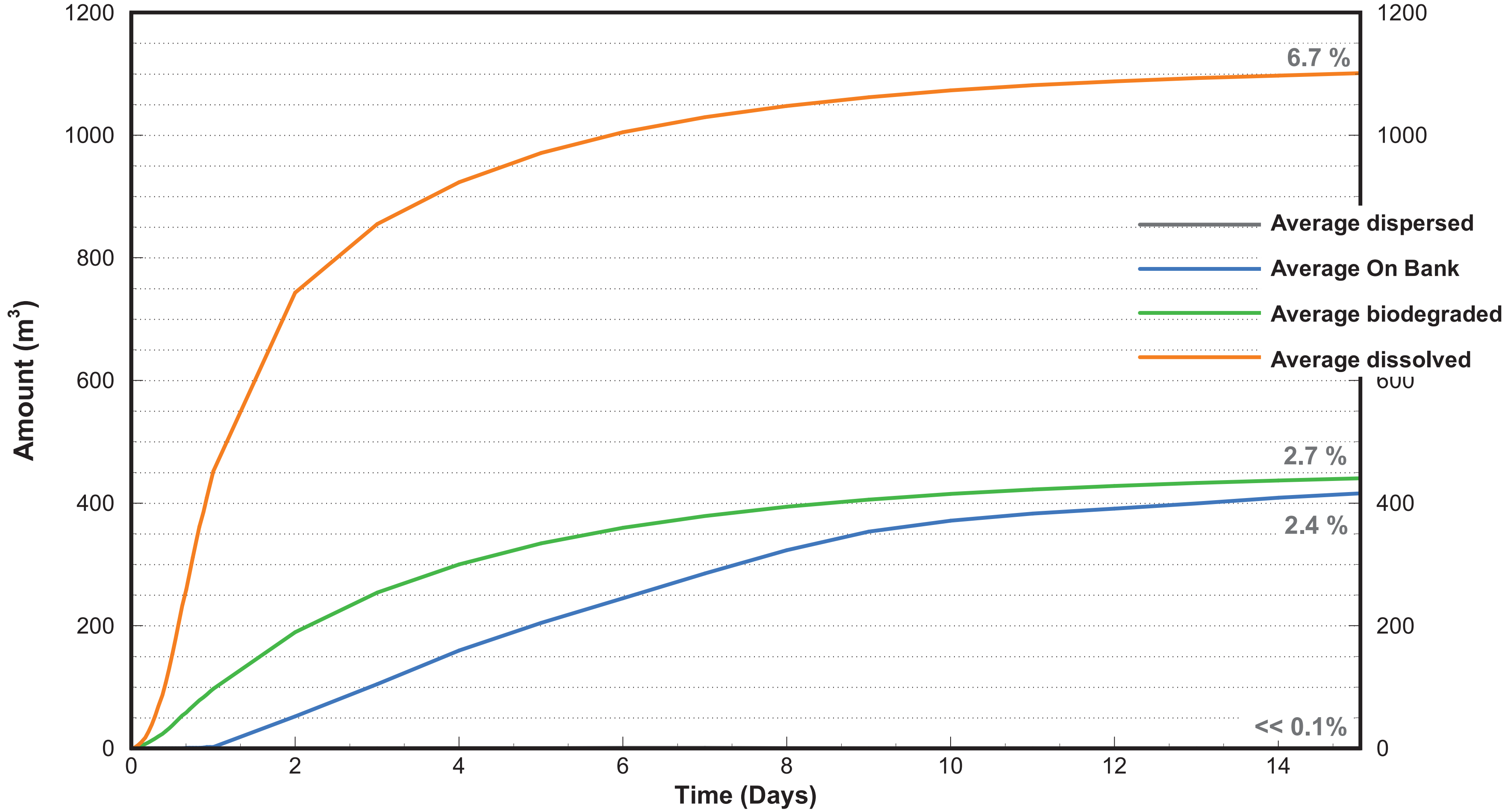
# TRANS MOUNTAIN OIL SPILL STUDY

## Stochastic Simulation Summer 2011, Site D (16,500 $m^3$) Major Components of the Mass Balance

| PROJECT NO. | DWN | CKD | APVD | REV | |
|---|---|---|---|---|---|
| V13203022 | AH | JAS | - | 0 | Figure 5.4.21 |
| OFFICE | DATE | | | | |
| EBA-VANC | October 4, 2013 | | | | |




## NOTES

- Statistical results based on independent spills occuring every 6 hours from July 01 00:00 to Septeber 30 23:00.
- Tracking time for each spill was 15 days.
- The minor components of the mass balance are shown above.

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## TRANS MOUNTAIN OIL SPILL STUDY

**Stochastic Simulation**
**Summer 2011, Site D (16,500 m$^3$)**
**Minor Components of the Mass Balance**

| PROJECT NO. | DWN | CKD | APVD | REV |
|---|---|---|---|---|
| V13203022 | AH | JAS | - | 0 |

| OFFICE | DATE |
|---|---|
| EBA-VANC | October 4, 2013 |

**Figure 5.4.22**

#### 5.4.4.7.2 Location E, Arachne Reef

Location E is located at Arachne Reef, at the northern end of Haro Strait. This location has been determined to be representative of an incident resulting from powered grounding and/or a collision. The potential volume of oil spilled was determined by DNV (TERMPOL 3.15, Volume 8C, TR 8C-12): the credible worst case scenario probability of side damage would result in 16,500 $m^3$ spilled. The simulated duration of the release is 13 hours with 25 per cent of the oil released in the first hour, and a constant hourly spill rate for the next 12 hours.

Winds at Location E (as recorded at Kelp Reef) are mainly oriented north-south with strong storms occurring in the fall-winter periods with winds reaching 20 m/s. The spring-summer period is characterized by weaker winds, rarely exceeding 10 m/s.

Figures 5.4.23 and 5.4.24 show the 50 per cent and 90 per cent probability maps at Hour 24, *i.e.*, 24 hours after the start of the incident, and Hour 48. In general, a wider range of probabilities is presented in a stochastic probability map, but selecting only two contours simplifies the discussion. Presenting the probabilities at 24 hours and 48 hours is useful when discussing mitigation measures and the need for prompt response.

The length of shoreline oiled is relevant for determining potential ecological damage, and for estimating shoreline clean up resources that would be required in the event of a spill. Figure 5.4.25 illustrates the length of shoreline contacted by oil for the summer simulation. Basic statistics on shoreline oiling for all seasons are presented in Table 5.4.10.

**TABLE 5.4.10**

**STATISTICS FOR SHORELINE CONTACT FOR A CREDIBLE WORST CASE SPILL AT LOCATION E (NO MITIGATION APPLIED)**

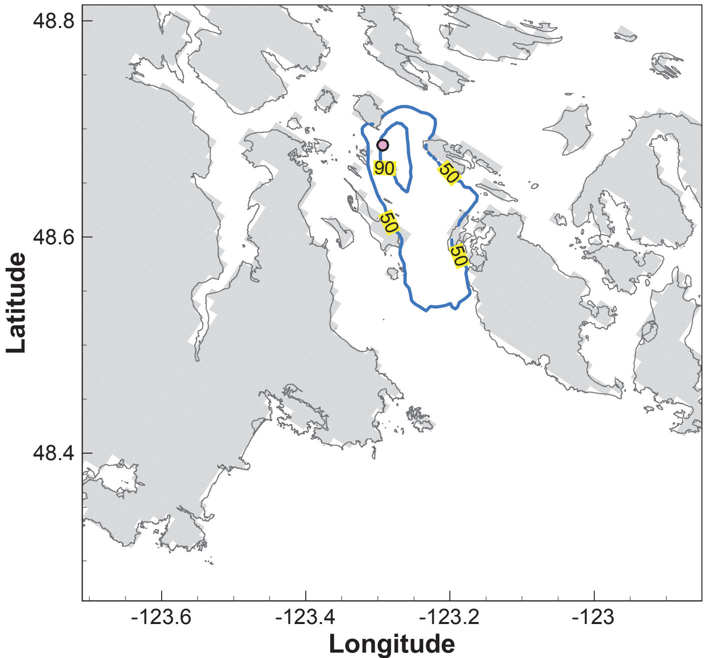
| | Median (km) | Average (km) | Maximum (km) | Minimum (km) |
|---|---|---|---|---|
| Winter | 290 | 292 | 387 | 162 |
| Spring | 304 | 306 | 427 | 206 |
| Summer | 312 | 309 | 407 | 174 |
| Fall | 301 | 301 | 391 | 169 |

The mass balance of the spilled oil provides a good summary of a particular spill, or, when averaged across all spills, a good understanding of spill behaviour for a spill that would occur in a particular season. Figures 5.4.26 and 5.4.27 show the mass balance for the summer spill scenario. Figure 5.4.26 shows the major components: on–water, on-shore and evaporated, and Figure 5.4.27 shows the minor components: dispersed, biodegraded, on banks and dissolved. Table 5.4.11 summarizes the mass balance for all four seasons at the end of the 15-day stochastic simulation period.

## TABLE 5.4.11

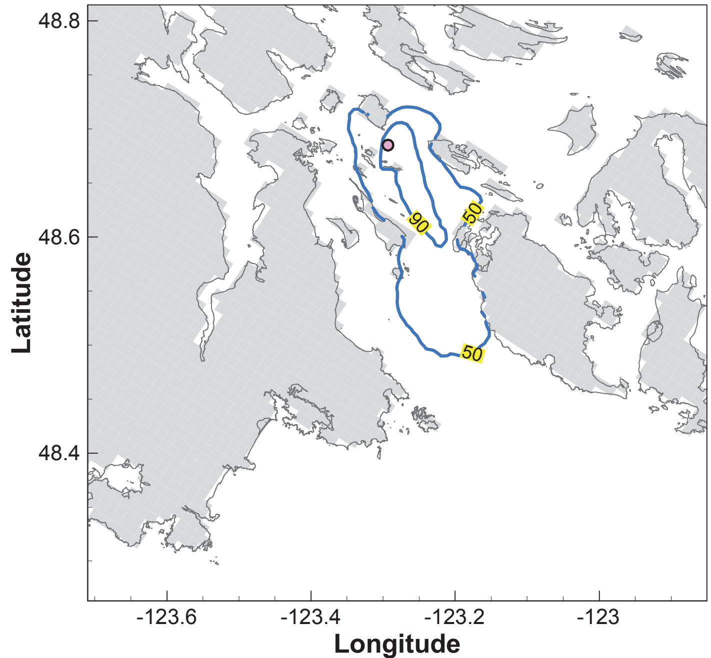
## MASS BALANCE SUMMARY FOR A CREDIBLE WORST CASE SPILL AT LOCATION E (NO MITIGATION APPLIED)

| Component | Winter | Spring | Summer | Fall | Yearly Average |
|---|---|---|---|---|---|
| On-Shore | 68.9 | 69.5 | 69.8 | 71.1 | 69.8 |
| Evaporated | 21.5 | 19.7 | 18.8 | 19.1 | 19.8 |
| On-Water | 1.6 | 2.3 | 2.9 | 1.9 | 2.2 |
| Dissolved | 5.2 | 5.8 | 5.7 | 5.3 | 5.5 |
| Biodegraded | 2.8 | 2.7 | 2.8 | 2.6 | 2.7 |
| On-Banks | 0 | 0 | 0 | 0 | 0.0 |
| Dispersed | 0 | 0 | 0 | 0 | 0.0 |



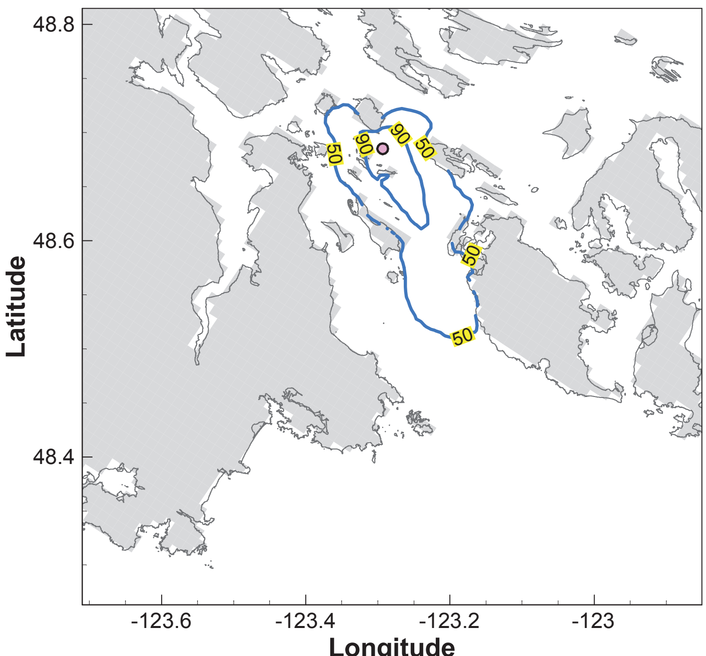

## Winter 2012

| | |
|---|---|
| Area within the $P_{50}$ Contour Line: | 139.3 km$^2$ |
| Area within the $P_{90}$ Contour Line: | 16.3 km$^2$ |
| Average Thickness within the $P_{50}$ Contour Line: | 54 um |
| Average Thickness within the $P_{90}$ Contour Line: | 133 um |
| Average Shore Oiled: | 29 km |



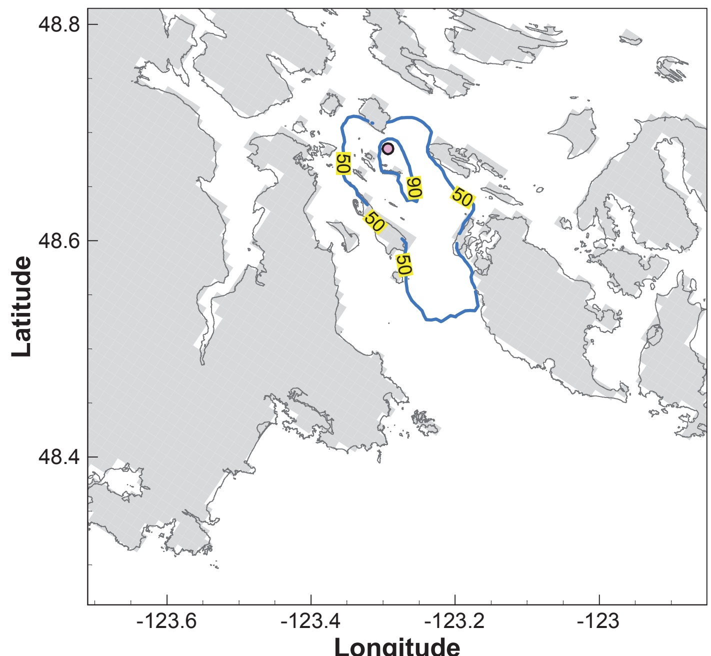

## Spring 2012

| | |
|---|---|
| Area within the $P_{50}$ Contour Line: | 210.0 km$^2$ |
| Area within the $P_{90}$ Contour Line: | 36.0 km$^2$ |
| Average Thickness within the $P_{50}$ Contour Line: | 41 um |
| Average Thickness within the $P_{90}$ Contour Line: | 89 um |
| Average Shore Oiled: | 35 km |




## Summer 2012

| | |
|---|---|
| Area within the $P_{50}$ Contour Line: | 196 km$^2$ |
| Area within the $P_{90}$ Contour Line: | 37.8 km$^2$ |
| Average Thickness within the $P_{50}$ Contour Line: | 36 um |
| Average Thickness within the $P_{90}$ Contour Line: | 78 um |
| Average Shore Oiled: | 36 km |




## Fall 2011

| | |
|---|---|
| Area within the $P_{50}$ Contour Line: | 167.5 km$^2$ |
| Area within the $P_{90}$ Contour Line: | 12.8 km$^2$ |
| Average Thickness within the $P_{50}$ Contour Line: | 43 um |
| Average Thickness within the $P_{90}$ Contour Line: | 133 um |
| Average Shore Oiled: | 34 km |

**NOTES**

Release Location

Probability of oil presence is the percentage of simulations in which oil was present at a given location.

$P_{50}$: after 24 hours, there is 50% or greater probability for the area within the $P_{50}$ contour line to have been contacted.

$P_{90}$: after 24 hours, there is 90% or greater probability for the area within the $P_{90}$ contour line to have been contacted.

Statistical results for each season based on independent spills occuring every 6 hours for three months.

Tracking time for each spill was 24 hours.

The average thickness is based on a full coverage of each grid cell that contains oil and lies within the contour line.

STATUS
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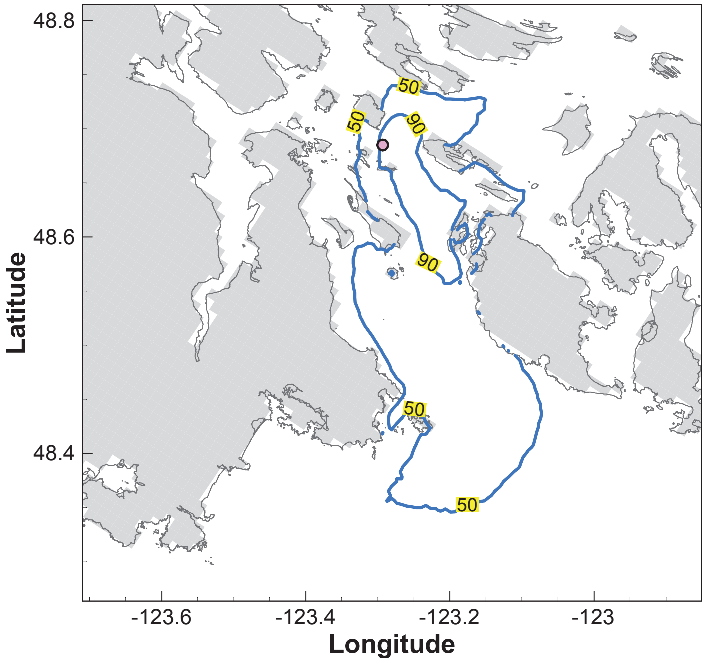
# TRANS MOUNTAIN OIL SPILL STUDY

## Stochastic Simulation Site E (16,500 m$^3$) $P_{50}$ and $P_{90}$ after 24 Hours

| PROJECT NO. | DWN | CKD | APVD | REV |
|---|---|---|---|---|
| V13203022 | DP | JAS | - | 0 |

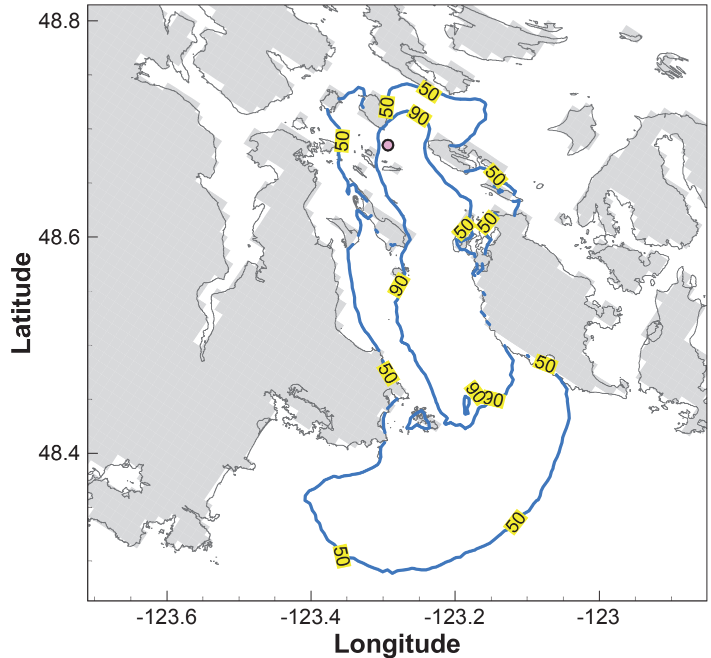
| OFFICE | DATE |
|---|---|
| EBA-VANC | October 25, 2013 |

**Figure 5.4.23**



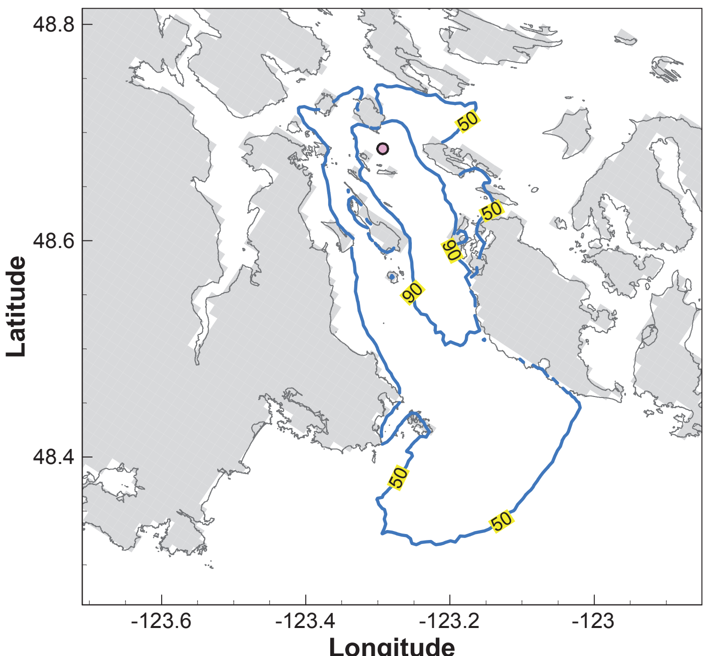

## Winter 2012

| | |
|---|---|
| Area within the $P_{50}$ Contour Line: | 516.5 $km^2$ |
| Area within the $P_{90}$ Contour Line: | 69.3 $km^2$ |
| Average Thickness within the $P_{50}$ Contour Line: | 17 um |
| Average Thickness within the $P_{90}$ Contour Line: | 47 um |
| Average Shore Oiled: | 75 km |



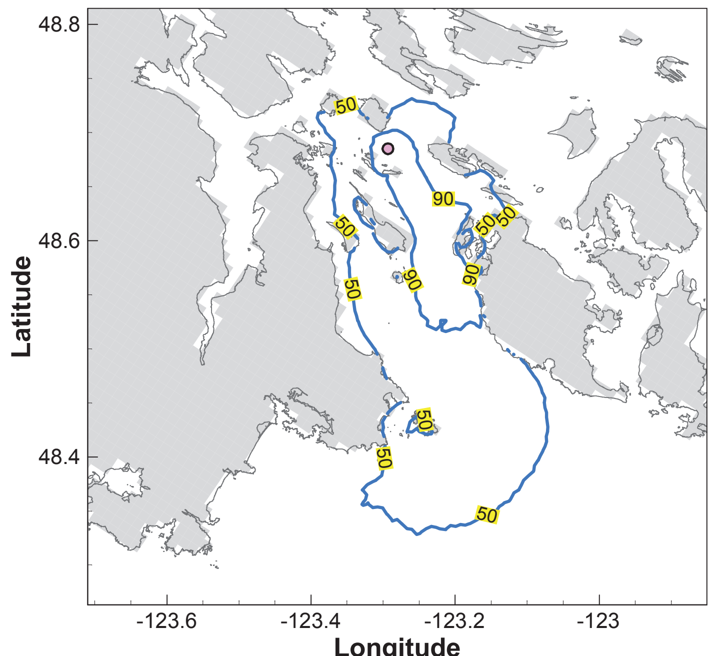

## Spring 2012

| | |
|---|---|
| Area within the $P_{50}$ Contour Line: | 767.5 $km^2$ |
| Area within the $P_{90}$ Contour Line: | 227.0 $km^2$ |
| Average Thickness within the $P_{50}$ Contour Line: | 10 um |
| Average Thickness within the $P_{90}$ Contour Line: | 21 um |
| Average Shore Oiled: | 90 km |




## Summer 2012

| | |
|---|---|
| Area within the $P_{50}$ Contour Line: | 646.0 $km^2$ |
| Area within the $P_{90}$ Contour Line: | 132.3 $km^2$ |
| Average Thickness within the $P_{50}$ Contour Line: | 11 um |
| Average Thickness within the $P_{90}$ Contour Line: | 27 um |
| Average Shore Oiled: | 85 km |




## Fall 2011

| | |
|---|---|
| Area within the $P_{50}$ Contour Line: | 603.7 $km^2$ |
| Area within the $P_{90}$ Contour Line: | 106.8 $km^2$ |
| Average Thickness within the $P_{50}$ Contour Line: | 12 um |
| Average Thickness within the $P_{90}$ Contour Line: | 28 um |
| Average Shore Oiled: | 83 km |

**NOTES**

● Release Location

Probability of oil presence is the percentage of simulations in which oil was present at a given location.
$P_{50}$: after 48 hours, there is 50% or greater probability for the area within the $P_{50}$ contour line to have been contacted.
$P_{90}$: after 48 hours, there is 90% or greater probability for the area within the $P_{90}$ contour line to have been contacted.
Statistical results for each season based on independent spills occuring every 6 hours for three months.
Tracking time for each spill was 48 hours.
The average thickness is based on a full coverage of each grid cell that contains oil and lies within the contour line.

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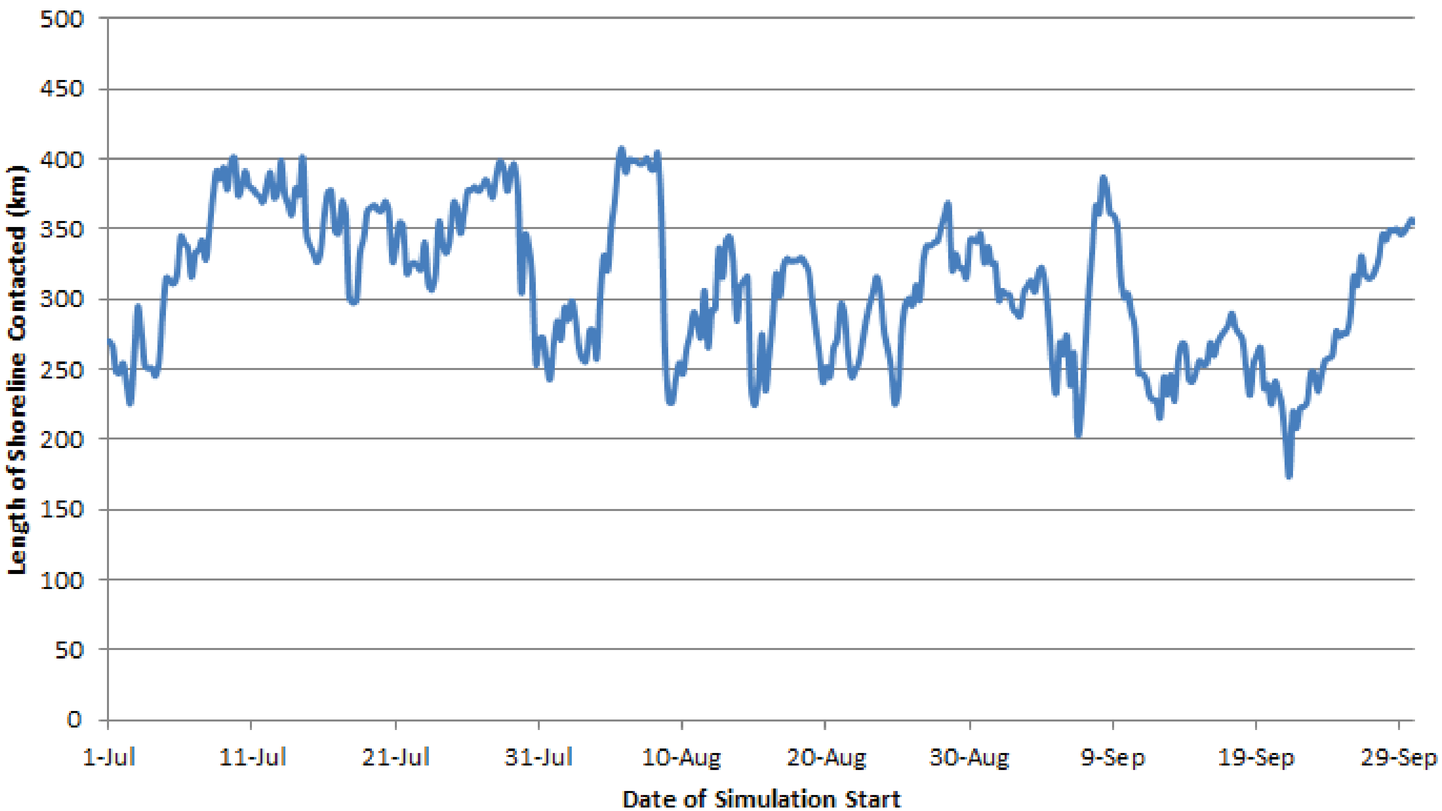
**TRANS MOUNTAIN OIL SPILL STUDY**

**Stochastic Simulation**
**Site E (16,500 $m^3$)**
**$P_{50}$ and $P_{90}$ after 48 Hours**

| PROJECT NO. | DWN | CKD | APVD | REV |
|---|---|---|---|---|
| V13203022 | DP | JAS | - | 0 |

| OFFICE | DATE |
|---|---|
| EBA-VANC | October 25, 2013 |

**Figure 5.4.24**




## NOTES

- Statistical results based on independent spills occuring every 6 hours from July 01 00:00 to September 30 23:00, for a total of 368 independant spills.
- Tracking time for each spill was 15 days.

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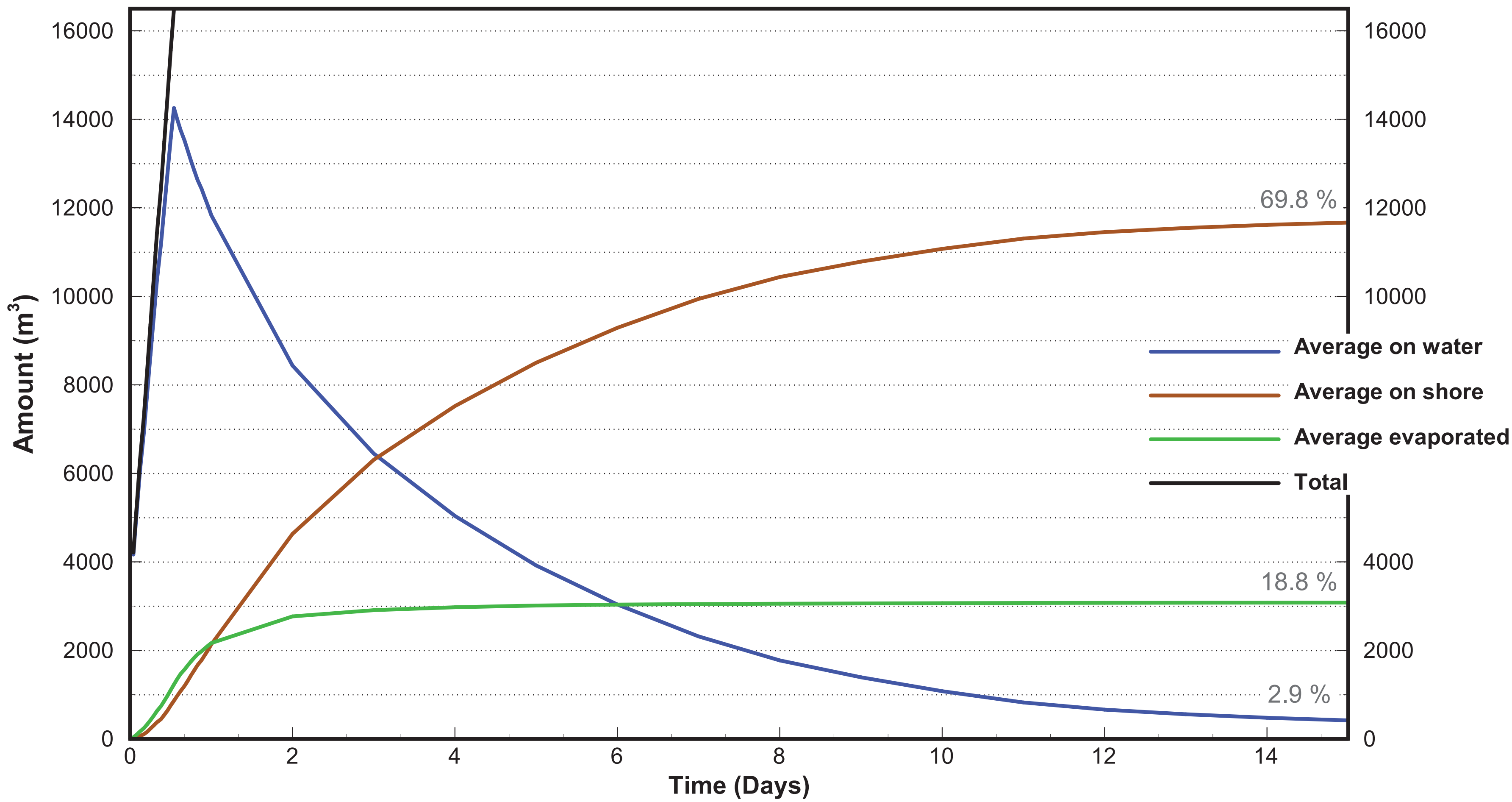
## TRANS MOUNTAIN OIL SPILL STUDY

**Stochastic Simulation**
**Summer 2012, Site E (16,500 $m^3$)**
**Length of Shoreline Contacted**

| PROJECT NO. | DWN | CKD | APVD | REV |
|---|---|---|---|---|
| V13203022 | AH | JAS | - | 0 |

| OFFICE | DATE |
|---|---|
| EBA-VANC | September 29, 2013 |

**Figure 5.4.25**




## NOTES

- Statistical results based on independent spills occuring every 6 hours from July 01 00:00 to September 30 23:00, for a total of 368 independant spills.
- Tracking time for each spill was 15 days.
- The major components of the mass balance are shown above.

STATUS
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# TRANS MOUNTAIN OIL SPILL STUDY

## Stochastic Simulation
## Summer 2012, Site E (16,500 $m^3$)
## Major Components of the Mass Balance

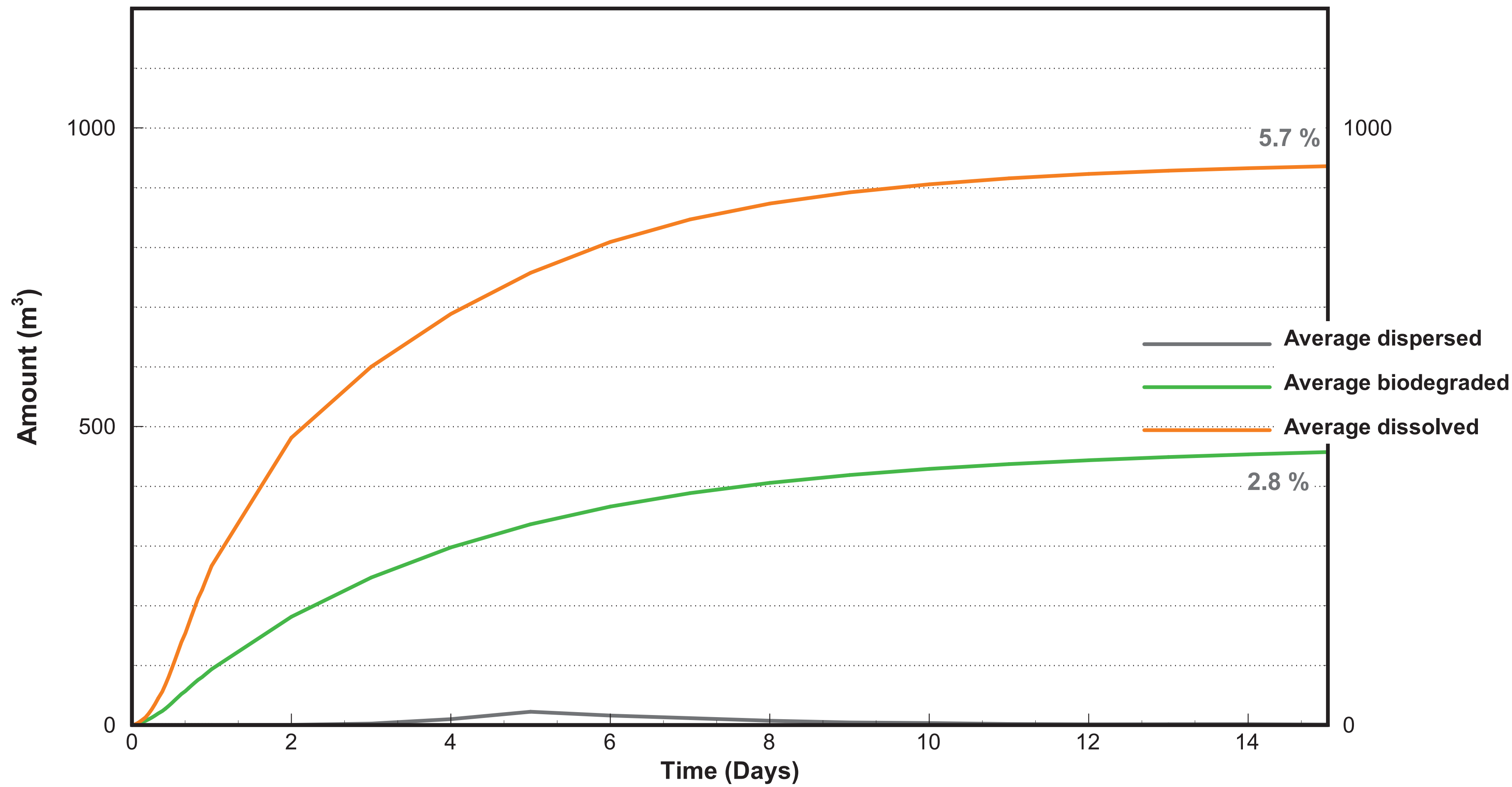
| PROJECT NO. | DWN | CKD | APVD | REV |
|---|---|---|---|---|
| V13203022 | AH | JAS | - | 0 |

| OFFICE | DATE |
|---|---|
| EBA-VANC | September 29, 2013 |

Figure 5.4.26

F:\Projects\V13203022-TransMountain\AH\02-SPILLCALC\503-Arachne_Reef_16500m3\Results_Summer\Tecplot\08-statistics_MB_1.lay

29 Sep 2013 13:29:34




## NOTES

- Statistical results based on independent spills occuring every 6 hours from July 01 00:00 to September 30 23:00, for a total of 368 independant spills.
- Tracking time for each spill was 15 days.
- The minor components of the mass balance are shown above.

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## TRANS MOUNTAIN OIL SPILL STUDY

### Stochastic Simulation Summer 2012, Site E (16,500 $m^3$) Minor Components of the Mass Balance

| PROJECT NO. | DWN | CKD | APVD | REV |
|---|---|---|---|---|
| V13203022 | AH | JAS | - | 0 |

| OFFICE | DATE |
|---|---|
| EBA-VANC | September 29, 2013 |

Figure 5.4.27

#### 5.4.4.7.3 Location G, Juan de Fuca Strait off Race Rocks

Location G is located in the Juan de Fuca Strait between Race Rocks and Port Angeles, as shown in Figure 5.4.17. This location has been determined to be representative of a hypothetical collision with crossing traffic from Puget Sound and Rosario Strait. The potential volume of oil spilled was determined by DNV to be 16,500 $m^3$ for the credible worst case. 25 per cent of the oil would be released in the first hour, and the balance over the succeeding 12 hours

The winds at Location G (as recorded at Port Angeles) blow either along the Strait from the northwest or off the land from the south-southwest. The winds blowing along the Strait are frequently up to 10 m/s and occur almost continuously in spring and summer but only intermittently in fall and winter. The winds coming off the land; however, are typically less than 5 m/s and dominate the fall and winter periods.

Figures 5.4.28 and 5.4.29 show the 50 per cent and 90 per cent probability maps at Hour 24, *i.e.*, 24 hours after the start of the incident, and Hour 48. In general, a wider range of probabilities is presented in a stochastic probability map, but selecting only two contours simplifies the discussion. Presenting the probabilities at 24 hours and 48 hours is useful when discussing mitigation measures and the need for prompt response.

The length of shoreline oiled is relevant for determining potential ecological damage, and for estimating shoreline clean up resources that would be required in the event of a spill. Figure 5.4.30 illustrates the length of shoreline contacted by oil for the summer simulation. Basic statistics on shoreline oiling for all seasons are presented in Table 5.4.12.

**TABLE 5.4.12**

**STATISTICS FOR SHORELINE CONTACT FOR A CREDIBLE WORST CASE SPILL AT LOCATION G (NO MITIGATION APPLIED)**

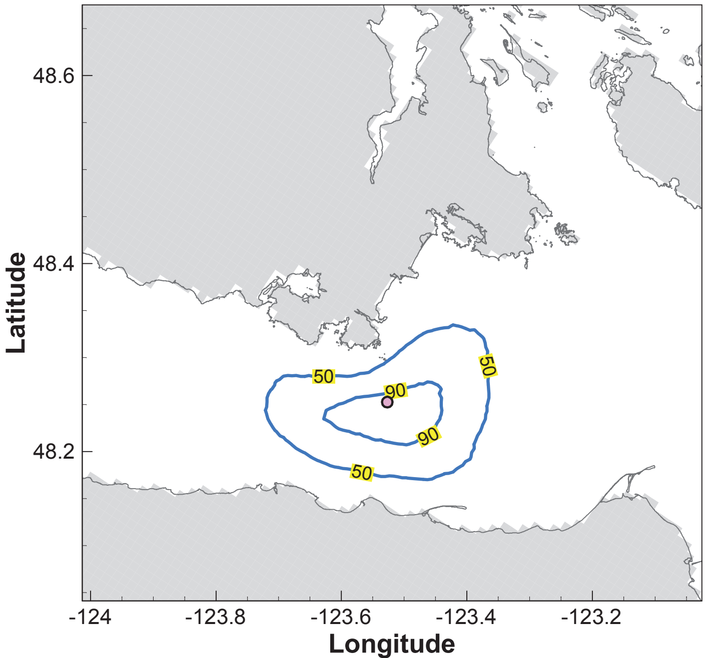
| | Median (km) | Average (km) | Maximum (km) | Minimum (km) |
|---|---|---|---|---|
| Winter | 183 | 175 | 316 | 33 |
| Spring | 129 | 136 | 259 | 44 |
| Summer | 110 | 114 | 196 | 44 |
| Fall | 140 | 141 | 296 | 42 |

The mass balance of the spilled oil provides a good summary of a particular spill, or, when averaged across all spills, a good understanding of spill behaviour for a spill that would occur in a particular season. Figures 5.4.31 and 5.4.32 show the mass balance for the summer spill scenario. Figure 5.4.31 shows the major components: on water, on shore and evaporated, and Figure 5.4.32 shows the minor components: dispersed, bio-degraded, on banks and dissolved. Table 5.4.13 summarizes the mass balance for all four seasons at the end of the 15-day stochastic simulation period.

**TABLE 5.4.13**

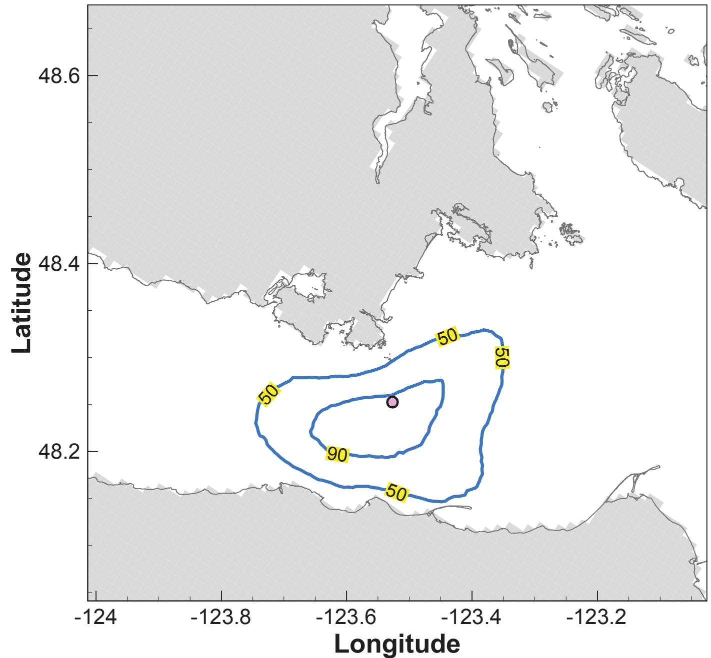
**MASS BALANCE SUMMARY FOR A CREDIBLE WORST CASE SPILL AT LOCATION G (NO MITIGATION APPLIED)**

| Component | Winter | Spring | Summer | Fall | Yearly Average |
|---|---|---|---|---|---|
| On Shore | 66.5 | 65.7 | 67.1 | 66.1 | 66.4 |
| Evaporated | 20.9 | 20.3 | 19.7 | 20.1 | 20.3 |
| On Water | 2.9 | 4.5 | 4.3 | 4.2 | 4.0 |
| Dissolved | 6.6 | 6.4 | 6.1 | 6.6 | 6.4 |
| Biodegraded | 3.1 | 3.1 | 2.7 | 2.9 | 3.0 |
| On Banks | 0 | 0 | 0 | 0 | 0.0 |
| Dispersed | 0 | 0 | 0 | 0 | 0.0 |



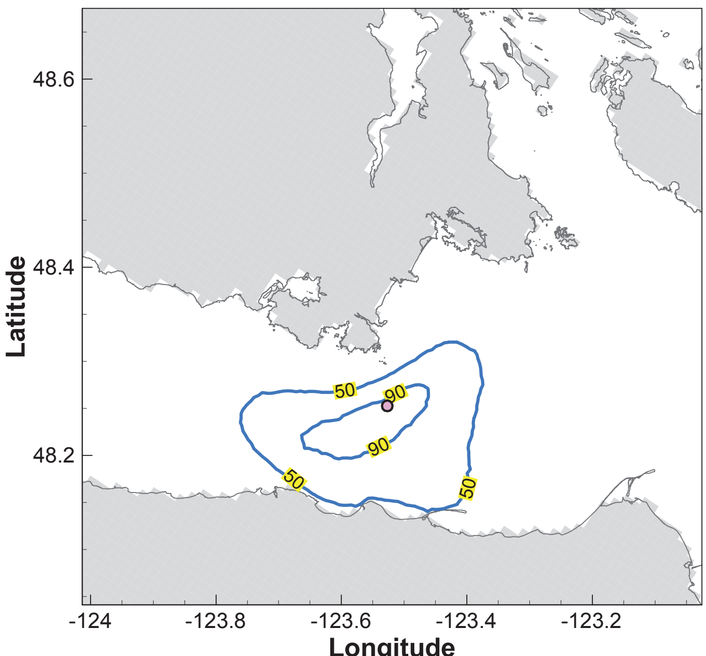

## Winter 2012

| | |
|---|---|
| Area within the $P_{50}$ Contour Line: | 326.5 km$^2$ |
| Area within the $P_{90}$ Contour Line: | 68.5 km$^2$ |
| Average Thickness within the $P_{50}$ Contour Line: | 38 um |
| Average Thickness within the $P_{90}$ Contour Line: | 69 um |
| Average Shore Oiled: | 4.3 km |



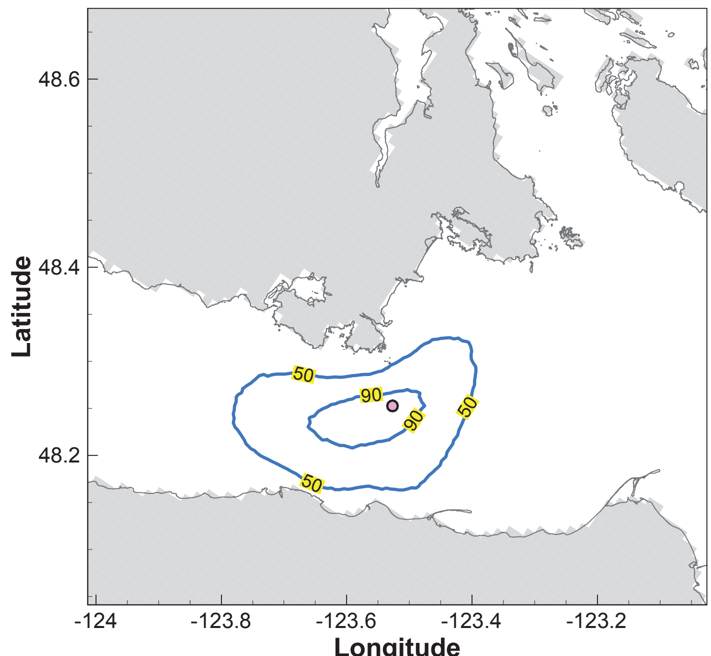

## Spring 2012

| | |
|---|---|
| Area within the $P_{50}$ Contour Line: | 395.0 km$^2$ |
| Area within the $P_{90}$ Contour Line: | 95.0 km$^2$ |
| Average Thickness within the $P_{50}$ Contour Line: | 33 um |
| Average Thickness within the $P_{90}$ Contour Line: | 48 um |
| Average Shore Oiled: | 5.6 km |




## Summer 2012

| | |
|---|---|
| Area within the $P_{50}$ Contour Line: | 372.2 km$^2$ |
| Area within the $P_{90}$ Contour Line: | 64.3 km$^2$ |
| Average Thickness within the $P_{50}$ Contour Line: | 35 um |
| Average Thickness within the $P_{90}$ Contour Line: | 54 um |
| Average Shore Oiled: | 6.8 km |




## Fall 2011

| | |
|---|---|
| Area within the $P_{50}$ Contour Line: | 347.5 km$^2$ |
| Area within the $P_{90}$ Contour Line: | 61.8 km$^2$ |
| Average Thickness within the $P_{50}$ Contour Line: | 37 um |
| Average Thickness within the $P_{90}$ Contour Line: | 57 um |
| Average Shore Oiled: | 5.3 km |

**NOTES**

● Release Location

Probability of oil presence is the percentage of simulations in which oil was present at a given location.
$P_{50}$: after 24 hours, there is 50% or greater probability for the area within the $P_{50}$ contour line to have been contacted.
$P_{90}$: after 24 hours, there is 90% or greater probability for the area within the $P_{90}$ contour line to have been contacted.
Statistical results for each season based on independent spills occuring every 6 hours for three months.
Tracking time for each spill was 24 hours.
The average thickness is based on a full coverage of each grid cell that contains oil and lies within the contour line.

STATUS
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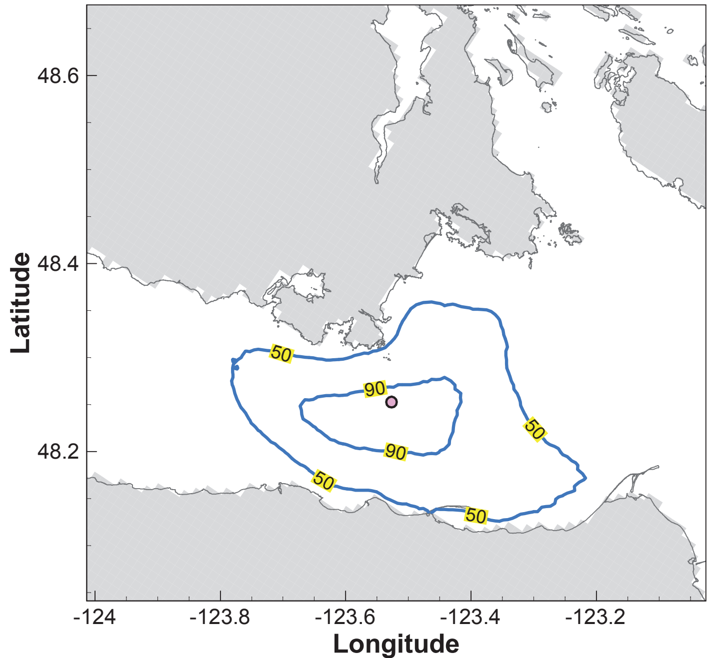
**TRANS MOUNTAIN OIL SPILL STUDY**

**Stochastic Simulation**
**Site G (16,500 m$^3$)**
**$P_{50}$ and $P_{90}$ after 24 Hours**

| PROJECT NO. | DWN | CKD | APVD | REV |
|---|---|---|---|---|
| V13203022 | DP | JAS | - | 0 |

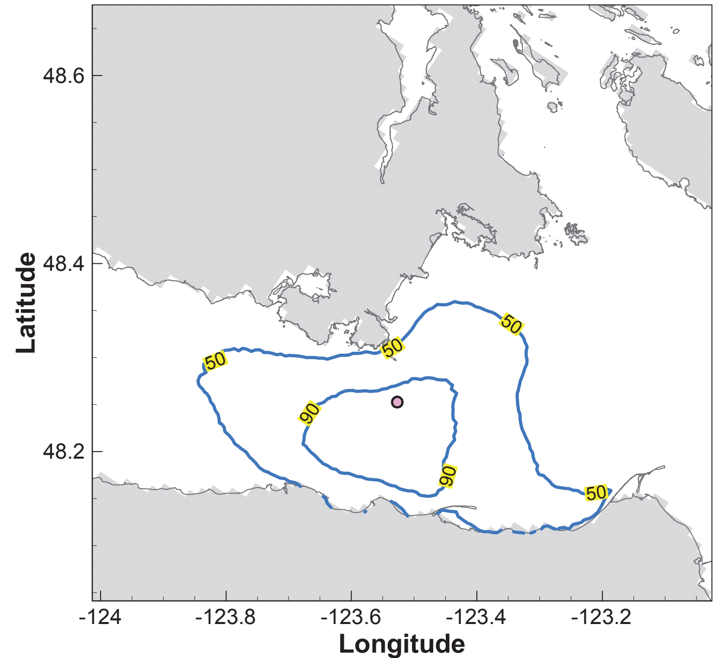
| OFFICE | DATE |
|---|---|
| EBA-VANC | October 25, 2013 |

**Figure 5.4.28**



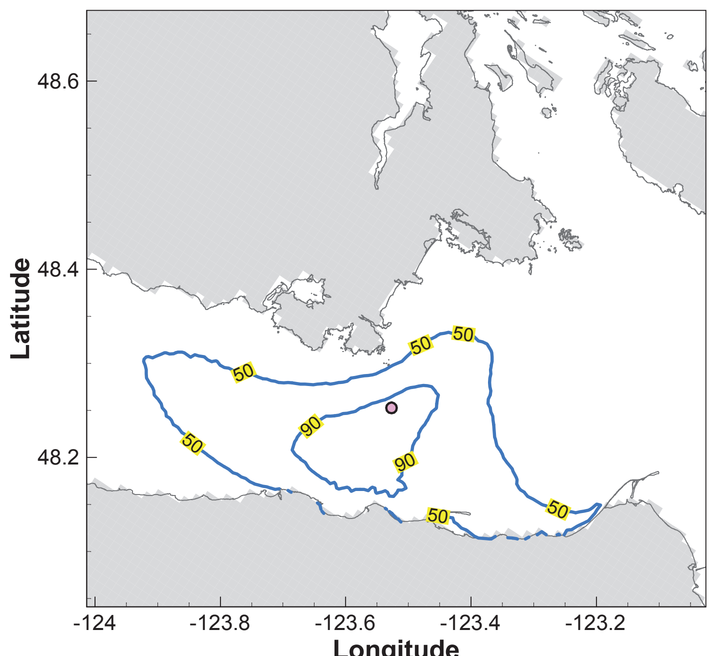

## Winter 2012

| | |
|---|---|
| Area within the $P_{50}$ Contour Line: | 639.3 $km^2$ |
| Area within the $P_{90}$ Contour Line: | 122.8 $km^2$ |
| Average Thickness within the $P_{50}$ Contour Line: | 21 um |
| Average Thickness within the $P_{90}$ Contour Line: | 35 um |
| Average Shore Oiled: | 23.5 km |



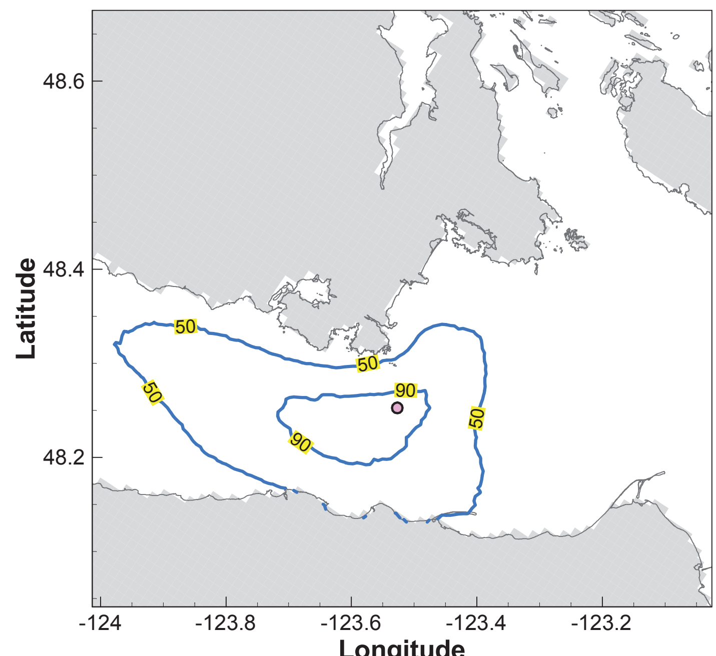

## Spring 2012

| | |
|---|---|
| Area within the $P_{50}$ Contour Line: | 748.2 $km^2$ |
| Area within the $P_{90}$ Contour Line: | 182.8 $km^2$ |
| Average Thickness within the $P_{50}$ Contour Line: | 18 um |
| Average Thickness within the $P_{90}$ Contour Line: | 29 um |
| Average Shore Oiled: | 27.4 km |




## Summer 2012

| | |
|---|---|
| Area within the $P_{50}$ Contour Line: | 674.0 $km^2$ |
| Area within the $P_{90}$ Contour Line: | 128.3 $km^2$ |
| Average Thickness within the $P_{50}$ Contour Line: | 20 um |
| Average Thickness within the $P_{90}$ Contour Line: | 33 um |
| Average Shore Oiled: | 29.4 km |




## Fall 2011

| | |
|---|---|
| Area within the $P_{50}$ Contour Line: | 675.2 $km^2$ |
| Area within the $P_{90}$ Contour Line: | 38.7 $km^2$ |
| Average Thickness within the $P_{50}$ Contour Line: | 21 um |
| Average Thickness within the $P_{90}$ Contour Line: | 39 um |
| Average Shore Oiled: | 25.9 km |

## NOTES

● Release Location

Probability of oil presence is the percentage of simulations in which oil was present at a given location.
$P_{50}$: after 48 hours, there is 50% or greater probability for the area within the $P_{50}$ contour line to have been contacted.
$P_{90}$: after 48 hours, there is 90% or greater probability for the area within the $P_{90}$ contour line to have been contacted.
Statistical results for each season based on independent spills occuring every 6 hours for three months.
Tracking time for each spill was 48 hours.
The average thickness is based on a full coverage of each grid cell that contains oil and lies within the contour line.

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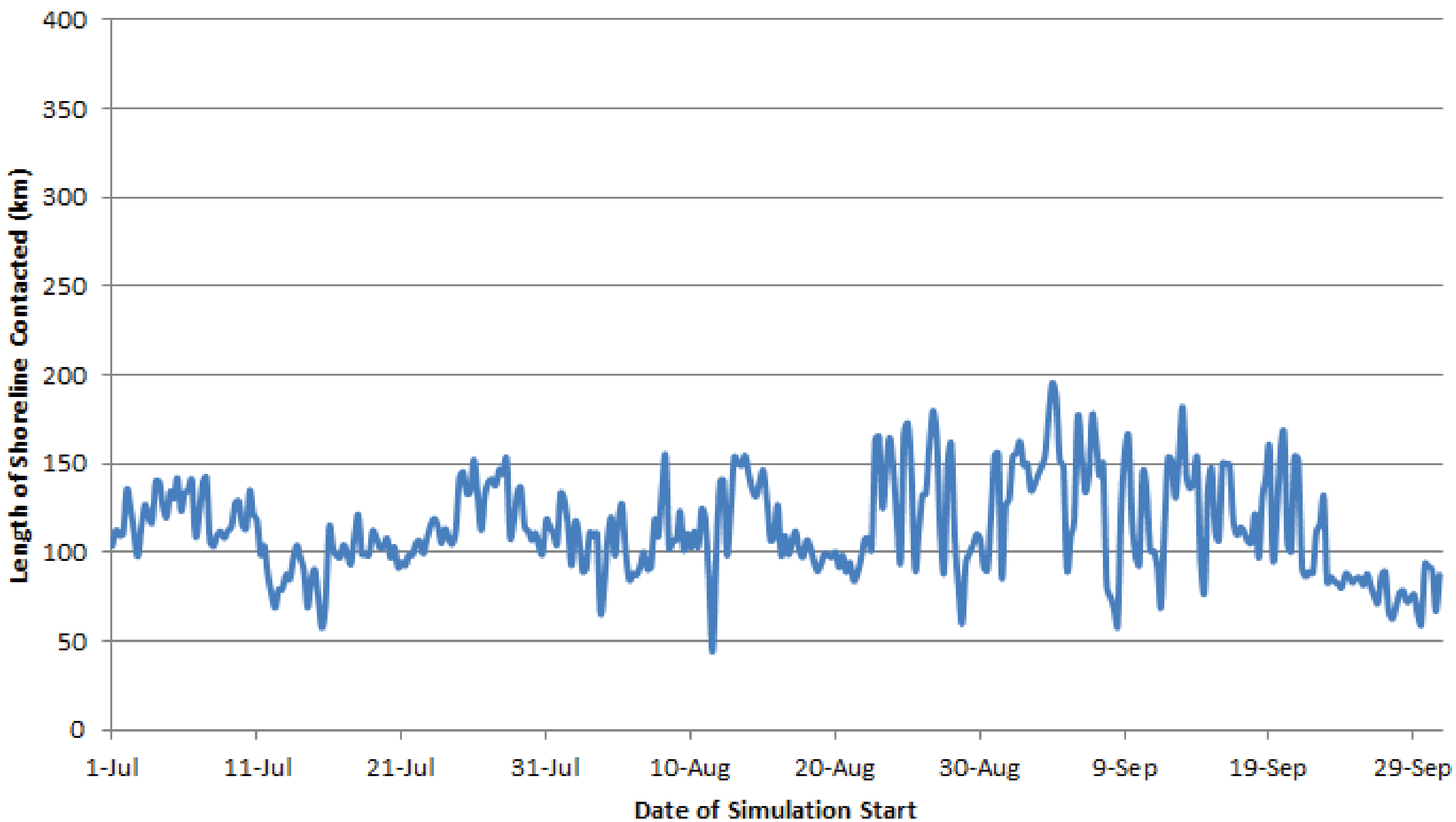
## TRANS MOUNTAIN OIL SPILL STUDY

**Stochastic Simulation**
**Site G (16,500 $m^3$)**
**$P_{50}$ and $P_{90}$ after 48 Hours**

| PROJECT NO. | DWN | CKD | APVD | REV |
|---|---|---|---|---|
| V13203022 | DP | JAS | - | 0 |

| OFFICE | DATE |
|---|---|
| EBA-VANC | October 25, 2013 |

**Figure 5.4.29**




## NOTES

- Statistical results based on independent spills occuring every 6 hours from July 01 00:00 to September 30 23:00, for a total of 364 independant spills.

- Tracking time for each spill was 15 days.

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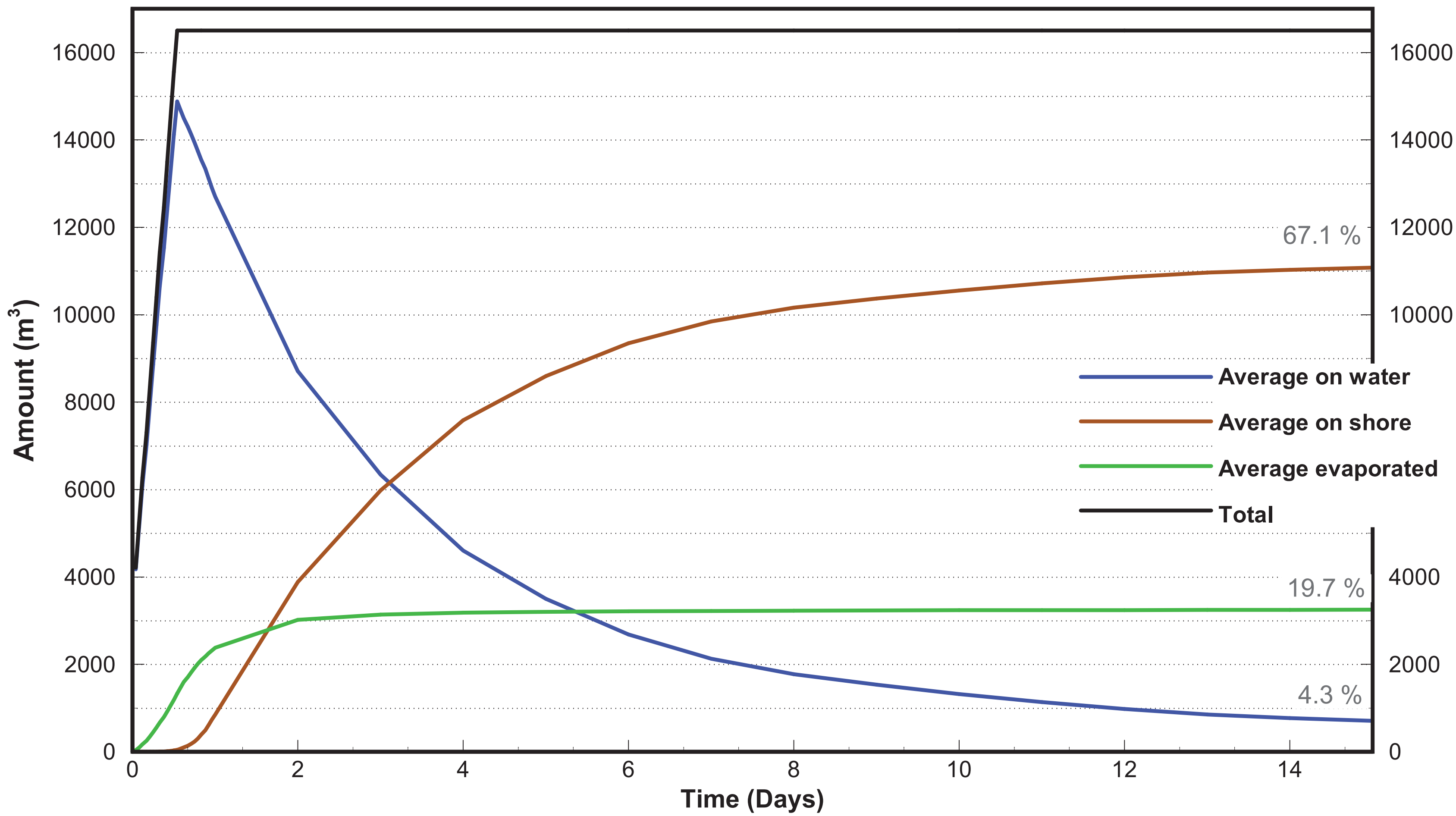
## TRANS MOUNTAIN OIL SPILL STUDY

**Stochastic Simulation**
**Summer 2012, Site G (16,500 m$^3$)**
**Length of Shoreline Contacted**

| PROJECT NO. | DWN | CKD | APVD | REV | |
|---|---|---|---|---|---|
| V13203022 | AH | JAS | - | 0 | Figure 5.4.30 |
| OFFICE | DATE | | | | |
| EBA-VANC | October 21, 2013 | | | | |




## NOTES

- Statistical results based on independent spills occuring every 6 hours from July 01 00:00 to September 30 23:00, for a total of 364 independant spills.
- Tracking time for each spill was 15 days.
- The major components of the mass balance are shown above.

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## TRANS MOUNTAIN OIL SPILL STUDY

### Stochastic Simulation
### Summer 2012, Site G (16,500 $m^3$)
### Major Components of the Mass Balance

| PROJECT NO. | DWN | CKD | APVD | REV |
|---|---|---|---|---|
| V13203022 | AH | JAS | - | 0 |

| OFFICE | DATE |
|---|---|
| EBA-VANC | October 21, 2013 |

**Figure 5.4.31**

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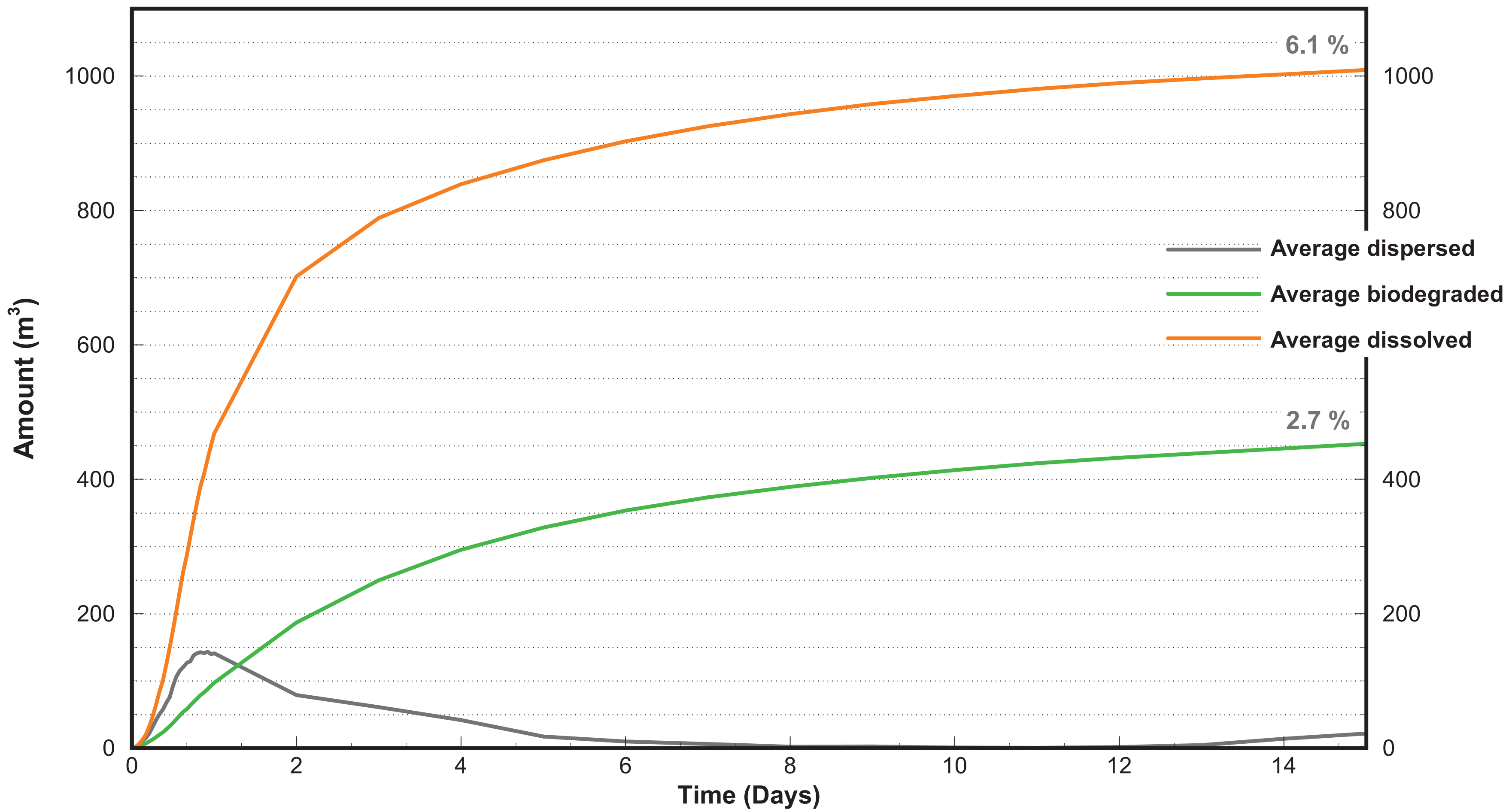
21 Oct 2013 10:46:24




## NOTES

- Statistical results based on independent spills occuring every 6 hours from July 01 00:00 to September 30 23:00, for a total of 364 independant spills.
- Tracking time for each spill was 15 days.
- The minor components of the mass balance are shown above.

STATUS
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# TRANS MOUNTAIN OIL SPILL STUDY

## Stochastic Simulation
## Summer 2012, Site G (16,500 $m^3$)
## Minor Components of the Mass Balance

| PROJECT NO. | DWN | CKD | APVD | REV |
|---|---|---|---|---|
| V13203022 | AH | JAS | - | 0 |

| OFFICE | DATE |
|---|---|
| EBA-VANC | October 21, 2013 |

Figure 5.4.32

#### *5.4.4.8 Location H, Buoy J*

Location H is located at the entrance of the Juan de Fuca Strait at Buoy J, as shown in Figure 5.5.2. This location has been determined to be representative of a hypothetical incident resulting from a collision. The potential volume of oil spilled was determined by DNV as 16,500 $m^3$ for a credible worst case. 25 per cent of the spill would be released in the first hour, and the balance at a uniform rate over the succeeding 12 hours. This location has very low probability for an oil spill from a laden tanker. However, this location represents the outer part of the assessment area, hence should be modelled.

Winds at Location H are primary from the south. Strong storms are observed in the fall-winter periods with winds reaching 20 m/s. The spring-summer period is characterized by weaker winds, about 10 m/s.

Figures 5.4.33 and 5.4.34 show the 50 per cent and 90 per cent probability maps at Hour 24, *i.e.*, 24 hours after the start of the incident, and Hour 48. In general, a wider range of probabilities is presented in a stochastic probability map, but selecting only two contours simplifies the discussion. Presenting the probabilities at 24 hours and 48 hours is useful when discussing mitigation measures and the need for prompt response.

The length of shoreline oiled is relevant for determining potential ecological damage, and for estimating shoreline clean up resources that would be required in the event of a spill. Figure 5.4.35 illustrates the length of shoreline contacted by oil for the summer simulation. Basic statistics on shoreline oiling for all seasons are presented in Table 5.4.14.

**TABLE 5.4.14**

**STATISTICS FOR SHORELINE CONTACT FOR A CREDIBLE WORST CASE SPILL AT LOCATION H (NO MITIGATION APPLIED)**

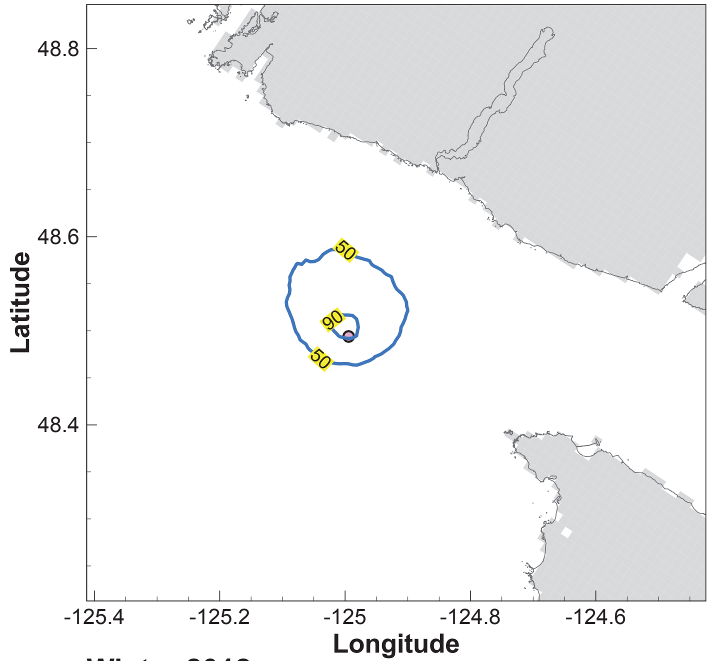
| | Median (km) | Average (km) | Maximum (km) | Minimum (km) |
|---|---|---|---|---|
| Winter | 183 | 175 | 316 | 33 |
| Spring | 129 | 135 | 259 | 44 |
| Summer | 110 | 114 | 196 | 44 |
| Fall | 107 | 114 | 314 | 0 |

The mass balance of the spilled oil provides a good summary of a particular spill, or, when averaged across all spills, a good understanding of spill behaviour for a spill that would occur in a particular season. Figures 5.4.36 and 5.4.37 show the mass balance for the summer spill scenario. Figure 5.4.36 shows the major components: on water, on shore and evaporated, and Figure 5.4.37 shows the minor components: dispersed, bio-degraded, on banks and dissolved. Table 5.4.15 summarizes the mass balance for all four seasons at the end of the 15-day stochastic simulation period.

**TABLE 5.4.15**

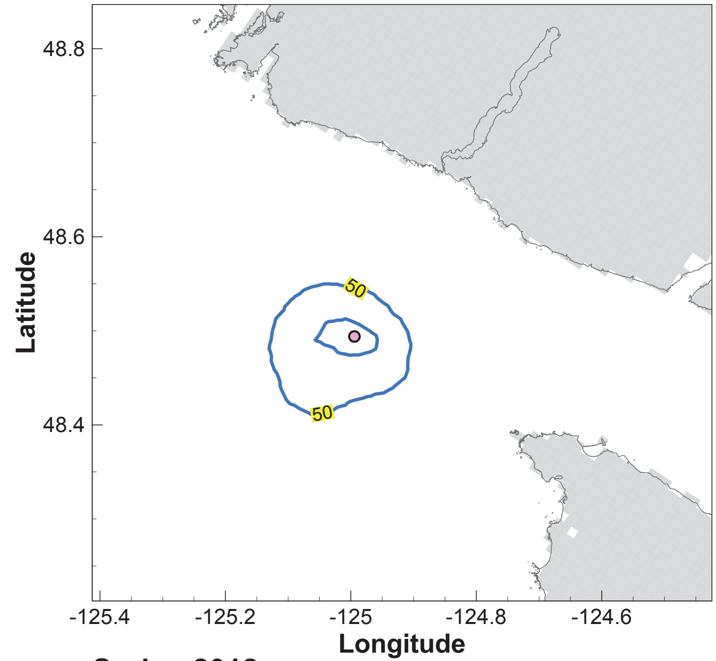
**MASS BALANCE SUMMARY FOR THE 16,500 M$^3$ SPILL AT LOCATION H (NO MITIGATION APPLIED)**

| Component | Winter | Spring | Summer | Fall | Yearly Average |
|---|---|---|---|---|---|
| On Shore | 59.6 | 34.3 | 28.2 | 41.5 | 40.9 |
| Evaporated | 22.7 | 23.6 | 24.2 | 23 | 23.4 |
| On Water | 6.9 | 26.4 | 31 | 21.5 | 21.5 |
| Dissolved | 6.9 | 9.5 | 10 | 8.8 | 8.8 |
| Biodegraded | 3.9 | 6.1 | 6.6 | 5.3 | 5.5 |
| On Banks | 0 | 0 | 0 | 0 | 0.0 |
| Dispersed | 1 | 2.2 | 8.7 | 1 | 3.2 |



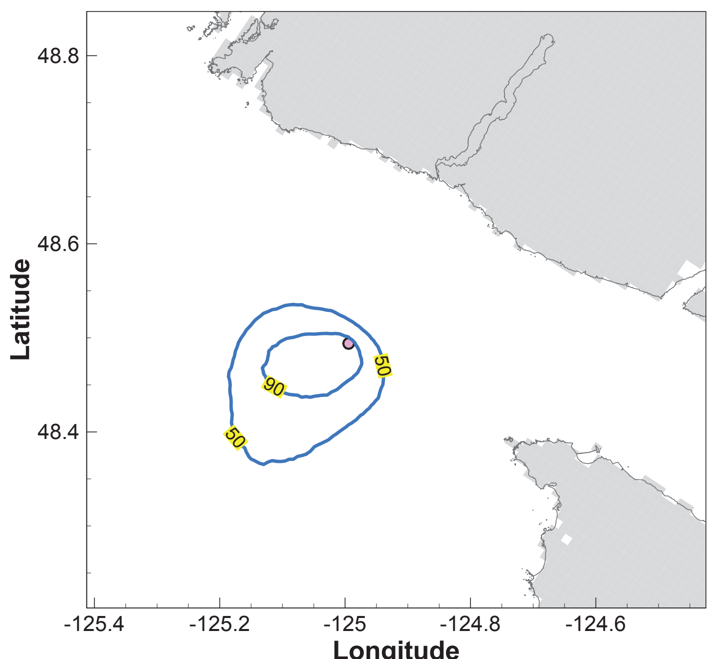

## Winter 2012

| | |
|---|---|
| Area within the $P_{50}$ Contour Line: | 146.3 km$^2$ |
| Area within the $P_{90}$ Contour Line: | 7.5 km$^2$ |
| Average Thickness within the $P_{50}$ Contour Line: | 59 um |
| Average Thickness within the $P_{90}$ Contour Line: | 108 um |
| Average Shore Oiled: | XX km |



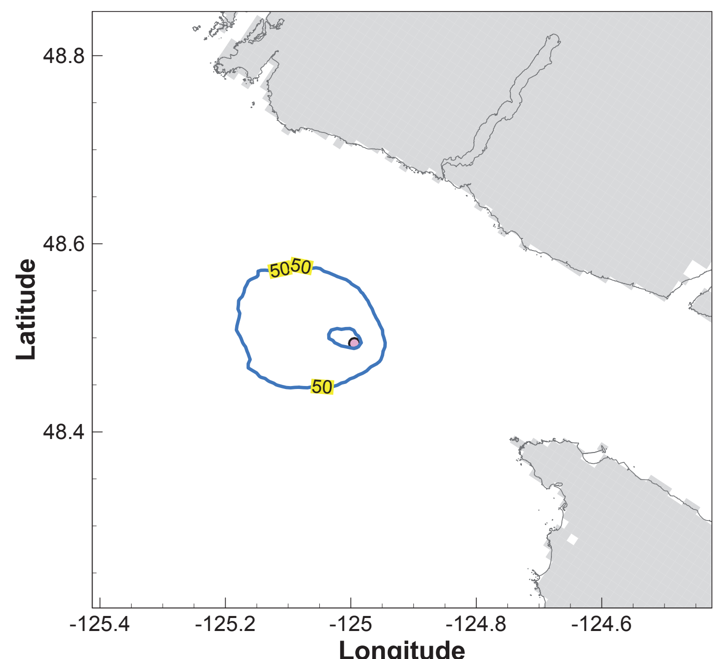

## Spring 2012

| | |
|---|---|
| Area within the $P_{50}$ Contour Line: | 195.0 km$^2$ |
| Area within the $P_{90}$ Contour Line: | 22.0 km$^2$ |
| Average Thickness within the $P_{50}$ Contour Line: | 53 um |
| Average Thickness within the $P_{90}$ Contour Line: | 87 um |
| Average Shore Oiled: | XX km |




## Summer 2012

| | |
|---|---|
| Area within the $P_{50}$ Contour Line: | 260.8 km$^2$ |
| Area within the $P_{90}$ Contour Line: | 69.3 km$^2$ |
| Average Thickness within the $P_{50}$ Contour Line: | 48 um |
| Average Thickness within the $P_{90}$ Contour Line: | 61 um |
| Average Shore Oiled: | XX km |




## Fall 2011

| | |
|---|---|
| Area within the $P_{50}$ Contour Line: | 200.5 km$^2$ |
| Area within the $P_{90}$ Contour Line: | 6.5 km$^2$ |
| Average Thickness within the $P_{50}$ Contour Line: | 54 um |
| Average Thickness within the $P_{90}$ Contour Line: | 115 um |
| Average Shore Oiled: | XX km |

**NOTES**

○ Release Location

Probability of oil presence is the percentage of simulations in which oil was present at a given location.
- $P_{50}$: after 24 hours, there is 50% or greater probability for the area within the $P_{50}$ contour line to have been contacted.
- $P_{90}$: after 24 hours, there is 90% or greater probability for the area within the $P_{90}$ contour line to have been contacted.

Statistical results for each season based on independent spills occuring every 6 hours for three months.
Tracking time for each spill was 24 hours.
The average thickness is based on a full coverage of each grid cell that contains oil and lies within the contour line.

STATUS
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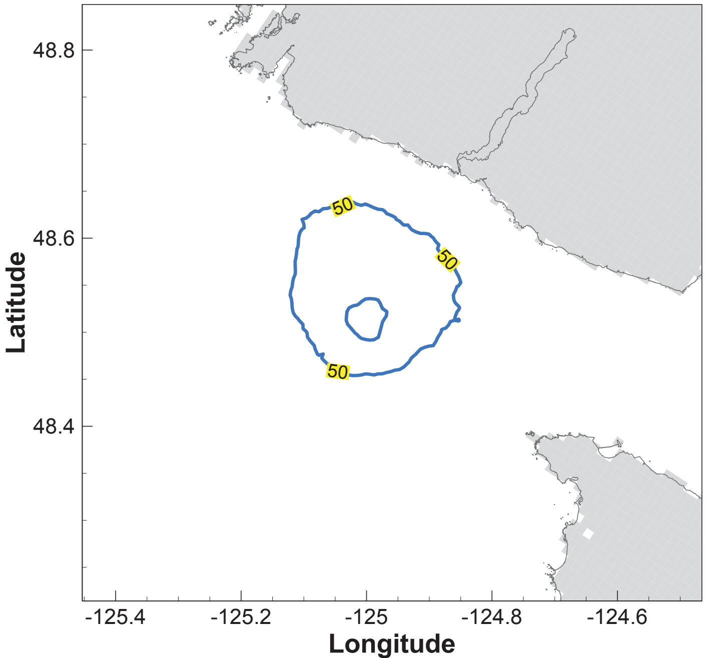
# TRANS MOUNTAIN OIL SPILL STUDY

**Stochastic Simulation**
**Site H (16,500 m$^3$)**
**$P_{50}$ and $P_{90}$ after 24 Hours**

| PROJECT NO. | DWN | CKD | APVD | REV |
|---|---|---|---|---|
| V13203022 | DP | JAS | - | 0 |

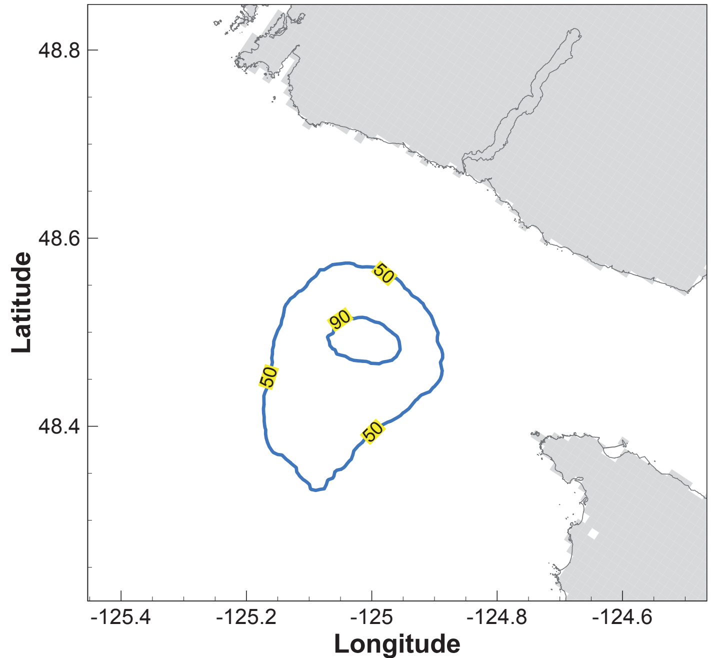
| OFFICE | DATE |
|---|---|
| EBA-VANC | November 7, 2013 |

**Figure 5.4.33**



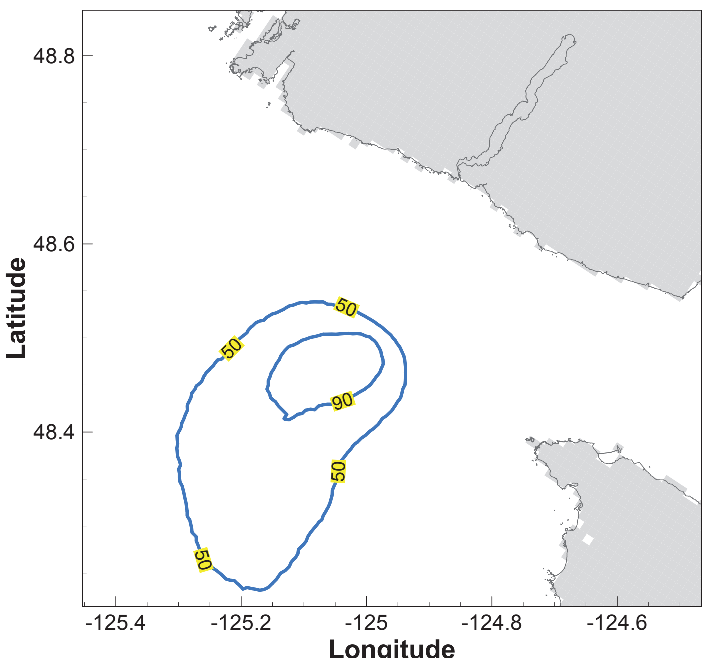

## Winter 2012

| | |
|---|---|
| Area within the $P_{50}$ Contour Line: | 308.5 km$^2$ |
| Area within the $P_{90}$ Contour Line: | 17.3 km$^2$ |
| Average Thickness within the $P_{50}$ Contour Line: | 40 um |
| Average Thickness within the $P_{90}$ Contour Line: | 74 um |
| Average Shore Oiled: | XX km |



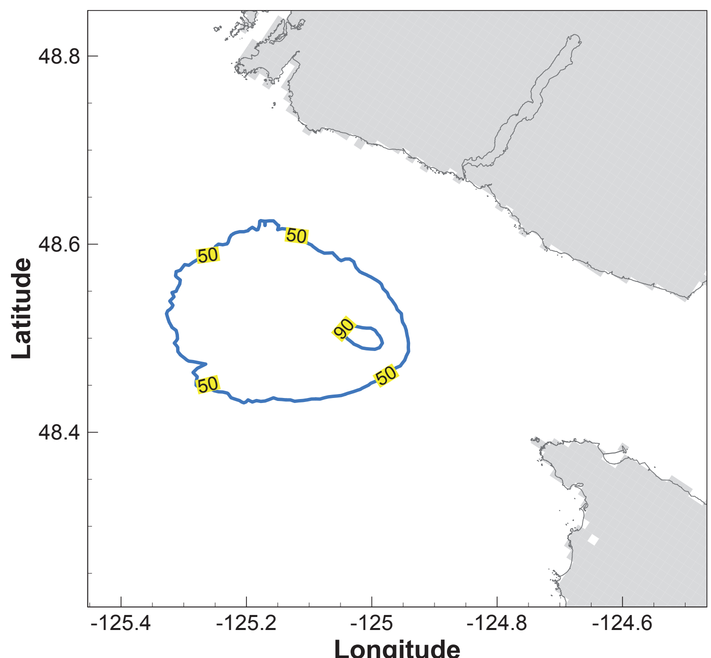

## Spring 2012

| | |
|---|---|
| Area within the $P_{50}$ Contour Line: | 378.7 km$^2$ |
| Area within the $P_{90}$ Contour Line: | 34.5 km$^2$ |
| Average Thickness within the $P_{50}$ Contour Line: | 32 um |
| Average Thickness within the $P_{90}$ Contour Line: | 64 um |
| Average Shore Oiled: | XX km |




## Summer 2012

| | |
|---|---|
| Area within the $P_{50}$ Contour Line: | 591.7 km$^2$ |
| Area within the $P_{90}$ Contour Line: | 95.78 km$^2$ |
| Average Thickness within the $P_{50}$ Contour Line: | 29 um |
| Average Thickness within the $P_{90}$ Contour Line: | 50 um |
| Average Shore Oiled: | XX km |




## Fall 2011

| | |
|---|---|
| Area within the $P_{50}$ Contour Line: | 440.7 km$^2$ |
| Area within the $P_{90}$ Contour Line: | 9.5 km$^2$ |
| Average Thickness within the $P_{50}$ Contour Line: | 34 um |
| Average Thickness within the $P_{90}$ Contour Line: | 99 um |
| Average Shore Oiled: | XX km |

**NOTES**

● Release Location

Probability of oil presence is the percentage of simulations in which oil was present at a given location.
$P_{50}$: after 48 hours, there is 50% or greater probability for the area within the $P_{50}$ contour line to have been contacted.
$P_{90}$: after 48 hours, there is 90% or greater probability for the area within the $P_{90}$ contour line to have been contacted.
Statistical results for each season based on independent spills occuring every 6 hours for three months.
Tracking time for each spill was 48 hours.
The average thickness is based on a full coverage of each grid cell that contains oil and lies within the contour line.

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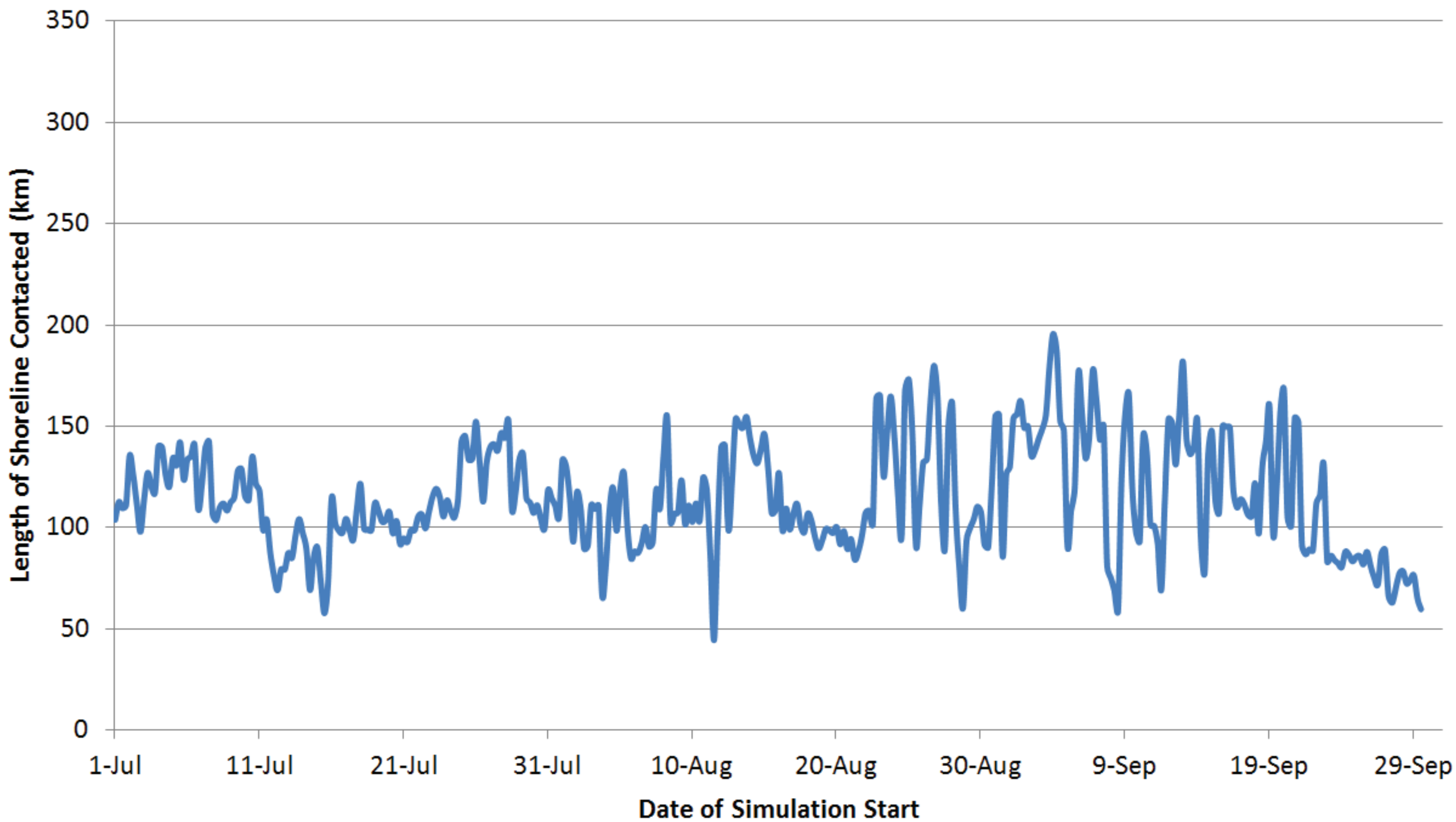
**TRANS MOUNTAIN OIL SPILL STUDY**

**Stochastic Simulation**
**Site H (16,500 m$^3$)**
**$P_{50}$ and $P_{90}$ after 48 Hours**

| PROJECT NO. | DWN | CKD | APVD | REV |
|---|---|---|---|---|
| V13203022 | DP | JAS | - | 0 |

| OFFICE | DATE |
|---|---|
| EBA-VANC | November 7, 2013 |

**Figure 5.4.34**




## NOTES

- Statistical results based on independent spills occuring every 6 hours from July 01 00:00 to September 30 23:00, for a total of 368 independant spills.
- Tracking time for each spill was 15 days.

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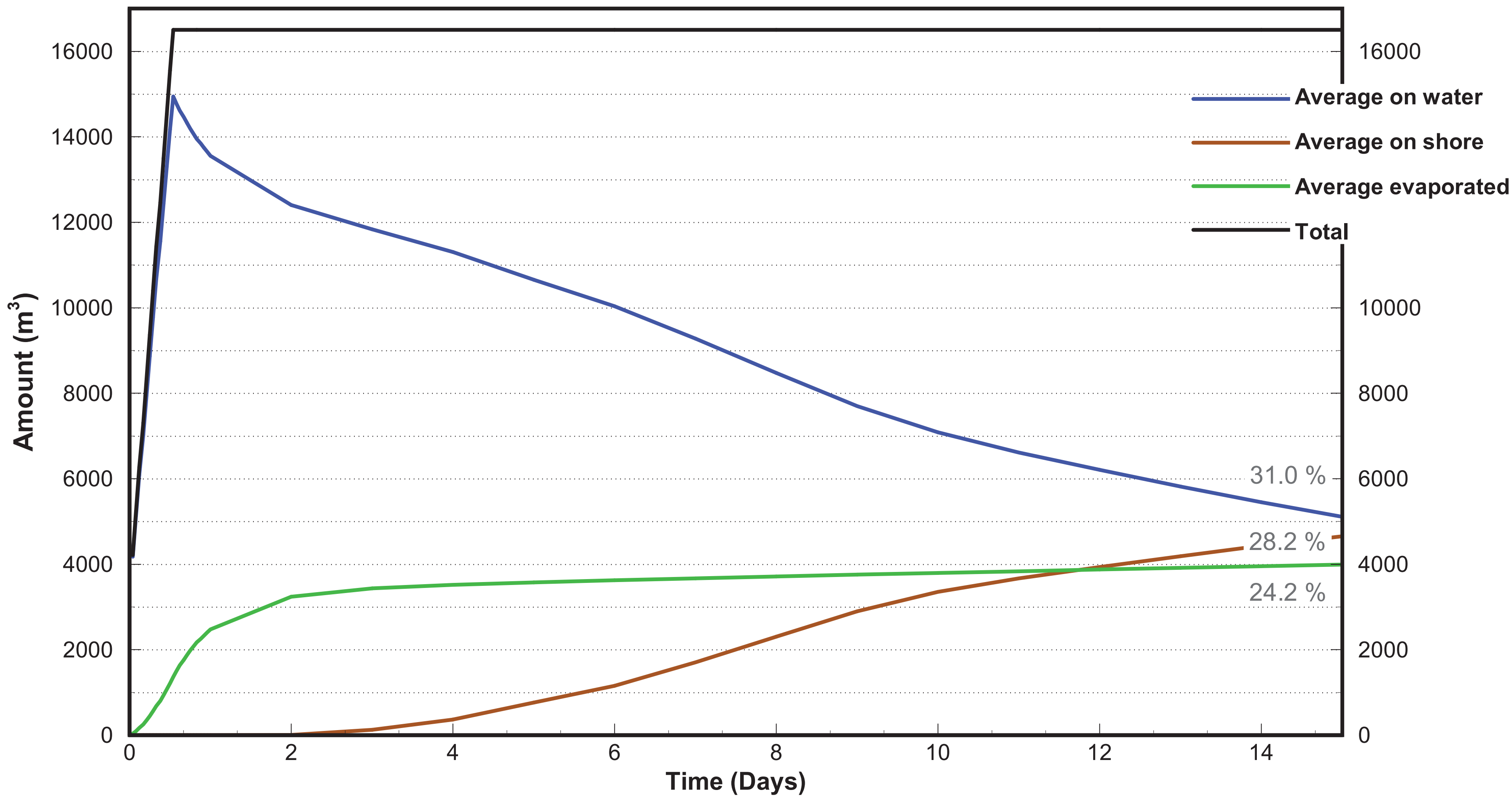
## TRANS MOUNTAIN OIL SPILL STUDY

### Stochastic Simulation
### Summer 2012, SiteH (16,500 m$^3$)
### Length of Shoreline Contacted

| PROJECT NO. | DWN | CKD | APVD | REV |
|---|---|---|---|---|
| V13203022 | AH | JAS | - | 0 |

| OFFICE | DATE |
|---|---|
| EBA-VANC | October 30, 2013 |

**Figure 5.4.35**




## NOTES

- Statistical results based on independent spills occuring every 6 hours from July 01 00:00 to September 30 23:00, for a total of 368 independant spills.
- Tracking time for each spill was 15 days.
- The major components of the mass balance are shown above.

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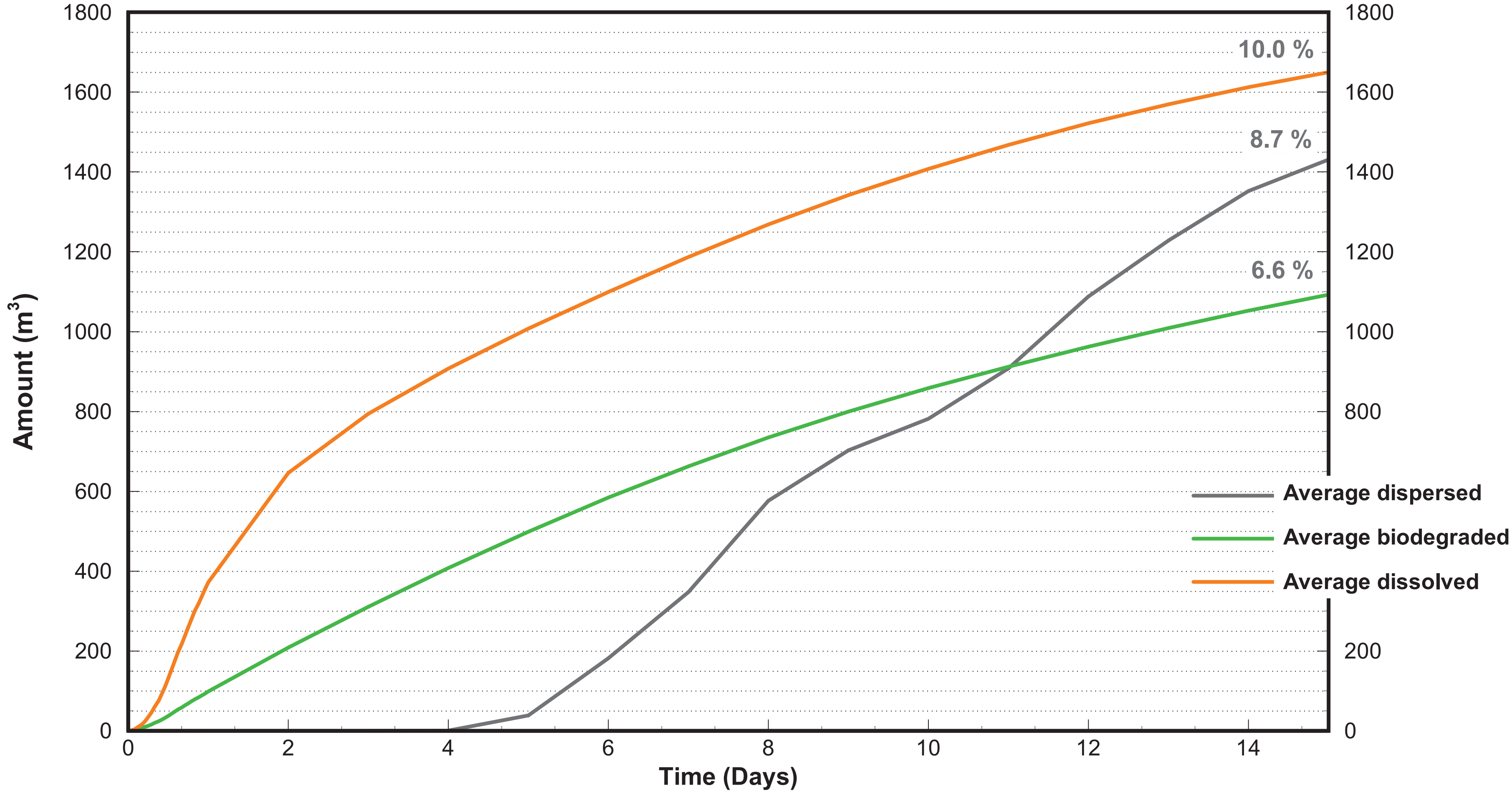
# TRANS MOUNTAIN OIL SPILL STUDY

## Stochastic Simulation Summer 2012, Site H (16,500 m$^3$) Major Components of the Mass Balance

| PROJECT NO. | DWN | CKD | APVD | REV |
|---|---|---|---|---|
| V13203022 | AH | JAS | - | 0 |

| OFFICE | DATE |
|---|---|
| EBA-VANC | October 30, 2013 |

Figure 5.4.36




## NOTES

- Statistical results based on independent spills occuring every 6 hours from July 01 00:00 to September 30 23:00, for a total of 368 independant spills.
- Tracking time for each spill was 15 days.
- The minor components of the mass balance are shown above.

STATUS
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# TRANS MOUNTAIN OIL SPILL STUDY

## Stochastic Simulation
## Summer 2012, Site H (16,500 $m^3$)
## Minor Components of the Mass Balance

| PROJECT NO. | DWN | CKD | APVD | REV |
|---|---|---|---|---|
| V13203022 | AH | JAS | - | 0 |

| OFFICE | DATE |
|---|---|
| EBA-VANC | October 30, 2013 |

Figure 5.4.37

#### *5.4.4.9 Summary of Stochastic Results*

In order to obtain a general understanding of spill behaviour, the results presented in the preceding sections are summarized into the following Table 5.4.16.

**TABLE 5.4.16**

**SUMMARY OF STOCHASTIC MODELLING RESULTS (NO MITIGATION APPLIED)**

| Property Modeled | Location D (Strait of Georgia) | Location E (Arachne Reef) | Location G (Juan de Fuca Strait - Race Rocks) | Location H (Buoy J) | Group Average |
|---|---|---|---|---|---|
| $P_{50}$ area at 24 hours (km$^2$) | 293.7 | 178.2 | 360.3 | 146.3 | 244.6 |
| $P_{50}$ area at 48 hours (km$^2$) | 853.8 | 633.4 | 684.2 | 308.5 | 620.0 |
| Shore oiled at 24 hours (km) | 12.6 | 33.5 | 5.5 | 4.3 | 14.0 |
| Shore oiled at 48 hours (km) | 60.6 | 83.3 | 26.6 | 23.5 | 48.5 |
| Shore oiled at 15 days (km) | 282 | 302 | 142 | 135 | 215.3 |
| Fraction on shore at 15 days (%) | 66.1 | 69.8 | 66.4 | 40.9 | 60.8 |
| Fraction evaporated 15 days (%) | 20.4 | 19.8 | 20.3 | 23.4 | 21.0 |
| Fraction on water at 15 days (%) | 2.0 | 2.2 | 4.0 | 21.5 | 7.4 |
| Fraction dissolved at 15 days (%) | 6.8 | 5.5 | 6.4 | 8.8 | 6.9 |
| Fraction biodegraded at 15 days (%) | 2.9 | 2.7 | 3.0 | 5.5 | 3.5 |
| Fraction on banks at 15 days (%) | 1.6 | 0.0 | 0.0 | 0 | 0.4 |
| Fraction dispersed at 15 days (%) | 0.1 | 0.0 | 0.0 | 1 | 0.3 |

From the summary table, it is clear that there are substantial differences between the hypothetical locations modeled. Spills in the inshore waters are generally larger in aerial extent than a spill at Buoy J (Location H), on the continental shelf. The extent of shoreline oiling depends on the proximity of land, and on the complexity of currents at the site: currents at the Juan de Fuca (Race Rocks) site (Location G) and at Buoy J (Location H), in summer, are dominated by the large-scale estuarine flow in these areas, whereas in the Strait of Georgia (Location D) and Arachne Reef (Location E), currents tend to be more tidal. The fraction evaporated is relatively constant for all four sites. The amount remaining on the water surface is much less at the inshore sites, because of the close proximity of shorelines. The dissolved fraction is larger at Buoy J (Location D), possibly because the flow and winds are more unidirectional, so the slick is always moving over new water which has not been exposed to the dissolved constituents: this would lead to an increased mass transfer rate at the oil-water interface. Biodegraded fractions are generally small, and it is not clear why the greatest biodegradation occurs at Buoy J (Location H). The fraction on banks is highest at the Strait of Georgia site (Location D), because of the proximity of Roberts and Sturgeon Banks, and the fraction dispersed is highest at Buoy J (Location H), because of the greater wave action in the open waters.

These stochastic simulations show the consequences of the oceanographic and meteorological factors in the area, as well as the consequences of the particular characteristics of the transported product CLWB. These results have also been used to inform mitigation planning, and as part of the environmental risk assessment, discussed in the next sections.

#### *5.4.4.10 Mitigation Methods*

The testing documented in the Gainford Study also assessed the effectiveness of mechanical skimming equipment, dispersants, beach cleaning agents, and in-situ burning on CLWB. This section provides a summary of the results. The results of these tests are discussed below. The effectiveness of alternate oil spill response methods such as the use of dispersants and in-situ burning were not found to be as effective as mechanical means. However weathered CLWB up to 24 hours did ignite in in-situ burn tests. Further details of all tests are available in the Gainford Study Report.

The Gainford Study also showed that fresh-to-very-weathered CLWB could be effectively removed from a hard substrate through a combination of shoreline cleaner (Corexit 9580) and low-to-moderate water pressure flushing. These techniques may not be suited for all types of shorelines; however, they are generally appropriate for coarse-grained materials (gravel, cobbles, and boulders, including coarse sediment mixes).

During the Gainford Study, WCMRC arranged to test several types of skimmers on progressively weathered CLWB. Throughout the allotted time period of 10 days, all of the skimmers proved effective in recovering the product, whether it was fresh, emulsified, or naturally weathered after a 10-day exposure to ambient element conditions. There were no conditions during the testing period under which any of the three skimmers failed to operate.

At discharge the CLWB product was less viscous than anticipated by the skimmer vendors, prompting them to state they would have preferred to use oleophilic discs at the outset of the test and then switch to brushes later as the oil became more viscous. It is obvious from the results of these tests that the responders would be well served to adjust their equipment in keeping with the pace of oil weathering, when dealing with spilled diluted bitumen. This observation is similar to what responders have faced when dealing with other types of oil and should not cause any issues in response management or oil recovery.

Table 5.4.17 and Table 5.4.18 provide a summary comparison of the changes in key physical properties and chemistry of crude oil products that are currently shipped from and to the West Coast of North America, including crude oil from the Alaska North Slope (ANS). Although general perceptions may conceive of dilbits as being very different types of oil from other commodities transported via pipelines and tankers, the fact is that the general physical and chemical properties of dilbit as it weathers are not significantly different than other heavy crude oil products, such as those illustrated in the following tables.

Emergency responders have developed procedures and techniques to respond to accidental spills of the heavy crude oil products shown in the following tables. Since dilbit behaves similarly to these products due to the effects of weathering, emergency response procedures and clean-up techniques for dilbit would be similar to these other heavy crude oil products.

## TABLE 5.4.17

## COMPARISON OF CHANGES IN KEY PHYSICAL PROPERTIES OF CRUDE OIL PRODUCTS AS THEY WEATHER

| | Weathering (weight %) | API | Water (vol %) | Flash Point (C) | Density (g/mL) @ 0/15 | | Pour Point (C) | Dynamic Viscosity (cP) @ 0/15 | | Adhesion (g/m$^2$) | Surface Tension (mN/m) @ 0/15 | | Oil/Brine (33 ppt) Interfacial Tension (mN/m) @ 0/15 | | Oil Freshwater Interfacial Tension (mN/m) @ 0/15 | | Emulsion Formation: Visual Stability | Emulsion Formation: Complex Modulus (Pa) | Emulsion Formation: Emulsion Water Content (%) | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 0°C/1°C* | 15°C | | 0°C/1°C* | 15°C | | 0°C | 15°C | 0°C | 15°C | 0°C | 15°C | 15°C/14°C* | | | |
| **ANS Crude Oil** | 0 | 30.89 | < 0.1 | < -8 | 0.877 | 0.8663 | -32 | 23.2 | 11.5 | 20 | 27.3 | 26.4 | 22.5 | 20.2 | 26.7 | 23.6 | Unstable | | | 1 |
| | 10 | | < 0.1 | 19 | 0.9054 | 0.894 | -20 | 76.7 | 31.8 | 35 | 29.8 | 28.4 | 25.3 | 23.1 | 28.1 | 25.5 | Unstable | | | 1 |
| | 22.5 | | < 0.1 | 75 | 0.9303 | 0.9189 | -9 | 614 | 152 | 38 | 31.2 | 30.4 | 26.8 | 24.2 | 30.8 | 27.7 | Unstable | | | 1 |
| | 30.5 | | < 0.1 | 115 | 0.9457 | 0.934 | -6 | 4,230 | 614.7 | 40 | 33.1 | 31.8 | 30.1 | 25.6 | 33.2 | 30.2 | Mesostable | 155 | 72.9 | 1 |
| **Fuel Oil #5** | 0 | 11.5 | 3.1 | 94 | 1.0034 | 0.9883 | -19 | 18,600 | 1,410 | 34 | NM | NM | NM | NM | NM | NM | Stable | 1,590 | 78.3 | 1 |
| | 7.2 | | < 0.1 | 136 | 1.016 | 1.0032 | -3 | 72,000 | 4,530 | 47 | NM | NM | NM | NM | NM | NM | Stable | 2,490 | 72.8 | 1 |
| **Heavy Fuel Oil** | 0 | 11.47 | 0.1 | 111 | 1.0015 | 0.9888 | -1 | 241,000 | 22,800 | 100 | NM | NM | NM | NM | NM | NM | Entrained | 752 | 57.7 | 1 |
| | 2.5 | | < 0.1 | 133 | 1.0101 | 0.9988 | 11 | 3,600,000 | 149,000 | 240 | NM | NM | NM | NM | NM | NM | Entrained | 984 | 24.1 | 1 |
| **CLWB** | 0 | 21.4$^{+}$ | 0.9 | -4.5 | 0.0948* | 0.936 | < -24 | 1,363* | 368 | | | | | 23.2 | | | Mesostable* | | 53 | 2/3 |
| | 14.3 | 14.3$^{+}$ | | 4 | 0.987* | 0.977 | -15 | 57,548* | 9,227 | | | | | 24.7 | | | Unstable* | | 0 | 2/3 |
| | 17 | 12.1$^{+}$ | | 4 | 0.990* | 0.981 | -12 | 98,625* | 14,486 | | | | | >27 | | | Unstable* | | 0 | 2/3 |
| | 23$^{+}$ | 10.2 | 33.4 | 56 | | 0.9986 | 9 | | | | | | | | | | | | | 3 |

**Source:** Fingas 2001.

## TABLE 5.4.18

## COMPARISON OF CHANGES IN KEY CHEMICAL PROPERTIES OF CRUDE OIL PRODUCTS AS THEY WEATHER

| | Weathering (weight %) | Benzene | | Toluene | | Ethylbenzene | | Xylenes | | BTEX | | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | % vol | ug/g | % vol | ug/g | % vol | ug/g | % vol | ug/g | % vol | ug/g | |
| **ANS Crude Oil** | 0 | 0.283 | 2,866 | 0.592 | 5,928 | 0.132 | 1,319 | 0.616 | 6,187 | 1.624 | 16,300 | 1 |
| | 30.5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| **Fuel Oil #5** | 0 | 0 | 0 | 0.017 | 149 | 0.014 | 124 | 0.070 | 612 | 0.101 | 890 | 1 |
| | 7.2 | 0 | 0 | 0 | 0 | 0.000 | 1 | 0.000 | 2 | 0.000 | 0 | 1 |
| **Heavy Fuel Oil** | 0 | 0.005 | 40 | 0.016 | 136 | 0.007 | 58 | 0.045 | 396 | 0.072 | 630 | 1 |
| | 2.5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| **CLWB** | 0 | 0.24 | 2,247 | 0.43 | 3,983 | 0.06 | 555 | 0.36 | 3,346 | 1.25 | 10,132 | 3 |
| | | | | | | | | | | | | |

**Source** Fingas 2001.

Observations at the end of the 10-day test period did not provide any instances where the buoyancy of the CLWB product was observed to have been compromised either neutrally downward in the water column or sunken to the bottom of the tank. Visual observations of the tanks during final decontamination further affirmed the absence of sunken oil. Vendors and contractors both agreed that under the test conditions the CLWB product behaved no differently than other crude oils and proved to be mechanically recoverable by the skimming units tested. As mentioned previously, due to the light viscosity, recovery of the early discharged CLWB product would have been improved by the use of drum and disc skimming attachments. It was not until after a few days of weathering that the vendors would have opted to use the brush/belt attachments. Participation in the Gainford Study has augmented WCMRC's knowledge and experience effectively address oil spills involving dilbit.

The effectiveness of alternate oil spill response methods such as the use of dispersants and in-situ burning were not found to be as effective as mechanical means. However weathered CLWB up to 24 hours did ignite in in-situ burn tests. Further details of all tests are available in the Gainford Study Report.

As the Gainford Study and similar lab and meso-scale tests have shown that CLWB remained on the surface throughout the test period spill containment strategies and tactics for floating oils are thereby applicable to diluted bitumen. Changes in spilled oil behaviour and movement on water can be influenced by numerous factors. Effective containment requires adjusting strategies and tactics to changing conditions for a spill of any oil type. Oil response organizations can take effective steps to limit the amount of oil adversely affecting the environment and shorelines if they are able to respond to an oil spill quickly. This is discussed with assistance of an oil spill response simulation exercise involving a hypothetical oil spill at Location E in Section 5.7.

## 5.5 Oil Spill Preparedness and Response

### *5.5.1 Current Capacity*

The conversions provided in Table 5.5.1 were calculated by WCMRC (WCMRC 2013b) based on an assumed density of 940 kg/m$^3$ and are used throughout this section.

**TABLE 5.5.1**

**CONVERSION FROM CUBIC METRE TO TONNE**

| m$^3$ | Tonne |
|---|---|
| 8,250 | 7,750 |
| 10,600 | 10,000 |
| 16,500 | 15,500 |

The regulatory framework, roles and responsibilities for emergency response and preparedness for an oil spill in a marine environment in Canada were described in detail in Volume 8A, Section 1.4. The *Canada Shipping Act,* 2001 is administered by Transport Canada and provides the overall regulatory framework for spill prevention, emergency preparedness and response in the marine environment. Under the *Canada Shipping Act, 2001* a federally certified response organization is required to have prescribed levels of equipment and resources available to carry out oil spill response activities upon request of one of their members or upon direction of the designated Authorities (*i.e.*, CCG or Transport Canada). This section describes the current capacity of the response organization for the West Coast of BC, WCMRC.

WCMRC, as a response organization, is required to submit an OSRP to Transport Canada every three years to maintain certification. The OSRP is developed by WCMRC to work within a framework of other federal, provincial and local emergency response plans, as well as tankers' SOPEP and oil handling facilities' OPEP and an on-site Oil Pollution Prevention Plan (WCMRC 2012).

WCMRC's area of operation for oil spill recovery (as designated by Transport Canada) and clean-up covers all of Canada's West Coast and all internal navigable waters and is referred to as the Geographic Area of Response (WCMRC 2012). Within the Geographic Area of Response, there are particular areas designated by Transport Canada as needing more rigorous planning standards given the increased risks associated with greater traffic density, convergence of vessels, and volume of oil transported. These particular areas are termed Designated Ports, Primary Area of Response, and Enhanced Response Areas (WCMRC 2012):

- **Designated Port** - The Port of Vancouver within PMV's jurisdiction is defined as a designated port due to the volume of oil handled, marine traffic volume, and marine traffic convergence. The Westridge Marine Terminal is within this area. Through this designation, WCMRC is required to maintain a dedicated package of response equipment that is capable of responding to a 150 tonne spill within 6 hours. Trans Mountain has jurisdiction over the Westridge Marine Terminal and would be responsible for undertaking response using Trans Mountain's own and WCMRC resources.

- **Primary Area of Response** - As the majority of large spills (> 1,000 tonnes) occur outside port boundaries where shipping lanes converge a Primary Area of Response is designated as an area associated with the Port of Vancouver, a Designated Port. The Primary Area of Response for the Port of Vancouver extends from the Port boundary to a distance of 50 nautical miles in all directions. WCMRC has specific levels of response within designated times to which it must demonstrate capability.

- **Enhanced Response Area** - Marine areas not covered in the previous designations but that hold a higher risk of oil spills due to traffic convergence and volume of shipping are identified as Enhanced Response Area. The Enhanced Response Area encompasses all Canadian waters between the western boundary consisting of a line running between Carmanah Point on Vancouver Island, to Cape Flattery, Washington State, and the eastern boundary consisting of a line running from Victoria due east to the Canada-US border.

Figure 5.5.1 illustrates these special areas. WCMRC's existing response capacity is summarized in the following paragraphs.

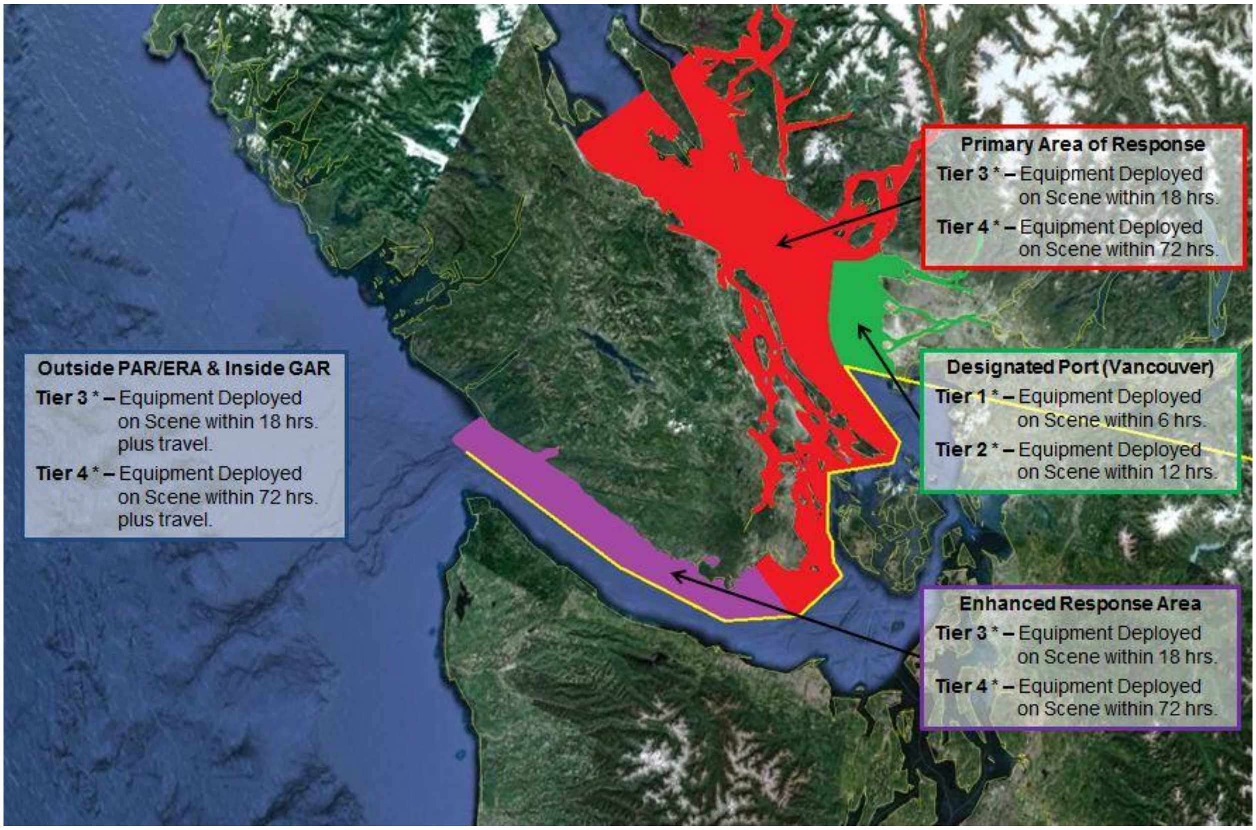



**Figure 5.5.1 Map of WCMRC's Special Areas (WCMRC 2012)**

Although the Primary Area of Response and Enhanced Response Area are defined separately the planning standards are effectively the same for both.

#### *5.5.1.1 Planning Standards for Response times and Capacity*

WCMRC must demonstrate to Transport Canada that it has logistical arrangements in place to meet the following Response Time Planning Standards (Table 5.5.2) within the Geographic Area of Response. The Planning Standards are more rigorous in the areas of special designation.

**TABLE 5.5.2**

**WCMRC RESPONSE TIME PLANNING STANDARDS**

| | 150 tonnes (Tier 1) | 1,000 tonnes (Tier 2) | 2,5000 tonnes (Tier 3) | 10,000 tonnes (Tier 4) |
|---|---|---|---|---|
| **Inside Designated Port boundary** | Deployed on-scene in Designated Port boundary<br><br>6 hours | Deployed on-scene in Designated Port boundary<br><br>12 hours | N/A | N/A |
| **Inside Primary Area of Response/ Enhanced Response Area** | N/A | N/A | Delivered on-scene in Primary Area of Response / Enhanced Response Area boundary<br><br>18 hours | Delivered on-scene in Primary Area of Response / Enhanced Response Area boundary<br><br>72 hours |
| **Outside Primary Area of Response/ Enhanced Response Area** | N/A | N/A | Delivered on-scene outside Primary Area of Response / Enhanced Response Area<br><br>18 hours + travel time | Delivered on-scene outside Primary Area of Response / Enhanced Response Area<br><br>72 hours + travel time |

**Note:** On water recovery operations for spills in sheltered and unsheltered waters are to be completed within 10 operational days from initial deployment of equipment.

**Source:** WCMRC 2012

Currently, WCMRC is certified to Tier 4, which is the highest certification level available to a Canadian spill response organization and has more than the capacity required to respond to an oil spill up to 10,000 tonnes. WCMRC’s current certification is based on a network of personnel and equipment capable of providing response to the spills to meet the Tier 4 requirement and ability to cascade the necessary resources within the federally required time allocated for doing so.

#### *5.5.1.2 Personnel*

With respect to personnel, WCMRC maintains a team of full-time and part-time employees, and has more than 20 contractor and 30 advisory agreements in place at any time (WCMRC 2012). Another key component of WCMRC’s marine response capability is the Fishers Oil Spill Emergency Team (FOSET). More than 100 vessels and crews from along the West Coast are registered with FOSET and WCMRC provides spill response training for this team.

#### *5.5.1.3 Training and Inspections*

Each year WCMRC undertakes a program of training for its personnel, FOSET members, and contractors to ensure they are ready for their spill response tasks (WCMRC 2012).

In addition to formal training, WCMRC conducts a program of equipment deployment and tabletop exercises over the 3-year certification cycle:

- Annually:
  - 150 tonne dedicated equipment deployment within the Port of Vancouver; and
  - 1,000 tonne tabletop exercise based on a scenario.
- Every two years:
  - 2,500 tonne equipment deployment.
- Every three years:
  - 10,000 tonne tabletop based on a scenario.

As well, WCMRC participates in annual joint exercises under the Canada-US Joint Contingency Plan, and cross border mutual aid exercises with partners in Washington and Alaska.

Transport Canada inspects the entire WCMRC equipment inventory over a continuous 3-year cycle (WCMRC 2012).

#### *5.5.1.4 Equipment*

WCMRC exceeds, the equipment requirements for Tier 4 certified response organizations by maintaining (WCMRC 2012):

- A dedicated fleet of specialized oil spill response vessels, with a combined skimming capacity of 280 tonnes/hour (*Canada Shipping Act, 2001* requirement is 27 tonnes/hour).
- More than 30,000 m of containment boom (*Canada Shipping Act, 2001* requirement is 15,000 m).
- The capacity to clean-up 1,500 m of shore line/day (*Canada Shipping Act, 2001* requirement is 500 m of shore line/day).
- Incident Command Post kits containing all the materials and equipment required to establish and operate a complete Incident Command Post. Three of these kits are currently stored in trailers ready to be mobilized in Burnaby, Duncan, and Prince Rupert, BC.
- A communications network that includes fixed and portable repeaters and a mobile communications vehicle for supporting remote operations.
- Equipment caches in Haida Gwaii, Prince Rupert, Kitimat, Shearwater, Port Hardy, Campbell River, Powell River, Sechelt, Port Alberni, Duncan, Nanaimo, Vancouver, and Victoria.

In addition to WCMRC's capability, the CCG operates three large equipment depots in Victoria, Richmond, and Prince Rupert and maintains equipment caches in an additional ten locations along the West Coast. WCMRC maintains mutual aid agreements with US oil spill response organizations in Washington and Alaska.

WCMRC personnel are trained in non-mechanical methods of oil spill clean-up, including the use of oil spill dispersants and in-situ burning of oil; however, because these methods are not pre-approved by Transport Canada they would only be considered on a case-by-case basis through consultation with Federal and local authorities and experts (WCMRC 2012).

#### *5.5.1.5 Mutual Aid Agreements*

WCMRC also has a number of mutual aid agreements in place with both Canadian and US counterparts that provide WCMRC the ability to call on those resources for assistance and equipment in case of a large oil spill. Mutual Aid is a formal agreement among responders to lend assistance across jurisdictional boundaries when required. Mutual Aid Agreements have been formed between WCMRC and three other organizations:

- Southeast Alaska Petroleum Response Organization (SEAPRO);
- Eastern Canada Response Corporation (ECRC); and
- Marine Spill Response Corporation (MSRC).

As a result of these agreements, organizations train and exercise together, ensure equipment is compatible, share communication frequencies and as well as best management practices. In addition, there are Joint Marine Contingency plans that exist between Canada and the US, France and Denmark.

#### *5.5.1.6 WCMRC Participation in Fate and Behaviour Study*

In May 2013 Trans Mountain conducted applied research on the fate and behaviour of diluted bitumen in a marine environment. WCMRC supported the testing of skimming equipment.

Diluted bitumen is expected to form a large proportion of the crude oil shipped from the Westridge Marine Terminal. Participants observed the diluted bitumen is a homogeneous substance and does not separate into bitumen and diluent when spilled on water. During the weathering tests conducted over a 10-day period the diluted bitumen remained floating and no product was observed to sink. While initially low, the viscosity of the diluted bitumen increased sharply over 48 hours and began to exhibit properties typical of heavy “conventional” crude oil. The tests were attended by a wide range of regulators and other agencies who were invited to attend.

WCMRC arranged for oil skimmer manufacturers to conduct tests with their equipment at various times during the oil weathering process. These equipment tests did not highlight any performance shortcomings on the part of the recovery equipment available to WCMRC. Operational adjustments to compensate for increased diluted bitumen viscosity were no different than field adjustments during any actual spill event involving crude oil and intermediate to heavy fuel oil.

The study tested in-situ burning of the spilled diluted bitumen and the use of dispersants and shoreline cleaning agents.

The study concluded that, given the appropriate safety, environmental and operating conditions, dispersants may be effective within the first day of a spill before weathering results in oil that is too viscous to effectively disperse.

With respect to in-situ burning, the study concluded that, given the appropriate safety, environmental and operating conditions, in-situ burning might be effective but likely only for a short time, during the first 12 to 24 hours of a spill, before weathering results in diluted bitumen that is too viscous to effectively ignite and sustain combustion.

With respect to shoreline cleaning agents the study concluded that fresh to very weathered diluted bitumen can be effectively removed from a hard substrate through a combination of a shoreline cleaner and low to moderate water pressure flushing. These techniques may not be suited for all types of shorelines; however, they generally are appropriate for coarse-grained materials (gravel, cobbles, and boulders and including coarse sediment mixes).

### *5.5.2 Proposed Improvements*

Trans Mountain acknowledges that despite the substantial measures that will be in place to reduce the probability of an oil spill from a Project-related tanker (Section 5.3), it is necessary to have resources and plans to minimize the effects of an oil spill, make the best efforts to control the spread of oil, and ensure that clean up is timely and effective.

The results of the fate and behaviour studies indicate that a prompt response can significantly reduce the consequences of a spill. As well, the diluted bitumen tested remained floating over the 10-day test period; therefore, to be effective, planning standards for on-water operations should be based on removing free oil with in 10 days.

WCMRC's current equipment capability exceeds requirements for Tier 4 (10,000 tonnes) certification. In theory, given the calculation for a credible worst-case oil spill from an oil tanker leaving the Westridge Marine Terminal (*i.e.*, 16,500 $m^3$ or 15,500 tonnes; Table 5.2.1), and the actual capacity of equipment currently owned by WCMRC, there is sufficient response equipment available to meet the credible worst-case scenario response requirements under current Canadian standards of response.

Trans Mountian asked WCMRC to develop emergency response measures capable of handling one credible worst case oil spill at any location along the tanker route within the Salish Sea region (*i.e.*, up to the 12 nautical mile limit [Buoy J]). WCMRC, in consultation with Trans Mountain, examined its current equipment locations and capacity, and the mandated response times against the results of the fate and behaviour study (Volume 8C, TR 8C-12), the results of the quantitative risk assessment (Volume 8C, TR 8C-12), known meteorological and oceanographic data, and hypothetical accidental oil spill locations (Figure 5.5.2) and concluded that certain improvements could be undertaken to improve the effectiveness of its current emergency preparedness and response capacity with respect to the increase in Project-related tankers. The results of their assessment are provided a report authored by WCMRC in Volume 8C, S12.

While the credible worst case spill volume based on partially laden Aframax tankers is 16,500 $m^3$ or an approximate 15,500 tonne release of heavy crude, this volume was increased for the WCMRC report to reflect the fact that larger cargos, not related to the Project, transit the WCMRC's Geographic Area of Response. DNV calculated that under the same conditions the credible worst case for a fully laden Aframax (not related to the Project) would equate to approximately 21,000 $m^3$ or a 20,000 tonne release of heavy crude oil. A fully laden Aframax was used as the basis to develop enhanced response capacity because at up to 120,000 DWT, a fully laden Aframax corresponds with the US federal regulation (33 CFR 156.1303) that effectively limits the maximum size of tankers calling in Puget Sound to 125,000 DWT. Laden vessels calling in Puget Sound transit through Canadian waters. While a 20,000 tonne credible worst case oil spill volume is larger than what is required for Project-related tankers it has been chosen to reflect the size of the largest oil cargo expected within WCMRC's area of response.

WCMRC and Trans Mountain also consulted with spill and response organizations including other response organizations in Canada, the US and Norway. The equipment specifications associated with the proposed enhancements (including size, speed and capabilities) have been determined in part from an assessment of response organizations around the world.

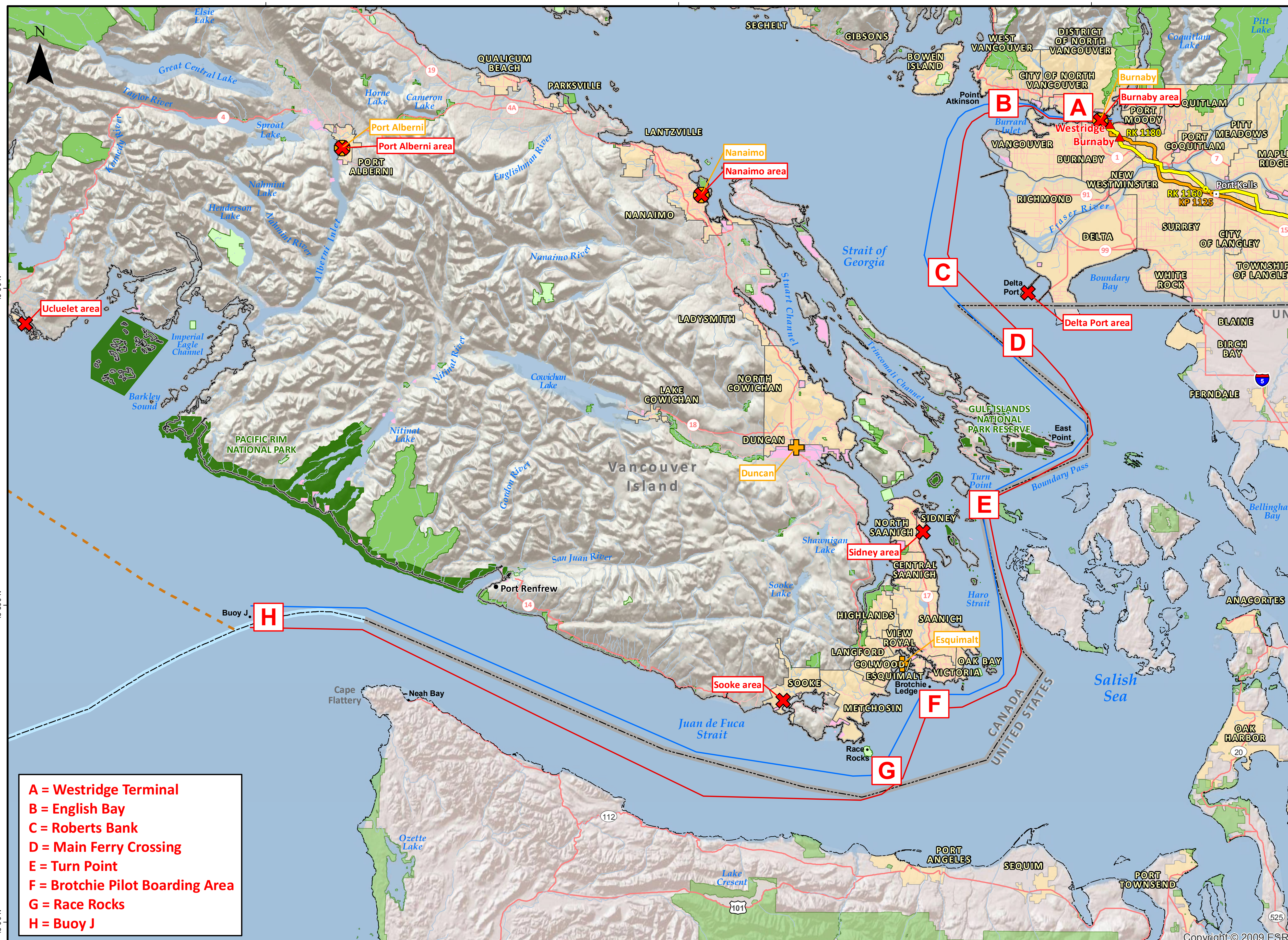
Since there is difference in planning standards for the existing Enhanced Response Area and Primary Area of Response a simplified division WCMRC's Geographic Area of Response has been proposed by WCMRC to combine the Primary Area of Response and Enhanced Response Area into one region that is referred to as the Increased Response Area (IRA). The IRA encompasses the area affected by Project-related marine traffic. Thus there would be three areas of response under the enhanced planning standards: inside the designated port (PMV), the IRA, outside the IRA.

The potential enhancements to current planning standards and WCMRC's current response capacity are summarized in Table 5.5.3, which compares the improvements to WCMRC's existing capacity that was described in detail in Section 5.5.1. It is important to note that the potential improvements to WCMRC's current capacity focus on the area potentially affected by the increase in Project-related tankers, specifically, Westridge Marine Terminal to Buoy J and the shipping lanes in between (see Figure 1.3.1). Of particular note are the more stringent response times.

## TABLE 5.5.3

## PROPOSED IMPROVEMENTS TO WCMRC'S EMERGENCY RESPONSE CAPACITY

| Topic | Existing Requirement or Capacity | Recommendation for Improved Capacity |
|---|---|---|
| **Special Areas Designation** | • Designated Port: Port of Vancouver<br>• Primary Area of Response: 50 NM in any direction from the boundary of the Port of Vancouver<br>• Enhanced Response Area: all Canadian waters between the western boundary consisting of a line running between Carmanah Point on Vancouver Island, to Cape Flattery, Washington State, and the eastern boundary consisting of a line running from Victoria due east to the Canada-US border. | • Designated Port would remain the same.<br>• Replace the Primary Area of Response and Enhanced Response Area designations with an IRA designation. The IRA would cover the Port of Vancouver and the transit route travelled by Project-related tankers, specifically from Delta Port to Buoy J, reflecting the more stringent response times outlined below. |
| **Response Capacity** | • Response organizations are certified based on their capacity to respond to oil spills of certain volumes:<br>– Tier 1 (150 tonnes);<br>– Tier 2 (1,000 tonnes);<br>– Tier 3 (2,500 tonnes); and<br>– Tier 4 (10,000 tonnes).<br>• WCMRC is currently certified as a Tier 4 response organization capable of responding to a spill of up to 10,000 tonnes or 10,000 $m^3$ | To account for a credible worst case oil spill and addition to the existing Tiers 1 to 4, create a new category of capacity:<br>• Tier 5 (20,000 tonnes or 21,000 $m^3$).<br>• WCMRC would be required to maintain Tier 5 capacity, which unless certified by Transport Canada shall be verified by an independent organization. |
| **Response Times** | • The current response times for WCMRC as a Tier 4 certified response organization were outlined in Section 5.5.1, Table 5.5.1 (WCMRC Response Time Planning Standards). | • Commence deployment of equipment and resources, provided safe to do so according to the tiered structure:<br>– Tiers 1, 2 and 3: for a spill within Port of Vancouver, within 2 hours of notification;<br>– Tiers 1, 2 and 3: for a spill within the IRA, within 6 hours of notification; and<br>– Tiers 4 and 5:<br>▪ commence response within timeframe corresponding to the Designated Port or IRA;<br>▪ cascade equipment and response based on scale of spill and type of product;<br>▪ deliver response equipment suitable for Tier 5 response within 36 hours of notification; and<br>▪ request assistance of mutual aid responders.<br>• Response times include travel time.<br>• On water recovery operations for spills in sheltered and unsheltered waters are to be completed within 10 operational days from initial deployment of equipment. |
| **Shoreline Clean-Up** | • WCMRC is required to have the capacity to treat 500 m of shoreline/day<br>• WCMRC currently has the capacity to treat 1,500 m of shoreline/day | • Increase WCMRC's capacity to treat up to 3,000 m of shoreline/day.<br>• Identify and train a suitable level of responders to meet this capacity. |
| **Response Plan Contents** | Currently, the WCMRC OSRP is required to address the following information (WCMRC 2012):<br>• declaration and submission process;<br>• response organization details;<br>• relationship to other plans and management systems;<br>• geographical area of response;<br>• call-out procedures;<br>• personnel and equipment resources;<br>• oil spill exercise program;<br>• training plan;<br>• health and safety program;<br>• response counter-measures; and<br>• wildlife protection and rehabilitation. | Additions to the WCMRC OSRP should include:<br>• An organizational structure that adhere to requirements of the ICS management system approach<br>• Include a list of response equipment and their location<br>• Response equipment must be of types that are effective for the local environment and appropriate for the product carried on oil tankers.<br>• Identification of ecologically sensitive areas in the IRA.<br>• Identification of economically sensitive areas in the IRA.<br>• Procedures to protect identified locations of shore line that might be affected by oil.<br>• Clean-up methods that include both conventional and unconventional response methods including dispersant use, in-situ burning, oil herders, for example.<br>• The ability for both marine and air transport and surveillance options.<br>• Procedures to treat oiled wildlife.<br>• Procedures to manage oiled waste, identifying cooperation with suppliers, government agencies.<br>• A list of mutual aid programs with other response organizations and marine service providers in Canada and in the US. |
| **Response Exercises** | • Training and exercise program carried out over the three-year certification cycle mandated under *Canada Shipping Act, 2001*<br>• Annually:<br>– 150 tonne dedicated equipment deployment within the Port of Vancouver; and<br>– 1,000 tonne tabletop exercise based on a scenario.<br>• Every 2 years:<br>– 2,500 tonne equipment deployment.<br>• Every 3 years:<br>– 10,000 tonne tabletop exercise based on a scenario.<br>• Also conduct:<br>– Cross border/mutual aid exercises;<br>– Canada-US Joint Contingency Plan exercises; and<br>– Member exercises | • The same training and exercise requirements would apply and would expand to include the new Tier 5 category.<br>• Every 3 years:<br>– 20,000 metric ton tabletop exercise based on a scenario.<br>• Exercises are intended to validate response strategies and demonstrate capabilities of all those involved in a response, including government agencies and mutual aid providers. |
| **Personnel Training** | • Must provide the name of each person who has received basic oil spill response training.<br>• Must provide description of the training provided to personnel and volunteers.<br>• Training program is vetted by Transport Canada. | • Maintain a list of personnel providers.<br>• Maintain a list of persons trained in ICS requirements.<br>• Maintain a list of persons and vessels of opportunity (*e.g.*, FOSET).<br>• Conduct training of pre-identified support staff, training to be refreshed every 5 years. |
| **Equipment** | • WCMRC must ensure all equipment is in a ready state.<br>• WCMRC must ensure a current inventory of equipment. | • Maintain up to date inventory of equipment identified to support Trans Mountain tankers, which must be in ready state, except that up to 10% of equipment of any one type may be de-mobilised for maintenance at any given time. |
| **Audits** | • Transport Canada conducts an annual audit of WCMRC against *Canada Shipping Act, 2001* requirements for a Tier 4 response organization. | • unless certified by Transport Canada shall be verified by an independent organization. |




![TRANS MOUNTAIN]

**FIGURE 5.5.2**

**EXISTING AND PROPOSED SPILL RESPONSE EQUIPMENT STAGING AREAS**

**TRANS MOUNTAIN EXPANSION PROJECT**

- Reference Kilometre Post (RK)
- Kilometre Post (KP)
- Trans Mountain Pipeline (TMPL)
- Trans Mountain Expansion Project Proposed Pipeline Corridor
- Terminal
- Existing Pump Station
- Highway
- Road
- 12 Nautical Mile Limit (Territorial Sea)
- Limit of Exclusive Economic Zone (EEZ)
- International Boundary
- Marine Vessel Outbound Shipping Lane
- Marine Vessel Inbound Shipping Lane
- Existing Staging Area
- Proposed Staging Area
- Potential Hypothetical Accident Site
- Traffic Separation Scheme
- City / Town / District Municipality
- Indian Reserve / Métis Settlement
- National Park
- Provincial / State Park
- Protected Area/Natural Area/ Provincial Recreation Area/Wilderness Provincial Park/Conservancy Area



Projection: 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: BC Forests, Lands and Natural Resource Operations, 2012 & ESRI, 2005; Geopolitical Boundaries: IHS Inc., 2011, BC FLNRO, 2007 & ESRI, 2005, Natural Resources Canada, 2012; First Nation Lands: Government of Canada, 2013 & IHS Inc., 2011; Hydrology: IHS Inc., 2004, United States National Imagery and Mapping Agency, 2000, Natural Resources Canada, 2010; Parks and Protected Areas: Natural Resources Canada, 2013, BC FLNRO, 2008; CHS: provided by KMC, 2013; Marine Shipping Lanes & Spill Response Locations: Moffatt and Nichol, 2013; Hillshade: TERA, derived from Geobase; US Hillshade: ESRI, 2010.

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_MR_00471_REV0 | | SHEET 1 OF 1 |
| DATE: December 2013 | TERA REF.: 7894 | REVISION: 0 |
| SCALE: 1:650,000 | PAGE SIZE: 11x17 | DISCIPLINE: MR |
| DRAWN: TGG | CHECKED: CAS | DESIGN: LM |

0 5 10 15 20 25 km

ALL LOCATIONS APPROXIMATE

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The WCMRC report (Volume 8C, TR 8C-12, S13) describes an enhanced response regime that would be capable of delivering 20,000 tonnes of capacity within 36 hours with dedicated resources staged within the study area. This represents a response capacity that is double and a delivery time that is half the existing planning standards. These enhancements would reduce times for initiating a response to two hours within Vancouver Harbour and six hours for the remainder of the study area and parts of the West Coast of Vancouver Island. These reduced times would be achieved by creating new base locations along the tanker route. Meeting the response capacities within the designated times requires redundancy of equipment, and as a result of the redundancy, the overall capacity of dedicated response equipment available in the Salish Sea region would be in excess of 30,000 tonnes equivalent when calculated under the current Federal guidelines for response organizations.

While the probability of the worst case scenario (total loss of containment for an Aframax tanker) is so low that it is not, in DNV's assessment, a credible planning scenario, this event could be addressed by cascading equipment from other areas. In addition to the resources that would be based in the Salish Sea region, WCMRC has, through its existing mutual aid assistance agreements, access to supplementary resources to provide sufficient capacity to respond to a spill larger than the credible worst case defined in this Application.

The effectiveness of the enhanced response was tested under simulated conditions by EBA with input from WCMRC for a credible worst case oil spill event. The results of these simulations are summarized in Section 5.7.

The WCMRC study serves as a practical example of how response capacity could be enhanced to accommodate the Project. Implementation of the plan would be subject to a number of factors and requires knowledge that will be gained through the outcome of the Federal and Provincial reviews of marine spill response, the TERMPOL process, and further consultation with Aboriginal groups and other marine communities.

While recognizing that there are alternative means to achieve similar results, Trans Mountain is supportive of the enhanced capacity and the general means of implementation described by WCMRC.

Table 5.5.3 summarizes and compares WCMRC's existing and proposed future capacity for emergency response and preparedness.

In order to meet these stricter response times and to ensure appropriate equipment (both type and quantity) is available, WCMRC study recommends the addition of five new spill response bases along the tanker route. New and existing bases are identified on Figure 5.5.2. The letter references on this figure correspond with the identifiers discussed in Table 5.2.2 (Volume 8A, Section 5.2.4). The locations are the hypothetical locations DNV identified as a result of their quantitative risk assessment where an accidental oil spill from a laden tanker leaving Westridge Marine Terminal might occur. The distance between the proposed equipment staging areas and the hypothetical oil spill locations is identified in Table 5.5.4.

The capacity of equipment at the existing and new equipment staging areas is described in more detail in Table 5.5.5.

**TABLE 5.5.4**

**DISTANCE FROM PROPOSED EQUIPMENT STAGING AREAS TO HYPOTHETICAL OIL SPILL LOCATION**

| | (NM) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Hypothetical Spill Location | | | | | | | |
| Proposed Equipment Staging Area | A | B | C | D | E | F | G | H |
| Burnaby | 2 | 10 | 25 | 35 | 50 | 75 | 80 | 130 |
| Nanaimo | 40 | 30 | 25 | 35 | 45 | 70 | 75 | 125 |
| Delta Port | 35 | 25 | 8 | 5 | 25 | 50 | 55 | 105 |
| Sidney | 55 | 45 | 30 | 20 | 8 | 25 | 30 | 80 |
| Sooke | 95 | 85 | 70 | 65 | 45 | 20 | 10 | 45 |
| Ucluelet | 180 | 170 | 155 | 150 | 130 | 110 | 100 | 40 |

Table 5.5.5 provides an example of how the total response capacity in the region could be distributed on a risk informed basis, subject to further development of geographic response plans.

**TABLE 5.5.5**

**PROPOSED RESPONSE BASE CAPACITY FOR FUTURE OIL SPILL EQUIPMENT STAGING AREAS**

| Example of Distribution of Proposed Equipment to Staging Areas | Response Capacity* | |
|---|---|---|
| | $m^3$ | Tonnes |
| Burrard Inlet (Burnaby) [1] | 9,550 | 9,000 |
| Delta Port area [1] | 1,350 | 1,250 |
| South Vancouver Island (Nanaimo – Chemainus area) | 2,800 | 2,650 |
| North Saanich Peninsula (Sidney area) [1] | 11,900 | 11,200 |
| South Vancouver Island (Victoria – Sooke area) | 4,700 | 4,400 |
| Southwest coast of Vancouver Island (Port Renfrew – Ucluelet area) | 1,600 | 1,500 |
| Total capacity at bases | 31,900 | 30,000 |
| Community response packages will be allocated (150 tonnes) × ten locations | 1,600 | 1,500 |

Notes: 1 These locations would require full-time staff, based on 24 hours/day, 7 days/week.
* Calculated basis current federal guidelines to Canadian response organizations.

These improvements would result in WCMRC having the capacity to respond quickly to spills in excess of the credible worst case oil spill predicted for a Project-related tanker. This would help minimize the adverse environmental and socio-economic effects potentially resulting from an accidental oil spill in the Salish Sea area.

### *5.5.3 Financial Liability and Compensation Regime in the Event of an Oil Spill*

The framework for financial liability and compensation respecting an oil spill in the marine environment from a vessel was outlined in Section 1.4.1.6. Through a combination of the Responsible Party's insurance, sources of international funding, and the Canadian SOPF, a party may be compensated for costs and damages related to an oil spill from a vessel in

Canadian waters in the following manner:

- The first level of funding for emergency response, clean up and compensation to affected parties is from the Responsible Party's protection and indemnity insurance. A protection and indemnity association of ship owners and operators known as the International Group of P&I Clubs offers insurance coverage to ship owners and charterers against third-party liabilities encountered in their commercial operations (Transport Canada 2013b). The Responsible Party's liability is limited based on vessel tonnage to a maximum of about CAD 136.76 million.
- If the Responsible Party's insurance is not adequate to cover costs and compensation, funds are available through the International Oil Pollution Compensation Fund (CAD 172.50 million) and the Supplementary Fund Protocol (CAD 833.34 million).
- Lastly, if the international funding is exhausted, Canada maintains its own source of funding called the SOPF, which has up to CAD 161.29 million of funding available.

In total, there is approximately CAD 1.3 billion in funding available to address the costs of emergency response, clean up and compensation in the event of an oil spill from a tanker.

The SOPF can also be a fund of first resort for claimants, including the Crown. Any party may file a claim with the SOPF administrator respecting loss or damage related to oil pollution from a vessel in Canadian waters. The SOPF administrator has the duty to investigate and assess claims filed with the SOPF. While a potential claim is paid out of the SOPF, the administrator is obliged to take all reasonable measures to recover the amount of compensation paid to the claimant from the Responsible Party.

## 5.6 Environmental and Socio-Economic Effects of an Oil Spill from a Tanker

This section discusses potential environmental and socio-economic effects of credible worst case and smaller oil spills as specified in the Filing Requirements Related to the Potential Environmental and Socio-Economic Effects of Increased Marine Shipping Activities, received by Trans Mountain on September 10, 2013. Although the historical casualty data and the Project-specific risk assessment summarized in Section 5.2 demonstrate that the probability of a Project-related tanker spills is low, Aboriginal groups and the public-at-large consulted about this Project were concerned about catastrophic spills - those that are least likely but of highest consequence. In addition to fulfilling regulatory requirements, the assessment of potential environmental and socio-economic provides information to regulatory authorities and emergency responders that can be used to identify mitigation opportunities and improvements to current spill response planning and preparedness.

The spill effects methodology and discussion provided here and in Volume 7A for the pipeline and facilities differs from that adopted for routine pipeline, facility and tanker activities because spills represent low-probability, unpredictable events (Section 5.2). Rather than estimating potential residual effects and significance for each element and indicator discussed for routine activities (Section 4.0), spill evaluations identify the potential consequences of credible worst-case spills using a structured risk assessment approach patterned on a process developed to support the Aleutian Islands Risk Assessment (AIRA 2013):

- This section (Section 5.6) provides a qualitative assessment of potential environmental and socio-economic consequences based on evidence from past oil spills and scientific studies as well as stochastic oil spill fate modelling conducted for the Project (Section 5.4.4). This considers a range of spill volumes (credible worst case and smaller) and locations along the shipping route a Project-related tanker would travel. While it focuses on documented effects, it does not explicitly factor in the way that emergency response approaches described in Section 5.4.4 could reduce these potential effects. Although the Aleutians Island Risk Assessment recommends that an initial qualitative evaluation such as this focus solely on the extent and concentrations of oil as a surrogate for effects on natural resources, the discussion provided in Section 5.6 incorporates information on actual effects observed to be more thorough. A more focused and detailed ERA and HHRA to verify conclusions provided here and inform specific mitigation and emergency response plans will be completed for the Arachne Reef Turn Point SOA scenario and submitted to the NEB in early 2014.

- More detailed assessments of credible worst case and smaller spill scenarios at the Westridge Marine Terminal are provided in Volume 7A, Section 8.0. The potential ecological and human health effects of this representative scenario assume that CLWB (the representative crude oil described in Section 5.4.4) is released during tanker loading. The general fate of oil under both mitigated and unmitigated conditions is described for this scenario. A qualitative ERA then assesses potential effects for a variety of marine ecological receptors making the conservative – and unrealistic – assumption that the mitigation previously described for hypothetical worst-case event would not be implemented. Finally, a qualitative HHRA assesses the potential for people's health to be affected by a spill, including sub-populations known to show heightened sensitivity to chemical exposures, such as young children, the elderly and people with compromised health.

### *5.6.1 Socio-Economic Effects*

Marine oil spills can affect the human environment in various ways. Spills can have community and regional economic effects, can contribute to changes in human health, and can affect the sense of individual and community well-being. Potential socio-economic effects of credible worst case and smaller spills will vary depending on the exact location and nature of the incident, and will be influenced by factors including:

- distance from human settlements;
- size and population density of nearby human settlements (*e.g.*, rural versus urban areas);
- particular patterns of resource use in the vicinity (*e.g.*, commercial, recreational, traditional); and

- key economic activities and sectors in areas that may be reached by the spill, in particular the presence of resource-based economic activities (*e.g.*, tourism, commercial fisheries, traditional uses by Aboriginal people).

This section provides a summary of how credible worst-case and smaller spills from a Project-related tanker could affect the health, economy and general well-being of people in the Salish Sea.

The discussion provided in Section 5.5 describes the spill response measures that would be undertaken by the ship owner, WCMRC, CCG and Transport Canada to respond quickly to an accidental oil spill thus minimizing the adverse environmental and socio-economic effects potentially resulting from an accidental oil spill in the Salish Sea region. Where applicable, the information provided here reflects issues identified by Aboriginal peoples, residents, land users, service providers and regulatory authorities. The complexity of predicting socio-economic effects, particularly for hypothetical scenarios, is a function of numerous factors including:

- the constant change that is occurring in socio-economic conditions of any community or region, influenced by an array of economic, political and cultural factors;
- a lack of precise information about goods, services, and employment demands for hypothetical spill scenarios;
- the role of human interpretation and its influence on individuals' physical and perceptual experiences of social effects; and
- inherent uncertainty regarding individuals' abilities, willingness and confidence to respond to change (Loxton *et al.* 2013).

Given the complexity of predicting socio-economic outcomes, this discussion of the potential socio-economic effects of marine oil spills references past spills and other relevant incidents as examples of actual documented effects rather than evaluating one or more specific scenarios. The Exxon Valdez Oil Spill (EVOS) is the largest and best studied example of the effects of a large oil spill on many aspects of the coldwater marine environment, and of communities and residents who live near, or depend on marine resources. The Exxon Valdez Oil Spill Trustee Council (EVOSTC) publishes periodic updates on the status of resources affected by the EVOS; the most recent assessment was published in 2010 (EVOSTC 2010). Many of the socio-economic studies following the EVOS are relevant to the shipping route a Project-related tanker would travel, although differences in regional human population, resource use patterns, and other economic, political and cultural factors are acknowledged.

A growing body of literature shows that both positive and adverse effects can occur, influenced by the spill volume, location, nature of the resources affected, the extent of traditional and non-traditional activities in the affected area, and the duration of clean-up and recovery. The assessment of potential socio-economic effects provided below can be used to:

- understand the types of effects that might result from credible worst case and smaller spills;
- highlight particularly vulnerable groups and resource uses; and
- help inform spill prevention, preparedness and response activities.

#### *5.6.1.1 Economy*

Marine spills can have both positive and negative effects on local and regional economies over the short- and long-term. Spill response and clean-up creates business and employment opportunities for affected communities, regions, and clean-up service providers, particularly in those communities where spill response equipment is, or would be, staged (Section 5.5). This demand for services and personnel can also directly or indirectly affect businesses and resource-dependant livelihoods. The net overall effect depends on the size and extent of a spill, the associated demand for clean-up services and personnel, the capacity of local and regional businesses to meet this demand, the willingness of local businesses and residents to pursue response opportunities, the extent of business and livelihoods adversely affected (directly or indirectly) by the spill, and the duration and extent of spill response and clean-up activities. As an example, positive spill-related economic effects were documented for major spill clean-up areas following the EVOS (McDowell Group 1990). Negative effects on tourism and commercial fishing were also documented, as described below.

##### 5.6.1.1.1 Commercial Fishing

Commercial fishing and aquaculture is an important economic activity in the Salish Sea region and available information on important fishery areas and effort are provided in Fishery Resources Survey (TERMPOL 3.3, Volume 8C, TR 8C-3). A marine spill, particularly a large one that affects one or more important commercial fishing areas, would likely result in loss of commercial fishing income due to regulated or voluntary closures and possibly reduced demand due to concerns about fish quality. For example, following the EVOS, emergency fishing closures were instituted for salmon, herring, crab, shrimp, rockfish and sablefish immediately following the spill. All fisheries were re-opened the next year, but income from commercial fishing decreased substantially (EVOSTC 2010). Changes to commercial fishing income persist, but as with other resources affected by the EVOS (Section 5.6.2.1), other factors have influenced this change and discerning what is spill-related has been difficult (EVOSTC 2010).

##### 5.6.1.1.2 Tourism and Recreation

The shipping route for Project-related tankers passes through or directly adjacent to areas important for boating, recreational fishing, ecotourism, kayaking, coastal camping and scuba diving. During stakeholder meetings, some attendees expressed concern over the potential of a pipeline spill affecting tourism in areas such as the Gulf Islands. A Project-related tanker spill could affect the tourism and recreation industry both by directly disrupting the activities of tourists and recreationalists and by causing economic effects to recreation or tourism-based businesses.

In the event of a spill, recreational fishing, boating and beach use may be restricted or prohibited near the spill site and in clean-up areas. These restrictions would typically apply during the active clean-up period, but voluntary and regulated changes in recreational use patterns could extend until affected areas and resources are stable or recovered. In addition, resident and non-resident visits to spill-affected areas may decrease due to lack of available business services such as accommodations and charter boats (McDowell Group 1990; EVOSTC 2010).

Effects on recreation or tourism-based businesses appear to be greatest during the clean-up period, both due to decreased demand by visitors, and labour shortages associated with service industry workers seeking higher paying spill clean-up jobs (McDowell Group 1990). Although money and jobs generated in this industry have grown since the EVOS, and future tourism projections are promising, EVOSTC (2010) does not currently consider recreation and tourism to be fully recovered because some ecological resources are not rated as recovered (see discussion of ecological resources in Section 5.6.2.1).

#### 5.6.1.1.3 Property Damage

Marine spills could potentially damage marinas, boats, and business/commercial establishments and infrastructure, resulting in costs for individuals and lost income for affected neighbourhood businesses. Municipalities may also incur infrastructure repair and replacement costs. In such cases, and other instances of economic loss, the vessel responsible for the spill would be responsible for compensating those who suffered damage.

### *5.6.1.2 Human Health*

In order to experience physical effects from hydrocarbon exposure, a person must inhale, ingest or touch the spilled product, and be exposed for a long enough period for it to be harmful. This can happen through a number of pathways, including:

- inhaling vapours released from spilled oil;
- direct contact with contaminated soil, or ingesting food that grows in contaminated soil;
- drinking from a source contaminated by a spill; and
- eating plants, fish or animals contaminated by a spill.

When discussing human health effects, the potential effects associated with short-term and long-term exposure to hydrocarbons are referred to as acute and chronic effects, respectively. In the event of a marine spill, the tanker owner, CCG, WCMRC, and Transport Canada will initiate spill response and notify municipal, provincial and federal authorities responsible for the protection of public health. Evacuation of affected areas will occur if health and safety of the public is threatened and this will limit opportunities for short-term exposure to hydrocarbon vapours and potential for acute effects. Involvement of local, provincial and federal public health officials will also ensure that controls to limit long-term exposure and chronic effects potential will be implemented if warranted. Examples of such controls include closure of recreational or commercial fisheries, beach closures, the issuance of drinking water or food consumption advisories, and forced evacuation. This will limit long-term exposure from all pathways, including: inhalation; ingesting contaminated food, fish, plants, or animals; drinking from a contaminated source; or incidental skin contact with oil.

Over the short-term, the primary risk factor for human health is lighter end, volatile and semi-volatile hydrocarbons ($C_1$ to $C_{12}$) that are present in the air as vapours at or near the source, and then disperse in a downwind direction. COPC include BTEX as well as simple polycyclic aromatic hydrocarbons (PAHs). Trace amounts of sulphur-containing chemicals and longer-chain, semi-volatile hydrocarbons ($C_{13}$ to $C_{21}$) also could be present. Based on the known health effects of these COPC, potential effects would likely be dominated by irritation of the eyes and/or breathing passages, possibly accompanied by nausea, headache, light headedness and/or dizziness. These effects could range from barely noticeable to quite noticeable, depending on the exposure circumstances and the sensitivity of the individuals exposed (see below). Odours might be apparent, dominated by a hydrocarbon-like smell, with some prospect for other distinct odours due to the presence of sulphur-containing chemicals in the vapour mix.

The odours themselves could contribute to discomfort, irritability and anxiety. The exact nature and severity of any health effects will depend on several factors, including:

- The circumstances surrounding the spill, including the time of year and meteorological conditions at the time. These circumstances will affect the extent to which chemical vapours are released from the surface of the spilled oil and the manner in which these vapours will disperse.
- A person's whereabouts in relation to the spill, including their distance from the source and their orientation to the spill with respect to wind direction. Exposures would be highest immediately downwind of the source, declining with increasing distance and the potential for health effects to occur as well as the severity of any effects will follow the same pattern. The potential for health effects at cross-wind or upwind locations will be lower or zero.
- The timeliness of emergency response measures. Measures taken to either remove the hazard from the general public (*e.g.*, spill isolation, containment and mitigation) or remove the general public from the hazard (*e.g.*, securing the spill area, evacuation of people from the area) will reduce exposure and probability of any associated health effects. The sooner these measures can be implemented, the lower the likelihood of any effects.
- A person's sensitivity to chemical exposures. It is widely accepted that a person's age, health status and other characteristics can affect the manner and extent to which they respond to COPC exposure, with the young, the elderly and people with compromised health often showing heightened sensitivity.

#### *5.6.1.3 Community Well-Being*

There is great diversity in the communities and regions along the shipping route a Project-related tanker would travel. Marine oil spills may adversely affect community well-being by affecting cultural and heritage resources, traditional lands, culture, and practices, and psychological well-being. Stakeholder engagement activities conducted for the Project indicate that in almost every geographic region people are currently concerned about the effects an oil spill would have on human and environmental health. In the event of a spill, it is likely that this concern would evolve into stress and anxiety among some residents.

##### 5.6.1.3.1 Cultural and Heritage Resources

Heritage resources could be affected by a spill in a number of ways. Oil and clean-up activities can directly damage artifacts and sites or disturb their context, which may result in permanent loss of information critical to scientific interpretation. Looting or vandalism of heritage sites was also reported immediately following the EVOS, but subsequent measures to manage the activities of spill response personnel appear to have been effective in preventing additional loss (EVOSTC 2010).

##### 5.6.1.3.2 Aboriginal Culture and Subsistence Use

Aboriginal peoples have historically used or presently use the shipping route to maintain a traditional lifestyle and continue to use marine resources throughout the Salish Sea region for a variety of purposes including fish, shell-fish, mammal and bird harvesting, aquatic plant gathering, and spiritual/cultural pursuits as well as through the use of waters within the region to access subsistence resources, neighbouring communities and coastal settlements.

The EVOS affected subsistence harvest of Aboriginal communities and individuals. Adverse effects resulted from reduced availability of fish and wildlife, concern about possible health effects of eating fish and wildlife, and disruption of traditional lifestyle due to participation in, or disturbance by, clean-up activities. Fears about food safety have diminished over time and harvest levels have increased since the spill, but the increase has been variable, and composition of harvested species has changed. Other factors have influenced this change and discerning what is spill-related is difficult (Palinkas et al 1993, EVOSTC 2010; see also Section 5.6.2.1).

#### 5.6.1.3.3 Local Infrastructure and Services

In the event of a spill, particularly a credible worst-case incident, demands are likely to be placed on local, municipal, regional and independent emergency responders (fire, police, ambulance, disaster agencies), hospitals, clinics, social service and relief organizations, and local, municipal, regional and federal government officials and staff. Actual effects would depend on the size and nature of a spill, the number of people potentially affected and the availability of proper equipment and trained personnel. Mutual aid agreements described in Section 5.5 have been reached to help responders lend assistance across jurisdictional boundaries if required.

#### 5.6.1.3.4 Psychological Effects

Research has shown that in the event of an oil spill, affected communities and individuals may experience a number of psycho-social effects. Culture is an important factor that affects the potential psycho-social effects of a spill. Documented effects include: declines in traditional social relations with family members, friends, neighbours and coworkers; a decline in subsistence production and distribution activities; perceived increases in the amount of and problems associated with drinking, drug abuse, and domestic violence; and a decline in perceived health status and an increase in the number of medical conditions verified by a physician including depression, anxiety and post-traumatic stress disorder. These effects may be short-term or persist for years in individuals or groups most directly affected by a spill (Palinkas *et al.* 1992, 1993; Picou and Gill 1996; Lyons *et al.* 1999, Arata *et al.* 2000, Gill *et al.* 2012). Psychological effects did not extend throughout the entire community; for example, the estimated rate of generalized anxiety disorder was around 20 per cent and post-traumatic stress disorder was about 9.4 per cent (Palinkas *et al.* 1993). Strongest predictors of stress were family health concerns, commercial ties to renewable resources, and concern about economic future, economic loss, and exposure to oil (Gill *et al.* 2012).

Regardless of the actual exposure, the possibility of exposure and the perception that contamination has occurred may be sufficient to cause anxiety or psychological effects in some people (Aguilera *et al.* 2010). Evidence from past incidents indicates that psychological effects would be most likely in the event of a large spill affects an important subsistence or commercial resource. Individuals and groups who would be at greatest risk of adverse effects include:

- those involved in the clean-up efforts;
- those who already have chronic physical or mental illness;

- those whose jobs and livelihoods are directly affected by the spill, including family members; and
- Aboriginal peoples who participate in subsistence hunting and gathering and whose families rely on subsistence foods to support healthy diets.

### *5.6.2 Environmental Effects*

As with socio-economic effects, numerous factors contribute to the complexity of predicting environmental outcomes of hypothetical worst case and smaller spills. However, the ecological risk assessment process provides an established, accepted and transparent method to evaluate potential acute and chronic effects of hypothetical spill scenarios for a suite of ecological receptors. For this reason, an ecological risk assessment process was applied to assess environmental effects, rather than the qualitative approach adopted to evaluate potential socio-economic effects of marine oil spills.

#### *5.6.2.1 Ecological Risk Assessment Methods*

This section summarizes results of the preliminary quantitative ecological risk assessment (ERA) completed to evaluate the effects of hypothetical credible worst case and smaller spills of CLWB along the shipping route a Project-related tanker would travel.

The ERA discusses the range of potential effects to ecological resources by considering the probability of exposure to predicted surface oil slicks, the probability that oil will impinge upon shorelines, and the characteristics and sensitivity of potentially affected aquatic and shoreline habitats within the study area. Potential environmental effects were visualized and quantified using GIS overlays of data layers containing information on biological resources, sensitive habitats and other areas of ecological importance, and the results of seasonal oil spill modelling summarized in Section 5.4.

The ERA followed a standard protocol composed of the following stages:

- problem formulation;
- exposure assessment;
- hazard assessment;
- risk characterization; and
- discussion of certainty and confidence in the predictions.

##### 5.6.2.1.1 Problem Formulation

Problem formulation defines the nature and scope of the work and establishes the boundaries so that the ERA is directed at the key areas and issues of concern. Data were gathered to provide information on the general characteristics of the study area, the oil being considered, the hypothetical scenarios being considered, potential ecological receptors and any other relevant issues.

A summary of information on the study area, ecological receptors and relevant findings from the EVOS, and the hypothetical scenarios considered by the ERA is provided here.

**Spatial Boundaries**

The spatial boundaries for this ERA were based on the oil spill modeling domain (Volume 8C, TR 8C-12, S9 and S10). The following spatial boundaries were considered in the ERA:

- oil spill footprint - the area predicted to be directly affected by oil as a result of a release at various locations along the shipping route; and
- RSA - The area of ecological relevance where environmental effects could potentially result from accidents and malfunctions within the limits of the domain for the stochastic oil spill modelling. The RSA is generally centered on the marine shipping route, which extend from the Westridge Marine Terminal through Burrard Inlet, south through the southern part of the Strait of Georgia, the Gulf Islands and Haro Strait, westward past Victoria and through the Juan de Fuca Strait out to the 12 nautical mile limit of Canada's territorial sea. The western boundary of the RSA extends further out to sea than the western boundary of the Salish Sea and the northern boundary of the RSA is limited to the southern portion of the Strait of Georgia. Puget Sound is excluded from the RSA.

**Ecological Receptors**

This section describes the ecological receptors selected for the marine spill ERA and also summarizes findings relevant to these receptors from monitoring conducted following the EVOS (1989).

**i) The Exxon Valdez Oil Spill (EVOS)**

The EVOS is the largest and best studied example of the effects of a large oil spill on many aspects of the coldwater marine environment. This spill is directly relevant to the Project for the purposes of an ERA as many of the ecological receptors studied following the EVOS also occur along the shipping route a Project-related tanker would travel, or in the Salish Sea more generally. That being said, despite the relevance from an ERA perspective, it is not predicted an EVOS type of oil spill would happen related to the Project. Improvements in tanker construction (*i.e.,* double *vs*. single hull; segregated cargo compartments) and navigational safety measures have resulted in fewer tanker accidents and few accidents resulting in the accidental release of oil (see Section 5.2) since EVOS.

Despite the intensive studies that followed the EVOS, findings on actual effects and recovery remain controversial. The EVOSTC publishes periodic updates on the status of resources affected by the EVOS; the most recent assessment was published in 2010 (EVOSTC 2010). The EVOSTC recognizes that as time passes, the ability to distinguish oil-related effects from other factors affecting fish and wildlife resources diminishes. Some resources currently identified as not having recovered from the spill may have been in decline regionally, and elsewhere, prior to the spill, so that recovery of the resource to its pre-spill status may be an unrealistic expectation.

Two major reviews of the ecological significance and residual effects of the EVOS (Peterson *et al.* 2003, Harwell and Gentile 2006) reached different conclusions. Peterson *et al.* (2003) concluded that unexpected persistence of sub-surface oil and chronic exposures at sublethal levels continue to affect wildlife, and that cascading indirect effects of oil exposure delayed recovery from the oil spill. Harwell and Gentile (2006) concluded that no ecologically significant effects were detectable across a suite of more than 20 ecological receptors including primary producers, filter feeders, fish, and bird primary consumers, fish and bird top predators, a bird scavenger, mammalian primary consumers and top predators, biotic communities, ecosystem level properties of trophodynamics and biogeochemical processes, and landscape level properties of habitat mosaic and wilderness quality.

A key point identified by Peterson *et al.* (2003) is the emerging appreciation of more complex, chronic, or ecosystem-based effects of oil spills than was previously understood under an “old paradigm” that considered primarily acute or short-term effects of spilled oil. The marine spills ERA summarized here integrates this understanding of acute and chronic effects of oil spills on ecological receptors.

#### ii) ERA Ecological Receptors

Potential environmental effects of the tanker marine spill scenarios are evaluated for four main ecological receptor group/habitat combinations:

- shoreline and near shore habitats;
- marine fish community and supporting habitat;
- marine birds and supporting habitat; and
- marine mammals and supporting habitat.

The EVOSTC (2010) lists 32 ‘injured resources’ and ecosystem services and evaluates the recovery status for each. Table 5.6.2.1 groups many of these resources together to represent the ecological resources being evaluated through the ERA .

**TABLE 5.6.2.1**

**RELATIONSHIP BETWEEN ERA ECOLOGICAL RECEPTORS AND ‘INJURED RESOURCES’ ASSESSED BY EVOSTC (2010)**

| Ecological Resource in ERA | Injured Resources Assessed by EVOSTC (2010) | Recovery Status from EVOSTC (2010) |
|---|---|---|
| Shoreline Habitats | Clams<br>Mussels<br>Intertidal Communities | Recovering<br>Recovering<br>Recovering |
| Marine Fish Community | Pacific Herring<br>Pink Salmon<br>Sockeye Salmon<br>Rockfish<br>Subtidal Communities<br>Sediments | Not recovering<br>Recovered<br>Recovered<br>Very likely recovered<br>Very likely recovered<br>Recovering |
| Marine Birds and Marine Bird Habitat | Black Oystercatcher<br>Cormorant<br>Common Loon<br>Harlequin Duck<br>Barrow’s Goldeneye<br>Common Murre<br>Kittlitz’s Murrelet<br>Marbled Murrelet<br>Pigeon Guillemot | Recovering<br>Recovered<br>Recovered<br>Recovering<br>Recovering<br>Recovered<br>Unknown<br>Unknown<br>Not recovering |

**TABLE 5.6.2.1**

**RELATIONSHIP BETWEEN ERA ECOLOGICAL RECEPTORS AND 'INJURED RESOURCES' ASSESSED BY EVOSTC (2010) (continued)**

| Ecological Resource in ERA | Injured Resources Assessed by EVOSTC (2010) | Recovery Status from EVOSTC (2010) |
|---|---|---|
| Marine Mammals | Harbour Seal<br>Killer Whales – AB Pod<br>Killer Whales – AT1 Population<br>River Otter<br>Sea Otter | Recovered<br>Recovering<br>Not recovering<br>Recovered<br>Recovering |

Each of the four ERA ecological receptor groups includes a variety of individual receptors and/or habitats with differing sensitivity to oil exposure. For this reason, each receptor group was divided into sub-categories that reflected their sensitivity to oil exposure. These sub-categories, termed biological sensitivity ranking factors (BSF), ranged from a value of 1 (low sensitivity) to a value of 4 (very high sensitivity). The potential for negative environmental effects of oil exposure at any given location was indicated by the overlap of the probability of oil presence (from the oil spill modeling results), and the sensitivity of the receptor or habitat present at that location. Where a specific receptor had status as an endangered species, the status was considered as an additional factor. Likewise, the presence of provincial and national parks or other designated conservation areas represented an additional factor for consideration (*i.e.,* societal values) in addition to intrinsic biological sensitivities.

The discussion provided here summarizes information on the four ERA ecological receptors, their biological sensitivity, and relevant findings from EVOS monitoring. Further detail on these receptors and their biological sensitivity ranking factors is provided in Ecological Risk Assessment of Marine Transportation Spills Technical Report (Volume 8B, TR 8B-7).

*a. Shoreline Habitats*

The shoreline habitats receptor includes 13 different shoreline and near shore habitat types in the intertidal or littoral zone, including the area of the foreshore and seabed that is exposed at low tide, and submerged at high tide. Substrate types for these habitats range from sand through to rock, with additional classes for marsh, as well as rip rap or wood bulkheads or pilings such as may be used for shoreline protection. In addition, areas of eelgrass are also considered to fall within the shoreline habitat, giving a total of fourteen different shoreline habitat types.

Low-energy or protected shorelines almost always have a fine subsurface substrate (sand or mud), even though the surface veneer may be coarse pebble, cobble or boulder. The presence of a water-saturated fine subsurface layer is an important factor that affects sensitivity to oil exposure because it provides a barrier that limits oil penetration of sub-surface sediment, and hence limits long-term retention of oil. In contrast, coarse (pebble, cobble or boulder) shorelines that are highly exposed may be coarse to considerable depth, increasing permeability and the potential for retention or sequestration of stranded oil.

Tidal marshes are often associated with river mouths and estuaries, behind barrier islands, or on tidal flats where low-energy wave action and fine-grained sediment accumulation provides an elevated surface where marsh vegetation can become established. Eelgrass beds are also typically found in soft sediments of protected bays, inlets and lagoons.

The ERA biological sensitivity ranking for each shoreline type was generally correlated with the tendency for shoreline types to absorb or retain spilled oil, they also represent habitat complexity and the ability of the different habitat types to sustain biodiversity and productivity. Exposed bedrock or sand substrates were considered to be subject to high levels of natural disturbance, and to have relatively low levels of biodiversity and productivity, and were assigned a low sensitivity ranking (BSF 1), whereas sheltered rocky substrates capable of supporting a rich and diverse intertidal community, marshes, and eelgrass beds were assigned high (BSF 3) or very high (BSF 4) biological sensitivity rankings.

The recovery status categories used by the EVOSTC to describe the status of injured resources are obviously critical to their assessment. The status of "recovering" (Table 5.6.2.1) means that the resources are demonstrating substantive progress toward recovery objectives, but are still being adversely affected by residual impacts of the spill or are currently being exposed to lingering oil. The recovery status of the Shoreline Habitats receptor group is impeded by effects on the seaweed and intertidal community exacerbated by isolated pockets of oil that became sequestered in beach substrates as well as oil spill response activities. With the advantage of hindsight, certain oil spill response activities (*e.g.,* hot water washing, pressure washing, and physical removal of oiled substrates) have been concluded to be more damaging than beneficial. For clams, both oil exposure and oil spill response activities affected the community, but baseline information on most clam species is lacking. The EVOSTC concede that clam populations found on oiled but untreated beaches have likely recovered from the effects of the spill. However, it appears that disturbance of the rock armoring on beaches impedes subsequent recovery, and this is an important finding that has been incorporated into oil spill response techniques. For mussels, bioaccumulation of PAHs continues to be a primary concern. In most instances, concentrations of oil in mussels from the most heavily oiled beds were indistinguishable from background by 1999. However, small areas of lingering or sequestered oil continue to hold back an assessment of "recovered".

Harwell and Gentile (2006) address the question of residual sources of oil exposure. In their view, the important question is not whether sources of hydrocarbon from the EVOS still exist, as they clearly do; but rather whether they pose a substantial risk to populations and communities comprising the Prince William Sound ecosystem. The beach surface area contaminated by subsurface oil in 2001 was estimated to be 6.7 ha, and the quantity of oil involved was estimated to represent about 6.5 $m^3$ of total residual oil from the EVOS. This compares to estimates that approximately 782 km of shoreline in Prince William Sound, and about 1,315 km of shoreline in the Gulf of Alaska were oiled to some degree. This comparatively small area of residual oiling in shoreline habitats is the rationale for EVOSTC "recovering" conclusion, but masks the fact that the vast majority of shoreline habitat had recovered within 10 years of the oil spill, notwithstanding inappropriate methods used during the oil spill response activities.

A key finding of the EVOS was that the negative effects of high-pressure hot water washing were substantial. Oiled but untreated shoreline sites recovered more quickly than oiled sites where aggressive cleaning techniques were applied. Whether cleaned or not, intertidal communities had recovered within 5 years after the EVOS (Harwell and Gentile 2006); recovery of oiled shoreline habitat within 2 to 5 years following a large oil spill is a reasonable expectation with the implementation of appropriate oil spill response activities.

#### *b. Marine Fish Community*

The ERA marine fish community receptor includes marine fish and marine invertebrates (*e.g.,* mollusks and crustaceans), but not marine mammals or birds. Acute effects of spilled oil on fish and marine invertebrates are rarely observed, except in situations where oil is confined and dispersed into shallow water. Hydrocarbon effects on fish are generally caused by exposure to relatively soluble components of the oil. BTEX compounds or light polycyclic aromatic hydrocarbons (PAHs) such as naphthalenes are usually considered to be the most likely contributors to acute toxicity, although some light aliphatic hydrocarbons may also contribute to toxicity. These compounds also tend to be volatile and are rapidly lost to the atmosphere, so the initial 24 to 48 hours following an oil spill is the period when acute toxicity is most likely to occur.

Two major mechanisms of toxicity to marine fish are recognized (although other more specific mechanisms may also exist). These are:

- Non-polar narcosis, whereby reversible exposure to and accumulation of hydrocarbons from the water column causes interference with intracellular functioning at a target lipid site, potentially causing death if a critical hydrocarbon concentration is exceeded in the target lipid. Salmonid fish are sensitive to the narcosis pathway, and small fish are more sensitive than large fish.
- Blue sac disease (BSD), whereby exposure to 3- and 4-ring PAH compounds results in a syndrome of cardiac, craniofacial, and/or spinal deformity and death in developing embryos. Sensitivity to BSD is greatest in newly fertilized eggs, and decreases with the hardening of the egg membrane, and with increasing developmental stage. Embryos of herring and salmon species are among those more sensitive to BSD.

Due to the behaviour of oil spilled on water, the potential for toxicity to the marine fish community is greatest near the surface where more soluble hydrocarbons can dissolve from the floating fresh oil, or form droplets that can be temporarily dispersed down in to the water column by wave action. However, extensive formation and dispersion of oil droplets into the water column is unlikely to occur in sheltered waters. The potential for acutely toxic concentrations of hydrocarbons to extend down into deep water is very low, due to the limited solubility of hydrocarbons, and the dilution that would accompany mixing into deep water.

For the non-polar narcosis mode of toxic action (see Ecological Risk Assessment of Marine Transportation Spills Technical Report [Volume 8B, TR 8B-7]), toxicity of a sensitive species, is defined as representing the 5$^{th}$ percentile on a species sensitivity distribution (Di Toro *et al.* 2000). Assuming that this synthetic sensitive species is the same regardless of the specific habitat under consideration, for the ERA, the sensitivity of the marine fish community is related to the degree of exposure of the particular habitat to dissolved hydrocarbons. Therefore, deep water habitat is assigned a low sensitivity rank (BSF 1) and shallow water habitat a high sensitivity rank (BSF 3). The very high biological sensitivity rank (BSF 4) is assigned to developing eggs and embryos in shallow water habitat (represented here by herring spawning areas).

The ERA Marine Fish Community ecological receptor group is represented in the EVOSTC (2010) assessment by a variety of fish species, as well as sediments and subtidal communities. Most of these are concluded to be “recovered” or “very likely recovered” (Table 5.6.2.1); the latter designation reflecting limited scientific research in recent years, but a low probability that there are any residual effects of the spill (EVOSTC 2010). Sediments (including both intertidal and subtidal areas) are listed as “recovering”, primarily because lingering or sequestered oil is present on some armored oiled beaches. No oil was found in sub-tidal sediments at previously oiled sites when re-sampled in 2001. Harwell and Gentile (2006) note that while just over one third of nearshore sediment samples collected after two years at heavily oiled sites had detectable residual traces of EVOS oil, results suggest that the vast majority of the approximately 4,500 $km^2$ seafloor of Prince William Sound had no detectable traces of oil from the EVOS within two years of the spill.

The most controversial EVOSTC recovery assessment for the Marine Fish Community receptor is for Pacific herring. Prior to the spill, the herring population (or harvest) was increasing as documented by record harvests in the late 1980s. The EVOS occurred at a time when herring were spawning, and there is no doubt that herring spawn was exposed to spilled oil and dissolved PAH at sufficient concentration to cause local effects (such as developmental deformities). Notwithstanding this exposure, the herring population continued to increase until four years after the spill when there was a crash in the adult herring population. Although many studies published in the 1990s and 2000s suggested that the herring population crash resulted from the EVOS, the cause of the decline and poor recovery of the Prince William Sound herring population has been described as perplexing by scientists working on behalf of the EVOSTC (Rice and Carls 2007). Pearson *et al.* (2011) argue that the underlying cause of the population collapse was poor nutrition, and perhaps disease associated with the very large herring population size, and generally low abundance of zooplankton. Harwell and Gentile (2006) conclude that the population loss resulting from direct mortality attributable to the EVOS is not clear. On balance, the population collapse four years after the spill was likely caused by factors other than the EVOS, suggesting that there are no remaining ecologically significant effects on Pacific herring that can be attributed to the spill.

Effects of the EVOS were generally localized and short-term on marine fish populations as a whole (EVOSTC 2010). Intertidal fishes showed declines in density and biomass at oiled sites relative to reference sites in 1990, but this could reflect changes in habitat quality as well as oil exposure. Rockfish utilize the nearshore environment as young-of-the-year and juveniles, and may have been affected in this manner, but studies have not identified any conclusive link between exposure to Exxon Valdez oil and endpoints such as larval growth of fish in 1989, or lesions associated with oil exposure. Pink salmon spawning in intertidal areas near Prince William Sound were potentially exposed to hydrocarbons in water, and in some cases to hydrocarbons in spawning substrates. Although potential for developmental effects on pink salmon embryos, including mortality was demonstrated at some locations, no convincing change in pink salmon population size was documented. Sockeye salmon appear to have been affected by the fishery closure, as more spawners than normal appear to have entered freshwater habitat in 1989, resulting in overgrazing of planktonic food webs in nursery lakes. This led to lower than optimal growth rates in juvenile sockeye that were never exposed to oil, which in turn appears to have led to a subsequent decrease in returns of adult spawners some years later.

Effects of the EVOS on marine fish and fish habitat were generally limited to areas where oil was driven into near-shore areas, and these effects were for the most part short-term (days to weeks, rather than years). Evidence has been presented for longer-term effects on some habitats, such as intertidal pink salmon spawning areas where sequestered oil may have leached into spawning gravels up to several years after the spill. However, these areas were very limited and did not result in effects at the population level for pink salmon. Evidence for the marine fish community receptor suggests that the EVOS did not have substantial effects on marine fish populations initially, or recovery occurred within one or two years at most.

#### c. *Marine Birds*

Seabirds can be highly sensitive to oil spills, due principally to the effects of oiling on feathers (*i.e.,* loss of insulative properties and buoyancy), as well as to ingestion of oil or contaminated food. In addition, birds that are gregarious are potentially at greater risk of population-level effects if oil is present in an area where they congregate or feed. The waters of the Strait of Georgia, Haro Strait, Juan de Fuca Strait and the Gulf Islands provide migratory, nesting, feeding and wintering habitat for a wide variety of shorebirds, gulls, waterfowl and alcids (auks).

Four biological sensitivity ranking classes are defined for the ERA marine bird receptor, on a scale of 1 (low sensitivity) to 4 (high sensitivity). The ranking scheme reflects guild membership, as is appropriate considering the similar lifestyle, behaviour, and exposure mechanisms that accompany each guild. A low sensitivity rank (BSF 1) is assigned to shoreline dwelling species and waders that are generally widely distributed. Medium sensitivity (BSF 2) is assigned to species with a life history that is not exclusively marine, such as gulls and terns. Ducks and other waterfowl that tend to be moderately sensitivity to oil exposure and may congregate are assigned a high sensitivity (BSF 3). Finally, a very high sensitivity (BSF 4) is assigned to species that tend to rely heavily on the marine environment or have high sensitivity to oil exposure, such as auks and divers. These birds tend to nest in colonies and also often congregate in feeding areas.

Additional consideration is also given to known breeding colony locations and Important Bird Areas (IBAs) located within the RSA. A description of each of these IBAs, including recorded species and corresponding seasonality (as available), is presented in Table 5.6.2.2. The location of known bird colonies is shown in Ecological Risk Assessment of Marine Transportation Spills Technical Report (Volume 8B, TR 8B-7).

**TABLE 5.6.2.2**

**SUMMARY OF IMPORTANT BIRD AREAS (IBAS) WITHIN THE RSA FOR MARINE TRANSPORTATION**

| Identification Number | Site Name | Description | Bird Species | Seasonality |
|---|---|---|---|---|
| **Canada** | | | | |
| BC001 | McFadden Creek Heronry | The McFadden Creek Heronry is a relatively small (0.5 km²), fully forested IBA, located on the north side of Saltspring Island, British Columbia. | Great Blue Heron (BC Coast) | Breeding |
| BC015 | Active Pass | The Active Pass IBA comprises the water body (approximately 17 km²) between Galiano and Mayne Islands in the southwest region of the Strait of Georgia. | Bald Eagle | Breeding<br>Spring Migration<br>Summer Non-Breeding<br>Wintering |
| | | | Bonaparte's Gull | Fall Migration<br>Spring Migration |
| | | | Brandt's Cormorant | Wintering |
| | | | Pacific Loon | Spring Migration<br>Wintering |
| BC017 | Boundary Bay – Roberts Bank – Sturgeon Bank (Fraser River Estuary) | This IBA represents the Fraser River Delta including Boundary Bay, Roberts Bank and Sturgeon Bank as well as agricultural lands in and around Richmond, Surrey and White Rock. It is a large (approximately 750 km²) complex IBA encompassing several types of habitats, including marine, estuarine, freshwater and agricultural habitats. | American Wigeon | Fall Migration<br>Wintering |
| | | | Barn Owl (BC) | Breeding<br>Wintering |
| | | | Black-bellied Plover | Fall Migration<br>Summer Non-Breeding<br>Wintering |
| | | | Brant | Spring Migration<br>Wintering |
| | | | Dunlin | Fall Migration<br>Spring Migration<br>Wintering |
| | | | Glaucous-winged Gull | Wintering |
| | | | Great Blue Heron (BC Coast) | Spring Migration<br>Summer Non-Breeding<br>Wintering |
| | | | Mallard | Fall Migration<br>Wintering |
| | | | Mew Gull | Fall Migration<br>Spring Migration<br>Wintering |
| | | | Northern Pintail | Fall Migration<br>Wintering |
| | | | Peregrine Falcon (BC) | Fall Migration<br>Spring Migration<br>Wintering |
| | | | Red-necked Grebe | Fall Migration<br>Spring Migration<br>Wintering |

## TABLE 5.6.2.2

## SUMMARY OF IMPORTANT BIRD AREAS (IBAS) WITHIN THE RSA FOR MARINE TRANSPORTATION (continued)

| Identification Number | Site Name | Description | Bird Species | Seasonality |
|---|---|---|---|---|
| **Canada** | | | | |
| BC017 | Boundary Bay – Roberts Bank – Sturgeon Bank (Fraser River Estuary) | This IBA represents the Fraser River Delta including Boundary Bay, Roberts Bank and Sturgeon Bank as well as agricultural lands in and around Richmond, Surrey and White Rock. It is a large (approximately 750 km²) complex IBA encompassing several types of habitats, including marine, estuarine, freshwater and agricultural habitats. | Snow Goose | Fall Migration<br>Wintering |
| | | | Surf Scoter | Fall Migration<br>Spring Migration<br>Wintering |
| | | | Thayer’s Gull | Fall Migration<br>Wintering |
| | | | Trumpeter Swan | Wintering |
| | | | Western Grebe | Fall Migration<br>Spring Migration<br>Wintering |
| | | | Western Sandpiper | Spring Migration |
| BC018 | Pacific Spirit Regional Park | The Pacific Spirit Regional Park IBA is a relatively small IBA (less than 2 km²) located on Point Grey, British Columbia. This IBA is bordered to the east by residential areas and to the west by the University of British Columbia Farm. | Great Blue Heron (BC Coast) | Breeding |
| BC020 | English Bay & Burrard Inlet | This large IBA (140 km²) comprises English Bay, False Creek and Burrard Inlet including Vancouver Harbor, Indian Arm and Port Moody Arm. It incorporates numerous types of habitats with industrial encroachment in and around Vancouver to less impacted areas in Indian Arm. | Barrow’s Goldeneye | Fall<br>Wintering |
| | | | Great Blue Heron (BC Coast) | Summer Non-Breeding |
| | | | Surf Scoter | Fall Migration<br>Wintering |
| | | | Waterfowl | Wintering |
| | | | Western Grebe | Fall<br>Wintering |
| BC023 | Squamish River Area | The Squamish River Area IBA is located at the northeastern tip of Howe Sound in proximity to Squamish, British Columbia. It comprises the Squamish, Mamquam and Cheakamus rivers and their respective shorelines (approximately 50 km²). | American Dipper | Year-Round Resident |
| | | | Bald Eagle | Wintering |
| | | | Trumpeter Swan | Wintering |
| BC025 | White Islets and Wilson Creek | This IBA comprises the water body south of Wilson Creek and surrounding the White Islets (approximately 30 km²) located west of Howe Sound in proximity of Sechelt, British Columbia. | Glaucous-winged Gull | Breeding |
| | | | Harlequin Duck | Other |
| | | | Marbled Murrelet | Wintering |
| | | | Pelagic Cormorant | Breeding |
| | | | Surf Scoter | Other |
| | | | Surfbird | Spring Migration |

## TABLE 5.6.2.2

## SUMMARY OF IMPORTANT BIRD AREAS (IBAS) WITHIN THE RSA FOR MARINE TRANSPORTATION (continued)

| Identification Number | Site Name | Description | Bird Species | Seasonality |
|---|---|---|---|---|
| **Canada** | | | | |
| BC045 | Chain Islets & Great Chain Islet | This IBA is a relatively small IBA (less than 2 km²) surrounding Great Chain Islet and several smaller islets located in waters southeast of Victoria, British Columbia. | Black Oystercatcher | Breeding |
| | | | Brandt's Cormorant | Fall Migration |
| | | | Double-crested Cormorant | Breeding |
| | | | Glaucous-winged Gull | Breeding |
| | | | Harlequin Duck | Other |
| | | | Pelagic Cormorant | Breeding |
| | | | Pigeon Guillemot | Breeding |
| BC047 | Sidney Channel | The Sidney Channel IBA, located in proximity to Sidney, British Columbia, comprises the water body (approximately 90 km²) between Vancouver Island, James Island and Sidney Island. It is located generally east of Haro Strait. | Black Oystercatcher | Breeding |
| | | | Brandt's Cormorant | Fall Migration |
| | | | Brant | Spring Migration Wintering |
| | | | Glaucous-winged Gull | Breeding |
| | | | Great Blue Heron (BC Coast) | Breeding Year-Round Resident |
| | | | Harlequin Duck | Fall Migration |
| | | | Marbled Murrelet | Summer Non-Breeding |
| | | | Mew Gull | Spring Migration |
| | | | Pigeon Guillemot | Wintering |
| | | | Rhinoceros Auklet | Breeding |
| BC048 | Cowichan estuary | The Cowichan estuary IBA includes Cowichan Bay and generally represents the water body (approximately 40 km²) located northwest of Saanich Inlet. Both Cowichan Bay and Saanich Inlet connect to Haro Strait through Satellite Channel. | Colonial Waterbirds/Seabirds | Wintering |
| | | | Double-crested Cormorant | Wintering |
| | | | Mew Gull | Wintering |
| | | | Mute Swan | Wintering |
| | | | Pacific Loon | Spring Migration |
| | | | Red-necked Grebe | Fall Migration |
| | | | Thayer's Gull | Wintering |
| | | | Trumpeter Swan | Wintering |
| | | | Waterfowl | Wintering |
| | | | Western Grebe | Wintering |
| BC052 | Porlier Pass | The Porlier Pass IBA (approximately 16 km²) comprises the water body between Valdes and Galiano Islands as well as some of the shorelines of both islands. | Black Oystercatcher | Breeding |
| | | | Cormorant species | Wintering |
| | | | Glaucous-winged Gull | Breeding |
| | | | Mew Gull | Fall Migration |
| | | | Scoters | Wintering |
| BC055 | Snake Island | This IBA is relatively small (4 km²) and surrounds Snake Island which is located within the approach to Nanaimo, British Columbia and approximately 3 km from the northwest point of Gabriola Island. | Black Oystercatcher | Breeding |
| | | | Glaucous-winged Gull | Breeding |
| | | | Pelagic Cormorant | Breeding |
| | | | Pigeon Guillemot | Breeding |

## TABLE 5.6.2.2

## SUMMARY OF IMPORTANT BIRD AREAS (IBAS) WITHIN THE RSA FOR MARINE TRANSPORTATION (continued)

| Identification Number | Site Name | Description | Bird Species | Seasonality |
|---|---|---|---|---|
| **Canada** | | | | |
| BC073 | Carmanah Walbran Forest | This large forested IBA (approximately 250 km²) is generally located inland on the west coast of Vancouver Island and includes Carmanah Walbran Provincial Park. | Marbled Murrelet | Breeding |
| BC097 | Amphitrite and Swiftsure Banks | This relatively large IBA comprises two separate water bodies located west of Vancouver Island: one in and around Amphitrite Bank, and the other around Swiftsure Bank. Only the Swiftsure Bank portion of this IBA (approximately 20 km²) is within the boundaries of the RSA. | Black-legged Kittiwake | Not Specified |
| | | | California Gull | Other |
| | | | Cassin’s Auklet | Other |
| | | | Common Murre | Not Specified |
| | | | Glaucous-winged Gull | Not Specified |
| | | | Herring Gull | Not Specified |
| | | | Northern Fulmar | Other |
| | | | Rhinoceros Auklet | Not Specified |
| | | | Sabine’s Gull | Other |
| | | | Sooty Shearwater | Other |
| | | | Thayer’s Gull | Not Specified |
| | | | Tufted Puffin | Not Specified |
| **United States** | | | | |
| USWA277 | Drayton Harbor / Semiahmoo | This IBA is a relatively small and relatively enclosed water body (approximately 6.5 km²) comprising Drayton Harbor in Blaine, Washington. It is located east of Semiahmoo Bay and generally enclosed by the Semiahmoo Spit. | Bald Eagle<br>Black Scoter<br>Common Loon<br>Greater Scaup<br>Harlequin Duck<br>Horned Grebe<br>Long-tailed Duck<br>Peregrine Falcon<br>Red-necked Grebe<br>Surf Scoter<br>White-winged Scoter | Not Specified |
| USWA282 | Lower Dungeness Riparian Corridor | The Lower Dungeness Riparian Corridor IBA includes the Dungeness River, adjacent riparian forest and estuary. This relatively small IBA (less than 5 km²) is located in Dungeness, Washington. | American Dipper<br>Bullock's Oriole<br>Cedar Waxwing<br>Olive-sided Flycatcher<br>Red-eyed Vireo<br>Warbling Vireo<br>Willow Flycatcher | Not Specified |
| USWA288 | Protection Island | This very small IBA (1 km²) comprises Protection Island located approximately 3 km off Diamond Point, Washington. | Double-crested Cormorant<br>Glaucous-winged Gull<br>Pelagic Cormorant<br>Pigeon Guillemot<br>Rhinoceros Auklet<br>Tufted Puffin | Not Specified |

## TABLE 5.6.2.2

## SUMMARY OF IMPORTANT BIRD AREAS (IBAS) WITHIN THE RSA FOR MARINE TRANSPORTATION (continued)

| Identification Number | Site Name | Description | Bird Species | Seasonality |
|---|---|---|---|---|
| **United States** | | | | |
| USWA3289 | Deception Pass | The Deception Pass IBA is a very small IBA (1 km²) comprising the water body located between Whidbey Island and Fidalgo Island, Washington. | Black Oystercatcher<br>Pigeon Guillemot<br>Red-throated Loon | Not Specified |
| USWA3347 | Samish / Padilla Bays | This large IBA (approximately 240 km²) comprises Samish and Padilla Bays, located in proximity to Anacortes, Washington. | Black Oystercatcher<br>Brant<br>Dunlin<br>Great Blue Heron<br>Marbled Murrelet<br>Red-necked Grebe<br>Trumpeter Swan<br>Western Grebe | Not Specified |
| USWA3348 | Olympic Continental Shelf | The Olympic Continental Shelf IBA is very large IBA (2,200 km²) generally comprising marine environments. It includes two general areas, one located in the Juan de Fuca Strait, the other in the Pacific Ocean. In the Juan de Fuca Strait, it follows the northwestern shoreline of Washington State, from the city of Port Angeles west to Cape Flattery extending a few kilometers from the mainland. From Cape Flattery, it then extends south to Taholah (located approximately 50 km northwest of Aberdeen, Washington), extending to the edge of the continental shelf, approximately 55 km from the mainland. | Black-footed Albatross Brandt's Cormorant<br>Brown Pelican<br>Cassin's Auklet<br>Common Murre<br>Leach's Storm-Petrel<br>Marbled Murrelet<br>Pelagic Cormorant<br>Pink-footed Shearwater<br>Rhinoceros Auklet<br>Sooty Shearwater<br>South Polar Skua<br>Tufted Puffin | Not Specified |
| USWA3351 | Port Angeles Harbor / Ediz Hook | This IBA is relatively small (approximately 5.5 km²) comprising Port Angeles Harbor bordered to the north by Ediz Hook. | Heermann's Gull<br>Thayer's Gull | Not Specified |
| USWA3786 | Sequim Bay | The Sequim Bay IBA (approximately 60 km²), located less than 5 km east of Sequim, Washington encompasses the open waters and intertidal zones of Sequim Bay and is partially enclosed by Travis Spit and Gibson Spit. | Black-bellied Plover<br>Dunlin<br>Heermann's Gull | Not Specified |

**Sources:** **Canada:** IBA Canada Site Summaries (2012).

**United States:** Audubon Important Bird Areas Profiles (2013).

The ERA marine bird ecological receptor group is represented in the EVOSTC literature by a variety of species including: cormorants and loons are (listed as "recovered"); black oystercatcher, harlequin duck and Barrow's goldeneye ("recovering"); Kittlitz's murrelet and marbled murrelet ("unknown"); and pigeon guillemot ("not recovering") (EVOSTC 2010; Table 5.6.2.1).

For the marine bird species listed as "recovering" the limiting factor in each case appears to be concern about exposure to lingering oil at sites that represent a small proportion of the available habitat. Only nine carcasses of adult black oystercatchers were recovered following the EVOS, and although the actual number of mortalities may have been several times higher, this represents a small fraction of the population of 1,500 to 2,000 black oystercatchers breeding in south-central Alaska. It is estimated that about 1,000 harlequin duck (about 7 per cent of the wintering population) were killed by oil exposure at the time of the spill. Similarly, an unknown number of Barrow's goldeneye died as a result of oil exposure, but population-level effects of oil exposure have not been documented since 1990. The listing of these species as "recovering" reflects a measured metabolic response linked to oil exposure (cytochrome P450 induction), but it is not clear whether this has affected on survival, growth or reproduction of individuals, or translates into a population-level effect. Harwell and Gentile (2006) noted that by 1993 population numbers for harlequin duck equalled pre-spill population numbers, and that the area of habitat affected by sequestered oil was so small in relation to the available habitat that no plausible risk remains to the harlequin duck population. The same rationale would also apply to black oystercatcher and Barrow's goldeneye.

Recovery of marine bird populations following the EVOS was generally rapid and uncomplicated. A major factor causing the EVOSTC to identify certain bird populations as "recovering" rather than "recovered" has been evidence of low-level exposure to hydrocarbons from cytochrome P450 testing. While this measure can identify exposure, it does not identify effects of hydrocarbon exposure on individuals or at a population level. It is reasonable to expect marine bird recovery at a population level within two to five years following a large oil spill.

*d. Marine Mammals*

The marine waters of the study area provide habitat for a variety of marine and semi-aquatic mammals including:

- terrestrial mammals such as bears and moose, which may frequent and be exposed to oil in shoreline areas, depending upon the availability of food resources they may be seeking;
- pinnipeds, including Steller sea lion and harbour seal;
- cetaceans, including but not limited to southern resident killer whale, humpback whale, various dolphins and porpoises, and other species; and
- river otter, mink and potentially sea otter, which are highly dependent upon the insulative value of their fur, and which are potentially exposed to high rates of oil ingestion through grooming, if their fur becomes oiled.

Aquatic mammals such as otters and mink that rely upon fur for insulation in cold ocean water are extremely sensitive to oiling, as well as having potentially high exposure to oil ingestion, if coastal habitat is oiled. Mammals that rely upon blubber for insulation are less sensitive to external oiling, although the potential for mortality cannot be ruled out due to other exposure pathways or mechanisms.

Oil ingestion remains a potentially important exposure pathway, and fouling of baleen plates can have adverse effects on baleen whales, although this would not be a problem for toothed whales.

Wildlife species that are normally terrestrial (such as bear and moose) could potentially be exposed to oil that strands along shorelines, or accumulates in coastal marshes or estuaries. External oiling and oil ingestion are a possibility for these animals, although these exposures are not likely to result in mortality.

For the ERA marine mammal receptor, a low sensitivity (BSF 1) is assigned to wildlife species that are normally terrestrial. The medium sensitivity (BSF 2) is assigned to pinniped species, such as seal and sea lions. Whales are assigned a high sensitivity rank (BSF 3) and species such as sea otter, river otter and mink that rely upon fur for insulation in cold ocean water are extremely sensitive to oiling, as well as having potentially high exposure to oil ingestion are assigned a very high sensitivity (BSF 4).

The ERA marine mammal ecological receptor group is represented in the EVOSTC literature by a variety of species, including harbour seal and river otter ("recovered"), sea otter and killer whale – AB Pod ("recovering") and killer whale – AT1 Population ("not recovered"; Table 5.6.2.1).

Sea otters were severely affected by the EVOS, with a large number of carcasses being collected throughout the spill area. No apparent population growth occurred for Prince William Sound sea otters between 1989 and 1991. Since that time, areas that were heavily oiled have shown slower rates of population increase than less-oiled areas (EVOSTC 2010). Since 2004; however, even cytochrome P450 biomarker results for sea otters from oiled and unoiled areas have been similar, and population trends in oiled areas have been positive. Harwell and Gentile (2006) concluded that at the scale of Prince William Sound, sea otter populations had returned to, or may exceed pre-spill numbers, and that no continuing ecologically significant effects persisted.

The effects of the EVOS on killer whales are complex and controversial. Two whale groups have received intensive follow-up since the EVOS: the AB pod (resident) and the AT1 population (transient). Resident killer whales feed primarily on fish (especially salmon), whereas transient killer whales feed primarily on seals. Despite being called transient, the AT1 pod appeared to range only through the Prince William Sound and Kenai Fjords region. Both groups lost members and exhibited higher than expected mortality rates following the EVOS, and it is possible that direct inhalation of vapours may have been a cause of mortality for some whales, as they were observed swimming in the freshly-spilled oil near the Exxon Valdez at the time of the spill.

The EVOSTC (2010) has established recovery objectives for killer whales that are specific to these two groups (*i.e.,* a return to the pre-spill number of 36 members in the AB pod, and a stable population trend in the AT1 population). These objectives may not account for natural variability, and both groups of whales were and continue to be subject to pressures external to the EVOS. Harwell and Gentile (2006) note that the AB pod clearly lost members following the EVOS, but this was the exception to the trend in the overall Prince William Sound population of killer whales, which rose from 117 in 1988 to 155 in 2003. Effects of the EVOS on the AB pod may also be compounded by stress introduced to this pod by conflict with the longline fishery prior to the EVOS (Harwell and Gentile 2006). The AB pod was also reported to split into two distinct units subsequent to 1990 (EVOSTC 2010). The AT1 population of killer whales is also subject to external pressures. This group of whales, which feeds preferentially on seals, has been exposed to dietary intakes of PCBs, DDT and DDT metabolites and carries levels of these substances in blubber that cause reproductive problems in other marine mammals (EVOSTC 2010).

Harwell and Gentile (2006) concluded that there is no plausible risk to killer whales from residual toxicity associated with the EVOS, and that such effects were limited to certain groups of whales, even at the time of the spill. The larger populations of both resident and transient killer whales did not show effects, and are showing increase.

Evaluating the recovery of marine mammal populations following the EVOS has been complex. River otter and harbour seal populations appeared to recover quickly. One factor causing the EVOSTC to identify sea otter populations as "recovering" rather than "recovered" has been evidence of low-level exposure to hydrocarbons based on cytochrome P450 testing. While this measure can identify exposure, it does not confirm effects of hydrocarbon exposure on individuals or at a population level. As discussed previously, recovery conclusions for killer whales are complicated by a focus on specific whale groups that are subject to additional stressors and have not recovered, in contrast with population-level trends which are increasing. On balance; however, it is reasonable to expect marine mammal recovery at a population level within five to ten years following a large oil spill.

**Hypothetical Oil Spill Scenarios**

No hypothetical scenario can represent all potential environmental and socio-economic outcomes, but scenario-based hydrocarbon spill evaluations can provide decision makers and resource managers with a clearer understanding of potential effects pathways, the range of potential outcomes, vulnerable resources, and spill preparedness and response priorities and capabilities. Stochastic oil spill fate modeling completed for three of the four hypothetical spill locations described in Section 5.4 (Figure 5.5.2) was used to evaluate potential ecological effects with a preliminary quantitative ERA (Buoy J) (Location H) was excluded because results of the Strait of Georgia (Location D), Arachne Reef (Location E) and Race Rocks (Juan de Fuca Strait, Location G) reflect the range and extent of ecological effects that could result from a spill along the shipping route a Project-related tanker would travel. The discussion provided in Section 5.5 describes the spill response measures that would be undertaken by the ship owner, WCMRC, CCG and Transport Canada to respond quickly to an accidental oil spill thus minimizing the adverse environmental and socio-economic effects potentially resulting from an accidental oil spill in the Salish Sea area.

The six hypothetical oil spill scenarios evaluated in the ERA are summarized in Table 5.6.2.3. These include scenarios at three locations along the marine transportation route, representing two crude oil spill volumes: a credible worst case spill of 16,500 $m^3$; and a smaller volume of 8,250 $m^3$ (see Section 5.2). Each hypothetical spill scenario was evaluated under a range of environmental conditions, including winter, spring, summer and fall. Stochastic spill modelling results are summarized in Section 5.4.

ERA results for the Strait of Georgia, Race Rocks and Arachne Reef scenarios are described in Sections 5.6.2.2, 5.6.2.3 and 5.6.2.4, respectively. An overall summary of potential marine spill ecological effects is provided in Section 5.6.2.5.

**TABLE 5.6.2.3**

**SUMMARY OF HYPOTHETICAL MARINE TRANSPORTATION OIL SPILL SCENARIOS**

| Scenario | Seasonal Condition | Incident Summary | Release Volume ($m^3$) | Representative Crude Oil |
|---|---|---|---|---|
| 1 | Winter | Strait of Georgia (Location D) - Main ferry crossing. Collision with crossing traffic from Fraser River and ferries is a low probability event, but considered because of higher number of crossings per day.<br>- See Section 5.6.2.2 | 16,500 $m^3$ | Cold Lake Winter Blend |
| | Spring | | | |
| | Summer | | | |
| | Fall | | | |
| 2 | Winter | | 8,250 $m^3$ | Cold Lake Winter Blend |
| | Spring | | | |
| | Summer | | | |
| | Fall | | | |
| 3 | Winter | Arachne Reef (Turn Point SOA, Location E) - Powered grounding is a low probability event due to pilots and tethered tug, but this location is rated with greatest level of navigation complexity for the entire passage. Location also has high environmental value.<br>- See Section 5.6.2.4 | 16,500 $m^3$ | Cold Lake Winter Blend |
| | Spring | | | |
| | Summer | | | |
| | Fall | | | |
| 4 | Winter | | 8,250 $m^3$ | Cold Lake Winter Blend |
| | Spring | | | |
| | Summer | | | |
| | Fall | | | |
| 5 | Winter | Race Rocks (Juan de Fuca Strait, Location G)- Collision with crossing traffic from Puget Sound and Rosario Strait or grounding at Race Rock is a low probability event, but considered because not all vessels in this location would have pilot onboard.<br>- See Section 5.6.2.3 | 16,500 $m^3$ | Cold Lake Winter Blend |
| | Spring | | | |
| | Summer | | | |
| | Fall | | | |
| 6 | Winter | | 8,250 $m^3$ | Cold Lake Winter Blend |
| | Spring | | | |
| | Summer | | | |
| | Fall | | | |

#### 5.6.2.1.2 Exposure and Hazard/Effect Assessment

The ERA exposure and hazard/effects assessment stage identified the probability of oiling at any given location within the modelling area. A low probability of oil exposure was assigned to areas having <10 per cent probability. Areas having a probability of ≥10 per cent but <50 per cent were assigned a medium exposure probability. A high exposure probability was assigned to areas having a probability of oiling ≥50 per cent but <90 per cent, and a very high exposure probability to areas having a probability of oiling ≥90 per cent.

Probability of oiling contours were superimposed on ecological resource sensitivity maps to quantify the length of shoreline (km) or the area of a particular habitat type ($km^2$) that is potentially affected at low, medium, high or very high probability levels. Because a low probability of oiling indicates that oil exposure is unlikely, the ERA focused on areas having medium, high or very high probability of oil exposure. Analyses were summarized in tabular format, so that the quantity of habitat exposed to different probabilities of oiling could be quantified, and then compared to the total amount of that habitat within the RSA. This approach was repeated for each biological sensitivity rank and each season (Ecological Risk Assessment of Marine Transportation Spills Technical Report [Volume 8B, TR 8B-7]).

#### 5.6.2.1.3 Risk Characterization

The ERA risk characterization stage considered the biophysical characteristics of the marine environments along with results of the exposure and hazard/effects assessments to define risk for each ecological receptor type. The potential ecological consequence of crude oil exposure at any given location were considered to be the product of the probability of oil presence, and the sensitivity of the receptor or supporting habitat that may be present at that location with results expressed in terms of probability ranges.

Potential ecological effects from accidental oil spills were evaluated using a different approach than potential effects from routine Project activities. Project construction or operation activities can usually be described with a high level of confidence. In contrast, serious accidents such as grounding or collision of a tanker with another vessel are expected to have a very low probability of occurring and spills may or may not result from these incidents (Section 5.2). All of the residual environmental effects of an accident leading to a crude oil spill were assumed to be of negative impact balance. ERA conclusions were expressed in terms of the spatial extent of effects and time to recovery of the environmental effects for each ecological receptor. Qualitative magnitude (or degree of injury) ratings were based on the following definitions:

- Negligible: a change from existing conditions that is difficult to detect; or a very low probability that an ecological receptor will be exposed to spilled oil.
- Low: a change that is detectable, but that remains well within regulatory standards; or a situation where an ecological receptor is exposed to spilled oil, but the exposure does not result in serious stress to the receptor.
- Medium: a change from existing conditions that is detectable, and approaches without exceeding a regulatory standard; or a situation where an ecological receptor is stressed, but does not die as a result of exposure to spilled oil.
- High: : a change from existing conditions that exceeds an environmental or regulatory standard; or a situation where a species of management concern dies as a result of exposure to spilled oil.

The temporal context of environmental effects is also important. Rather than focusing on the duration and frequency of accidents, the effects assessment considered the reversibility, and in particular to the expected time to recovery for each ecological receptor in the event of exposure to spilled oil. The recovery assessment phase considered the potential beneficial effects of remediation (such as oil spill cleanup activities) that would be applied following an oil spill to promote biological recovery of affected ecological receptors (Ecological Risk Assessment of Marine Transportation Spills Technical Report [Volume 8B, TR 8B-7]).

#### 5.6.2.1.4 ERA Certainty and Confidence

When conducting ecological risk assessments, it is standard practice to implement conservative assumptions (*i.e.,* to make assumptions that are inherently biased towards safety) when uncertainty is encountered. This strategy generally results in an overestimation of actual risk. For this ERA, prediction confidence is based on the following factors:

- environmental fate modeling;

- selection of marine ecological receptors and derivation/assignment of biological sensitivity factors; and
- exposure and hazard assessment.

In the event of an oil spill, the fate and effects would be strongly determined by specific characteristics of the oil, environmental conditions, and the precise locations and types of organisms exposed. The goal of ERA scenario modelling investigations was not to forecast every situation that could potentially occur, but to describe a range of possible consequences so that an informed analysis can be made as to the likely effects of oil spills under various environmental conditions.

Ecological receptors were selected to represent species believed or known to be sensitive to spills, and which act as indicators of overall environmental health. Each of the four ecological receptor groups includes a variety of individual receptors and/or habitats with differing sensitivity to oil exposure. For this reason, each receptor group was divided into sub-categories that reflected their sensitivity to oil exposure. For nearshore and shoreline littoral (intertidal) habitats, biological sensitivity factors were based on habitat complexity and ability of different habitat types to sustain high levels of biodiversity and productivity. For the marine fish community and marine fish habitat receptor, biological sensitivity factors were based on water depth with the highest biological sensitivity class reserved for developing eggs and embryos in shallow water habitat. For marine birds and marine bird habitats, and marine mammals the classification scheme considered lifestyle, behaviour, and exposure mechanisms, and in particular the role of fur or feathers in providing thermal insulation.

The recovery assessment was carried out primarily based on the recovery of ecological receptors following the 1989 EVOS. That oil spill, while a major disaster caused by the grounding of a large single-hulled oil tanker, shows that marine ecosystems do recover from the effects of oil spills. Most of the instances of delayed recovery are associated with the effects of lingering or sequestered oil affecting a small area of habitat, or relate to effects on specific groups of whales which experienced harm from which they may not fully recover, but which are compensated for by gains made by other groups in the region. The EVOS was also an important learning experience in terms of oil spill response, and some of the oil spill response strategies that were employed at that time were found to be inappropriate. Current oil spill response planning and deployment incorporates those lessons, so that better outcomes can be expected than were observed at some sites following the EVOS. For the four ecological receptor groups considered here: shoreline habitats; marine fish community; marine birds; and marine mammals, recovery predictions and time to recovery are based upon relevant real-world experience, and are accorded a high level of confidence.

A summary of ERA results for the three marine tanker spill scenarios is provided below. Additional information is contained in Ecological Risk Assessment of Marine Transportation Spills Technical Report (Volume 8B, TR 8B-7).

#### *5.6.2.2 Location D: Strait of Georgia*

The Strait of Georgia (Location D) credible worst case and smaller spill scenarios are described in Sections 5.4.4 and 5.6.2.2 (Figure 5.5.2). This discussion begins with a summary of the modelled fate and behaviour of oil spilled as a result of this hypothetical scenario, specifically relating to the probability of surface oiling and shoreline oiling. Potential effects on each of the four ecological indicators are then described. Additional information is contained in Ecological Risk Assessment of Marine Transportation Spills Technical Report (Volume 8B). While not specifically considered here, the mitigation (spill response) measures that would be employed to minimize environmental effects - should such a spill occur - are described in Sections 5.4.4.10 and 5.5.

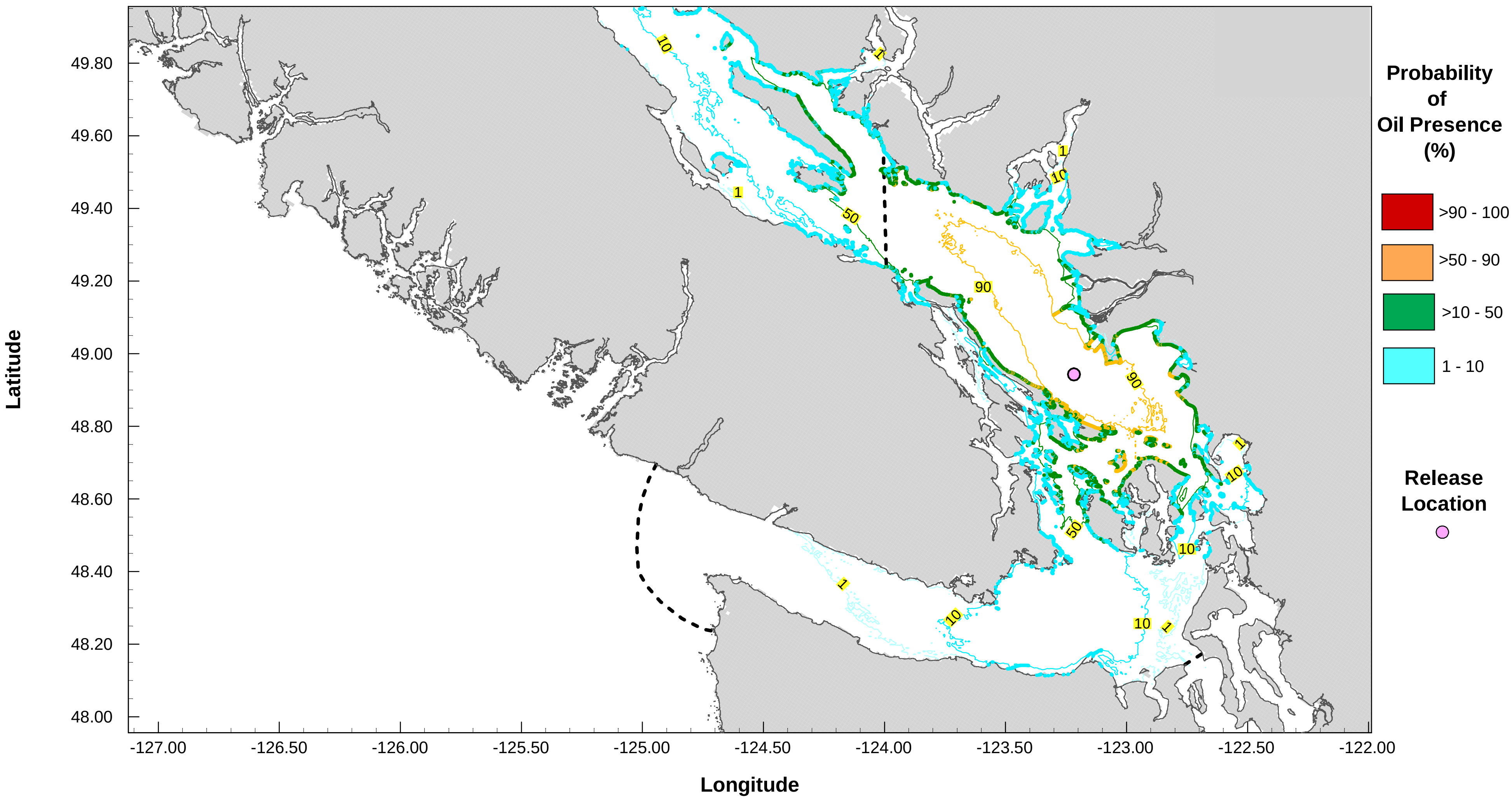
#### 5.6.2.2.1 Fate and Behaviour

**Probability of Surface Oiling**

Stochastic oil fate modelling predictions indicate that a spill at the Strait of Georgia site (Location D) has a high or very high probability (≥50 per cent) for potential surface oiling to extend beyond the northern boundary of the RSA for both the 16,500 $m^3$ spill (winter, spring and fall seasons) and 8,250 $m^3$ spill (winter and spring seasons). In the case of a credible worst case spill, the ≥50 per cent probability contour extends as far north as Powell River during the winter season. In the case of the smaller 8,250 $m^3$ spill, the ≥50 per cent probability contour extends slightly beyond the RSA into the northern Strait of Georgia off Madeira Park. The ≥50 per cent probability contour does not extend beyond the RSA boundaries to the west or south for either scenario, or any of the seasonal conditions.

Predicted high and very high probabilities of oiling were similar for each scenario and seasonal condition. Slight differences in the seasonal spill trajectories do exist and these primarily result from variations in predominant current or wind direction and speed, as well as the influence of the peak spring and summer discharges from the Fraser River. The largest difference in the predicted surface oiling area occurred under winter conditions for a credible worst case spill where the ≥90 per cent (very high) probability contour extended in the Strait of Georgia from just north of Gibsons, BC to Patos Island (located in US waters) in the south. Refer to Figure 5.6.2.1.

Table 5.6.2.4 provides a summary of the predicted spatial extent of surface oiling ($km^2$) within the RSA for each spill volume and seasonal combination. Results are presented for each of three probability ranges (≥ 10 per cent, ≥50 per cent and ≥90 per cent). The release location and probability contours for seasonal stochastic surface oiling are shown in Figures 5.6.2.1 to 5.6.2.4 for a 16,500 $m^3$ spill. Comparable figures for a 8,250 $m^3$ spill are included in the Ecological Risk Assessment of Marine Transportation Spills Technical Report (Volume 8B, TR 8C-7).




## NOTES

- Statistical results based on independent spills occuring every 6 hours from January 01 00:00 to March 31 23:00, for a total of 364 independent spills.

- Probability of oil presence is the percentage of simulations in which oil was present at a given location on shoreline or on water surface.

- Tracking time for each spill was 15 days.

STATUS
ISSUED FOR USE

CLIENT

TRANSMOUNTAIN

eba
A TETRA TECH COMPANY

## TRANS MOUNTAIN OIL SPILL STUDY

**Probability of Oiling**
**Strait of Georgia Stochastic Simulation**
**16,500 m$^3$ Spill - Winter Season**

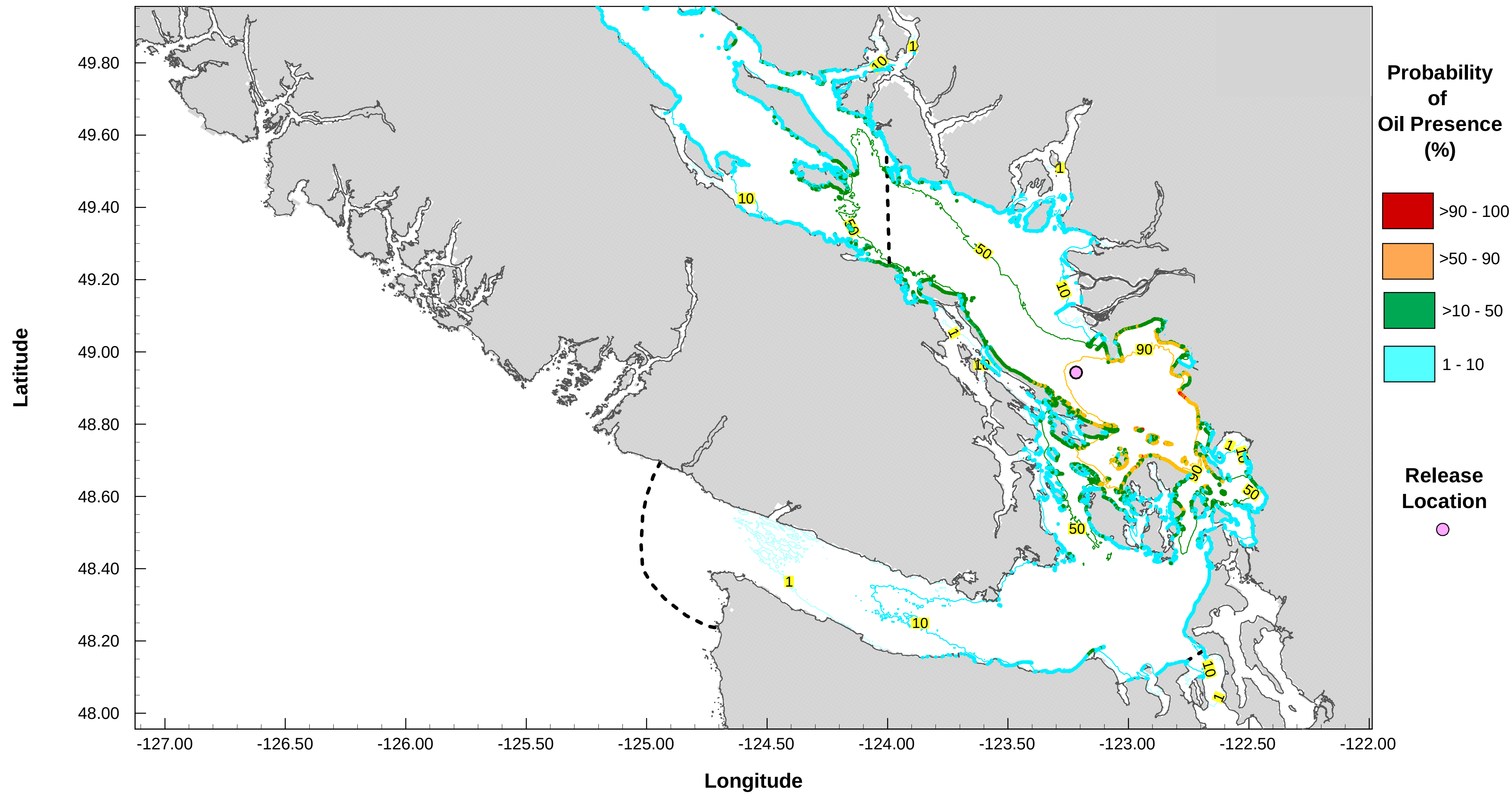
| PROJECT NO. | DWN | CKD | APVD | REV |
|---|---|---|---|---|
| V13203022 | AH | JAS | MS | 0 |

| OFFICE | DATE |
|---|---|
| EBA-VANC | December 6, 2013 |

**Figure 5.6.2-1**

T:\TMEP\working\AH\02-SPILLCALC\551-Stochastic_SOG_16500m3\Results_Winter2012\Tecplot\02-stochastic_map_lines_4Stantec.lay

09 Dec 2013 11:47:04




## NOTES

- Statistical results based on independent spills occuring every 6 hours from April 01 00:00 to June 30 23:00, for a total of 364 independent spills.

- Probability of oil presence is the percentage of simulations in which oil was present at a given location on shoreline or on water surface.

- Tracking time for each spill was 15 days.

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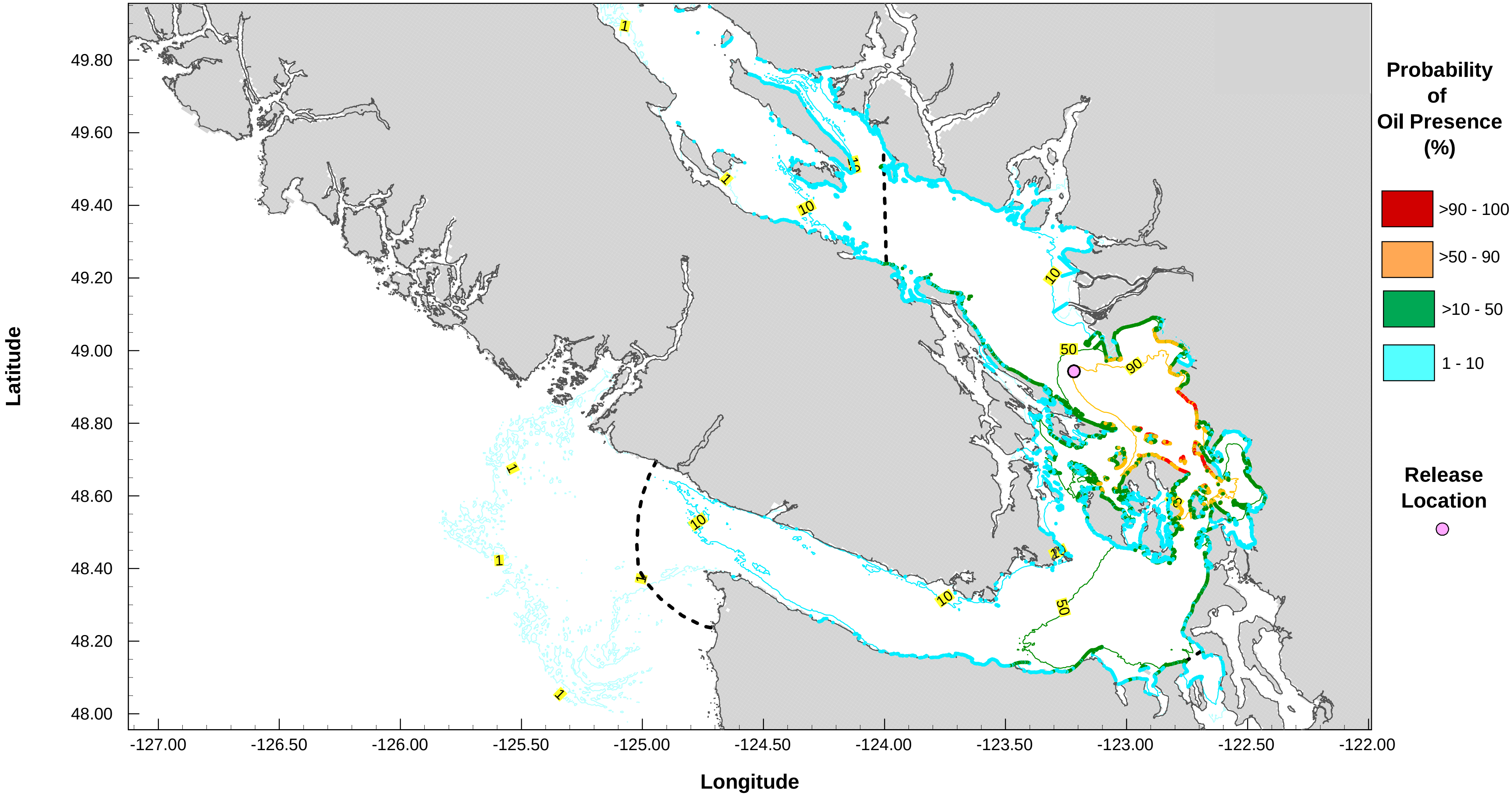
## TRANS MOUNTAIN OIL SPILL STUDY

**Probability of Oiling**
**Strait of Georgia Stochastic Simulation**
**16,500 m$^3$ Spill - Spring Season**

| PROJECT NO. | DWN | CKD | APVD | REV |
|---|---|---|---|---|
| V13203022 | AH | JAS | MS | 0 |

| OFFICE | DATE |
|---|---|
| EBA-VANC | December 6, 2013 |

**Figure 5.6.2-2**




## NOTES

- Statistical results based on independent spills occuring every 6 hours from July 01 00:00 to September 30 23:00, for a total of 368 independent spills.

- Probability of oil presence is the percentage of simulations in which oil was present at a given location on shoreline or on water surface.

- Tracking time for each spill was 15 days.

STATUS
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## TRANS MOUNTAIN OIL SPILL STUDY

**Probability of Oiling**
**Strait of Georgia Stochastic Simulation**
**16,500 m$^3$ Spill - Summer Season**

| PROJECT NO. | DWN | CKD | APVD | REV |
|---|---|---|---|---|
| V13203022 | AH | JAS | MS | 0 |

| OFFICE | DATE |
|---|---|
| EBA-VANC | December 6, 2013 |

**Figure 5.6.2-3**

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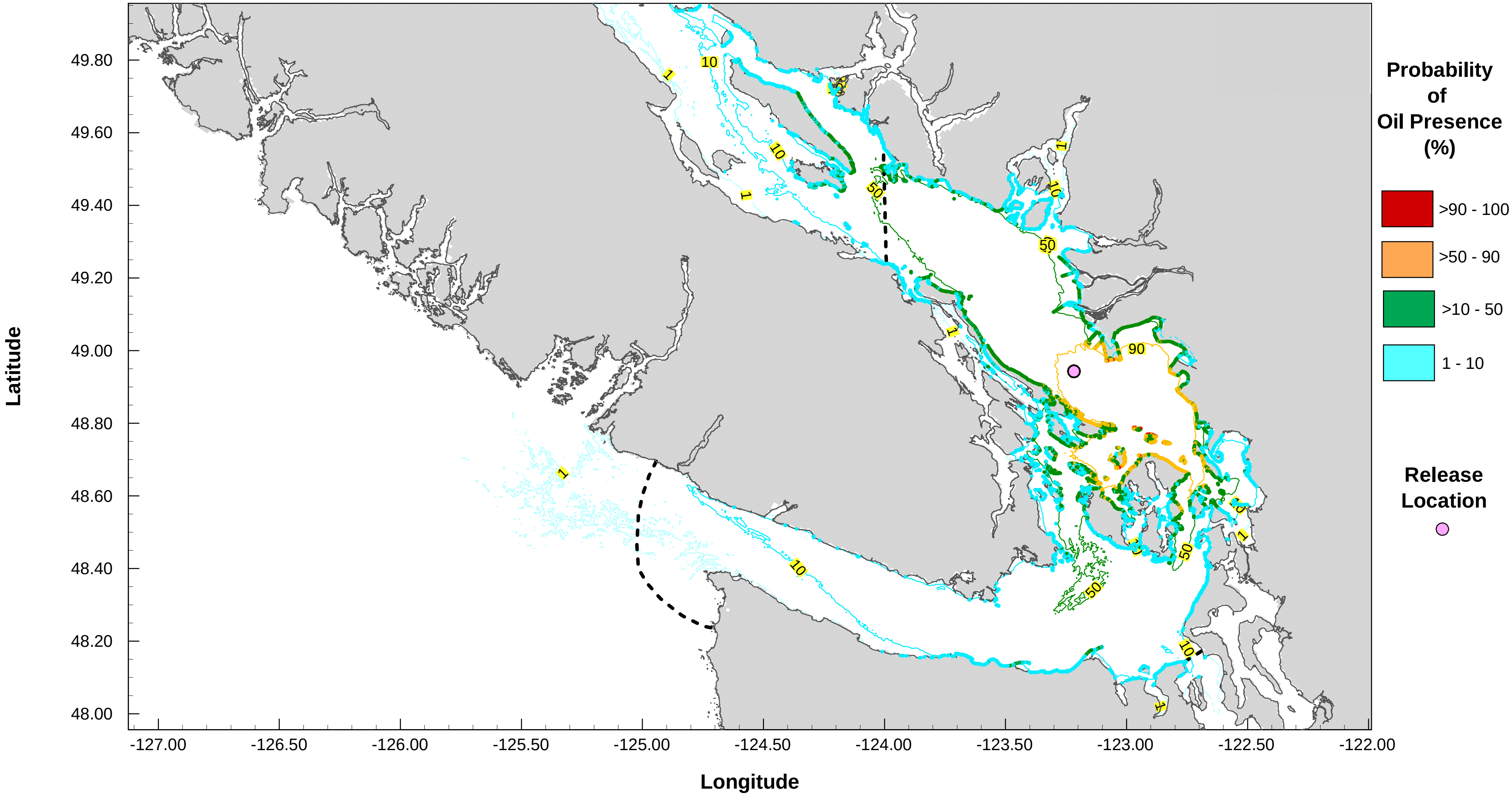
09 Dec 2013 12:29:08




## NOTES

- Statistical results based on independent spills occuring every 6 hours from October 01 00:00 to December 31 23:00, for a total of 368 independent spills.
- Probability of oil presence is the percentage of simulations in which oil was present at a given location on shoreline or on water surface.
- Tracking time for each spill was 15 days.

STATUS
ISSUED FOR USE

CLIENT

TRANSMOUNTAIN

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## TRANS MOUNTAIN OIL SPILL STUDY

**Probability of Oiling**
**Strait of Georgia Stochastic Simulation**
**16,500 $m^3$ Spill - Fall Season**

| PROJECT NO. | DWN | CKD | APVD | REV |
|---|---|---|---|---|
| V13203022 | AH | JAS | MS | 0 |

| OFFICE | DATE |
|---|---|
| EBA-VANC | December 6, 2013 |

**Figure 5.6.2-4**

**TABLE 5.6.2.4**

**AREA OF SURFACE OILING (BY PROBABILITY OF OILING) – STRAIT OF GEORGIA SCENARIOS (LOCATION D)**

| Scenario | Spill Volume ($m^3$) | Seasonal Condition | Maximum Average Slick Area ($km^2$) | Total Affected Surface Area ($km^2$) by Probability of Oiling | | |
|---|---|---|---|---|---|---|
| | | | | ≥ 10% | ≥ 50% | ≥ 90% |
| 1 | Credible Worst Case 16,500 $m^3$ | Winter | 423 | 6,461 | 3,850 | 1,379 |
| | | Spring | 435 | 7,372 | 3,194 | 1,143 |
| | | Summer | 355 | 8,667 | 3,311 | 934 |
| | | Fall | 425 | 8,465 | 4,013 | 1,267 |
| 2 | Smaller Spill Case 8,250 $m^3$ | Winter | 370 | 5,302 | 3,473 | 431 |
| | | Spring | 385 | 6,353 | 2,561 | 889 |
| | | Summer | 308 | 6,827 | 2,142 | 754 |
| | | Fall | 363 | 7,129 | 2,907 | 985 |

It is important to correctly interpret the data presented in Table 5.6.2.4. The values presented under the column headed “Maximum Average Slick Area ($km^2$)” indicate, for the average simulated spill, the largest sea surface area occupied by spilled oil at any point in time during the modelling run. When oil is spilled, the surface area of the slick increases rapidly to a maximum value, and then decreases as oil evaporates and strands on shorelines. Because an oil slick is moved around by tides and winds and is not static, the total area affected by the moving oil is greater than the predicted slick surface area at any given time. Therefore the values presented under the columns headed “Total Affected Surface Area ($km^2$)” indicate the predicted probability that an individual modelling sea surface grid area contained surface oil during at least one point in time. The three columns indicate the total area of sea surface affected by oil over the length of the oil spill simulation, at probability levels of ≥10 per cent, ≥50 per cent and ≥90 per cent, respectively. Accordingly, the areas presented in these columns of Table 5.6.2.3, and the same data represented by contour outlines in Figures 5.6.2.1 to 5.6.2.4 do not represent the surface area of a single, continuous oil slick.

Additional information on predicted spill fate and behaviour and mass balance is provided in Section 5.4.4 and Volume 8C, TR 8C-12, S9.

**Probability of Shoreline Contact**

Table 5.6.2.5 provides a summary of predicted shoreline contact within the RSA. Results for the credible worst case spill indicate a high to very high probability (≥50 per cent) of between 143 km and 458 km of shoreline contact, with the greatest shoreline contact occurring during winter conditions. The smaller spill case predicts a high to very high probability of shoreline contact between 94 km and 248 km, with the greatest contact also under winter conditions. Because oil that contacts shorelines tends to be retained on beach substrate, the average length of affected shoreline is more consistent with the total affected shoreline length at ≥50 per cent probability than was the case for water surface affected by oil.

**TABLE 5.6.2.5**

**LENGTH OF SHORELINE CONTACT (BY PROBABILITY OF OILING) – STRAIT OF GEORGIA SCENARIOS (LOCATION D)**

| Scenario | Spill Volume ($m^3$) | Seasonal Condition | Average length of Affected Shoreline (km) | Total Affected Shoreline Length (km) by Probability of Oiling | | |
|---|---|---|---|---|---|---|
| | | | | ≥ 10% | ≥ 50% | ≥ 90% |
| 1 | Credible Worst Case 16,500 $m^3$ | Winter | 263 | 3,397 | 458 | 0.2 |
| | | Spring | 291 | 814 | 143 | 4.4 |
| | | Summer | 278 | 648 | 150 | 268 |
| | | Fall | 293 | 878 | 181 | 6.5 |
| 2 | Smaller Spill Case 8,250 $m^3$ | Winter | 185 | 2,307 | 248 | 0.0 |
| | | Spring | 217 | 582 | 94 | 0.7 |
| | | Summer | 205 | 472 | 101 | 9.1 |
| | | Fall | 211 | 563 | 120 | 3.7 |

The RSA includes approximately 4,130 km of shorelines. Based on this overall length, the modelling predicts the maximum shoreline contacted would be 248 km (6 per cent - smaller spill) to 458 km (11 per cent - credible worst case spill) of the RSA with high or very high probability. However, the average length of shoreline contact for a single oil spill ranges from 185 km (smaller spill) to 293 km (credible worst case spill) representing 4.5 per cent to 7.2 per cent of the shoreline within the RSA.

#### 5.6.2.2.2 Shoreline Habitats

Of the 4,130 km of shoreline habitat in the RSA, 51 per cent (2,125 km) comprises low and high exposure rock and sand, low exposure rip rap and wood bulkheads and high exposure sand and gravel assigned a low biological sensitivity (BSF 1). Shorelines including low exposure veneer over rock, low exposure pebble veneer over sand, high exposure cobble/boulder veneer over rock and high exposure cobble/boulder represent 27 per cent (1,120 km) of the coastline and have medium biological sensitivity (BSF 2). Approximately 15 per cent (619 km) of the RSA has a high biological sensitivity (BSF 3) and includes low exposure cobble/boulder veneer over sand. The highest biological sensitivity (BSF 4) is generally limited to more sheltered bays and represents less than 6.4 per cent (266 km) of the shoreline in the RSA. Summaries of shoreline contact probability for each shoreline sensitivity class for the Strait of Georgia spill scenarios are provided in Table 5.6.2.6 and Table 5.6.2.7 for a 16,500 $m^3$ and an 8,250 $m^3$ spill, respectively.

Shorelines with a high to very high probability of oiling (≥50 per cent) generally represent less than 10 per cent of the available habitat belonging to that sensitivity class within the RSA. Results indicate that shorelines with the lowest biological sensitivity factor (BSF 1) have the highest overall probability of oiling under winter conditions where between 15 per cent and 8.2 per cent of the available habitat may be affected for credible worst case and smaller spills respectively.

For a 16,500 $m^3$ spill, areas with high probability of oiling (≥50 per cent) represent 3.9 per cent to 15 per cent of the total shoreline within the RSA assigned to BSF 1; 2.4 per cent to 8.7 per cent of the total RSA shoreline assigned to BSF 2; 3.9 per cent to 6.6 per cent of the total RSA shoreline assigned to BSF 3, and less than 1 per cent of the total RSA shoreline assigned to BSF 4.

**TABLE 5.6.2.6**

**SUMMARY OF EFFECTS ANALYSIS FOR SHORELINE HABITATS – STRAIT OF GEORGIA – 16,500 M$^3$ SPILL (LOCATION D)**

| Seasonal Condition | BSF | Length in RSA (km) | Affected Shoreline (by Shoreline Oiling Probabilities) | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Affected Length According to Sensitivity Factor (km) | | | Percent Length According to Sensitivity Factor (%) | | |
| | | | Medium (≥ 10%) | High (≥ 50%) | Very High (≥ 90%) | Medium (≥ 10%) | High (≥ 50%) | Very High (≥ 90%) |
| Winter | 1 | 2,125 | 2,087 | 317 | 0.0 | 98 | 15 | 0.0 |
| | 2 | 1,120 | 835 | 98 | 0.2 | 75 | 8.7 | 0.0 |
| | 3 | 619 | 406 | 41 | 0.0 | 66 | 6.6 | 0.0 |
| | 4 | 266 | 69 | 1.6 | 0.0 | 26 | 0.6 | 0.0 |
| Spring | 1 | 2,125 | 526 | 91 | 3.1 | 25 | 4.3 | 0.1 |
| | 2 | 1,120 | 184 | 27 | 0.7 | 17 | 2.4 | 0.1 |
| | 3 | 619 | 94 | 24 | 0.6 | 15 | 3.9 | 0.1 |
| | 4 | 266 | 9.8 | 0.7 | 0.0 | 3.7 | 0.3 | 0.0 |
| Summer | 1 | 2,125 | 387 | 83 | 12.6 | 18 | 3.9 | 0.6 |
| | 2 | 1,120 | 156 | 34 | 7.6 | 14 | 3.0 | 0.7 |
| | 3 | 619 | 91 | 33 | 5.7 | 15 | 5.4 | 0.9 |
| | 4 | 266 | 15 | 0.0 | 0.0 | 5.7 | 0.0 | 0.0 |
| Fall | 1 | 2,125 | 537 | 119 | 6.2 | 25 | 5.6 | 0.3 |
| | 2 | 1,120 | 214 | 35 | 0.3 | 19 | 3.1 | 0.0 |
| | 3 | 619 | 110 | 27 | 0.0 | 18 | 4.3 | 0.0 |
| | 4 | 266 | 18 | 0.1 | 0.0 | 6.7 | 0.0 | 0.0 |

For the 8,250 m$^3$ spill scenario, areas with high probability of oiling represent 2.4 per cent to 8.2 per cent of the total shoreline within the RSA assigned to BSF 1; 1.7 per cent to 4.5 per cent of the total RSA shoreline assigned to BSF 2; and 2.7 per cent to 4.1 per cent of the total RSA shoreline assigned to BSF 3.

**TABLE 5.6.2.7**

**SUMMARY OF EFFECTS ANALYSIS FOR SHORELINE HABITATS – STRAIT OF GEORGIA – 8,250 M$^3$ SPILL (LOCATION D)**

| Seasonal Condition | BSF | Length in RSA (km) | Affected Shoreline (by Shoreline contact Probabilities) | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Affected Length According to Sensitivity Ranking (km) | | | Percent Length According to Sensitivity Factor (%) | | |
| | | | Medium (≥ 10%) | High (≥ 50%) | Very High (≥ 90%) | Medium (≥ 10%) | High (≥ 50%) | Very High (≥ 90%) |
| Winter | 1 | 2,125 | 1,411 | 175.2 | 0.0 | 66 | 8.2 | 0.0 |
| | 2 | 1,120 | 576 | 50.6 | 0.0 | 51 | 4.5 | 0.0 |
| | 3 | 619 | 264 | 21.7 | 0.0 | 43 | 3.5 | 0.0 |
| | 4 | 266 | 56 | 0.0 | 0.0 | 21 | 0.0 | 0.0 |

**TABLE 5.6.2.7**

**SUMMARY OF EFFECTS ANALYSIS FOR SHORELINE HABITATS – STRAIT OF GEORGIA – 8,250 M$^3$ SPILL (LOCATION D) (continued)**

| Seasonal Condition | BSF | Length in RSA (km) | Affected Shoreline (by Shoreline contact Probabilities) | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Affected Length According to Sensitivity Ranking (km) | | | Percent Length According to Sensitivity Factor (%) | | |
| | | | Medium (≥ 10%) | High (≥ 50%) | Very High (≥ 90%) | Medium (≥ 10%) | High (≥ 50%) | Very High (≥ 90%) |
| Spring | 1 | 2,125 | 371 | 58.3 | 0.7 | 17 | 2.7 | 0.0 |
| | 2 | 1,120 | 136 | 19.4 | 0.0 | 12 | 1.7 | 0.0 |
| | 3 | 619 | 68 | 16.4 | 0.0 | 11 | 2.7 | 0.0 |
| | 4 | 266 | 7 | 0.0 | 0.0 | 2.7 | 0.0 | 0.0 |
| Summer | 1 | 2,125 | 280 | 51 | 5.4 | 13 | 2.4 | 0.3 |
| | 2 | 1,120 | 112 | 25 | 1.9 | 10 | 2.2 | 0.2 |
| | 3 | 619 | 71 | 25 | 1.8 | 12 | 4.1 | 0.3 |
| | 4 | 266 | 9 | 0.0 | 0.0 | 3.4 | 0.0 | 0.0 |
| Fall | 1 | 2,125 | 350 | 79 | 3.5 | 16 | 3.7 | 0.2 |
| | 2 | 1,120 | 130 | 24 | 0.2 | 12 | 2.1 | 0.0 |
| | 3 | 619 | 70 | 17 | 0.0 | 11 | 2.8 | 0.0 |
| | 4 | 266 | 13 | 0.0 | 0.0 | 5.1 | 0.0 | 0.0 |

Predicted oil spill mass balance results indicate that about 2 per cent of the spilled oil may contact mudflats of the Fraser River Delta (*i.e.,* Roberts Bank and Sturgeon Bank) or Boundary Bay. Because the hypothetical spill location is close to the Delta, the time to first contact for these areas is on the order of 1 day for Roberts Bank and 2 to 3 days for Boundary Bay. Owing to the fine-grained (sand and mud) substrates, which are expected to remain water-saturated at low tide, the probability of the oil penetrating the surface of the mudflats is low. Instead, the oil will tend to accumulate near the high tide mark in these areas, so that most of the mudflat areas will experience low levels of oiling. One important aspect of the intertidal habitat associated with the banks and mudflats is the presence of "biofilm", an assemblage of algal and bacterial cells and organic debris that forms an important part of the diet for some migratory birds (*e.g.,* Western sandpiper) as well as other ecological receptors such as marine invertebrates. The presence of oil is unlikely to have long-term negative effects on the biofilm, which has the capacity to recover quickly from physical or chemical disturbance.

Stochastic results for both spill scenarios also suggest that areas throughout the central Strait of Georgia, the Gulf Islands and south into US waters of the Juan de Fuca Strait have a high to very high probability of oiling (≥50 per cent) from a spill at this location (refer to Figures 5.6.2.1 to 5.6.2.4). A number of ecological and socially important sites are located in this area, and prompt and effective response in the event of a spill would help reduce effects on shoreline habitats.

### 5.6.2.2.3 Marine Fish Community

The RSA comprises approximately 11,111 km$^2$ of habitat for the marine fish community, and includes habitats for all four biological sensitivity rankings. Habitats classified as low sensitivity (BSF 1) to high sensitivity (BSF 3) are based on water depth, and are deemed to be exclusive with no overlap in area. However, BSF 4 (very high sensitivity) is based on habitats important areas for specific species (such as herring spawning areas), and can overlap areas with other sensitivity factors. Areas with a water depth of 30 m or more (BSF 1) represent slightly more than 78 per cent of the RSA (8,636 km$^2$). Areas represented by BSF 2 (water depths between 10 and 30 m with medium sensitivity), and areas with BSF 3 (water depths less than 10 m with high sensitivity) represent approximately 12 per cent (1,280 km$^2$) and 11 per cent (1,196 km$^2$) of the RSA, respectively. Critical habitats for herring spawn, rockfish and crab combined as BSF 4 (very high sensitivity) overlap with other areas and represent approximately 35 per cent (3,934 km$^2$) of the RSA.

For a 16,500 m$^3$ spill, areas with a high to very high (≥50 per cent) probability of oiling represent: 28 per cent (under summer conditions) to 39 per cent (under fall conditions) of the total area with water depths >30m (BSF 1); 24 per cent (under spring conditions) to 42 per cent (under summer conditions) of the total area with water depths between 10 m and 30m (BSF 2); 24 per cent (under spring conditions) to 30 per cent (under summer conditions) of the total area with depths <10 m (BSF 3); and 12 per cent (under spring and summer conditions) to 16 per cent (under winter conditions) of the important habitat for herring spawn, rockfish and crab. The overlap between surface oiling probability and marine fish community sensitivity for the 16,500 m$^3$ spill scenario is summarized in Table 5.6.2.8.

**TABLE 5.6.2.8**

**SUMMARY OF EFFECTS ANALYSIS FOR THE MARINE FISH COMMUNITY – STRAIT OF GEORGIA – 16,500 M$^3$ SPILL (LOCATION D)**

| Seasonal Condition | BSF | Area in RSA (km$^2$) | Affected Surface Water (by Surface Water Oiling Probabilities) | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Area According to Sensitivity Factor (km$^2$) | | | Percent Area According to Sensitivity Factor (%) | | |
| | | | Medium (≥ 10%) | High (≥ 50%) | Very High (≥ 90%) | Medium (≥ 10%) | High (≥ 50%) | Very High (≥ 90%) |
| Winter | 1 | 8,636 | 5,233 | 3,219 | 1,290 | 61 | 37 | 15 |
| | 2 | 1,280 | 680 | 307 | 44 | 53 | 24 | 3.4 |
| | 3 | 1,196 | 548 | 324 | 46 | 46 | 27 | 3.8 |
| | 4 | 3,934 | 1,109 | 609 | 132 | 28 | 16 | 3.4 |
| Spring | 1 | 8,636 | 5,931 | 2,569 | 902 | 69 | 30 | 10 |
| | 2 | 1,280 | 818 | 338 | 183 | 64 | 26 | 14 |
| | 3 | 1,196 | 624 | 287 | 58 | 52 | 24 | 4.9 |
| | 4 | 3,934 | 1,118 | 477 | 182 | 28 | 12 | 4.6 |
| Summer | 1 | 8,636 | 7,030 | 2,421 | 694 | 81 | 28 | 8.0 |
| | 2 | 1,280 | 893 | 532 | 170 | 70 | 42 | 13 |
| | 3 | 1,196 | 743 | 359 | 70 | 62 | 30 | 5.9 |
| | 4 | 3,934 | 947 | 451 | 163 | 24 | 12 | 4.1 |
| Fall | 1 | 8,636 | 6,796 | 3,338 | 1,013 | 79 | 39 | 12 |
| | 2 | 1,280 | 972 | 337 | 185 | 76 | 26 | 14 |
| | 3 | 1,196 | 698 | 339 | 69 | 58 | 28 | 5.8 |
| | 4 | 3,934 | 1,195 | 603 | 204 | 30 | 15 | 5.2 |

For a 8,250 m$^3$ spill, areas with a high to very high (≥50 per cent) probability of oiling represent: 18 per cent (under summer conditions) to 34 per cent (under fall conditions) of the total area with water depths >30 m (BSF 1); 20 per cent (under fall conditions) to 29 per cent (under summer conditions) of the total area with water depths between 10 m and 30m (BSF 2); 20 per cent (under spring conditions) to 22 per cent (under various conditions) of the total area with depths <10 m (BSF 3); and 9 per cent (under summer conditions) to 13 per cent (under winter conditions) of the important habitat for herring spawn, rockfish and crab. The overlap between surface oiling probability and marine fish community sensitivity for the 8,250 $m^3$ spill is summarized in Table 5.6.2.9.

**TABLE 5.6.2.9**

**SUMMARY OF EFFECTS ANALYSIS FOR THE MARINE FISH COMMUNITY – STRAIT OF GEORGIA – 8,250 $M^3$ SPILL (LOCATION D)**

| Seasonal Condition | BSF | Area in RSA ($km^2$) | Affected Surface Water (by Surface Water Oiling Probabilities) | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Area According to Sensitivity Factor ($km^2$) | | | Percent Area According to Sensitivity Factor (%) | | |
| | | | Medium (≥ 10%) | High (≥ 50%) | Very High (≥ 90%) | Medium (≥ 10%) | High (≥ 50%) | Very High (≥ 90%) |
| Winter | 1 | 8,636 | 5,820 | 2,380 | 834 | 67 | 28 | 9.7 |
| | 2 | 1,280 | 756 | 270 | 122 | 59 | 21 | 9.5 |
| | 3 | 1,196 | 554 | 257 | 29 | 46 | 22 | 2.5 |
| | 4 | 3,934 | 974 | 511 | 8 | 25 | 13 | 0.2 |
| Spring | 1 | 8,636 | 5,212 | 2,046 | 765 | 60 | 24 | 8.9 |
| | 2 | 1,280 | 633 | 271 | 106 | 50 | 21 | 8.3 |
| | 3 | 1,196 | 508 | 244 | 19 | 43 | 20 | 1.6 |
| | 4 | 3,934 | 900 | 382 | 142 | 23 | 10 | 3.6 |
| Summer | 1 | 8,636 | 5,459 | 1,507 | 624 | 63 | 18 | 7.2 |
| | 2 | 1,280 | 744 | 371 | 84 | 58 | 29 | 6.6 |
| | 3 | 1,196 | 625 | 264 | 46 | 52 | 22 | 3.8 |
| | 4 | 3,934 | 867 | 362 | 140 | 22 | 9 | 3.6 |
| Fall | 1 | 8,636 | 4,322 | 2,954 | 424 | 50 | 34 | 4.9 |
| | 2 | 1,280 | 487 | 254 | 6 | 38 | 20 | 0.5 |
| | 3 | 1,196 | 493 | 266 | 1.5 | 41 | 22 | 0.1 |
| | 4 | 3,934 | 1,028 | 429 | 151 | 26 | 11 | 3.8 |

Of a total of 8,635 $km^2$ of deep water habitat (> 30 m) in the RSA (BSF 1), between 28 per cent and 39 per cent of this habitat type within the RSA has a high or very high (≥ 50 per cent) probability of oil exposure from a 16,500 $m^3$ spill. Between 18 per cent and 34 per cent has a high or very high probability of oil exposure from an 8,250 $m^3$ spill. While these ranges represent a comparatively large portion of this habitat type, it is very unlikely that fish in this habitat type would be harmed by exposure to oil due to water depth.

A predicted range of 24 per cent to 42 per cent of the total of 1,280 $km^2$ of intermediate depth habitat (< 30 to ≥ 10) in the RSA (BSF 2) has a high or very high (≥ 50 per cent) probability of oil exposure from a 16,500 $m^3$ spill. Between 20 per cent and 29 per cent of this medium sensitivity habitat in the RSA has a high or very high probability of oil exposure from an 8,250 $m^3$ spill. As with deep water habitat, given the water depth this sensitivity rank represents, it is also very unlikely that fish would be harmed by exposure to oil in this habitat type.

Between 24 per cent and 30 per cent of the RSA total of 1,196 $km^2$ of high sensitivity (BSF 3) shallow water habitat (≤ 10 m) has a high or very high (≥ 50 per cent) probability of oil exposure from a 16,500 $m^3$ spill. Between 244 and 266 $km^2$ has a high or very high probability of oil exposure from an 8,250 $m^3$ spill, representing 20 per cent to 22 per cent of this habitat type within the RSA. In circumstances where oil is driven into this shallow water habitat by strong winds, there would be a greater potential for negative effects, including potential mortality of fish, crustaceans and shellfish. While this could occur at any time of year, such windy conditions are most likely to occur during the winter.

Of a total of 3,934 $km^2$ of RSA habitat with a very high biological sensitivity (BSF 4), between 12 per cent and 16 per cent has a high or very high (≥50 per cent) probability of oil exposure from a 16,500 $m^3$ spill, and between 9 per cent and 13 per cent has a high or very high probability of oil exposure from an 8,250 $m^3$ spill. In areas where this very high-sensitivity habitat overlaps with shallow water areas, the potential for negative effects would be greater. Critical time periods for herring spawn would be in the spring, when exposure to PAH in the oil could cause developmental effects on fish embryos. As noted for shallow water habitat, the potential for negative effects would be greatest if the spill were to occur at a time when strong winds cause the oil to be driven into shallow water used as spawning or nursery areas for herring, rockfish or crab.

#### 5.6.2.2.4 Marine Birds

Marine birds were assessed using two approaches. The first assumes that marine birds could generally be present anywhere within the RSA and the potential for shorebirds and other marine birds to be affected was estimated using the stochastic shoreline contact and surface contours, respectively. The second approach considers the potential for spilled crude oil to come into contact with known bird colonies and designated IBAs.

The habitat oiling probability for each marine bird sensitivity group is summarized in Tables 5.6.2.10 and 5.6.2.11 for 16,500 $m^3$ spills and 8,250 $m^3$ spills respectively. For shorebirds (BSF 1), potential exposure is determined by the length of shoreline predicted to have a high or very high probability of oiling. For a 16,500 $m^3$ spill, the seasonal variation in spatial extent represents between 143 km (3.5 per cent) and 458 km (11 per cent) of the available shoreline habitat within the RSA. For an 8,250 $m^3$ spill, the predicted length of affected shoreline is ranges between 94 km (2.3 per cent) and 247 km (6 per cent) of the available shoreline habitat. Shorebirds generally have low sensitivity to oiling when compared to other guilds, and it is unlikely that lightly oiled individuals would die as a result of low or moderate exposure. Heavily oiled individuals would probably die; however, and even lightly oiled individuals could transfer sufficient oil to eggs to cause egg mortality, if exposure occurred shortly before or during the period when eggs were being incubated. An oil spill that occurred in the Strait of Georgia would be physically close to the important Fraser River Delta area, where shorebirds are present, and seasonal migrants congregate. The threat to birds in this area is mitigated; however, by the low percentage of spilled crude oil that is predicted to contact on Sturgeon or Roberts Banks, or Boundary Bay. Therefore, the environmental effects on shorebirds of crude oil exposure from an accidental spill during marine transportation could be high locally, although medium to Low effects levels are likely to be more prevalent.

For other marine birds (BSF 2, BSF 3, and BSF 4), potential exposure is based on surface water oiling. The seasonal variation in spatial extent for a 16,500 $m^3$ spill represents between 29 per cent and 36 per cent of the available habitat for these receptors, while for an 8,250 $m^3$ spill, between 19 per cent and 31 per cent of the RSA habitat is predicted to be affected. Therefore, there is a relatively high probability of exposure for aquatic birds in the event that an oil spill occurs. The environmental effects and effect magnitude of such exposure would depend upon the season (which would determine the numbers and types of birds present) as well as the actual level and duration of exposure, and the relative sensitivity of the exposed birds. Gulls and terns tend to have medium sensitivity, whereas ducks, cormorants, divers and alcids tend to have high to very high sensitivity. However, regardless of these factors, it is likely that seabirds would be exposed to oil, and would die as a result of that exposure, so that the effect magnitude would be high.

### TABLE 5.6.2.10

### SUMMARY OF EFFECTS ANALYSIS FOR MARINE BIRDS AND MARINE BIRD HABITATS – STRAIT OF GEORGIA – 16,500 M³ SPILL (LOCATION D)

| Seasonal Condition | BSF | Length or Area in RSA (km or km$^2$) | Affected Surface Water (by Shoreline or Surface Water Oiling Probabilities) | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Affected Length or Area According to Sensitivity Factor (km or km$^2$) | | | Percent Length or Area According to Sensitivity Factor (%) | | |
| | | | Medium (≥ 10%) | High (≥ 50%) | Very High (≥ 90%) | Medium (≥ 10%) | High (≥ 50%) | Very High (≥ 90%) |
| Winter | 1 | 4,130 [1] | 3,397 [1] | 458 [1] | 0.2 [1] | 82 [2] | 11 [2] | <0.1 [2] |
| | 2, 3, 4 | 11,112 | 6,461 | 3,850 | 1,379 | 58 | 35 | 12 |
| Spring | 1 | 4,130 [1] | 814 [1] | 143 [1] | 4.4 [1] | 20 [2] | 3.5 [2] | 0.1 [2] |
| | 2, 3, 4 | 11,112 | 7,372 | 3,194 | 1,143 | 66 | 29 | 10 |
| Summer | 1 | 4,130 [1] | 648 [1] | 150 [1] | 26 [1] | 16 [2] | 3.6 [2] | 0.6 [2] |
| | 2, 3, 4 | 11,112 | 8,667 | 3,311 | 934 | 78 | 30 | 8.4 |
| Fall | 1 | 4,130 [1] | 878 [1] | 181 [1] | 6.5 [1] | 21 [2] | 4.4 [2] | 0.2 [2] |
| | 2, 3, 4 | 11,112 | 8,466 | 4,014 | 1,267 | 76 | 36 | 11 |

**Notes:** 1 Total length of shoreline in the RSA, or length affected (km).
2 Expressed as % length of shoreline in that sensitivity class.

### TABLE 5.6.2.11

### SUMMARY OF EFFECTS ANALYSIS FOR MARINE BIRDS AND MARINE BIRD HABITATS – STRAIT OF GEORGIA – 8,250 M³ SPILL (LOCATION D)

| Seasonal Condition | BSF | Length or Area in RSA (km or km$^2$) | Affected Surface Water (by Shoreline or Surface Water Oiling Probabilities) | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Affected Length or Area According to Sensitivity Factor (km or km$^2$) | | | Percent Length or Area According to Sensitivity Factor (%) | | |
| | | | Medium (≥ 10%) | High (≥ 50%) | Very High (≥ 90%) | Medium (≥ 10%) | High (≥ 50%) | Very High (≥ 90%) |
| Winter | 1 | 4,130 [1] | 2,307 [1] | 247 [1] | --- | 56 [2] | 6.0 [2] | --- |
| | 2, 3, 4 | 11,112 | 5,302 | 3,473 | 431 | 48 | 31 | 3.9 |

**TABLE 5.6.2.11**

**SUMMARY OF EFFECTS ANALYSIS FOR MARINE BIRDS AND MARINE BIRD HABITATS – STRAIT OF GEORGIA – 8,250 M³ SPILL (LOCATION D) (continued)**

| Seasonal Condition | BSF | Length or Area in RSA (km or km$^2$) | Affected Surface Water (by Shoreline or Surface Water Oiling Probabilities): Affected Length or Area According to Sensitivity Factor (km or km$^2$) | | | Percent Length or Area According to Sensitivity Factor (%) | | |
|---|---|---|---|---|---|---|---|---|
| | | | Medium (≥ 10%) | High (≥ 50%) | Very High (≥ 90%) | Medium (≥ 10%) | High (≥ 50%) | Very High (≥ 90%) |
| Spring | 1 | 4,130 [1] | 582 [1] | 94 [1] | 0.7 [1] | 14 [2] | 2.3 [2] | 0.02 [2] |
| | 2, 3, 4 | 11,112 | 6,353 | 2,561 | 890 | 57 | 23 | 8.0 |
| Summer | 1 | 4,130 [1] | 472 [1] | 101 [1] | 9.1 [1] | 11 [2] | 2.5 [2] | 0.2 [2] |
| | 2, 3, 4 | 11,112 | 6,828 | 2,142 | 754 | 61 | 19 | 6.8 |
| Fall | 1 | 4,130 [1] | 563 [1] | 120 [1] | 3.7 [1] | 14 [2] | 2.9 [2] | 0.1 [2] |
| | 2, 3, 4 | 11,112 | 7,130 | 2,907 | 985 | 64 | 26 | 9 |

**Notes:** 1 Total length of shoreline in the RSA, or length affected (km).
2 Expressed as % length of shoreline in that sensitivity class.

Stochastic modeling results were used to identify areas of medium (≥10 per cent), high (≥50 per cent), and very high (≥90 per cent) probability for spilled crude oil extending to known colony locations. The number of known colonies affected for each of the marine bird BSF rankings are summarized in Tables 5.6.2.12 and 5.6.2.13 for 16,500 m$^3$ spills and 8,250 m$^3$ spills respectively.

For gulls and terns (BSF 2), potential effects on colonies are determined by identifying the probability that crude oil will contact these areas if spilled during the spring or summer seasons. For a 16,500 m$^3$ spill, crude oil is predicted to have high to very high probability (≥50 per cent) to contact 15 or 16 of the 79 known colonies. For an 8,250 m$^3$ spill, this is predicted to represent 11 to 13 of the 79 known colonies.

For ducks and cormorants (BSF 3), the 16,500 m$^3$ spill, crude oil is predicted to have high to very high (≥50 per cent) probability to come in contact with 9 to 14 of the 40 known colonies. For the 8,250 m$^3$ spill, this is predicted to represent 8 to 10 of the 40 known colonies.

For auks and divers (BSF 4), the 16,500 m$^3$ spill, crude oil is predicted to have high to very high (≥50 per cent) probability to come in contact with 17 to 28 of the 55 known colonies. For the 8,250 m$^3$ spill, this is predicted to represent 16 to 22 of the 55 known colonies.

The presence of seabirds at colony locations is seasonal, and the overlap of oil with a colony location does not necessarily indicate that seabirds at nest sites will experience oiling, as their feeding grounds may be located at some distance from the nest site. However, the substantial overlap of high probability areas for oil on the water surface with known seabird colony locations (whether representing gulls and terns, ducks and cormorants, or auks and divers) indicates that the potential for negative effects, up to and including mortality of birds or oiling and mortality of eggs, is high for the Strait of Georgia spill scenario.

### TABLE 5.6.2.12

### SUMMARY OF EFFECTS ANALYSIS FOR MARINE BIRD COLONIES – STRAIT OF GEORGIA – 16,500 M³ SPILL (LOCATION D)

| Seasonal Condition | BSF | Affected Marine Bird Colonies (by Surface Water Oiling Probabilities) | | |
|---|---|---|---|---|
| | | Medium (≥ 10%) | High (≥ 50%) | Very High (≥ 90%) |
| Spring | 1 | --- | --- | --- |
| | 2 | 39 of 79 known colony sites affected. | 16 of 79 known colony sites affected. | 2 of 79 known colony sites affected. |
| | 3 | 20 of 40 known colony sites affected. | 9 of 40 known colony sites affected. | 5 of 40 known colony sites affected. |
| | 4 | 37 of 55 known colony sites affected. | 17 of 55 known colony sites affected. | 7 of 55 known colony sites affected. |
| Summer | 1 | --- | --- | --- |
| | 2 | 35 of 79 known colony sites affected. | 15 of 79 known colony sites affected. | 2 of 79 known colony sites affected. |
| | 3 | 22 of 40 known colony sites affected. | 14 of 40 known colony sites affected. | 3 of 40 known colony sites affected. |
| | 4 | 42 of 55 known colony sites affected. | 28 of 55 known colony sites affected. | 8 of 55 known colony sites affected. |

### TABLE 5.6.2.13

### SUMMARY OF EFFECTS ANALYSIS FOR MARINE BIRD COLONIES – STRAIT OF GEORGIA – 8,250 M³ SPILL (LOCATION D)

| Seasonal Condition | BSF | Affected Marine Bird Colonies (by Surface Water Oiling Probabilities) | | |
|---|---|---|---|---|
| | | Medium (≥ 10%) | High (≥ 50%) | Very High (≥ 90%) |
| Spring | 1 | --- | --- | --- |
| | 2 | 33 of 79 known colony sites affected. | 13 of 79 known colony sites affected. | 2 of 79 known colony sites affected. |
| | 3 | 19 of 40 known colony sites affected. | 8 of 40 known colony sites affected. | 2 of 40 known colony sites affected. |
| | 4 | 32 of 55 known colony sites affected. | 16 of 55 known colony sites affected. | 3 of 55 known colony sites affected. |
| Summer | 1 | --- | --- | --- |
| | 2 | 30 of 79 known colony sites affected. | 11 of 79 known colony sites affected. | 2 of 79 known colony sites affected. |
| | 3 | 19 of 40 known colony sites affected. | 10 of 40 known colony sites affected. | 3 of 40 known colony sites affected. |
| | 4 | 40 of 55 known colony sites affected. | 22 of 55 known colony sites affected. | 7 of 55 known colony sites affected. |

Stochastic modeling results were used to identify areas of medium (≥10 per cent), high (≥50 per cent), and very high (≥90 per cent) probability for spilled crude oil extending to IBA locations. The number of IBAs affected are summarized in Tables 5.6.2.14 and 5.6.2.15 for 16,500 m$^3$ spills and 8,250 m$^3$ spills respectively.

There are 19 IBAs that have ≥10 per cent probability of being affected by spilled crude oil, in the event of a credible worst case or smaller oil spill at the Strait of Georgia hypothetical spill location. Of these, 11 and 6, respectively, have a high or very high probability (≥50 per cent) of oil exposure in the event of the credible worst case or smaller spill. The utilization of IBAs by seabirds and other birds is seasonal, but most IBAs are used by one or more species in any season. It is likely that oil exposure at an IBA would result in oiling of birds, with a high potential for mortality of adults, juveniles, and/or eggs in the event of oil being transferred from plumage to incubating eggs. Given the high potential for negative effects on seabirds at IBAs, the effect magnitude is high.

### TABLE 5.6.2.14

### SUMMARY OF EFFECTS ANALYSIS FOR IMPORTANT BIRD AREAS – STRAIT OF GEORGIA – 16,500 M³ SPILL (LOCATION D)

| IBA | Highest Oiling Probability (by seasonal condition) | | | |
|---|---|---|---|---|
| | Winter | Spring | Summer | Fall |
| **Canada** | | | | |
| BC015 | ≥ 90% | ≥ 50% | ≥ 10% | ≥ 90% |
| BC017 | ≥ 90% | ≥ 90% | ≥ 90% | ≥ 90% |
| BC018 | ≥ 10% | --- | --- | --- |
| BC020 | ≥ 10% | ≥ 10% | --- | ≥ 10% |
| BC025 | ≥ 90% | ≥ 10% | ≥ 10% | ≥ 50% |
| BC045 | ≥ 10% | ≥ 10% | ≥ 10% | ≥ 10% |
| BC047 | ≥ 10% | ≥ 10% | ≥ 10% | ≥ 50% |
| BC052 | ≥ 50% | ≥ 50% | ≥ 10% | ≥ 50% |
| BC055 | ≥ 50% | ≥ 50% | ≥ 10% | ≥ 10% |
| BC073 | --- | --- | ≥ 10% | ≥ 10% |
| BC097 | --- | --- | ≥ 10% | --- |
| **United States** | | | | |
| USWA 277 | ≥ 50% | ≥ 50% | ≥ 50% | ≥ 50% |
| USWA 282 | --- | --- | ≥ 10% | --- |
| USWA 288 | --- | ≥ 10% | ≥ 50% | ≥ 10% |
| USWA 3289 | --- | ≥ 10% | ≥ 50% | ≥ 10% |
| USWA 3347 | ≥ 10% | ≥ 50% | ≥ 90% | ≥ 10% |
| USWA 3348 | ≥ 10% | ≥ 10% | ≥ 10% | ≥ 10% |
| USWA 3351 | ≥ 10% | ≥ 10% | ≥ 50% | ≥ 10% |
| USWA 3786 | --- | --- | ≥ 10% | ≥ 10% |

### TABLE 5.6.2.15

### SUMMARY OF EFFECTS ANALYSIS FOR IMPORTANT BIRD AREAS – STRAIT OF GEORGIA – 8,250 M³ SPILL (LOCATION D)

| IBA | Highest Oiling Probability (by seasonal condition) | | | |
|---|---|---|---|---|
| | Winter | Spring | Summer | Fall |
| **Canada** | | | | |
| BC015 | ≥ 90% | ≥ 50% | ≥ 10% | ≥ 90% |
| BC017 | ≥ 90% | ≥ 50% | ≥ 50% | ≥ 90% |
| BC018 | ≥ 10% | --- | --- | ≥ 10% |
| BC020 | ≥ 10% | ≥ 10% | --- | ≥ 10% |
| BC025 | ≥ 50% | ≥ 10% | ≥ 10% | ≥ 50% |

**TABLE 5.6.2.15**

**SUMMARY OF EFFECTS ANALYSIS FOR IMPORTANT BIRD AREAS – STRAIT OF GEORGIA – 8,250 M³ SPILL (LOCATION D) (continued)**

| IBA | Highest Oiling Probability (by seasonal condition) | | | |
|---|---|---|---|---|
| | Winter | Spring | Summer | Fall |
| **Canada** | | | | |
| BC045 | ≥ 10% | ≥ 10% | --- | ≥ 10% |
| BC047 | ≥ 10% | ≥ 10% | ≥ 10% | ≥ 10% |
| BC048 | --- | --- | --- | --- |
| BC052 | ≥ 50% | ≥ 50% | ≥ 10% | ≥ 50% |
| BC055 | ≥ 10% | ≥ 10% | ≥ 10% | ≥ 10% |
| **United States** | | | | |
| USWA 277 | ≥ 50% | ≥ 50% | ≥ 50% | ≥ 50% |
| USWA 288 | --- | --- | ≥ 10% | --- |
| USWA 3289 | --- | --- | ≥ 10% | --- |
| USWA 3347 | --- | ≥ 10% | ≥ 50% | --- |
| USWA 3348 | --- | ≥ 10% | ≥ 10% | --- |
| USWA 3351 | --- | ≥ 10% | ≥ 10% | --- |

### 5.6.2.2.5 Marine Mammals

Stochastic modelling results identify areas of medium (≥10 per cent), high (≥50 per cent), and very high (≥90 per cent), exposure probability for each class of mammals. The overlap between habitat oiling probabilities for each mammal sensitivity class is summarized in Tables 5.6.2.16 and 5.6.2.17 for 16,500 $m^3$ spills and 8,250 $m^3$ spills respectively.

**TABLE 5.6.2.16**

**SUMMARY OF EFFECTS ANALYSIS FOR MARINE MAMMALS – STRAIT OF GEORGIA – 16,500 M³ SPILL (LOCATION D)**

| Seasonal Condition | BSF | Area in RSA ($km^2$) | Affected Surface Water (by Probability of Oiling) | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Area (or length) According to Sensitivity Factor ($km^2$) | | | Percent Area (or length) According to Sensitivity Factor (%) | | |
| | | | Medium (≥ 10%) | High (≥ 50%) | Very High (≥ 90%) | Medium (≥ 10%) | High (≥ 50%) | Very High (≥ 90%) |
| Winter | 1 | 4,130 [1] | 3,397 [1] | 458 [1] | 0.2 [1] | 82 [2] | 11 [2] | 0.0 [2] |
| | 2 | 2,476 | 1,228 | 631 | 90 | 50 | 25 | 3.6 |
| | 3 | 7,578 | 4,007 | 1,883 | 779 | 53 | 25 | 10 |
| | 4 | 1,196 | 548 | 324 | 46 | 46 | 27 | 3.8 |
| Spring | 1 | 4,130 [1] | 814 [1] | 143 [1] | 4.4 [1] | 20 [2] | 3.5 [2] | 0.1 [2] |
| | 2 | 2,476 | 1,441 | 625 | 241 | 58 | 25 | 9.7 |
| | 3 | 7,578 | 5,164 | 1,923 | 1,133 | 68 | 25 | 15 |
| | 4 | 1,196 | 624 | 287 | 58 | 52 | 24 | 4.9 |

**TABLE 5.6.2.16**

**SUMMARY OF EFFECTS ANALYSIS FOR MARINE MAMMALS – STRAIT OF GEORGIA – 16,500 M$^3$ SPILL (LOCATION D) (continued)**

| Seasonal Condition | BSF | Area in RSA (km$^2$) | Affected Surface Water (by Probability of Oiling) | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Area (or length) According to Sensitivity Factor (km$^2$) | | | Percent Area (or length) According to Sensitivity Factor (%) | | |
| | | | Medium (≥ 10%) | High (≥ 50%) | Very High (≥ 90%) | Medium (≥ 10%) | High (≥ 50%) | Very High (≥ 90%) |
| Summer | 1 | 4,130 [1] | 648 [1] | 150 [1] | 26 [1] | 16 [2] | 3.6 [2] | 0.6 [2] |
| | 2 | 2,476 | 1,637 | 891 | 240 | 66 | 36 | 9.7 |
| | 3 | 7,578 | 6,641 | 3,211 | 934 | 88 | 42 | 12 |
| | 4 | 1,196 | 743 | 359 | 71 | 62 | 30 | 5.9 |
| Fall | 1 | 4,130 [1] | 878 [1] | 181 [1] | 6.5 [1] | 21 [2] | 4.4 [2] | 0.2 [2] |
| | 2 | 2,476 | 1670 | 676 | 254 | 67 | 27 | 10 |
| | 3 | 7,578 | 6,062 | 2,291 | 1,253 | 80 | 30 | 17 |
| | 4 | 1,196 | 698 | 339 | 69 | 58 | 28 | 5.8 |

**Notes:** 1 total length of shoreline in the RSA, or length affected (km).
2 Expressed as % length of shoreline in that sensitivity class.

For terrestrial mammals (*e.g.,* bears, moose, raccoon, etc., BSF 1), potential exposure is determined by the length of shoreline habitat predicted to have a high or very high probability of oiling. For a 16,500 m$^3$ spill, the seasonal variation in spatial extent represents between 143 km (3.5 per cent) and 458 km (11 per cent) of the available shoreline habitat; this drops slightly to between 94 km (2.3 per cent) and 248 km (6 per cent) for an 8,250 m$^3$ spill. These animals have generally low sensitivity to oiling, and it is unlikely that oiled individuals would die as a result of exposure. It is very unlikely that such exposure would result in a measurable effect at the population level.

For pinnipeds such as seals and sea lions (BSF 2), potential exposure is based on habitat having a water depth of ≤30m. The seasonal variation in likely spatial extent for a 16,500 m$^3$ spill affecting pinniped habitat represents 25 per cent to 36 per cent of the available habitat, whereas for an 8,250 m$^3$ spill, between 21 per cent and 26 per cent of the habitat could be affected. Therefore, there is a relatively high probability of exposure for seals and sea lions in the event of an accidental oil spill. While some level of negative effect would be expected for animals exposed to oil, the effects would not likely be lethal, except in the case of weaker animals such as pups or older and diseased animals.

For whales such as porpoises, or the humpback and southern resident killer whale (BSF 3), potential exposure is based on habitat having a water depth of ≥10m. For a 16,500 m$^3$ spill, the seasonal variation in the predicted area of affected habitat ranges between 25 per cent and 42 per cent of the RSA. The predictions for an 8,250 m$^3$ spill range between 22 and 27 per cent of the available habitat. Therefore, there is a relatively high probability of exposure for whales should an oil spill occur at this location. Some level of negative effect would be expected for animals exposed to oil, but the effects would not likely be lethal, except in the case of weaker animals such as calves or older and diseased animals, or animals that were exposed to heavy surface oiling and inhalation of vapours from fresh oil, as could occur in the immediate vicinity of the spill location.

For furred marine mammals such as otters (BSF 4), potential exposure is based on the available habitat represented by water depths along the coast of ≤10 m. The seasonal variation in spatial extent for a 16,500 $m^3$ spill for this receptor type represents between 24 per cent and 30 per cent of the available habitat, while for an 8,250 $m^3$ spill, between 20 per cent and 22 per cent of the habitat is predicted to be affected. Therefore there is a relatively high probability of exposure for some of otters along the marine transportation route, in the event of an oil spill. Some level of negative effect would be expected for animals exposed to oil. Exposure during the winter season would be more stressful than exposure during the summer, but in either case, the combination of hypothermia and damage to the gastro-intestinal system caused by oil ingested through grooming the fur would have the potential to cause death.

**TABLE 5.6.2.17**

**SUMMARY OF EFFECTS ANALYSIS FOR MARINE MAMMALS – STRAIT OF GEORGIA – 8,250 $M^3$ SPILL (LOCATION D)**

| Seasonal Condition | BSF | Area in RSA ($km^2$) | Affected Surface Water (by Probability of Oiling) | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Area (or length) According to Sensitivity Factor ($km^2$) | | | Percent Area (or length) According to Sensitivity Factor (%) | | |
| | | | Medium (≥ 10%) | High (≥ 50%) | Very High (≥ 90%) | Medium (≥ 10%) | High (≥ 50%) | Very High (≥ 90%) |
| Winter | 1 | 4,130 [1] | 2,307 [1] | 248 [1] | 0.0 [1] | 56 [2] | 6.0 [2] | 0.0 [2] |
| | 2 | 2,476 | 980 | 519.7 | 7.5 | 40 | 21 | 0.3 |
| | 3 | 7,578 | 4,841 | 1,862 | 985 | 64 | 25 | 13 |
| | 4 | 1,196 | 493 | 266 | 1.5 | 41 | 22 | 0.1 |
| Spring | 1 | 4,130 [1] | 582 [1] | 94 [1] | 0.7 [1] | 14 [2] | 2.3 [2] | 0.02 [2] |
| | 2 | 2,476 | 1,142 | 515 | 125 | 46 | 21 | 5.0 |
| | 3 | 7,578 | 4,271 | 1,709 | 890 | 56 | 23 | 12 |
| | 4 | 1,196 | 508 | 244 | 19 | 43 | 20 | 1.6 |
| Summer | 1 | 4,130 [1] | 472 [1] | 101 [1] | 9.1 [1] | 11 [2] | 2.5 [2] | 0.2 [2] |
| | 2 | 2,476 | 1,369 | 635 | 130 | 55 | 26 | 5.2 |
| | 3 | 7,578 | 4,896 | 2,060 | 754 | 65 | 27 | 9.9 |
| | 4 | 1,196 | 625 | 264 | 46 | 52 | 22 | 3.8 |
| Fall | 1 | 4,130 [1] | 563 [1] | 119.8 [1] | 3.7 [1] | 14 [2] | 2.9 [2] | 0.09 [2] |
| | 2 | 2,476 | 1,310 | 527 | 151 | 53 | 21 | 6.1 |
| | 3 | 7,578 | 2,947 | 1,687 | 370 | 39 | 22 | 4.9 |
| | 4 | 1,196 | 554 | 257 | 29 | 46 | 21 | 2.5 |

**Notes:** 1 total length of shoreline in the RSA, or length affected (km).
2 Expressed as % length of shoreline in that sensitivity class.

### *5.6.2.3 Location G: Race Rocks*

The Race Rocks (Location G; Juan de Fuca Strait) credible worst case and smaller spill scenarios are described in Section 5.4.4. This discussion begins with a summary of the modelled fate and behaviour of oil spilled as a result of this hypothetical scenario, specifically relating to the probability of surface oiling and shoreline contact. Potential effects on each of the four ecological indicators are then described. Additional information is contained in Ecological Risk Assessment of Marine Transportation Spills Technical Report (Volume 8B, TR 8B-7). While not specifically considered here, the mitigation (spill response) measures that would be employed to minimize environmental effects - should such a spill occur - are described in Sections 5.4.4.10 and 5.5.

#### 5.6.2.3.1 Fate and Behaviour

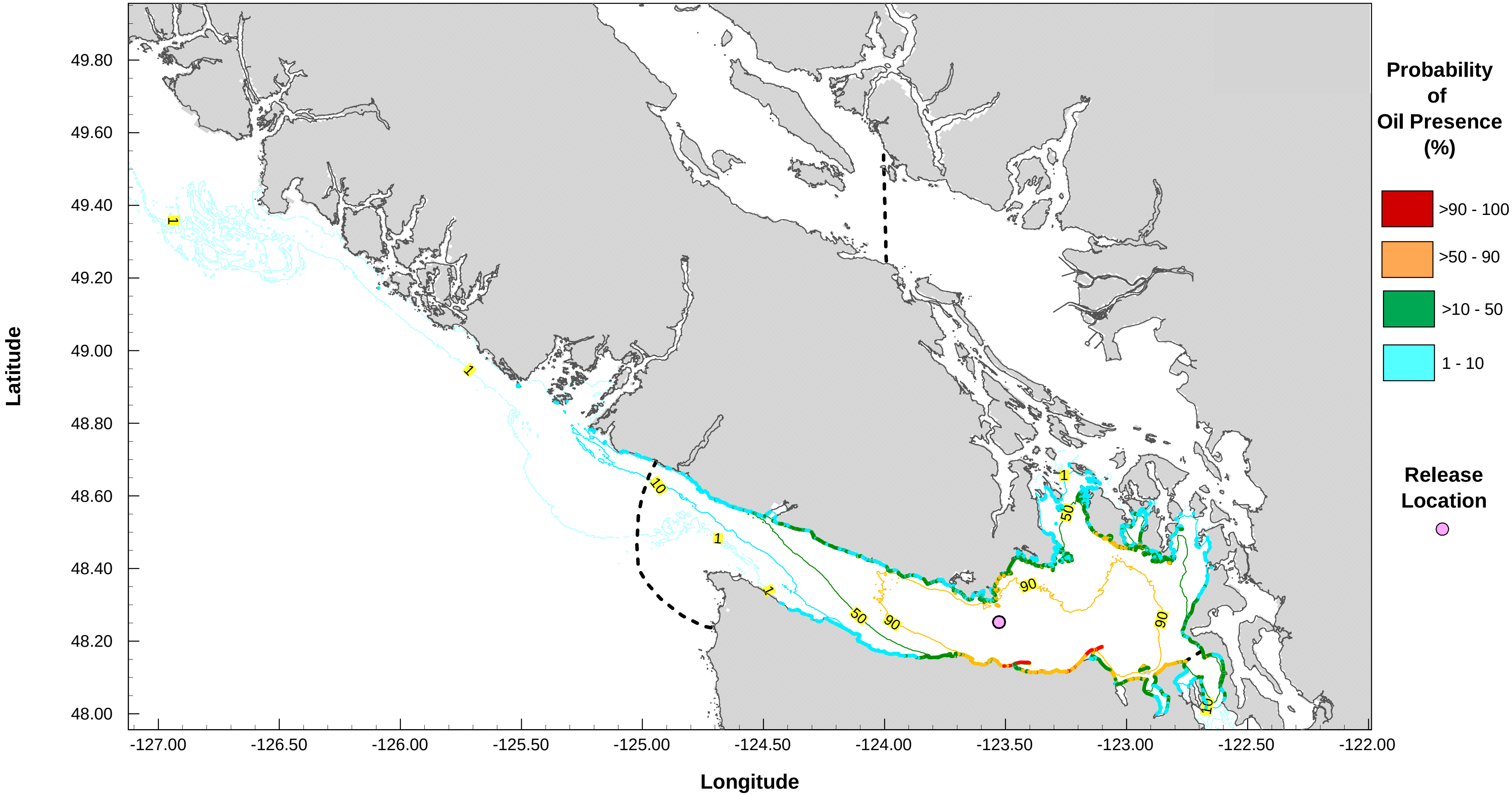
**Probability of Surface Oiling**

Stochastic oil fate modelling predictions indicate that a spill at the Race Rocks site has a high or very high probability (≥50 per cent) for potential surface oiling from a 16,500 $m^3$ spill to extend beyond the southern boundary of the RSA under winter, spring and fall conditions and to the west under the fall seasonal conditions (Figures 5.6.2.5 to 5.6.2.8). For an 8,250 $m^3$ spill, areas with high to very high probability of oiling extend south beyond the RSA only under winter conditions.

Overall the results for the high to very high probabilities of oiling for each scenario were quite similar, however some slight seasonal differences in the seasonal spill trajectories were identified for the lower probabilities, which are primarily due to variations in predominant current direction and speed, and/or predominant wind direction and speed.

Predicted high and very high probabilities of oiling were similar for each scenario and seasonal condition. Slight differences in the seasonal spill trajectories do exist and these primarily result from variations in predominant current or wind direction and speed. The highest probabilities for surface oiling were centered in the Juan de Fuca Strait around Race Rocks, west of the San Juan Islands and east of Canada's 12 nautical mile territorial limit.

Table 5.6.2.18 provides a summary of the predicted spatial extent of surface oiling ($km^2$) within the RSA for each spill volume and seasonal combination. Results are presented for each of three probability ranges (≥ 10 per cent, ≥50 per cent and ≥90 per cent). The release location and probability contours for seasonal stochastic surface oiling are shown in Figures 5.6.2.5 to 5.6.2.8 for a 16,500 $m^3$ spill. Comparable figures for an 8,250 $m^3$ spill are included in the Ecological Risk Assessment of Marine Transportation Spills Technical Report (Volume 8B, TR 8B-7).




## NOTES

- Statistical results based on independent spills occuring every 6 hours from January 1 00:00 to March 31 23:00, for a total of 364 independant spills.
- Probability of oil presence is the percentage of simulations in which oil was present at a given location on shoreline or on water surface.
- Tracking time for each spill was 15 days.

STATUS
ISSUED FOR USE

CLIENT

TRANSMOUNTAIN

eba
A TETRA TECH COMPANY

## TRANS MOUNTAIN OIL SPILL STUDY

**Probability of Oiling**
**Race Rocks Stochastic Simulation**
**16,500 m$^3$ Spill - Winter Season**

| PROJECT NO. | DWN | CKD | APVD | REV |
|---|---|---|---|---|
| V13203022 | AH | JAS | MS | 0 |

| OFFICE | DATE |
|---|---|
| EBA-VANC | December 9, 2013 |

**Figure 5.6.2-5**

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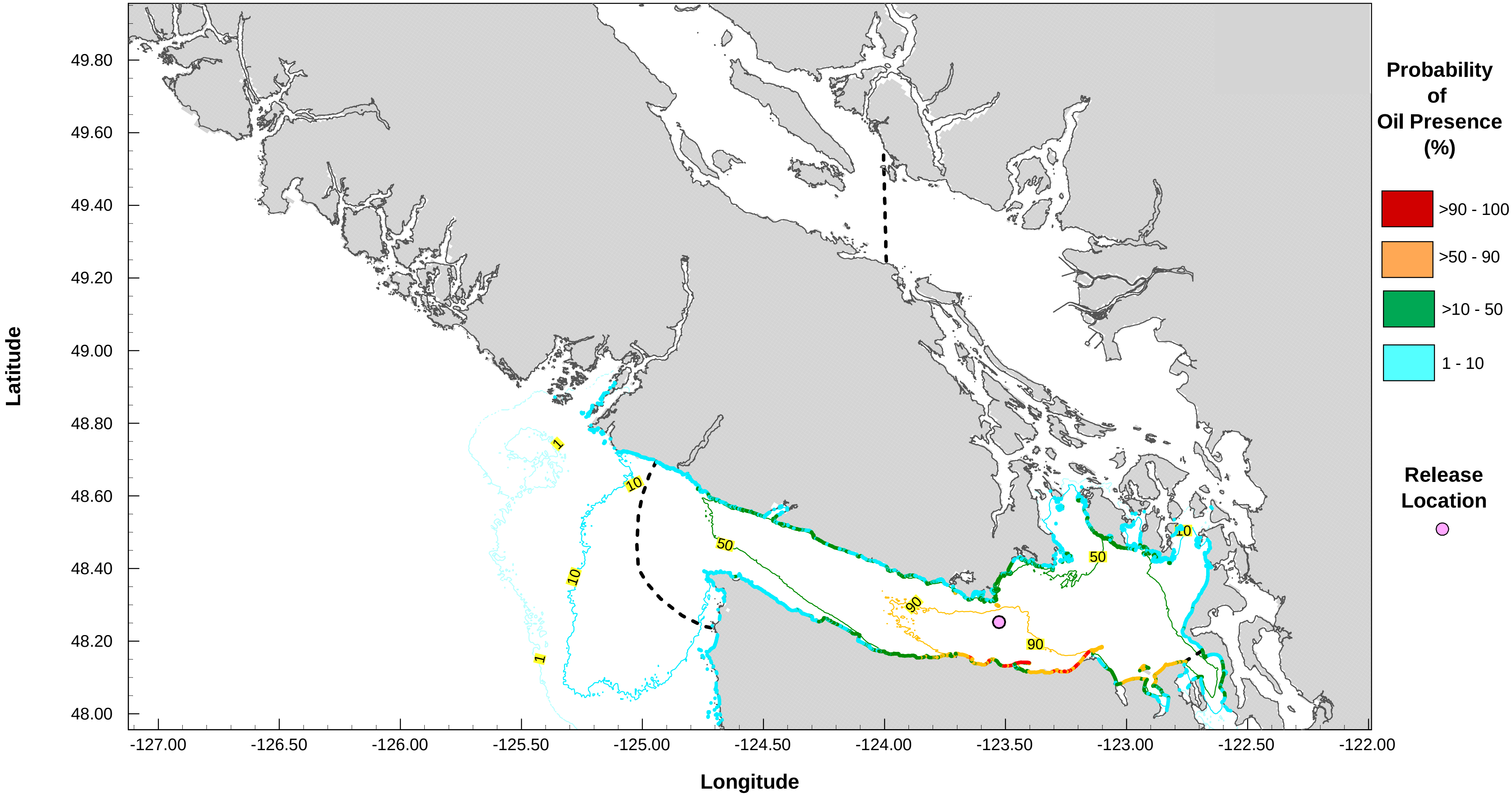
09 Dec 2013 09:50:48




## NOTES

- Statistical results based on independent spills occuring every 6 hours from April 1 00:00 to June 30 23:00, for a total of 364 independant spills.
- Probability of oil presence is the percentage of simulations in which oil was present at a given location on shoreline or on water surface.
- Tracking time for each spill was 15 days.

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**TRANS MOUNTAIN OIL SPILL STUDY**

**Probability of Oiling**
**Race Rocks Stochastic Simulation**
**16,500 m$^3$ Spill - Spring Season**

| PROJECT NO. | DWN | CKD | APVD | REV |
|---|---|---|---|---|
| V13203022 | AH | JAS | MS | 0 |

| OFFICE | DATE |
|---|---|
| EBA-VANC | December 9, 2013 |

**Figure 5.6.2-6**

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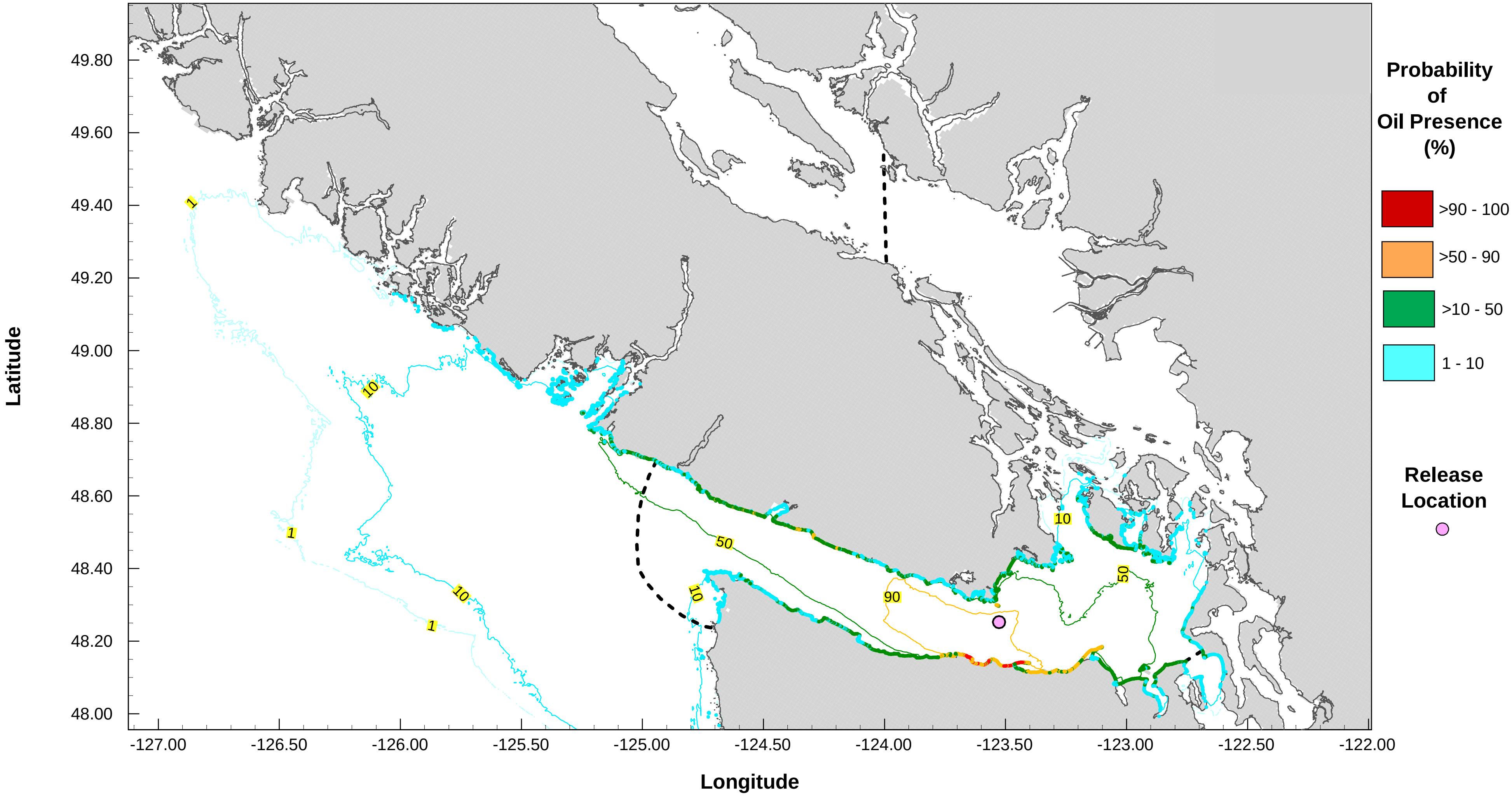


## NOTES

- Statistical results based on independent spills occuring every 6 hours from October 1 00:00 to December 31 23:00, for a total of 368 independant spills.
- Probability of oil presence is the percentage of simulations in which oil was present at a given location on shoreline or on water surface.
- Tracking time for each spill was 15 days.

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## TRANS MOUNTAIN OIL SPILL STUDY

**Probability of Oiling**
**Race Rocks Stochastic Simulation**
**16,500 $m^3$ Spill - Fall Season**

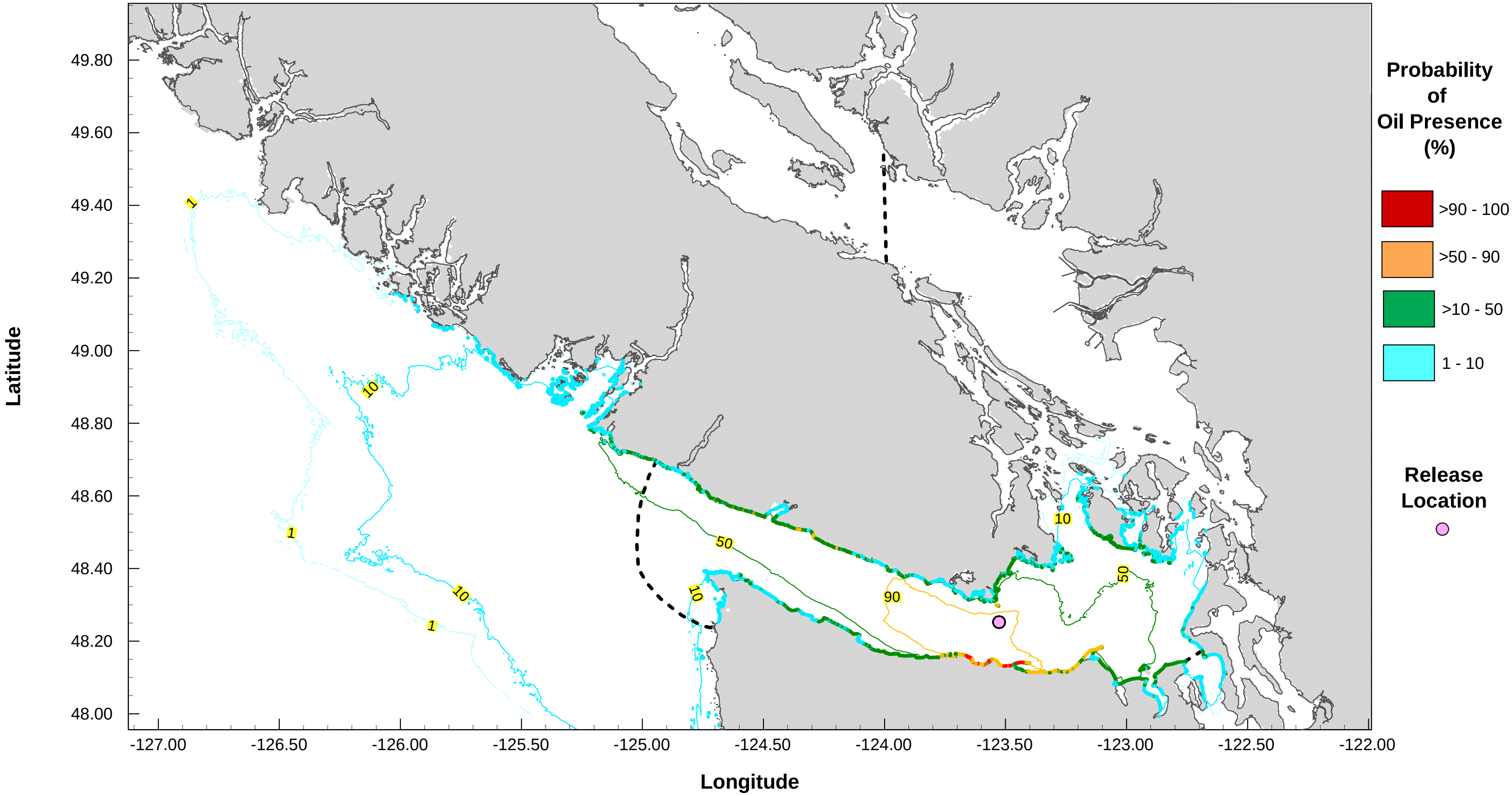
| PROJECT NO. | DWN | CKD | APVD | REV |
|---|---|---|---|---|
| V13203022 | AH | JAS | MS | 0 |

| OFFICE | DATE |
|---|---|
| EBA-VANC | December 9, 2013 |

**Figure 5.6.2-7**

T:\TMEP\working\AH\02-SPILLCALC\541-Stochastic_Race_Rocks_16500m3\Results_Fall\Tecplot\02-stochastic_map_lines_4Stantec.lay

09 Dec 2013 09:47:50




## NOTES

- Statistical results based on independent spills occuring every 6 hours from October 1 00:00 to December 31 23:00, for a total of 368 independant spills.

- Probability of oil presence is the percentage of simulations in which oil was present at a given location on shoreline or on water surface.

- Tracking time for each spill was 15 days.

STATUS
ISSUED FOR USE

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## TRANS MOUNTAIN OIL SPILL STUDY

**Probability of Oiling**
**Race Rocks Stochastic Simulation**
**16,500 $m^3$ Spill - Fall Season**

| PROJECT NO. | DWN | CKD | APVD | REV |
|---|---|---|---|---|
| V13203022 | AH | JAS | MS | 0 |

| OFFICE | DATE |
|---|---|
| EBA-VANC | December 9, 2013 |

**Figure 5.6.2-8**

T:\TMEP\working\AH\02-SPILLCALC\541-Stochastic_Race_Rocks_16500m3\Results_Fall\Tecplot\02-stochastic_map_lines_4Stantec.lay

09 Dec 2013 09:47:50

**TABLE 5.6.2.18**

**AREA OF SURFACE OILING (BY PROBABILITY OF OILING) – RACE ROCKS SCENARIOS (LOCATION G)**

| Scenario | Spill Volume ($m^3$) | Seasonal Condition | Maximum Average Slick Area ($km^2$) | Total Affected Surface Area ($km^2$) by Probability of Oiling | | |
|---|---|---|---|---|---|---|
| | | | | ≥ 10% | ≥ 50% | ≥ 90% |
| 1 | Credible Worst Case 16,500 $m^3$ | Winter | 353 | 4,398 | 3,382 | 1,849 |
| | | Spring | 295 | 5,244 | 3,486 | 701 |
| | | Summer | 265 | 4,964 | 2,549 | 310 |
| | | Fall | 375 | 5,158 | 3,058 | 651 |
| 2 | Smaller Spill Case 8,250 $m^3$ | Winter | 310 | 4,021 | 2,931 | 703 |
| | | Spring | 275 | 4,841 | 2,399 | 495 |
| | | Summer | 225 | 4,712 | 1,675 | 248 |
| | | Fall | 355 | 4,895 | 2,295 | 551 |

It is important to correctly interpret the data presented in Table 5.6.2.18. The values presented under the column headed "Maximum Average Slick Area ($km^2$)" indicate, for the average simulated spill, the largest sea surface area occupied by spilled oil at any point in time during the modelling run. When oil is spilled, the surface area of the slick increases rapidly to a maximum value, and then decreases as oil evaporates and strands on shorelines. Because an oil slick is moved around by tides and winds and is not static, the total area affected by the moving oil is greater than the predicted slick surface area at any given time. Therefore the values presented under the columns headed "Total Affected Surface Area ($km^2$)" indicate the predicted probability that an individual modelling sea surface grid area contained surface oil during at least one point in time. The three columns indicate the total area of sea surface affected by oil over the length of the oil spill simulation, at probability levels of ≥10 per cent, ≥50 per cent and ≥90 per cent, respectively. Accordingly, the areas presented in these columns of Table 5.6.2.3, and the same data represented by contour outlines in Figures 5.6.2.5 to 5.6.2.8 do not represent the surface area of a single, continuous oil slick.

Additional information on predicted spill fate and behaviour and mass balance is provided in Section 5.4.4 and Modeling the Fate and Behaviour of Marine Oil Spills for the Trans Mountain Expansion Project (Volume 8C, TR 8C, S9).

### Probability of Shoreline Contact

Table 5.6.2.19 provides a summary of predicted shoreline contact within the RSA. Results for the credible worst case spill indicate a high to very high probability (≥50 per cent) of between 114 km and 175 km of shoreline contact, with the greatest shoreline contact occurring during fall conditions. The smaller spill case predicts a high to very high probability of shoreline contact between 88 km and 124 km, with the greatest contact under spring conditions. Because oil that contacts shorelines tends to be retained on beach substrate, the average length of affected shoreline is more consistent with the total affected shoreline length at ≥50 per cent probability than was the case for water surface affected by oil.

**TABLE 5.6.2.19**

**LENGTH OF SHORELINE CONTACT (BY PROBABILITY OF OILING) – RACE ROCKS SCENARIOS (LOCATION G)**

| Scenario | Spill Volume ($m^3$) | Seasonal Condition | Average length of Affected Shoreline (km) | Total Affected Shoreline Length (km) by Probability of Oiling | | |
|---|---|---|---|---|---|---|
| | | | | ≥ 10% | ≥ 50% | ≥ 90% |
| 1 | Credible Worst Case 16,500 $m^3$ | Winter | 175 | 408 | 90 | 1.0 |
| | | Spring | 136 | 297 | 30 | 2.5 |
| | | Summer | 114 | 161 | 22 | 0.2 |
| | | Fall | 141 | 399 | 36 | 6.7 |
| 2 | Smaller Spill Case 8,250 $m^3$ | Winter | 124 | 289 | 33 | 0.5 |
| | | Spring | 99 | 186 | 24 | 0.9 |
| | | Summer | 88 | 115 | 17 | 0.1 |
| | | Fall | 112 | 301 | 25 | 0.8 |

The RSA includes approximately 4,130 km of shorelines. Based on this overall length, the modelling predicts the maximum shoreline contacted would be 33 km (0.8 per cent - smaller spill) to 90 km (2.2 per cent - credible worst case spill) of the RSA with high or very high probability. However, the average length of shoreline contact for a single oil spill ranges from 124 km (smaller spill) to 175 km (credible worst case spill) representing 3 per cent to 4.2 per cent of the shoreline within the RSA.

### 5.6.2.3.2 Shoreline Habitats

Section 5.6.2.2 provides a description and summary statistics for the length of each shoreline type in the RSA for each shoreline sensitivity class. Shoreline contact probability statistics for each shoreline sensitivity class for the for the Race Rocks spill scenarios are summarized in Tables 5.6.2.20 and 5.6.2.21 for a 16,500 $m^3$ and an 8,250 $m^3$ spill, respectively.

Shorelines with a high to very high probability of oiling (≥50 per cent) represent less than 3.4 per cent of the available habitat belonging to that sensitivity class within the RSA. Results indicate that shorelines with the lowest biological sensitivity factor (BSF 1) have the highest overall probability of oiling under winter conditions where between 3.4 per cent and 1.1 per cent of the available habitat may be affected for credible worst case and smaller spills respectively.

Stochastic results indicate that shoreline types with highest biological sensitivity factor (BSF 4) have a very low probability of being oiled, with the greatest spatial extent of oiling predicted at 0.2 km for a 16,500 $m^3$ spill, and 0.0 km of affected shoreline predicted for an 8,250 $m^3$ spill in this location. Therefore, it is highly unlikely that any individual oil spill originating at this location would result in oiling of these sensitive areas.

For the 16,500 $m^3$ spill, areas with high to very high probability of oiling (≥50 per cent) represent 0.7 per cent to 3.4 per cent of the total shoreline within the RSA assigned to BSF 1; 0.6 per cent to 1.3 per cent of the total shoreline within the RSA assigned to BSF 2; and 0.0 per cent to 0.2 per cent of the total shoreline within the RSA assigned to BSF 3.

## TABLE 5.6.2.20

## SUMMARY OF EFFECTS ANALYSIS FOR SHORELINE HABITATS – RACE ROCKS – 16,500 M$^3$ SPILL (LOCATION G)

| Seasonal Condition | BSF | Length in RSA (km) | Affected Shoreline (by Shoreline Oiling Probabilities) | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Affected Length According to Sensitivity Factor (km) | | | Percent Length According to Sensitivity Factor (%) | | |
| | | | Medium (≥ 10%) | High (≥ 50%) | Very High (≥ 90%) | Medium (≥ 10%) | High (≥ 50%) | Very High (≥ 90%) |
| Winter | 1 | 2,125 | 293 | 73.0 | 0.3 | 13.8 | 3.4 | 0.0 |
| | 2 | 1,120 | 89 | 15 | 0.7 | 8.0 | 1.3 | 0.1 |
| | 3 | 619 | 23 | 1.5 | 0.0 | 3.7 | 0.2 | 0.0 |
| | 4 | 266 | 3.4 | 0.5 | 0.0 | 1.3 | 0.2 | 0.0 |
| Spring | 1 | 2,125 | 223 | 21 | 1.8 | 10.5 | 1.0 | 0.1 |
| | 2 | 1,120 | 63 | 9.1 | 0.7 | 5.7 | 0.8 | 0.1 |
| | 3 | 619 | 8.6 | 0.5 | 0.0 | 1.4 | 0.1 | 0.0 |
| | 4 | 266 | 2.0 | 0.0 | 0.0 | 0.8 | 0.0 | 0.0 |
| Summer | 1 | 2,125 | 110 | 15 | 0.0 | 5.2 | 0.7 | 0.0 |
| | 2 | 1,120 | 44 | 6.5 | 0.2 | 3.9 | 0.6 | 0.0 |
| | 3 | 619 | 5.4 | 0.6 | 0.0 | 0.9 | 0.1 | 0.0 |
| | 4 | 266 | 2.3 | 0.0 | 0.0 | 0.9 | 0.0 | 0.0 |
| Fall | 1 | 2,125 | 308 | 24 | 6.1 | 14.5 | 1.1 | 0.3 |
| | 2 | 1,120 | 80 | 12 | 0.6 | 7.2 | 1.1 | 0.1 |
| | 3 | 619 | 11 | 0.2 | 0.0 | 1.8 | 0.0 | 0.0 |
| | 4 | 266 | 0.9 | 0.0 | 0.0 | 0.3 | 0.0 | 0.0 |

For the 8,250 m$^3$ spill, areas with high to very high probability of oiling (≥50 per cent) represent 0.6 per cent to 1.1 per cent of the total shoreline within the RSA assigned to BSF 1; 0.4 per cent to 0.9 per cent of the total shoreline within the RSA assigned to BSF 2; and 0.0 per cent to 0.1 per cent of the total shoreline within the RSA assigned to BSF 3.

## TABLE 5.6.2.21

## SUMMARY OF EFFECTS ANALYSIS FOR SHORELINE HABITATS – RACE ROCKS – 8,250 M$^3$ SPILL (LOCATION G)

| Seasonal Condition | BSF | Length in RSA (km) | Affected Shoreline (by Shoreline Oiling Probabilities) | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Affected Length According to Sensitivity Factor (km) | | | Percent Length According to Sensitivity Factor (%) | | |
| | | | Medium (≥ 10%) | High (≥ 50%) | Very High (≥ 90%) | Medium (≥ 10%) | High (≥ 50%) | Very High ( ≥90%) |
| Winter | 1 | 2,125 | 209 | 24 | 0.1 | 9.8 | 1.1 | 0.0 |
| | 2 | 1,120 | 63 | 8.8 | 0.4 | 5.6 | 0.8 | 0.0 |
| | 3 | 619 | 15 | 0.4 | 0.0 | 2.4 | 0.1 | 0.0 |
| | 4 | 266 | 2.4 | 0.0 | 0.0 | 0.9 | 0.0 | 0.0 |
| Spring | 1 | 2,125 | 133 | 17 | 0.2 | 6.2 | 0.8 | 0.0 |
| | 2 | 1,120 | 48 | 6.0 | 0.7 | 4.2 | 0.5 | 0.1 |
| | 3 | 619 | 4.7 | 0.4 | 0.0 | 0.8 | 0.1 | 0.0 |
| | 4 | 266 | 1.0 | 0.0 | 0.0 | 0.4 | 0.0 | 0.0 |

**TABLE 5.6.2.21**

**SUMMARY OF EFFECTS ANALYSIS FOR SHORELINE HABITATS – RACE ROCKS – 8,250 M$^3$ SPILL (LOCATION G) (continued)**

| Seasonal Condition | BSF | Length in RSA (km) | Affected Shoreline (by Shoreline Oiling Probabilities) | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Affected Length According to Sensitivity Factor (km) | | | Percent Length According to Sensitivity Factor (%) | | |
| | | | Medium (≥ 10%) | High (≥ 50%) | Very High (≥ 90%) | Medium (≥ 10%) | High (≥ 50%) | Very High ( ≥90%) |
| Summer | 1 | 2,125 | 77 | 12.8 | 0.0 | 3.6 | 0.6 | 0.0 |
| | 2 | 1,120 | 35 | 4.3 | 0.1 | 3.1 | 0.4 | 0.0 |
| | 3 | 619 | 2.4 | 0.1 | 0.0 | 0.4 | 0.0 | 0.0 |
| | 4 | 266 | 0.3 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 |
| Fall | 1 | 2,125 | 227 | 15 | 0.8 | 11 | 0.7 | 0.0 |
| | 2 | 1,120 | 66 | 10 | 0.0 | 5.9 | 0.9 | 0.0 |
| | 3 | 619 | 7.0 | 0.0 | 0.0 | 1.1 | 0.0 | 0.0 |
| | 4 | 266 | 0.9 | 0.0 | 0.0 | 0.3 | 0.0 | 0.0 |

Stochastic results for both spill scenarios indicate areas with a high to very high probability of oiling (≥50 per cent) from a spill at this location range from west of the Gulf Islands, south into US waters and throughout the Juan de Fuca Strait to the 12 nautical mile limit (refer to Figures 5.6.2.5 to 5.6.2.8). A number of ecological and socially important sites are located in this area, and prompt and effective response in the event of a spill would help reduce effects on shoreline habitats.

### 5.6.2.3.3 Marine Fish Community

Section 5.6.2.2 provides a description and summary statistics for the area of each type of marine fish community habitat within the RSA. Summaries of shoreline contact probability predictions for each marine fish sensitivity class are shown in Table 5.6.2.20 and Table 5.6.2.21 for the 16,500 m$^3$ and the 8,250 m$^3$ spills respectively.

For a 16,500 m$^3$ spill, areas with a high (≥50 per cent) probability of oiling represent: 26 per cent (under summer conditions) to 36 per cent (under spring conditions) of the total area with water depths >30 m (BSF 1); 15 per cent (under summer conditions) to 26 per cent (under winter conditions) of the total area with water depths between 10 m and 30 m (BSF 2); 7.7 per cent (under summer conditions) to 13 per cent (under winter conditions) of the total area with depths <10 m (BSF 3); and 1.6 per cent (under fall conditions) to 4 per cent (under winter conditions) of the very high sensitivity habitat for herring spawn, rockfish and crab. The overlap between surface oiling probability and marine fish community sensitivity for the 16,500 m$^3$ spill scenario is summarized in Table 5.6.2.22.

For the 8,250 m$^3$ spill, areas with a high (≥50 per cent) probability of oiling represent: 17 per cent (under summer conditions) to 29 per cent (under winter conditions) of the total area with water depths >30 m (BSF 1); 10 per cent (under summer conditions) to 22 per cent (under winter conditions) of the total area with water depths between 10 m and 30 m (BSF 2); 6.1 per cent (under fall conditions) to 9.8 per cent (under winter conditions) of the total area with depths <10 m (BSF 3); and 0.6 per cent (under fall conditions) to 2.8 per cent (under winter conditions) of the important habitat for herring spawn, rockfish and crab (BSF 4). The overlap between surface oiling probability and marine fish community sensitivity for the 8,250 m$^3$ spill is summarized in Table 5.6.2.23.

## TABLE 5.6.2.22

## SUMMARY OF EFFECTS ANALYSIS FOR THE MARINE FISH COMMUNITY – RACE ROCKS – 16,500 M$^3$ SPILL (LOCATION G)

| Seasonal Condition | BSF | Area in RSA (km$^2$) | Affected Surface Water (by Surface Water Oiling Probabilities) | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Area According to Sensitivity Factor (km$^2$) | | | Percent Area According to Sensitivity Factor (%) | | |
| | | | Medium (≥ 10%) | High (≥ 50%) | Very High (≥ 90%) | Medium (≥ 10%) | High (≥ 50%) | Very High (≥ 90%) |
| Winter | 1 | 8,636 | 3,675 | 2,899 | 1,654 | 43 | 34 | 20 |
| | 2 | 1,280 | 460 | 331 | 145 | 36 | 26 | 11 |
| | 3 | 1,196 | 263 | 152 | 50 | 22 | 13 | 4.2 |
| | 4 | 3,934 | 268 | 158 | 56 | 6.8 | 4.0 | 1.4 |
| Spring | 1 | 8,636 | 4,541 | 3,063 | 594 | 53 | 36 | 6.9 |
| | 2 | 1,280 | 442 | 298 | 75 | 35 | 23 | 5.9 |
| | 3 | 1,196 | 261 | 126 | 32 | 22 | 11 | 2.7 |
| | 4 | 3,934 | 233 | 85 | 0.6 | 5.9 | 2.1 | 0.0 |
| Summer | 1 | 8,636 | 4,321 | 2,267 | 263 | 50 | 26 | 3.0 |
| | 2 | 1,280 | 408 | 189 | 36 | 32 | 15 | 2.8 |
| | 3 | 1,196 | 234 | 93 | 11 | 20 | 7.7 | 0.9 |
| | 4 | 3,934 | 116 | 71 | 0.0 | 3.0 | 1.8 | 0.0 |
| Fall | 1 | 8,636 | 4,472 | 2,709 | 597 | 52 | 31 | 6.9 |
| | 2 | 1,280 | 426 | 250 | 38 | 33 | 20 | 3.0 |
| | 3 | 1,196 | 261 | 98 | 16 | 22 | 8.2 | 1.3 |
| | 4 | 3,934 | 193 | 64 | 0.0 | 4.9 | 1.6 | 0.0 |

## TABLE 5.6.2.23

## SUMMARY OF EFFECTS ANALYSIS FOR THE MARINE FISH COMMUNITY – RACE ROCKS – 8,250 M3 SPILL (LOCATION G)

| Seasonal Condition | BSF | Area in RSA (km$^2$) | Affected Surface Water (by Surface Water Oiling Probabilities) | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Area According to Sensitivity Factor (km$^2$) | | | Percent Area According to Sensitivity Factor (%) | | |
| | | | Medium (≥ 10%) | High (≥ 50%) | Very High (≥ 90%) | Medium (≥ 10%) | High (≥ 50%) | Very High (≥ 90%) |
| Winter | 1 | 8,636 | 3,381 | 2,529 | 608 | 39 | 29 | 7.0 |
| | 2 | 1,280 | 411 | 285 | 73 | 32.1 | 22 | 5.7 |
| | 3 | 1,196 | 229 | 117 | 23 | 19.1 | 9.8 | 1.9 |
| | 4 | 3,934 | 233 | 110 | 3.4 | 5.9 | 2.8 | 0.1 |
| Spring | 1 | 8,636 | 4,232 | 2,100 | 401 | 49 | 24 | 4.6 |
| | 2 | 1,280 | 393 | 210 | 67 | 31 | 16 | 5.2 |
| | 3 | 1,196 | 215 | 89 | 27 | 18 | 7.4 | 2.3 |
| | 4 | 3,934 | 192 | 66 | 0.6 | 4.9 | 1.7 | 0.0 |
| Summer | 1 | 8,636 | 4,111 | 1,467 | 210 | 48 | 17 | 2.4 |
| | 2 | 1,280 | 392 | 130 | 30 | 30.6 | 10 | 2.3 |
| | 3 | 1,196 | 203 | 78 | 8.4 | 17.0 | 6.5 | 0.7 |
| | 4 | 3,934 | 110 | 46 | 0.0 | 2.8 | 1.2 | 0.0 |
| Fall | 1 | 8,636 | 4,253 | 2,045 | 506 | 49.2 | 24 | 5.9 |
| | 2 | 1,280 | 408 | 177 | 31 | 31.9 | 14 | 2.4 |
| | 3 | 1,196 | 234 | 73 | 14 | 19.6 | 6.1 | 1.2 |
| | 4 | 3,934 | 174 | 24 | 0.0 | 4.4 | 0.6 | 0.0 |

Of a total of 8,635 $km^2$ of deep water habitat (>30 m) in the RSA (BSF 1), between 26 per cent and 36 per cent of this habitat type within the RSA has a high or very high (≥50 per cent) probability of oil exposure from a 16,500 $m^3$ spill. Between 17 per cent and 29 per cent has a high or very high probability of oil exposure from an 8,250 $m^3$ spill. While these ranges represent a comparatively large portion of this habitat type, it is very unlikely that fish in this habitat type would be harmed by exposure to oil due to water depth.

A predicted range of 15 per cent to 26 per cent of the total of 1,280 $km^2$ of intermediate depth habitat (<30 to ≥ 10) in the RSA (BSF 2) has a high or very high (≥50 per cent) probability of oil exposure from a 16,500 $m^3$ spill. Between 10 per cent and 22 per cent of this medium sensitivity habitat in the RSA has a high or very high probability of oil exposure from an 8,250 $m^3$ spill. As with deep water habitat, given the water depth this sensitivity rank represents, it is also very unlikely that fish would be harmed by exposure to oil in this habitat type.

Between 7.7 per cent and 13 per cent of the RSA total of 1,196 $km^2$ of high sensitivity (BSF 3) shallow water habitat (≤10 m) has a high or very high (≥50 per cent) probability of oil exposure from a 16,500 $m^3$ spill. Predictions for the smaller spill scenario indicate that between 7.7 per cent and 13 per cent of this habitat type within the RSA has a high or very high probability of oil exposure. In circumstances where oil is driven into this shallow water habitat by strong winds, there would be a greater potential for negative effects, including potential mortality of fish, crustaceans and shellfish.

Of a total of 3,934 $km^2$ of RSA habitat with a very high biological sensitivity (BSF 4), between 1.6 per cent and 4.0 per cent has a high or very high (≥50 per cent) probability of oil exposure from a 16,500 $m^3$ spill, and between 0.6 per cent and 2.8 per cent has a high or very high probability of oil exposure from an 8,250 $m^3$ spill. In areas where this very high-sensitivity habitat overlaps with shallow water areas, the potential for negative effects would be greater. Critical time periods for herring spawn would be in the spring, when exposure to PAH in the oil could cause developmental effects on fish embryos. As noted for shallow water habitat, the potential for negative effects would be greatest if the spill were to occur at a time when strong winds cause the oil to be driven into shallow water used as spawning or nursery areas for herring, rockfish or crab.

#### 5.6.2.3.4 Marine Birds

The same two approaches discussed in Section 5.6.2.2 were applied to Race Rocks for the marine bird assessment. The first assumes that marine birds could generally be present anywhere within the RSA and the potential for shorebirds and other marine birds to be affected was estimated using the stochastic shoreline contact and surface contours, respectively. The second approach considers the potential for spilled crude oil to come into contact with known bird colonies and designated IBAs.

The habitat oiling probability for each marine bird sensitivity group is summarized in Tables 5.6.2.24 and 5.6.2.25 for 16,500 $m^3$ spills and 8,250 $m^3$ spills respectively. For shorebirds (BSF 1), potential exposure is determined by the length of shoreline predicted to have a high or very high probability of oiling. For a 16,500 $m^3$ spill, the seasonal variation in spatial extent represents between 22 km (0.5 per cent) and 90 km (2.2 per cent) of the available shoreline habitat within the RSA. For an 8,250 $m^3$ spill, the predicted length of affected shoreline is ranges between 17 km (0.4 per cent) and 33 km (0.8 per cent) of the available shoreline habitat. Shorebirds generally have low sensitivity to oiling when compared to other guilds, and it is unlikely that lightly oiled individuals would die as a result of low or moderate exposure. Heavily oiled individuals would probably die; however, and even lightly oiled individuals could transfer sufficient oil to eggs to cause egg mortality, if exposure occurred shortly before or during the period when eggs were being incubated. An oil spill that occurred at the Race Rocks site would be physically close to the shorelines of the Juan de Fuca Strait which exhibits areas with medium, high and very high probability of oiling. Therefore, the potential for environmental effects on shorebirds of crude oil exposure from an accidental spill at this site is high.

For other marine birds (BSF 2, BSF 3, and BSF 4), potential exposure is based on surface water oiling. The seasonal variation in spatial extent for a 16,500 $m^3$ spill represents between 23 per cent and 31 per cent of the available habitat for these receptors, while for an 8,250 $m^3$ spill, between 15 per cent and 26 per cent of the RSA habitat is predicted to be affected. Therefore, there is a relatively high probability of exposure for aquatic birds in the event that an oil spill occurs. The environmental effects and effect magnitude of such exposure would depend upon the season (which would determine the numbers and types of birds present) as well as the actual level and duration of exposure, and the relative sensitivity of the exposed birds. Gulls and terns tend to have medium sensitivity, whereas ducks, cormorants, divers and alcids tend to have high to very high sensitivity. However, regardless of these factors, it is likely that seabirds would be exposed to oil, and would die as a result of that exposure, so that the effect magnitude would be high.

### TABLE 5.6.2.24

### SUMMARY OF EFFECTS ANALYSIS FOR MARINE BIRDS – RACE ROCKS – 16,500 $M^3$ SPILL (LOCATION G)

| Seasonal Condition | BSF | Length or Area in RSA (km or $km^2$) | Affected Surface Water (by Shoreline or Surface Water Oiling Probabilities) | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Affected Length or Area According to Sensitivity Factor (km or $km^2$) | | | Percent Length or Area According to Sensitivity Factor (%) | | |
| | | | Medium (≥ 10%) | High (≥ 50%) | Very High (≥ 90%) | Medium (≥ 10%) | High (≥ 50%) | Very High (≥ 90%) |
| Winter | 1 | 4,130 [1] | 408 [1] | 90 [1] | 1.0 [1] | 9.9 [2] | 2.2 [2] | <0.1 [2] |
| | 2 | | | | | | | |
| | 3 | 11,112 | 4,398 | 3,382 | 1,849 | 40 | 30 | 17 |
| | 4 | | | | | | | |
| Spring | 1 | 4,130 [1] | 297 [1] | 30 [1] | 2.5 [1] | 7.2 [2] | 0.7 [2] | 0.1 [2] |
| | 2 | | | | | | | |
| | 3 | 11,112 | 5,244 | 3,486 | 701 | 47 | 31 | 6.3 |
| | 4 | | | | | | | |
| Summer | 1 | 4,130 [1] | 161 [1] | 22 [1] | 0.2 [1] | 3.9 [2] | 0.5 [2] | <0.1 [2] |
| | 2 | | | | | | | |
| | 3 | 11,112 | 4,964 | 2,549 | 310 | 45 | 23 | 2.8 |
| | 4 | | | | | | | |
| Fall | 1 | 4,130 [1] | 400 [1] | 36 [1] | 6.7 [1] | 9.7 [2] | 0.9 [2] | 0.2 [2] |
| | 2 | | | | | | | |
| | 3 | 11,112 | 5,158 | 3,058 | 651 | 46 | 28 | 5.9 |
| | 4 | | | | | | | |

**Notes:** 1 Total length of shoreline in the RSA, or length affected (km).

2 Expressed as % length of shoreline in that sensitivity class.

**TABLE 5.6.2.25**

**SUMMARY OF EFFECTS ANALYSIS FOR MARINE BIRDS AND MARINE BIRD HABITATS – RACE ROCKS – 8,250 $M^3$ SPILL (LOCATION G)**

<table>
<tr><th rowspan="3">Seasonal Condition</th><th rowspan="3">BSF</th><th rowspan="3">Length or Area in RSA (km or km$^2$)</th><th colspan="6">Affected Surface Water (by Shoreline or Surface Water Oiling Probabilities)</th></tr>
<tr><th colspan="3">Affected Length or Area According to Sensitivity Factor (km or km$^2$)</th><th colspan="3">Percent Length or Area According to Sensitivity Factor (%)</th></tr>
<tr><th>Medium (≥ 10%)</th><th>High (≥ 50%)</th><th>Very High (≥ 90%)</th><th>Medium (≥ 10%)</th><th>High (≥ 50%)</th><th>Very High (≥ 90%)</th></tr>
<tr><td rowspan="4">Winter</td><td>1</td><td>4,130 [1]</td><td>289 [1]</td><td>33 [1]</td><td>0.5 [1]</td><td>7.0 [2]</td><td>0.8 [2]</td><td><0.1 [2]</td></tr>
<tr><td>2</td><td rowspan="3">11,112</td><td rowspan="3">4,021</td><td rowspan="3">2,931</td><td rowspan="3">703</td><td rowspan="3">36</td><td rowspan="3">26</td><td rowspan="3">6.3</td></tr>
<tr><td>3</td></tr>
<tr><td>4</td></tr>
<tr><td rowspan="4">Spring</td><td>1</td><td>4,130 [1]</td><td>186 [1]</td><td>24 [1]</td><td>0.9 [1]</td><td>4.5 [2]</td><td>0.6 [2]</td><td><0.1 [2]</td></tr>
<tr><td>2</td><td rowspan="3">11,112</td><td rowspan="3">4,841</td><td rowspan="3">2,399</td><td rowspan="3">495</td><td rowspan="3">44</td><td rowspan="3">22</td><td rowspan="3">4.5</td></tr>
<tr><td>3</td></tr>
<tr><td>4</td></tr>
<tr><td rowspan="4">Summer</td><td>1</td><td>4,130 [1]</td><td>115 [1]</td><td>17 [1]</td><td>0.1 [1]</td><td>2.8 [2]</td><td>0.4 [2]</td><td><0.1 [2]</td></tr>
<tr><td>2</td><td rowspan="3">11,112</td><td rowspan="3">4,712</td><td rowspan="3">1,675</td><td rowspan="3">248</td><td rowspan="3">42</td><td rowspan="3">15</td><td rowspan="3">2.2</td></tr>
<tr><td>3</td></tr>
<tr><td>4</td></tr>
<tr><td rowspan="4">Fall</td><td>1</td><td>4,130 [1]</td><td>300 [1]</td><td>25 [1]</td><td>0.8 [1]</td><td>7.3 [2]</td><td>0.6 [2]</td><td><0.1 [2]</td></tr>
<tr><td>2</td><td rowspan="3">11,112</td><td rowspan="3">4,895</td><td rowspan="3">2,295</td><td rowspan="3">551</td><td rowspan="3">44</td><td rowspan="3">21</td><td rowspan="3">5.0</td></tr>
<tr><td>3</td></tr>
<tr><td>4</td></tr>
</table>

**Notes:** 1 Total length of shoreline in the RSA, or length affected (km).
2 Expressed as % length of shoreline in that sensitivity class.

Stochastic modeling results were used to identify areas of medium (≥10 per cent), high (≥50 per cent), and very high (≥90 per cent) probability for spilled crude oil extending to known colony locations. The number of known colonies affected for each of the marine bird BSF rankings are summarized in Tables 5.6.2.26 and 5.6.2.27 for 16,500 m$^3$ spills and 8,250 m$^3$ spills respectively.

For gulls and terns (BSF 2), potential effects on colonies are determined by identifying the probability that crude oil will contact these areas if spilled during the spring or summer seasons. For a 16,500 m$^3$ spill, crude oil is predicted to have high to very high probability (≥50 per cent) to contact up to 2 of the 79 known colonies. For an 8,250 m$^3$ spill, this is predicted to represent none of the 79 known colonies.

For ducks and cormorants (BSF 3), under both 16,500 m$^3$ and 8,250 m$^3$ spill scenarios, crude oil is predicted to have high to very high (≥50 per cent) probability to come in contact with 1 of the 40 known colonies.

For auks and divers (BSF 4), the 16,500 m$^3$ spill, crude oil is predicted to have high to very high (≥50 per cent) probability to come in contact with 3 or 4 of the 55 known colonies. For the 8,250 m$^3$ spill, this is predicted to represent 2 or 3 of the 55 known colonies.

The presence of seabirds at colony locations is seasonal, and the overlap of oil with a colony location does not necessarily indicate that seabirds at nest sites will experience oiling, as their feeding grounds may be located at some distance from the nest site. However, even though low overlap of high probability surface oiling areas with known seabird colony locations is predicted (whether representing gulls and terns, ducks and cormorants, or auks and divers), results indicate potential for negative effects, up to and including mortality of birds or oiling and mortality of eggs at some sites. The effect rating is high for Race Rocks scenarios.

**TABLE 5.6.2.26**

**SUMMARY OF EFFECTS ANALYSIS FOR MARINE BIRD COLONIES – RACE ROCKS – 16,500 M³ SPILL (LOCATION G)**

| Seasonal Condition | BSF | Affected Marine Bird Colonies (by Surface Water Oiling Probabilities) | | |
|---|---|---|---|---|
| | | Medium (≥ 10%) | High (≥ 50%) | Very High (≥ 90%) |
| Spring | 1 | --- | --- | --- |
| | 2 | 12 of 79 known colony sites affected. | 2 of 79 known colony sites affected. | 0 of 79 known colony sites affected. |
| | 3 | 16 of 40 known colony sites affected. | 1 of 40 known colony sites affected. | 0 of 40 known colony sites affected. |
| | 4 | 17 of 55 known colony sites affected. | 4 of 55 known colony sites affected. | 1 of 55 known colony sites affected. |
| Summer | 1 | --- | --- | --- |
| | 2 | 14 of 79 known colony sites affected. | 0 of 79 known colony sites affected. | 0 of 79 known colony sites affected. |
| | 3 | 14 of 40 known colony sites affected. | 1 of 40 known colony sites affected. | 0 of 40 known colony sites affected. |
| | 4 | 13 of 55 known colony sites affected. | 3 of 55 known colony sites affected. | 0 of 55 known colony sites affected. |

**TABLE 5.6.2.27**

**SUMMARY OF EFFECTS ANALYSIS FOR MARINE BIRD COLONIES – RACE ROCKS – 8,250 M³ SPILL (LOCATION G)**

| Seasonal Condition | BSF | Affected Marine Bird Colonies (by Surface Water Oiling Probabilities) | | |
|---|---|---|---|---|
| | | Medium (≥ 10%) | High (≥ 50%) | Very High (≥ 90%) |
| Spring | 1 | --- | --- | --- |
| | 2 | 7 of 79 known colony sites affected. | 0 of 79 known colony sites affected. | 0 of 79 known colony sites affected. |
| | 3 | 10 of 40 known colony sites affected. | 1 of 40 known colony sites affected. | 0 of 40 known colony sites affected. |
| | 4 | 12 of 55 known colony sites affected. | 3 of 55 known colony sites affected. | 0 of 55 known colony sites affected. |
| Summer | 1 | --- | --- | --- |
| | 2 | 9 of 79 known colony sites affected. | 0 of 79 known colony sites affected. | 0 of 79 known colony sites affected. |
| | 3 | 9 of 40 known colony sites affected. | 1 of 40 known colony sites affected. | 0 of 40 known colony sites affected. |
| | 4 | 11 of 55 known colony sites affected. | 2 of 55 known colony sites affected. | 0 of 55 known colony sites affected. |

Stochastic modeling results were used to identify areas of medium (≥10 per cent), high (≥50 per cent), and very high (≥ 90 per cent) probability for spilled crude oil extending to IBA locations. The number of IBAs affected are summarized in Tables 5.6.2.28 and 5.6.2.29 for 16,500 $m^3$ spills and 8,250 $m^3$ spills respectively.

There are 10 IBAs that have ≥10 per cent probability of being affected by spilled crude oil, in the event of a credible worst case or smaller oil spill at the Race Rocks hypothetical spill location. Of these, 8 and 7, respectively, have a high or very high probability (≥50 per cent) of oil exposure in the event of the credible worst case or smaller spill. The utilization of IBAs by seabirds and other birds is seasonal, but most IBAs are used by one or more species in any season. It is likely that oil exposure at an IBA would result in oiling of birds, with a high potential for mortality of adults, juveniles, and/or eggs in the event of oil being transferred from plumage to incubating eggs. Given the high potential for negative effects on seabirds at IBAs, the effect magnitude is high.

**TABLE 5.6.2.28**

**SUMMARY OF EFFECTS ANALYSIS FOR IMPORTANT BIRD AREAS – RACE ROCKS – 16,500 M³ SPILL (LOCATION G)**

| IBA | Highest Oiling Probability (by seasonal condition) | | | |
|---|---|---|---|---|
| | Winter | Spring | Summer | Fall |
| **Canada** | | | | |
| BC045 | ≥ 50% | ≥ 10% | ≥ 10% | ≥ 10% |
| BC047 | ≥ 10% | ≥ 10% | --- | --- |
| BC073 | ≥ 10% | ≥ 50% | ≥ 10% | ≥ 50% |
| BC097 | ≥ 10% | ≥ 10% | ≥ 10% | ≥ 50% |
| **United States** | | | | |
| USWA 282 | ≥ 50% | ≥ 10% | ≥ 10% | ≥ 10% |
| USWA 288 | ≥ 90% | ≥ 50% | ≥ 50% | ≥ 50% |
| USWA 3289 | ≥ 10% | ≥ 10% | --- | --- |
| USWA 3348 | ≥ 90% | ≥ 90% | ≥ 90% | ≥ 90% |
| USWA 3351 | ≥ 90% | ≥ 90% | ≥ 90% | ≥ 90% |
| USWA 3786 | ≥ 90% | ≥ 50% | ≥ 50% | ≥ 50% |

**TABLE 5.6.2.29**

**SUMMARY OF EFFECTS ANALYSIS FOR IMPORTANT BIRD AREAS – RACE ROCKS – 8,250 M³ SPILL (LOCATION G)**

| IBA | Highest Oiling Probability (by seasonal condition) | | | |
|---|---|---|---|---|
| | Winter | Spring | Summer | Fall |
| **Canada** | | | | |
| BC045 | ≥ 50% | ≥ 10% | ≥ 10% | ≥ 10% |
| BC047 | ≥ 10% | --- | --- | --- |
| BC073 | ≥ 10% | ≥ 10% | ≥ 10% | ≥ 50% |
| BC097 | --- | ≥ 10% | ≥ 10% | ≥ 50% |
| **United States** | | | | |
| USWA 282 | ≥ 10% | ≥ 10% | --- | ≥ 10% |
| USWA 288 | ≥ 50% | ≥ 50% | ≥ 50% | ≥ 10% |
| USWA 3348 | ≥ 90% | ≥ 90% | ≥ 90% | ≥ 90% |
| USWA 3351 | ≥ 90% | ≥ 90% | ≥ 90% | ≥ 90% |
| USWA 3786 | ≥ 50% | ≥ 50% | ≥ 10% | ≥ 10% |

#### 5.6.2.3.5 Marine Mammals

Stochastic results identify areas of medium (≥10 per cent), high (≥50 per cent), and very high (≥90 per cent), exposure probability for each class of mammals. The overlap between habitat oiling probabilities for each mammal sensitivity class are summarized in Tables 5.6.2.30 and 5.6.2.31 for 16,500 $m^3$ spills and 8,250 $m^3$ spills, respectively.

For terrestrial mammals (*e.g.,* bears, moose, raccoon, etc., BSF 1), potential exposure is determined by the length of shoreline habitat predicted to have a high or very high probability of oiling. For a 16,500 $m^3$ spill, the seasonal variation in spatial extent represents between 22 km (0.5 per cent) and 90 km (2.2 per cent) of the available shoreline habitat; this drops slightly to between 17 km (0.4 per cent) and 33 km (0.8 per cent) for an 8,250 $m^3$ spill. These animals have generally low sensitivity to oiling, and it is unlikely that oiled individuals would die as a result of exposure. It is very unlikely that such exposure would result in a measurable effect at the population level.

For pinnipeds such as seals and sea lions (BSF 2), potential exposure is based on habitat having a water depth of ≤30m. The seasonal variation in likely spatial extent for a 16,500 $m^3$ spill affecting pinniped habitat represents 11 per cent to 20 per cent of the available habitat, whereas for an 8,250 $m^3$ spill, between 8.4 per cent and 16 per cent of the habitat could be affected. Therefore, there is a relatively high probability of exposure for seals and sea lions in the event of an accidental oil spill. While some level of negative effect would be expected for animals exposed to oil, the effects would not likely be lethal, except in the case of weaker animals such as pups or older and diseased animals.

For whales such as porpoises, or the humpback and southern resident killer whale (BSF 3), potential exposure is based on habitat having a water depth of ≥10m. For a 16,500 $m^3$ spill, the seasonal variation in the predicted area of affected habitat ranges between 34 per cent and 46 per cent of the RSA. The predictions for an 8,250 $m^3$ spill range between 22 and 39 per cent of the available habitat. Therefore, there is a relatively high probability of exposure for whales should an oil spill occur at this location. Some level of negative effect would be expected for animals exposed to oil, but the effects would not likely be lethal, except in the case of weaker animals such as calves or older and diseased animals, or animals that were exposed to heavy surface oiling and inhalation of vapours from fresh oil, as could occur in the immediate vicinity of the spill location.

For furred marine mammals such as otters (BSF 4), potential exposure is based on the available habitat represented by water depths along the coast of ≤10 m. The seasonal variation in spatial extent for a 16,500 $m^3$ spill for this receptor type represents between 7.7 per cent and 13 per cent of the available habitat, while for an 8,250 $m^3$ spill, between 6.1 per cent and 9.8 per cent of the habitat is predicted to be affected. Therefore there is a relatively high probability of exposure for some of otters along the marine transportation route, in the event of an oil spill. Some level of negative effect would be expected for animals exposed to oil. Exposure during the winter season would be more stressful than exposure during the summer, but in either case, the combination of hypothermia and damage to the gastro-intestinal system caused by oil ingested through grooming the fur would have the potential to cause death.

## TABLE 5.6.2.30

## SUMMARY OF EFFECTS ANALYSIS FOR MARINE MAMMALS – RACE ROCKS – 16,500 $M^3$ SPILL (LOCATION G)

| Seasonal Condition | BSF | Area in RSA ($km^2$) | Affected Surface Water (by Probability of Oiling) | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Area (or length) According to Sensitivity Factor ($km^2$) | | | Percent Area (or length) According to Sensitivity Factor (%) | | |
| | | | Medium (≥ 10%) | High (≥ 50%) | Very High (≥ 90%) | Medium (≥10%) | High (≥ 50%) | Very High (≥ 90%) |
| Winter | 1 | 4,130 [1] | 408 [1] | 90 [1] | 1.0 [1] | 9.9 [2] | 2.2 [2] | 0.02 [2] |
| | 2 | 2,476 | 723 | 483 | 195 | 29 | 20 | 7.9 |
| | 3 | 7,578 | 4,341 | 3,382 | 1,849 | 57 | 45 | 24 |
| | 4 | 1,196 | 263 | 152 | 50 | 22 | 13 | 4.2 |
| Spring | 1 | 4,130 [1] | 297 [1] | 30 [1] | 2.5 [1] | 7.2 [2] | 0.73 [2] | 0.1 [2] |
| | 2 | 2,476 | 703 | 424 | 107 | 28 | 17 | 4.3 |
| | 3 | 7,578 | 4,832 | 3,486 | 701 | 64 | 46 | 9.3 |
| | 4 | 1,196 | 261 | 126 | 32 | 22 | 11 | 2.7 |
| Summer | 1 | 4,130 [1] | 161 [1] | 22 [1] | 0.2 [1] | 3.9 [2] | 0.5 [2] | 0.0 [2] |
| | 2 | 2,476 | 643 | 282 | 47 | 26 | 11 | 1.9 |
| | 3 | 7,578 | 4,523 | 2,549 | 310 | 60 | 34 | 4.1 |
| | 4 | 1,196 | 234 | 93 | 11 | 20 | 7.7 | 0.9 |
| Fall | 1 | 4,130 [1] | 400 [1] | 36 [1] | 6.7 [1] | 9.7 [2] | 0.9 [2] | 0.2 [2] |
| | 2 | 2,476 | 687 | 349 | 54 | 28 | 14 | 2.2 |
| | 3 | 7,578 | 4,816 | 3,058 | 651 | 64 | 40 | 8.6 |
| | 4 | 1,196 | 261 | 98 | 16 | 22 | 8.2 | 1.3 |

**Notes:** 1 Total length of shoreline in the RSA, or length affected (km).

2 Expressed as % length of shoreline in that sensitivity class.

## TABLE 5.6.2.31

## SUMMARY OF EFFECTS ANALYSIS FOR MARINE MAMMALS – RACE ROCKS – 8,250 $M^3$ SPILL (LOCATION G)

| Seasonal Condition | BSF | Area in RSA ($km^2$) | Affected Surface Water (by Probability of Oiling) | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Area (or length) According to Sensitivity Factor ($km^2$) | | | Percent Area (or length) According to Sensitivity Factor (%) | | |
| | | | Medium (≥ 10%) | High (≥ 50%) | Very High (≥ 90%) | Medium (≥ 10%) | High (≥ 50%) | Very High (≥ 90%) |
| Winter | 1 | 4,130 [1] | 289 [1] | 33 [1] | 0.5 [1] | 7.0 [2] | 0.8 [2] | 0.01 [2] |
| | 2 | 2,476 | 640 | 402 | 95 | 26 | 16 | 3.9 |
| | 3 | 7,578 | 3,992 | 2,931 | 703 | 53 | 39 | 9.3 |
| | 4 | 1,196 | 229 | 116.9 | 23 | 19 | 9.8 | 1.9 |
| Spring | 1 | 4,130 [1] | 186 [1] | 24 [1] | 0.9 [1] | 4.5 [2] | 0.6 [2] | 0.02 [2] |
| | 2 | 2,476 | 609 | 299 | 95 | 25 | 12 | 3.8 |
| | 3 | 7,578 | 4,614 | 2,399 | 495 | 61 | 32 | 6.5 |
| | 4 | 1,196 | 215 | 89 | 27 | 18 | 7.4 | 2.3 |
| Summer | 1 | 4,130 [1] | 115 [1] | 17 [1] | 0.1 [1] | 2.8 [2] | 0.4 [2] | 0.0 [2] |
| | 2 | 2,476 | 595 | 208 | 38 | 24 | 8.4 | 1.5 |
| | 3 | 7,578 | 4,288 | 1,675 | 248 | 57 | 22 | 3.3 |
| | 4 | 1,196 | 203 | 78 | 8.4 | 17 | 6.5 | 0.7 |

**TABLE 5.6.2.31**

**SUMMARY OF EFFECTS ANALYSIS FOR MARINE MAMMALS – RACE ROCKS – 8,250 $M^3$ SPILL (LOCATION G) (continued)**

| Seasonal Condition | BSF | Area in RSA ($km^2$) | Affected Surface Water (by Probability of Oiling) | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Area (or length) According to Sensitivity Factor ($km^2$) | | | Percent Area (or length) According to Sensitivity Factor (%) | | |
| | | | Medium (≥ 10%) | High (≥ 50%) | Very High (≥ 90%) | Medium (≥ 10%) | High (≥ 50%) | Very High (≥ 90%) |
| Fall | 1 | 4,130 [1] | 301 [1] | 25 [1] | 0.8 [1] | 7.3 [2] | 0.6 [2] | 0.02 [2] |
| | 2 | 2,476 | 642 | 250 | 46 | 26 | 10 | 1.8 |
| | 3 | 7,578 | 4,632 | 2,295 | 551 | 61 | 30 | 7.3 |
| | 4 | 1,196 | 234 | 73 | 14 | 20 | 6.1 | 1.2 |

**Notes:** 1 Total length of shoreline in the RSA, or length affected (km).

2 Expressed as % length of shoreline in that sensitivity class.

### *5.6.2.4 Location E: Arachne Reef*

The Arachne Reef (Location E; Turn Point Special Operating Area) credible worst case and smaller spill scenarios are described in Section 5.4.4. This discussion begins with a summary of the modelled fate and behaviour of oil spilled as a result of this hypothetical scenario, specifically relating to the probability of surface oiling and shoreline contact. Potential effects on each of the four ecological indicators are then described. Additional information is contained in Ecological Risk Assessment of Marine Transportation Spills Technical Report (Volume 8B). While not specifically considered here, the mitigation (spill response) measures that would be employed to minimize environmental effects - should such a spill occur - are described in Sections 5.4.4 and 5.7.3.

#### 5.6.2.4.1 Fate and Behaviour

**Probability of Surface Oiling**

Stochastic modelling predictions for the Arachne Reef (Location E) site indicate that surface oiling would extend beyond the southern boundary of the RSA for both scenarios during the spring and summer seasons. Predicted high and very high probabilities of oiling were similar for each scenario and seasonal condition. Slight differences in the seasonal spill trajectories do exist and these primarily result from variations in predominant current or wind direction and speed. The highest probabilities for surface oiling were centered in the Salish Sea and the Juan de Fuca Strait, west of Stuart Island in the Gulf Islands (Figures 5.6.2.9 to 5.6.2.12).

Table 5.6.2.32 provides a summary of the predicted spatial extent of surface oiling ($km^2$) within the RSA for each spill volume and seasonal combination. Results are presented for each of three probability ranges (≥ 10 per cent, ≥50 per cent and ≥90 per cent). Figures depicting the release location and probability contours for seasonal stochastic surface oiling for both credible worst case and smaller spill scenarios are included in the Ecological Risk Assessment of Marine Transportation Spills Technical Report (Volume 8B, TR 8B-7).

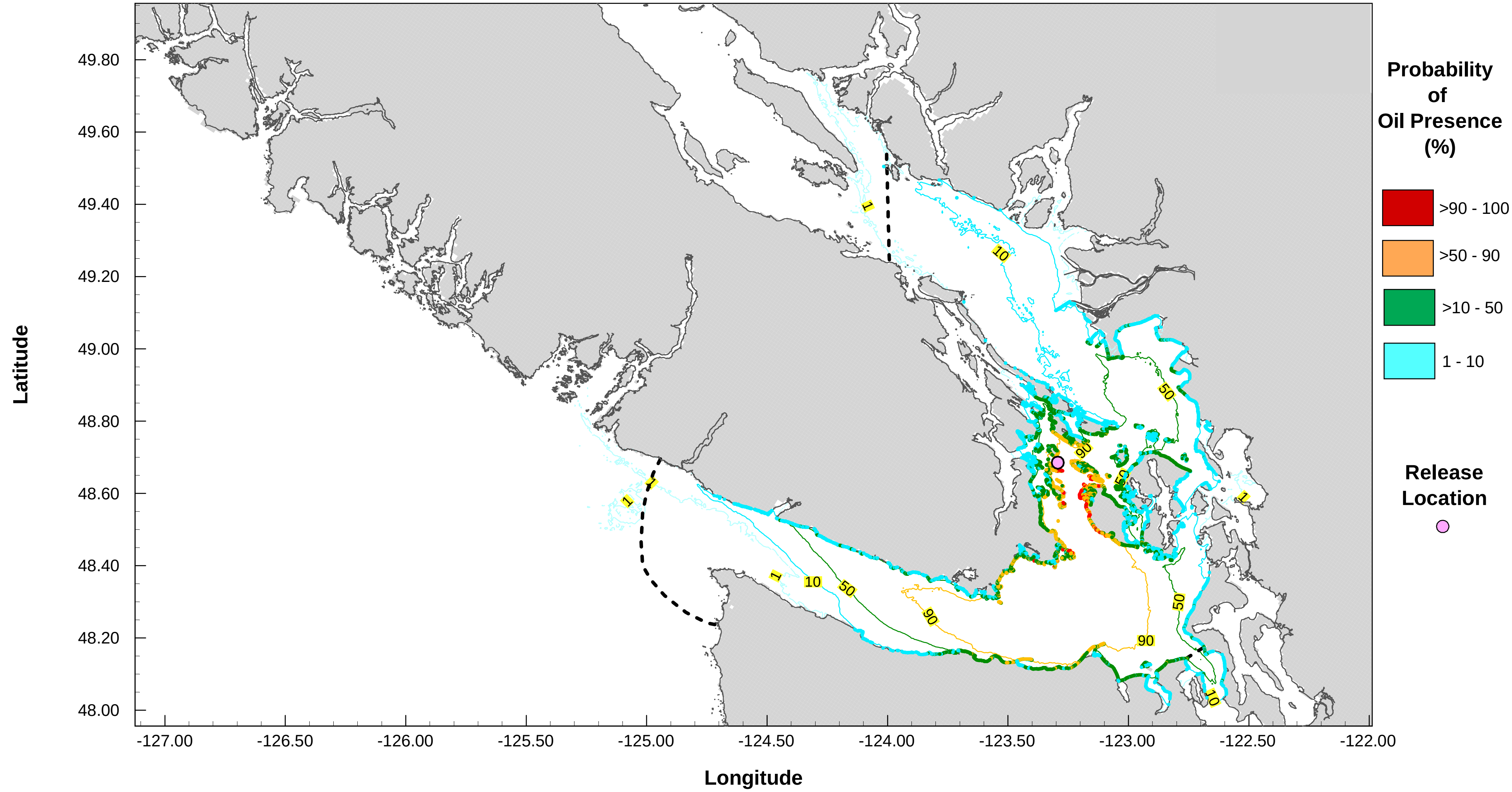
**TABLE 5.6.2.32**

**AREA OF SURFACE OILING (BY PROBABILITY OF OILING) – ARACHNE REEF (LOCATION E)**

| Scenario | Spill Volume ($m^3$) | Seasonal Condition | Average Maximum Average Slick Area ($km^2$) | Total Affected Surface Area ($km^2$) by Probability of Oiling | | |
|---|---|---|---|---|---|---|
| | | | | ≥ 10% | ≥ 50% | ≥ 90% |
| 1 | Credible Worst Case 16,500 $m^3$ | Winter | 400 | 6,710 | 4,156 | 2,145 |
| | | Spring | 538 | 6,665 | 4,697 | 2,917 |
| | | Summer | 480 | 7,137 | 4,683 | 2,386 |
| | | Fall | 420 | 7,618 | 4,439 | 2,288 |
| 2 | Smaller Spill Case 8,250 $m^3$ | Winter | 320 | 5,508 | 3,120 | 1,394 |
| | | Spring | 430 | 5,793 | 3,815 | 2,317 |
| | | Summer | 385 | 6,748 | 3,894 | 1,819 |
| | | Fall | 320 | 6,375 | 3,563 | 1,723 |

It is important to correctly interpret the data presented in Table 5.6.2.32. The values presented under the column headed “Maximum Average Slick Area ($km^2$)” indicate, for the average simulated spill, the largest sea surface area occupied by spilled oil at any point in time during the modelling run. When oil is spilled, the surface area of the slick increases rapidly to a maximum value, and then decreases as oil evaporates and strands on shorelines. Because an oil slick is moved around by tides and winds and is not static, the total area affected by the moving oil is greater than the predicted slick surface area at any given time. Therefore the values presented under the columns headed “Total Affected Surface Area ($km^2$)” indicate the predicted probability that an individual modelling sea surface grid area contained surface oil during at least one point in time. The three columns indicate the total area of sea surface affected by oil over the length of the oil spill simulation, at probability levels of ≥ 10 per cent, ≥ 50 per cent and ≥ 90 per cent, respectively. Accordingly, the areas presented in these columns of Table 5.6.2.32 do not represent the surface area of a single, continuous oil slick.

Additional information on predicted spill fate and behaviour and mass balance at the Arachne Reel spill scenario site is provided in Section 5.7.2 and Modeling the Fate and Behaviour of Marine Oil Spills for the Trans Mountain Expansion Project (Volume 8C, TR 8C-12, S9).




## NOTES

- Statistical results based on independent spills occuring every 6 hours from January 1 00:00 to March 31 23:00, for a total of 364 independent spills.
- Probability of oil presence is the percentage of simulations in which oil was present at a given location on shoreline or on water surface.
- Tracking time for each spill was 15 days.

STATUS
ISSUED FOR USE

CLIENT
TRANSMOUNTAIN

eba
A TETRA TECH COMPANY

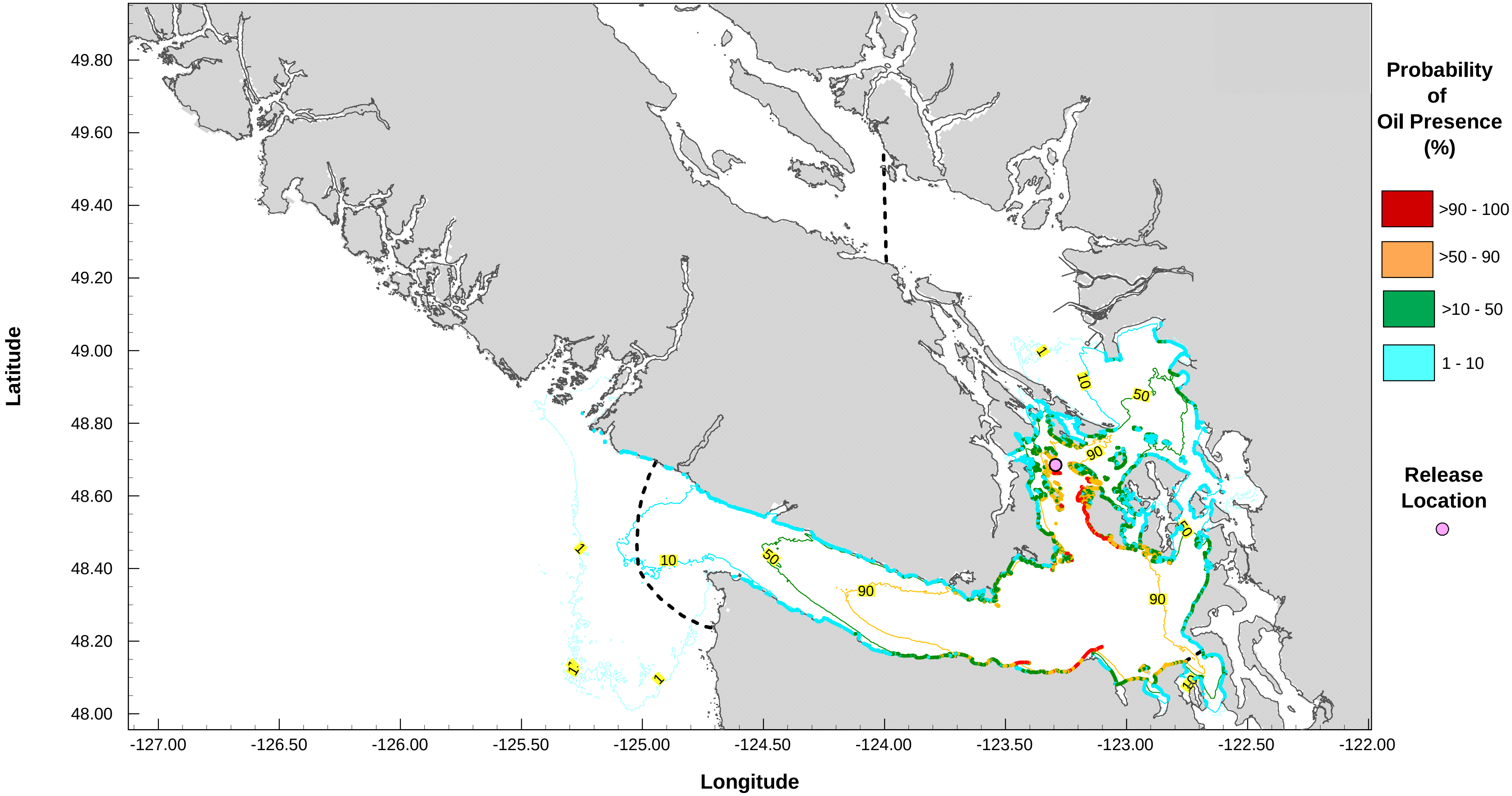
## TRANS MOUNTAIN OIL SPILL STUDY

### Probability of Oiling
### Arachne Reef Stochastic Simulation
### 16,500 $m^3$ Spill - Winter Season

| PROJECT NO. | DWN | CKD | APVD | REV |
|---|---|---|---|---|
| V13203022 | AH | JAS | MS | 0 |

| OFFICE | DATE |
|---|---|
| EBA-VANC | December 9, 2013 |

**Figure 5.6.2-9**




## NOTES

- Statistical results based on independent spills occuring every 6 hours from April 1 00:00 to June 30 23:00, for a total of 364 independent spills.
- Probability of oil presence is the percentage of simulations in which oil was present at a given location on shoreline or on water surface.
- Tracking time for each spill was 15 days.

STATUS
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## TRANS MOUNTAIN OIL SPILL STUDY

**Probability of Oiling**
**Arachne Reef Stochastic Simulation**
**16,500 m$^3$ Spill - Spring Season**

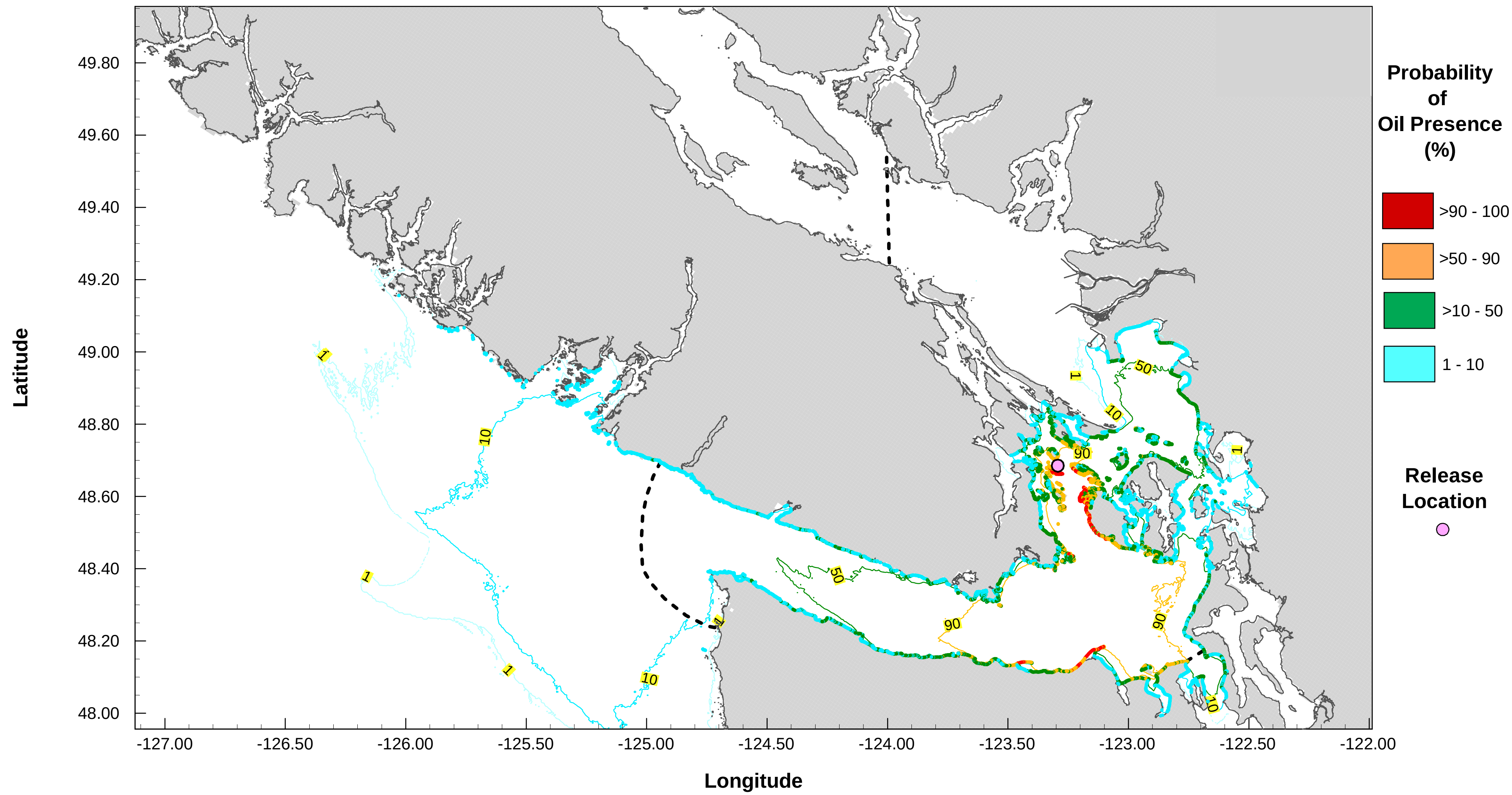
| PROJECT NO. | DWN | CKD | APVD | REV |
|---|---|---|---|---|
| V13203022 | AH | JAS | MS | 0 |

| OFFICE | DATE |
|---|---|
| EBA-VANC | December 9, 2013 |

**Figure 5.6.2-10**

T:\TMEP\working\AH\02-SPILLCALC\503-Arachne_Reef_16500m3\Results_Spring\Tecplot\02-stochastic_map_lines_4Stantec.lay

09 Dec 2013 11:47:05




## NOTES

- Statistical results based on independent spills occuring every 6 hours from July 1 00:00 to September 30 23:00, for a total of 368 independent spills.
- Probability of oil presence is the percentage of simulations in which oil was present at a given location on shoreline or on water surface.
- Tracking time for each spill was 15 days.

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## TRANS MOUNTAIN OIL SPILL STUDY

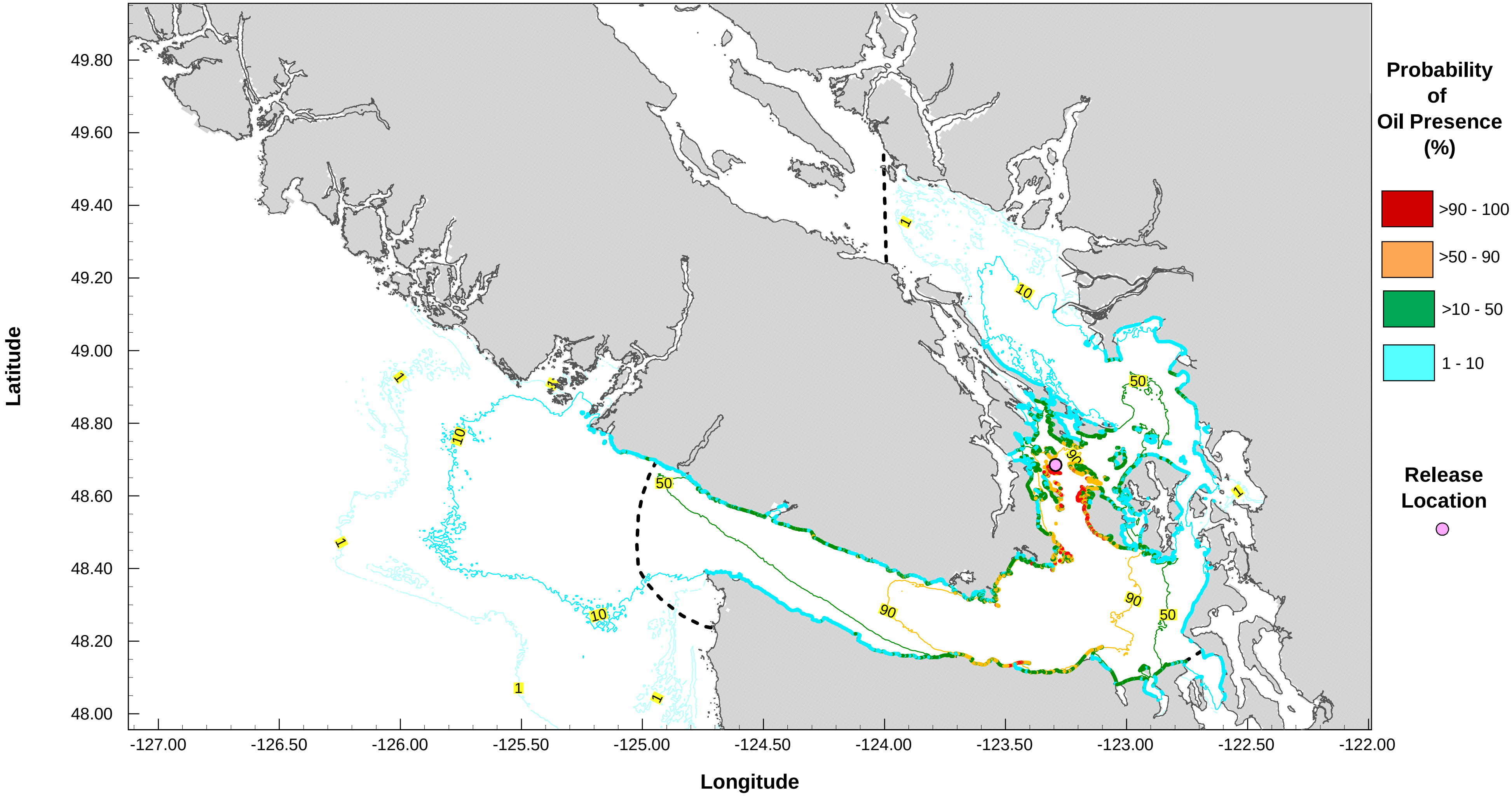
**Probability of Oiling**
**Arachne Reef Stochastic Simulation**
**16,500 $m^3$ Spill - Summer Season**

| PROJECT NO. | DWN | CKD | APVD | REV |
|---|---|---|---|---|
| V13203022 | AH | JAS | MS | 0 |

| OFFICE | DATE |
|---|---|
| EBA-VANC | December 9, 2013 |

**Figure 5.6.2-11**

T:\TMEP\working\AH\02-SPILLCALC\503-Arachne_Reef_16500m3\Results_Summer\Tecplot\02-stochastic_map_lines_4Stantec.lay
09 Dec 2013 11:50:28




## NOTES

- Statistical results based on independent spills occuring every 6 hours from October 1 00:00 to December 31 23:00, for a total of 368 independent spills.

- Probability of oil presence is the percentage of simulations in which oil was present at a given location on shoreline or on water surface.

- Tracking time for each spill was 15 days.

STATUS
ISSUED FOR USE

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# TRANS MOUNTAIN OIL SPILL STUDY

## Probability of Oiling
## Arachne Reef Stochastic Simulation
## 16,500 $m^3$ Spill - Fall Season

| PROJECT NO. | DWN | CKD | APVD | REV |
|---|---|---|---|---|
| V13203022 | AH | JAS | MS | 0 |

| OFFICE | DATE |
|---|---|
| EBA-VANC | December 9, 2013 |

**Figure 5.6.2-12**

**Probability of Shoreline Contact**

For the credible worst case spill (16,500 $m^3$), results indicate a high probability of oiling (≥50 per cent) of between 274 km and 300 km of shoreline, with greatest spatial extent of oiling occurring during the fall season. The smaller spill case predicts a ≥50 per cent probability of between 182 km and 207 km of shoreline becoming oiled with the greatest spatial extent being oiled during the spring season. Because oil that contacts shorelines tends to be retained on beach substrate, the average length of affected shoreline is more consistent with the total affected shoreline length at a ≥50 per cent than was the case for water surface swept by an oil slick.

Table 5.6.2.33 provides a summary of predicted shoreline contact within the RSA. The RSA includes approximately 4,130 km of shoreline. Based on this overall length, the modelling predicts a maximum shoreline length of 300 km or 7.3 per cent (credible worst case spill) and 207 km or 5 per cent (smaller spill) of the RSA with high to very high probability of being oiled. However, in this case the maximum average length of shoreline contact for a single oil spill ranges from 309 km (credible worst case spill) to 207 km (average smaller spill) representing 7.5 per cent and 5.4 per cent of the shoreline within the RSA respectively. The average length of shoreline contact for each seasonal condition is slightly larger than the ≥50 per cent probability value, but less than the length represented by the 10 per cent probability of shoreline contact.

**TABLE 5.6.2.33**

**LENGTH OF SHORELINE CONTACT (BY PROBABILITY OF OILING) – ARACHNE REEF (LOCATION E)**

| Scenario | Spill Volume ($m^3$) | Seasonal Condition | Average length of Affected Shoreline (km) | Total Affected Shoreline Length (km) by Probability of Contact | | |
|---|---|---|---|---|---|---|
| | | | | ≥ 10% | ≥ 50% | ≥ 90% |
| 1 | Credible Worst Case 16,500 $m^3$ | Winter | 292 | 836 | 283 | 38 |
| | | Spring | 306 | 761 | 299 | 75 |
| | | Summer | 309 | 783 | 274 | 55 |
| | | Fall | 301 | 816 | 300 | 62 |
| 2 | Smaller Spill Case 8,250 $m^3$ | Winter | 207 | 665 | 182 | 16 |
| | | Spring | 223 | 594 | 207 | 34 |
| | | Summer | 224 | 608 | 190 | 32 |
| | | Fall | 211 | 616 | 196 | 27 |

### 5.6.2.4.2 Shoreline Habitats

Of the 4,130 km of shoreline habitat in the RSA, 51 per cent (2,125 km) comprises low and high exposure rock and sand, low exposure rip rap and wood bulkheads and high exposure sand and gravel assigned a low biological sensitivity (BSF 1). Shorelines including low exposure veneer over rock, low exposure pebble veneer over sand, high exposure cobble/boulder veneer over rock and high exposure cobble/boulder represent 27 per cent (1,120 km) of the coastline and have medium biological sensitivity (BSF 2). Approximately 15 per cent (619 km) of the RSA has a high biological sensitivity (BSF 3) and includes low exposure cobble/boulder veneer over sand. The highest biological sensitivity (BSF 4) is generally limited to more sheltered bays and represents less than 6.4 per cent (266 km) of the shoreline in the RSA. Summaries of shoreline contact probability for each shoreline sensitivity class for the Arachne Reef spill scenarios are provided in Table 5.6.2.34 and Table 5.6.2.35 for a 16,500 $m^3$ and an 8,250 $m^3$ spill, respectively.

Shorelines with a high to very high probability of oiling (≥ 50 per cent) represent 11 per cent or less of the available habitat belonging to that sensitivity class within the RSA. Results indicate that shorelines with the lowest biological sensitivity factor (BSF 1) have the highest overall probability of oiling under spring conditions where between 11 per cent and 7 per cent of the available habitat may be affected for credible worst case and smaller spills respectively.

Stochastic results indicate that shoreline types with highest biological sensitivity (BSF 4) have a very low probability of being oiled, with the greatest spatial extent of oiling predicted at 1.7 km for a 16,500 $m^3$ spill, and 0.4 km of affected shoreline predicted for an 8,250 $m^3$ spill.

For a 16,500 $m^3$ spill, areas with high probability of oiling (≥50 per cent) represent 10 per cent to 11 per cent of the total shoreline within the RSA assigned to BSF 1; 3.1 per cent to 3.5 per cent of the total RSA shoreline assigned to BSF 2; 3.9 per cent to 4.4 per cent of the total RSA shoreline assigned to BSF 3, and less than 1 per cent of the total RSA shoreline assigned to BSF 4.

**TABLE 5.6.2.34**

**SUMMARY OF EFFECTS ANALYSIS FOR SHORELINE HABITATS – ARACHNE REEF – 16,500 $M^3$ SPILL (LOCATION E)**

| Seasonal Condition | BSF | Length in RSA (km) | Affected Shoreline (by Shoreline contact Probabilities) | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Affected Length According to Sensitivity Factor (km) | | | Percent Length According to Sensitivity Factor (%) | | |
| | | | Medium (≥ 10%) | High (≥ 50%) | Very High (≥ 90%) | Medium (≥ 10%) | High (≥ 50%) | Very High (≥ 90%) |
| Winter | 1 | 2,125 | 544 | 217 | 33 | 26 | 10 | 1.6 |
| | 2 | 1,120 | 175 | 39 | 2.9 | 16 | 3.5 | 0.3 |
| | 3 | 619 | 111 | 26 | 1.7 | 18 | 4.2 | 0.3 |
| | 4 | 266 | 6.3 | 1.4 | 0.1 | 2.4 | 0.5 | 0.1 |
| Spring | 1 | 2,125 | 520 | 237 | 64 | 25 | 11 | 3.0 |
| | 2 | 1,120 | 149 | 35 | 6.8 | 13 | 3.1 | 0.6 |
| | 3 | 619 | 86 | 25 | 3.3 | 14 | 4.0 | 0.5 |
| | 4 | 266 | 6.8 | 1.6 | 0.3 | 2.6 | 0.6 | 0.1 |
| Summer | 1 | 2,125 | 531 | 216 | 44 | 25 | 10 | 2.1 |
| | 2 | 1,120 | 148 | 32 | 6.3 | 13 | 2.9 | 0.6 |
| | 3 | 619 | 99 | 24 | 3.7 | 16 | 3.9 | 0.6 |
| | 4 | 266 | 5.6 | 1.7 | 0.3 | 2.1 | 0.6 | 0.1 |
| Fall | 1 | 2,125 | 555 | 234 | 52 | 26 | 11 | 2.4 |
| | 2 | 1,120 | 156 | 37 | 5.1 | 14 | 3.3 | 0.5 |
| | 3 | 619 | 99 | 27 | 5.0 | 16 | 4.4 | 0.8 |
| | 4 | 266 | 6.3 | 1.1 | 0.3 | 2.4 | 0.4 | 0.1 |

For the 8,250 $m^3$ spill scenario, areas with high probability of oiling represent 6.7 per cent to 7.8 per cent of the total shoreline within the RSA assigned to BSF 1; 1.8 per cent to 2.0 per cent of the total RSA shoreline assigned to BSF 2; 2.8 per cent to 3.1 per cent of the total shoreline within the RSA assigned to BSF 3; and 0.1 per cent to 0.2 per cent of the total shoreline within the RSA assigned to BSF 4 (Table 5.6.2.35).

**TABLE 5.6.2.35**

**SUMMARY OF EFFECTS ANALYSIS FOR SHORELINE HABITATS – ARACHNE REEF – 8,250 M$^3$ SPILL (LOCATION E)**

| Seasonal Condition | BSF | Length in RSA (km) | Affected Shoreline (by Shoreline contact Probabilities) | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Affected Length According to Sensitivity Factor (km) | | | Percent Length According to Sensitivity Factor (%) | | |
| | | | Medium (≥ 10%) | High (≥ 50%) | Very High (≥ 90%) | Medium (≥ 10%) | High (≥ 50%) | Very High (≥ 90%) |
| Winter | 1 | 2,125 | 440 | 142 | 14 | 21 | 6.7 | 0.7 |
| | 2 | 1,120 | 135 | 22 | 1.3 | 12 | 2.0 | 0.1 |
| | 3 | 619 | 85 | 17.3 | 0.7 | 14 | 2.8 | 0.1 |
| | 4 | 266 | 4.4 | 0.3 | 0.0 | 1.6 | 0.1 | 0.0 |
| Spring | 1 | 2,125 | 421 | 166 | 30 | 20 | 7.8 | 1.4 |
| | 2 | 1,120 | 100 | 22 | 2.7 | 8.9 | 2.0 | 0.2 |
| | 3 | 619 | 67 | 18 | 1.4 | 11 | 3.0 | 0.2 |
| | 4 | 266 | 4.8 | 0.4 | 0.0 | 1.8 | 0.2 | 0.0 |
| Summer | 1 | 2,125 | 423 | 149 | 26 | 20 | 7.0 | 1.2 |
| | 2 | 1,120 | 105 | 22 | 2.5 | 9.4 | 1.9 | 0.2 |
| | 3 | 619 | 76 | 19 | 2.9 | 12 | 3.1 | 0.5 |
| | 4 | 266 | 3.8 | 0.4 | 0.0 | 1.4 | 0.2 | 0.0 |
| Fall | 1 | 2,125 | 425 | 157 | 24 | 20 | 7.4 | 1.1 |
| | 2 | 1,120 | 109 | 20 | 1.6 | 9.7 | 1.8 | 0.1 |
| | 3 | 619 | 78 | 20 | 1.5 | 13 | 3.1 | 0.2 |
| | 4 | 266 | 3.91 | 0.3 | 0.3 | 1.5 | 0.1 | 0.1 |

Stochastic results for both spill scenarios also indicate areas with a high to very high probability of oiling (≥50 per cent) from a spill at this location range from the southern Strait of Georgia, throughout the Gulf Islands and south into US waters and the Juan de Fuca Strait (Figure 5.6.2.9 to 5.6.2.12). A number of ecological and socially important sites are located in this area, and prompt and effective response in the event of a spill would help reduce effects on shoreline habitats.

### 5.6.2.4.3 Marine Fish Community

The RSA comprises approximately 11,111 km$^2$ of habitat for the marine fish community, and includes habitats for all four biological sensitivity rankings. Habitats classified as low sensitivity (BSF 1) to high sensitivity (BSF 3) are based on water depth, and are deemed to be exclusive with no overlap in area. However, BSF 4 (very high sensitivity) is based on habitats important areas for specific species (such as herring spawning areas), and can overlap areas with other sensitivity factors. Areas with a water depth of 30 m or more (BSF 1) represent slightly more than 78 per cent of the RSA (8,636 km$^2$). Areas represented by BSF 2 (water depths between 10 and 30 m with medium sensitivity), and areas with BSF 3 (water depths less than 10 m with high sensitivity) represent approximately 12 per cent (1,280 km$^2$) and 11 per cent (1,196 km$^2$) of the RSA, respectively. Critical habitats for herring spawn, rockfish and crab combined as BSF 4 (very high sensitivity) overlap with other areas and represent approximately 35 per cent (3,934 km$^2$) of the RSA.

The overlap between surface oiling probability and marine fish community sensitivity for the 16,500 m$^3$ spill scenario is summarized in Table 5.6.2.36. For a 16,500 m$^3$ spill, areas with a high to very high (≥50 per cent) probability of oiling represent: 40 per cent (under winter conditions) to 46 per cent (under spring and summer conditions) of the total area with water depths >30m (BSF 1); 35 per cent (under fall conditions) to 40 per cent (under summer conditions) of the total area with water depths between 10 m and 30m (BSF 2); 17 per cent (under winter conditions) to 20 per cent (under summer conditions) of the total area with depths <10 m (BSF 3); and 11 per cent (under fall conditions) to 13 per cent (under summer conditions) of the important habitat for herring spawn, rockfish and crab.

**TABLE 5.6.2.36**

**SUMMARY OF EFFECTS ANALYSIS FOR THE MARINE FISH COMMUNITY – ARACHNE REEF – 16,500 M$^3$ SPILL (LOCATION E)**

| Seasonal Condition | BSF | Area in RSA (km$^2$) | Affected Surface Water (by Surface Water Oiling Probabilities) | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Area According to Sensitivity Factor (km$^2$) | | | Percent Area According to Sensitivity Factor (%) | | |
| | | | Medium (≥ 10%) | High (≥ 50%) | Very High (≥ 90%) | Medium (≥ 10%) | High (≥ 50%) | Very High (≥ 90%) |
| Winter | 1 | 8,636 | 5,372 | 3,482 | 1910 | 62 | 40 | 22 |
| | 2 | 1,280 | 745 | 475 | 186 | 58 | 37 | 14 |
| | 3 | 1,196 | 592 | 198 | 51 | 50 | 17 | 4.3 |
| | 4 | 3,934 | 850 | 464 | 206 | 22 | 12 | 5.2 |
| Spring | 1 | 8,636 | 5,382 | 3,979 | 2551 | 62 | 46 | 30 |
| | 2 | 1,280 | 758 | 492 | 268 | 59 | 39 | 21 |
| | 3 | 1,196 | 526 | 226 | 99 | 44 | 19 | 8.2 |
| | 4 | 3,934 | 714 | 461 | 269 | 18 | 12 | 6.8 |
| Summer | 1 | 8,636 | 5,675 | 3,930 | 2,082 | 66 | 46 | 24 |
| | 2 | 1,280 | 857 | 517 | 223 | 67 | 40 | 17 |
| | 3 | 1,196 | 605 | 235 | 82 | 51 | 20 | 6.8 |
| | 4 | 3,934 | 775 | 510 | 234 | 20 | 13 | 5.9 |
| Fall | 1 | 8,636 | 6,279 | 3,792 | 2,014 | 73 | 44 | 23 |
| | 2 | 1,280 | 784 | 446 | 197 | 61 | 35 | 15 |
| | 3 | 1,196 | 554 | 202 | 77 | 46 | 17 | 6.5 |
| | 4 | 3,934 | 766 | 434 | 222 | 20 | 11 | 5.7 |

For the 8,250 m$^3$ spill, areas with a high (≥50 per cent) probability of oiling represent: 31 per cent (under winter conditions) to 39 per cent (under summer conditions) of the total area with water depths >30 m (BSF 1); 24 per cent (under winter conditions) to 31 per cent (under summer conditions) of the total area with water depths between 10 m and 30 m (BSF 2); 10 per cent (under winter conditions) to 14 per cent (under summer conditions) of the total area with depths <10 m (BSF 3); and 8.7 per cent (under fall conditions) to 11 per cent (under summer conditions) of the important habitat for herring spawn, rockfish and crab (BSF 4). The overlap between surface oiling probability and marine fish community sensitivity for the 8,250 m$^3$ spill is summarized in Table 5.6.2.37.

**TABLE 5.6.2.37**

**SUMMARY OF EFFECTS ANALYSIS FOR THE MARINE FISH COMMUNITY – ARACHNE REEF – 8,250 M³ SPILL (LOCATION E)**

| Seasonal Condition | BSF | Area in RSA (km²) | Affected Surface Water (by Surface Water Oiling Probabilities) | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Area According to Sensitivity Factor (km²) | | | Percent Area According to Sensitivity Factor (%) | | |
| | | | Medium (≥ 10%) | High (≥ 50%) | Very High (≥ 90%) | Medium (≥ 10%) | High (≥ 50%) | Very High (≥ 90%) |
| Winter | 1 | 8,636 | 4,343 | 2,687 | 1,270 | 50 | 31 | 15 |
| | 2 | 1,280 | 698 | 310 | 94 | 55 | 24 | 7.4 |
| | 3 | 1,196 | 466 | 123 | 30 | 39 | 10 | 2.5 |
| | 4 | 3,934 | 734 | 360 | 176 | 19 | 9.2 | 4.5 |
| Spring | 1 | 8,636 | 4,652 | 3,276 | 2,030 | 54 | 38 | 24 |
| | 2 | 1,280 | 698 | 381 | 218 | 55 | 30 | 17 |
| | 3 | 1,196 | 443 | 158 | 70 | 37 | 13 | 5.8 |
| | 4 | 3,934 | 658 | 372 | 231 | 17 | 9.5 | 5.9 |
| Summer | 1 | 8,636 | 5,440 | 3,333 | 1,613 | 63 | 39 | 19 |
| | 2 | 1,280 | 767 | 399 | 157 | 60 | 31 | 12 |
| | 3 | 1,196 | 542 | 163 | 49 | 45 | 14 | 4.1 |
| | 4 | 3,934 | 719 | 448 | 187 | 18 | 11 | 4.8 |
| Fall | 1 | 8,636 | 5,270 | 3,068 | 1,554 | 61 | 36 | 18 |
| | 2 | 1,280 | 723 | 345 | 131 | 57 | 27 | 10 |
| | 3 | 1,196 | 382 | 149 | 37 | 32 | 13 | 3.1 |
| | 4 | 3,934 | 635 | 342 | 197 | 16 | 8.7 | 5.0 |

Of a total of 8,635 km² of deep water habitat (>30 m) in the RSA (BSF 1), between 40 per cent and 46 per cent of this habitat type within the RSA has a high or very high (≥50 per cent) probability of oil exposure from a 16,500 m³ spill. Between 31 per cent and 39 per cent has a high or very high probability of oil exposure from an 8,250 m³ spill. While these ranges represent a comparatively large portion of this habitat type, it is very unlikely that fish in this habitat type would be harmed by exposure to oil due to water depth.

A predicted range of 35 per cent to 40 per cent of the total of 1,280 km² of intermediate depth habitat (< 30 to ≥ 10) in the RSA (BSF 2) has a high or very high (≥ 50 per cent) probability of oil exposure from a 16,500 m³ spill. Between 24 per cent and 31 per cent of this medium sensitivity habitat in the RSA has a high or very high probability of oil exposure from an 8,250 m³ spill. As with deep water habitat, given the water depth this sensitivity rank represents, it is also very unlikely that fish would be harmed by exposure to oil in this habitat type.

Between 17 per cent and 20 per cent of the RSA total of 1,196 km² of high sensitivity (BSF 3) shallow water habitat (≤10 m) has a high or very high (≥50 per cent) probability of oil exposure from a 16,500 m³ spill. Between 123 and 163 km² has a high or very high probability of oil exposure from an 8,250 m³ spill, representing 10 per cent to 14 per cent of this habitat type within the RSA. In circumstances where oil is driven into this shallow water habitat by strong winds, there would be a greater potential for negative effects, including potential mortality of fish, crustaceans and shellfish.

Of a total of 3,934 km² of RSA habitat with a very high biological sensitivity (BSF 4), between 11 per cent and 13 per cent has a high or very high (≥50 per cent) probability of oil exposure from a 16,500 m³ spill, and between 9 per cent and 11 per cent has a high or very high probability of oil exposure from an 8,250 m³ spill. In areas where this very high-sensitivity habitat overlaps with shallow water areas, the potential for negative effects would be greater. Critical time periods for herring spawn would be in the spring, when exposure to PAH in the oil could cause developmental effects on fish embryos. As noted for shallow water habitat, the potential for negative effects would be greatest if the spill were to occur at a time when strong winds cause the oil to be driven into shallow water used as spawning or nursery areas for herring, rockfish or crab.

#### 5.6.2.4.4 Marine Birds

For the Arachne Reef scenarios, marine birds and their habitats were assessed using two approaches. The first assumes that marine birds could generally be present anywhere within the RSA and the potential for shorebirds and other marine birds to be affected was estimated using the stochastic shoreline contact and surface contours, respectively. The second approach considers the potential for spilled crude oil to come into contact with known bird colonies and designated IBAs.

The habitat oiling probability for each marine bird sensitivity group is summarized in Tables 5.6.2.38 and 5.6.2.39 for 16,500 $m^3$ spills and 8,250 $m^3$ spills respectively. For shorebirds (BSF 1), potential exposure is determined by the length of shoreline predicted to have a high or very high probability of oiling. For a 16,500 $m^3$ spill, the seasonal variation in spatial extent represents between 274 km (6.6 per cent) and 300 km (7.3 per cent) of the available shoreline habitat within the RSA. For an 8,250 $m^3$ spill, the predicted length of affected shoreline is ranges between 182 km (4.4 per cent) and 207 km (5 per cent) of the available shoreline habitat. Shorebirds generally have low sensitivity to oiling when compared to other guilds, and it is unlikely that lightly oiled individuals would die as a result of low or moderate exposure. Heavily oiled individuals would probably die; however, and even lightly oiled individuals could transfer sufficient oil to eggs to cause egg mortality, if exposure occurred shortly before or during the period when eggs were being incubated. An oil spill that occurred near Arachne Reef would be physically close to the Sidney Channel IBA, where shorebirds are present. The threat to birds in this area is mitigated; however, by the generally low percentage of spilled crude oil that is predicted to strand on Vancouver, James and Coal Islands. Therefore, the environment effects on shorebirds of crude oil exposure from an accidental spill during marine transportation could be high locally, although medium to low effects levels are likely to be more prevalent.

For other marine birds (BSF 2, BSF 3, and BSF 4), potential exposure is based on surface water oiling. The seasonal variation in spatial extent for a 16,500 $m^3$ spill represents between 37 per cent and 42 per cent of the available habitat for these receptors, while for an 8,250 $m^3$ spill, between 28 per cent and 35 per cent of the RSA habitat is predicted to be affected. Therefore, there is a relatively high probability of exposure for aquatic birds in the event that an oil spill occurs. The environmental effects and effect magnitude of such exposure would depend upon the season (which would determine the numbers and types of birds present) as well as the actual level and duration of exposure, and the relative sensitivity of the exposed birds. Gulls and terns tend to have medium sensitivity, whereas ducks, cormorants, divers and alcids tend to have high to very high sensitivity. However, regardless of these factors, it is likely that seabirds would be exposed to oil, and would die as a result of that exposure, so that the effect magnitude would be high.

Stochastic modeling results were used to identify areas of medium (≥10 per cent), high (≥50 per cent), and very high (≥90 per cent) probability for spilled crude oil extending to known colony locations. The number of known colonies affected for each of the marine bird biological sensitivity rankings are summarized in Tables 5.6.2.40 and 5.6.2.41 for 16,500 m$^3$ spills and 8,250 m$^3$ spills respectively.

## TABLE 5.6.2.38

## SUMMARY OF EFFECTS ANALYSIS FOR MARINE BIRDS – ARACHNE REEF – 16,500 M³ SPILL (LOCATION E)

| Seasonal Condition | BSF | Length or Area in RSA (km or km$^2$) | Affected Surface Water (by Shoreline or Surface Water Oiling Probabilities) | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Affected Length or Area According to Sensitivity Factor (km or km$^2$) | | | Percent Length or Area According to Sensitivity Factor (%) | | |
| | | | Medium (≥ 10%) | High (≥ 50%) | Very High (≥ 90%) | Medium (≥ 10%) | High (≥ 50%) | Very High (≥ 90%) |
| Winter | 1 | 4,130 [1] | 836 [1] | 283 [1] | 38 [1] | 20 [2] | 6.9 [2] | 0.9 [2] |
| | 2, 3, 4 | 11,112 | 6,710 | 4,156 | 2,145 | 60 | 37 | 19 |
| Spring | 1 | 4,130 [1] | 761 [1] | 299 [1] | 75 [1] | 18 [2] | 7.2 [2] | 1.8 [2] |
| | 2, 3, 4 | 11,112 | 6,665 | 4,698 | 2,917 | 60 | 42 | 26 |
| Summer | 1 | 4,130 [1] | 783 [1] | 274 [1] | 55 [1] | 19 [2] | 6.6 [2] | 1.3 [2] |
| | 2, 3, 4 | 11,112 | 7,137 | 4,683 | 2,386 | 64 | 42 | 21 |
| Fall | 1 | 4,130 [1] | 816 [1] | 300 [1] | 62 [1] | 20 [2] | 7.3 [2] | 1.5 [2] |
| | 2, 3, 4 | 11,112 | 7,618 | 4,439 | 2,288 | 69 | 40 | 21 |

**Notes:** 1 Total length of shoreline in the RSA, or length affected (km).

2 Expressed as % length of shoreline in that sensitivity class.

## TABLE 5.6.2.39

## SUMMARY OF EFFECTS ANALYSIS FOR MARINE BIRDS – ARACHNE REEF – 8,250 M³ SPILL (LOCATION E)

| Seasonal Condition | BSF | Length or Area in RSA (km or km$^2$) | Affected Surface Water (by Shoreline or Surface Water Oiling Probabilities) | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Affected Length or Area According to Sensitivity Factor (km or km$^2$) | | | Percent Length or Area According to Sensitivity Factor (%) | | |
| | | | Medium (≥ 10%) | High (≥ 50%) | Very High (≥ 90%) | Medium (≥ 10%) | High (≥ 50%) | Very High (≥ 90%) |
| Winter | 1 | 4,130 [1] | 665 [1] | 182 [1] | 16 [1] | 16 [2] | 4.4 [2] | 0.4 [2] |
| | 2, 3, 4 | 11,112 | 5,508 | 3,120 | 1,394 | 50 | 28 | 13 |

## TABLE 5.6.2.39

## SUMMARY OF EFFECTS ANALYSIS FOR MARINE BIRDS – ARACHNE REEF – 8,250 M³ SPILL (LOCATION E) (continued)

| Seasonal Condition | BSF | Length or Area in RSA (km or $km^2$) | Affected Surface Water (by Shoreline or Surface Water Oiling Probabilities) | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Affected Length or Area According to Sensitivity Factor (km or $km^2$) | | | Percent Length or Area According to Sensitivity Factor (%) | | |
| | | | Medium (≥ 10%) | High (≥ 50%) | Very High (≥ 90%) | Medium (≥ 10%) | High (≥ 50%) | Very High (≥ 90%) |
| Spring | 1 | 4,130 [1] | 594 [1] | 207 [1] | 34 [1] | 14 [2] | 5.0 [2] | 0.8 [2] |
| | 2 | 11,112 | 5,793 | 3,815 | 2,317 | 52 | 34 | 21 |
| | 3 | | | | | | | |
| | 4 | | | | | | | |
| Summer | 1 | 4,130 [1] | 608 [1] | 190 [1] | 32 [1] | 15 [2] | 4.6 [2] | 0.8 [2] |
| | 2 | 11,112 | 6,748 | 3,894 | 1,819 | 61 | 35 | 16 |
| | 3 | | | | | | | |
| | 4 | | | | | | | |
| Fall | 1 | 4,130 [1] | 616 [1] | 196 [1] | 27 [1] | 15 [2] | 4.8 [2] | 0.7 [2] |
| | 2 | 11,112 | 6,375 | 3,563 | 1,723 | 57 | 32 | 16 |
| | 3 | | | | | | | |
| | 4 | | | | | | | |

**Notes:** 1 Total length of shoreline in the RSA, or length affected (km).
2 Expressed as % length of shoreline in that sensitivity class.

For gulls and terns (BSF 2), potential effects on colonies are determined by identifying the probability that crude oil will contact these areas if spilled during the spring or summer seasons. For a 16,500 $m^3$ spill, crude oil is predicted to have high to very high probability (≥50 per cent) to contact 21 of the 79 known colonies. For an 8,250 $m^3$ spill, this is predicted to represent 18 of the 79 known colonies.

For ducks and cormorants (BSF 3), potentially affected colonies and IBAs are determined by identifying contact of the spilled crude oil with these areas. For a 16,500 $m^3$ spill, crude oil is predicted to have high to very high probability (≥50 per cent) to contact 14 to 16 of the 40 known colonies. For an 8,250 $m^3$ spill, this is predicted to represent 10 or 11 of the 40 known colonies.

For auks and divers (BSF 4), the 16,500 $m^3$ spill, crude oil is predicted to have high to very high (≥50 per cent) probability to come in contact with 23 to 27 of the 55 known colonies. For the 8,250 $m^3$ spill, this is predicted to represent 17 of the 55 known colonies.

The presence of seabirds at colony locations is seasonal, and the overlap of oil with a colony location does not necessarily indicate that seabirds at nest sites will experience oiling, as their feeding grounds may be located at some distance from the nest site. However, the substantial overlap of high probability surface oiling areas with known seabird colony locations is predicted (whether representing gulls and terns, ducks and cormorants, or auks and divers), indicates that potential for negative effects, up to and including mortality of birds or oiling and mortality of eggs, is high for Arachne Reef scenarios.

**TABLE 5.6.2.40**

**SUMMARY OF EFFECTS ANALYSIS FOR MARINE BIRD COLONIES – ARACHNE REEF – 16,500 M³ SPILL (LOCATION E)**

| Seasonal Condition | BSF | Affected Marine Bird Colonies (by Surface Water Oiling Probabilities) | | |
|---|---|---|---|---|
| | | Medium (≥ 10%) | High (≥ 50%) | Very High (≥ 90%) |
| Spring | 1 | --- | --- | --- |
| | 2 | 32 of 79 known colony sites affected. | 21 of 79 known colony sites affected. | 8 of 79 known colony sites affected. |
| | 3 | 19 of 40 known colony sites affected. | 14 of 40 known colony sites affected. | 4 of 40 known colony sites affected. |
| | 4 | 35 of 55 known colony sites affected. | 23 of 55 known colony sites affected. | 5 of 55 known colony sites affected. |
| Summer | 1 | --- | --- | --- |
| | 2 | 36 of 79 known colony sites affected. | 21 of 79 known colony sites affected. | 12 of 79 known colony sites affected. |
| | 3 | 23 of 40 known colony sites affected. | 16 of 40 known colony sites affected. | 7 of 40 known colony sites affected. |
| | 4 | 38 of 55 known colony sites affected. | 27 of 55 known colony sites affected. | 8 of 55 known colony sites affected. |

**TABLE 5.6.2.41**

**SUMMARY OF EFFECTS ANALYSIS FOR MARINE BIRD COLONIES – ARACHNE REEF – 8,250 M³ SPILL (LOCATION E)**

| Seasonal Condition | BSF | Affected Marine Bird Colonies (by Surface Water Oiling Probabilities) | | |
|---|---|---|---|---|
| | | Medium (≥ 10%) | High (≥ 50%) | Very High (≥ 90%) |
| Spring | 1 | --- | --- | --- |
| | 2 | 28 of 79 known colony sites affected. | 18 of 79 known colony sites affected. | 5 of 79 known colony sites affected. |
| | 3 | 18 of 40 known colony sites affected. | 11 of 40 known colony sites affected. | 2 of 40 known colony sites affected. |
| | 4 | 31 of 55 known colony sites affected. | 17 of 55 known colony sites affected. | 1 of 55 known colony sites affected. |
| Summer | 1 | --- | --- | --- |
| | 2 | 32 of 79 known colony sites affected. | 18 of 79 known colony sites affected. | 11 of 79 known colony sites affected. |
| | 3 | 21 of 40 known colony sites affected. | 10 of 40 known colony sites affected. | 4 of 40 known colony sites affected. |
| | 4 | 36 of 55 known colony sites affected. | 17 of 55 known colony sites affected. | 4 of 55 known colony sites affected. |

Stochastic modeling results were used to identify areas of medium (≥10 per cent), high (≥50 per cent), and very high (≥90 per cent) probability for spilled crude oil extending to IBA locations. The number of IBAs affected are summarized in Tables 5.6.2.42 and 5.6.2.43 for 16,500 $m^3$ spills and 8,250 $m^3$ spills respectively.

There are 16 IBAs that have ≥10 per cent probability of being affected by spilled crude oil, in the event of a credible worst case or smaller oil spill at the Arachne Reef hypothetical spill location.

Of these, 9 and 5, respectively, have a high or very high probability (≥50 per cent) of oil exposure in the event of the credible worst case or smaller spill. The utilization of IBAs by seabirds and other birds is seasonal, but most IBAs are used by one or more species in any season. It is likely that oil exposure at an IBA would result in oiling of birds, with a high potential for mortality of adults, juveniles, and/or eggs in the event of oil being transferred from plumage to incubating eggs. Given the high potential for negative effects on seabirds at IBAs, the effect magnitude is high.

**TABLE 5.6.2.42**

**SUMMARY OF EFFECTS ANALYSIS FOR IMPORTANT BIRD AREAS – ARACHNE REEF – 16,500 M³ SPILL (LOCATION E)**

| IBA | Highest Oiling Probability (by seasonal condition) | | | |
|---|---|---|---|---|
| | Winter | Spring | Summer | Fall |
| **Canada** | | | | |
| BC015 | ≥ 50% | ≥ 10% | ≥ 10% | ≥ 10% |
| BC017 | ≥ 10% | ≥ 10% | ≥ 10% | ≥ 10% |
| BC025 | ≥ 10% | --- | --- | --- |
| BC045 | ≥ 90% | ≥ 90% | ≥ 90% | ≥ 90% |
| BC047 | ≥ 90% | ≥ 90% | ≥ 90% | ≥ 90% |
| BC052 | --- | --- | --- | ≥ 10% |
| BC073 | ≥ 10% | ≥ 10% | ≥ 10% | ≥ 50% |
| BC097 | --- | ≥ 10% | ≥ 10% | ≥ 50% |
| **United States** | | | | |
| USWA 277 | ≥ 10% | ≥ 10% | ≥ 10% | ≥ 10% |
| USWA 282 | ≥ 10% | ≥ 10% | ≥ 10% | ≥ 10% |
| USWA 288 | ≥ 50% | ≥ 90% | ≥ 90% | ≥ 50% |
| USWA 3289 | --- | ≥ 10% | ≥ 10% | --- |
| USWA 3347 | --- | --- | ≥ 10% | --- |
| USWA 3348 | ≥ 90% | ≥ 90% | ≥ 90% | ≥ 90% |
| USWA 3351 | ≥ 90% | ≥ 90% | ≥ 90% | ≥ 90% |
| USWA 3786 | ≥ 50% | ≥ 50% | ≥ 50% | ≥ 50% |

**TABLE 5.6.2.43**

**SUMMARY OF EFFECTS ANALYSIS FOR IMPORTANT BIRD AREAS – ARACHNE REEF – 8,250 M³ SPILL (LOCATIONE)**

| IBA | Highest Oiling Probability (by seasonal condition) | | | |
|---|---|---|---|---|
| | Winter | Spring | Summer | Fall |
| **Canada** | | | | |
| BC015 | ≥ 10% | ≥ 10% | ≥ 10% | ≥ 10% |
| BC017 | ≥ 10% | ≥ 10% | ≥ 10% | ≥ 10% |

**TABLE 5.6.2.43**

**SUMMARY OF EFFECTS ANALYSIS FOR IMPORTANT BIRD AREAS – ARACHNE REEF – 8,250 M³ SPILL (LOCATIONE) (continued)**

| IBA | Highest Oiling Probability (by seasonal condition) | | | |
|---|---|---|---|---|
| | Winter | Spring | Summer | Fall |
| **Canada** | | | | |
| BC045 | ≥ 90% | ≥ 90% | ≥ 90% | ≥ 90% |
| BC047 | ≥ 90% | ≥ 90% | ≥ 90% | ≥ 90% |
| BC073 | --- | --- | ≥ 10% | ≥ 10% |
| BC097 | --- | --- | ≥ 10% | ≥ 10% |
| **United States** | | | | |
| USWA 277 | ≥ 10% | ≥ 10% | ≥ 10% | --- |
| USWA 282 | ≥ 10% | ≥ 10% | ≥ 10% | ≥ 10% |
| USWA 288 | ≥ 50% | ≥ 90% | ≥ 90% | ≥ 10% |
| USWA 3289 | --- | ≥ 10% | ≥ 10% | --- |
| USWA 3347 | --- | --- | ≥ 10% | --- |
| USWA 3348 | ≥ 50% | ≥ 90% | ≥ 90% | ≥ 90% |
| USWA 3351 | ≥ 50% | ≥ 90% | ≥ 90% | ≥ 90% |
| USWA 3786 | ≥ 50% | ≥ 50% | ≥ 10% | ≥ 10% |

### 5.6.2.4.5 Marine Mammals

Stochastic modelling results identify areas of medium (≥10 per cent), high (≥50 per cent), and very high (≥90 per cent), exposure probability for each class of mammals. The overlap between habitat oiling probabilities for each mammal sensitivity class is summarized in Tables 5.6.2.44 and 5.6.2.45 for 16,500 $m^3$ spills and 8,250 $m^3$ spills respectively.

For terrestrial mammals (*e.g.,* bears, moose, raccoon, etc., BSF 1), potential exposure is determined by the length of shoreline habitat predicted to have a high or very high probability of oiling. For a 16,500 $m^3$ spill, the seasonal variation in spatial extent represents between 274 km (6.6 per cent) and 300 km (7.3 per cent) of the available shoreline habitat; this drops to between 182 km (4.4 per cent) and 207 km (5 per cent) for an 8,250 $m^3$ spill. These animals have generally low sensitivity to oiling, and it is unlikely that oiled individuals would die as a result of exposure. It is very unlikely that such exposure would result in a measurable effect at the population level.

For pinnipeds such as seals and sea lions (BSF 2), potential exposure is based on habitat having a water depth of ≤30m. The seasonal variation in likely spatial extent for a 16,500 $m^3$ spill affecting pinniped habitat represents 26 per cent to 30 per cent of the available habitat, whereas for an 8,250 $m^3$ spill, between 18 per cent and 23 per cent of the habitat could be affected. Therefore, there is a relatively high probability of exposure for seals and sea lions in the event of an accidental oil spill. While some level of negative effect would be expected for animals exposed to oil, the effects would not likely be lethal, except in the case of weaker animals such as pups or older and diseased animals.

## TABLE 5.6.2.44

## SUMMARY OF EFFECTS ANALYSIS FOR MARINE MAMMALS – ARACHNE REEF – 16,500 M³ SPILL (LOCATION E)

| Seasonal Condition | BSF | Area in RSA ($km^2$) | Affected Surface Water (by Probability of Oiling) | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Area (or length) According to Sensitivity Factor ($km^2$) | | | Percent Area (or length) According to Sensitivity Factor (%) | | |
| | | | Medium (≥ 10%) | High (≥ 50%) | Very High (≥ 90%) | Medium (≥ 10%) | High (≥ 50%) | Very High (≥ 90%) |
| Winter | 1 | 4,130 [1] | 836 [1] | 283 [1] | 38 [1] | 20 [2] | 6.9 [2] | 0.92 [2] |
| | 2 | 2,476 | 1,338 | 674 | 235 | 54 | 27 | 9.5 |
| | 3 | 7,578 | 5,850 | 4,013 | 2,076 | 77 | 53 | 27 |
| | 4 | 1,196 | 592 | 199 | 51 | 50 | 17 | 4.3 |
| Spring | 1 | 4,130 [1] | 761 [1] | 299 [1] | 75 [1] | 18 [2] | 7.2 [2] | 1.8 [2] |
| | 2 | 2,476 | 1,283 | 719 | 367 | 52 | 29 | 15 |
| | 3 | 7,578 | 6,214 | 4550 | 2,850 | 82 | 60 | 38 |
| | 4 | 1,196 | 526 | 226 | 99 | 44 | 19 | 8.2 |
| Summer | 1 | 4,130 [1] | 783 [2] | 274 [1] | 55 [1] | 19 [2] | 6.6 [2] | 1.3 [2] |
| | 2 | 2,476 | 1,462 | 752 | 305 | 59 | 30 | 12 |
| | 3 | 7,578 | 6,455 | 4,518 | 2,309 | 85 | 60 | 30 |
| | 4 | 1,196 | 605 | 235 | 82 | 51 | 20 | 6.8 |
| Fall | 1 | 4,130 [1] | 816 [1] | 300 [1] | 62 [1] | 20 [2] | 7.3 [2] | 1.5 [2] |
| | 2 | 2,476 | 1,339 | 647 | 275 | 54 | 26 | 11 |
| | 3 | 7,578 | 6,654 | 4,273 | 2,191 | 88 | 56 | 29 |
| | 4 | 1,196 | 554 | 202 | 77 | 46 | 17 | 6.5 |

**Notes:** 1 Total length of shoreline in the RSA, or length affected (km).

2 Expressed as % length of shoreline in that sensitivity class.

## TABLE 5.6.2.45

## SUMMARY OF EFFECTS ANALYSIS FOR MARINE MAMMALS – ARACHNE REEF – 8,250 M³ SPILL (LOCATION E)

| Seasonal Condition | BSF | Area in RSA ($km^2$) | Affected Surface Water (by Probability of Oiling) | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Area (or Length) According to Sensitivity Factor ($km^2$) | | | Percent Area (or Length) According to Sensitivity Factor (%) | | |
| | | | Medium (≥10%) | High (≥50%) | Very High (≥90%) | Medium (≥10%) | High (≥50%) | Very High (≥90%) |
| Winter | 1 | 4,130 [1] | 665 [1] | 182 [1] | 16 [1] | 16 [2] | 4.4 [2] | 0.4 [2] |
| | 2 | 2,476 | 1,165 | 434 | 124 | 47 | 18 | 5.0 |
| | 3 | 7,578 | 5,236 | 2,996 | 1,344 | 69 | 40 | 18 |
| | 4 | 1,196 | 467 | 123 | 30 | 39 | 10 | 2.5 |
| Spring | 1 | 4,130 [1] | 594 [1] | 207 [1] | 34 [1] | 14 [2] | 5 [2] | 0.8 [2] |
| | 2 | 2,476 | 1,140 | 538 | 288 | 46 | 22 | 12 |
| | 3 | 7,578 | 5,543 | 3,678 | 2,260 | 73 | 49 | 30 |
| | 4 | 1,196 | 443 | 158 | 70 | 37 | 13 | 5.8 |
| Summer | 1 | 4,130 [1] | 608 [1] | 190 [1] | 32 [1] | 15 [2] | 4.6 [2] | 0.8 [2] |
| | 2 | 2,476 | 1,309 | 561 | 206 | 53 | 23 | 8.3 |
| | 3 | 7,578 | 6,275 | 3,740 | 1,761 | 83 | 49 | 23 |
| | 4 | 1,196 | 542 | 163 | 49 | 45 | 14 | 4.1 |

**TABLE 5.6.2.45**

**SUMMARY OF EFFECTS ANALYSIS FOR MARINE MAMMALS – ARACHNE REEF – 8,250 M³ SPILL (LOCATION E) (continued)**

| Seasonal Condition | BSF | Area in RSA (km²) | Affected Surface Water (by Probability of Oiling) | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Area (or Length) According to Sensitivity Factor (km²) | | | Percent Area (or Length) According to Sensitivity Factor (%) | | |
| | | | Medium (≥10%) | High (≥50%) | Very High (≥90%) | Medium (≥10%) | High (≥50%) | Very High (≥90%) |
| Fall | 1 | 4,130 [1] | 616[1] | 196 [1] | 27 [1] | 15 [2] | 4.8 [2] | 0.7 [2] |
| | 2 | 2,476 | 1,105 | 494 | 169 | 45 | 20 | 6.8 |
| | 3 | 7,578 | 6,103 | 3,407 | 1,644 | 81 | 45 | 22 |
| | 4 | 1,196 | 382 | 149 | 38 | 32 | 12 | 3.1 |

Notes: 1 Total length of shoreline in the RSA, or length affected (km).

2 Expressed as % length of shoreline in that sensitivity class.

For whales such as porpoises, or the humpback and southern resident killer whale (BSF 3), potential exposure is based on habitat having a water depth of ≥10m. For a 16,500 m³ spill, the seasonal variation in the predicted area of affected habitat ranges between 53 per cent and 60 per cent of the RSA. The predictions for an 8,250 m³ spill range between 40 and 49 per cent of the available habitat. Therefore, there is a relatively high probability of exposure for whales should an oil spill occur at this location. Some level of negative effect would be expected for animals exposed to oil, but the effects would not likely be lethal, except in the case of weaker animals such as calves or older and diseased animals, or animals that were exposed to heavy surface oiling and inhalation of vapours from fresh oil, as could occur in the immediate vicinity of the spill location.

For furred marine mammals such as otters (BSF 4), potential exposure is based on the available habitat represented by water depths along the coast of ≤10 m. The seasonal variation in spatial extent for a 16,500 m³ spill for this receptor type represents between 17 per cent and 20 per cent of the available habitat, while for an 8,250 m³ spill, between 10 per cent and 14 per cent of the habitat is predicted to be affected. Therefore there is a relatively high probability of exposure for some of otters along the marine transportation route, in the event of an oil spill. Some level of negative effect would be expected for animals exposed to oil. Exposure during the winter season would be more stressful than exposure during the summer, but in either case, the combination of hypothermia and damage to the gastro-intestinal system caused by oil ingested through grooming the fur would have the potential to cause death.

### *5.6.2.5 Summary of Potential Ecological Effects and Recovery*

#### 5.6.2.5.1 Shoreline Habitat

The ERA indicates that while shoreline habitats would be affected by spilled oil along the marine transportation route, the affected areas generally represent a small fraction of total amount of shoreline belonging to each shoreline sensitivity class within the RSA.

In the case of a 16,500 m³ spill at the Strait of Georgia (Location D), Arachne Reef (Location E) and Race Rocks (Location G) representative scenario sites, the maximum spatial extent of affected shorelines with a high to very high probability of oiling ranges from: 3.4 per cent to 15 per cent of the available low sensitivity habitat (BSF 1); 1.3 per cent to 8.7 per cent of available habitat RSA for medium sensitivity BSF 2; 0.2 per cent to 6.6 per cent of available habitat for high sensitivity BSF 3; and 0.5 per cent to 1.6 per cent of available highly sensitive habitat. Comparable ranges for an 8,250 $m^3$ spill are: 1.1 per cent to 8.2 per cent of the available habitat for BSF 1; 0.9 per cent to 4.5 per cent of available habitat for BSF 2; 0.1 per cent to 4.1 per cent of available habitat BSF 3; and 0.0 per cent to 0.2 per cent of available very high sensitivity habitat (BSF 4).

Very little of the potentially affected shoreline habitat is of a type that would tend to sequester spilled oil (*e.g.*, deep gravel or cobble-boulder substrates that are not underlain by fine substrates that will remain saturated at low tide). Although salt marsh and eelgrass habitats are considered to be highly sensitive to oil exposure, these habitats have a very low probability of oiling for these representative scenarios. Shoreline classes with low exposure cobble/boulder veneer over sand would be most affected, but shorelines of this type are more readily restored if oiled, and would recover in a relatively short period of time.

Therefore, it is expected that shoreline clean-up and assessment techniques (SCAT) would be applied to the spilled oil that reached the shore, and that most of this oil would be recovered. Biological recovery from spilled oil, where shoreline communities were contacted by and harmed by the oil or by subsequent clean-up efforts, would be expected to lead to recovery of the affected habitat within two to five years. By comparison, whether cleaned or not, intertidal communities had recovered within five years after the EVOS.

#### 5.6.2.5.2 Marine Fish Community

The ERA indicates that fish habitat would be affected by spilled oil along the marine transportation route for all scenarios and seasonal conditions. The areas with the greatest spatial extent with a high to very probability of oiling can represent a substantial fraction of total amount of each habitat type with up to 46 per cent of the habitat affected in comparison to the overall habitat present within the RSA. Not all fish habitat; however, is of equal sensitivity to oiling.

In the case of a 16,500 $m^3$ spill at the Strait of Georgia (Location D), Arachne Reef (Location E) and Race Rocks (Location G) sites, the maximum spatial extent of habitat with a high to very high probability of oiling ranges from: 36 per cent to 46 per cent of the available RSA low sensitivity habitat (BSF 1); 26 per cent to 42 per cent of available habitat for medium sensitivity BSF 2; 13 per cent to 30 per cent of available habitat for BSF 3; and 4 per cent to 16 per cent of very high sensitivity habitat within the RSA (BSF 4). For an 8,250 $m^3$ spill, comparable ranges are: 29 per cent to 39 per cent for BSF 1; 22 per cent to 29 per cent for BSF 2; 9.8 per cent to 22 per cent for BSF 3; and 2.8 per cent to 13 per cent of the available RSA habitat for very high sensitivity BSF 4.

The potential for negative effects to the marine fish community is generally low as a result of the low potential for dissolved hydrocarbon concentrations in water to reach thresholds that would cause mortality of fish or other aquatic life. The representative crude oil has a relatively high viscosity, and this increases with weathering, so that the formation of oil droplets in the water column, that would enhance the dissolution of more toxic hydrocarbon constituents such as BTEX and light PAHs requires high wind speeds and rough water conditions, and even then this affects only the surface water layer in deep water environments. The potential for dissolved hydrocarbon concentrations to reach toxic levels would be greatest in shallow water areas, under weather conditions that caused spilled oil to be driven into shallow areas with wave action, leading to localized high concentrations of dissolved hydrocarbons in the water. This could result in the death of fish and invertebrates as a result of narcosis, or could cause abnormalities in developing embryos if spawn was present. Effects of this type were seen locally following the EVOS, but large-scale effects at the population level were not observed.

Due to the generally low potential for the spill scenarios to cause wide-spread mortality of fish, recovery of the marine fish community would be expected to be rapid. Even under a worst-case outcome event where localized fish kills might be observed, it is expected that the lost biological productivity would be compensated for by natural processes within one to two years. By comparison, effects of the EVOS on marine fish populations, were either not significant to begin with, or recovery occurred within one or two years at most.

#### 5.6.2.5.3 Marine Birds

Ecological risk assessment findings indicate that marine bird habitat would be affected by spilled oil along the marine transportation route for all scenarios and seasonal conditions. The areas with the greatest spatial extent with a high to very probability of oiling can represent a substantial proportion of each sensitivity class, with up to 42 per cent of the habitat affected in comparison to the overall habitat present within the RSA.

In the case of a 16,500 $m^3$ spill at the Strait of Georgia (Location D), Arachne Reef (Location E) and Race Rocks (Location G) sites, the maximum spatial extent of habitat with a high to very high probability of oiling ranges from: 0.5 per cent to 11 per cent of available shorebird habitat in the RSA (BSF 1); and from 23 per cent to 42 per cent of the available habitat in the RSA for gulls and terns, ducks and cormorants, or auks and divers (BSF 2, 3, and 4, respectively). For an 8,250 $m^3$ spill the maximum spatial extent of impacted habitat ranges from 0.4 to 6 per cent of the available RSA habitat for shorebirds; and from 15 per cent to 35 per cent of the available habitat in the RSA for the other seabirds.

There is high potential for oiling of marine bird habitat following an accidental spill of crude oil along the marine transportation route. The extent to which this potential could be realized would depend upon the size of the oil spill, the efficacy of measures intended to promptly contain and recover spilled oil, the ability of oil spill responders to capture and treat oiled animals, and the intrinsic sensitivity of the animals to exposure. Shorebirds have generally low sensitivity to oiling, and it is noteworthy that the Fraser River Delta is not predicted to be highly exposed to spilled crude oil in the event of a marine transportation accident. It is likely; however, that some shorebirds would be sufficiently oiled to result in mortality of adult or juvenile birds, or that eggs would become oiled as a result of oil in the feathers of the parent birds during the breeding season, resulting in embryo mortality.

There is also a high probability of exposure for other seabirds (including but not limited to gulls and terns, ducks and cormorants, and auks and divers) in the event of a crude oil spill. Some level of negative effect would be expected for birds exposed to crude oil, up to and including death as a result of hypothermia, loss of buoyancy, and/or oil ingestion. While the actual effects would depend upon the season, as well as other factors related to the oil spill and response activities, an effect magnitude rating of high would result under most if not all combinations of exposure scenarios and seabird sensitivity classes for the credible worst case and smaller spills.

Oil exposure could also extend to affect a large number of known breeding or colony sites for seabirds, as well as a large number of IBAs in the Strait of Georgia, Gulf Islands, and Juan de Fuca Strait region. This exposure is also considered likely to result in mortality of seabirds associated with the nesting sites during the spring and summer, and the IBAs at any time of the year. An effect magnitude rating of high would result.

Recovery of marine bird populations following the EVOS was generally rapid and uncomplicated (see Section 5.6.2.1). A major factor causing the EVOS Trustee Council to identify certain bird populations as “recovering” rather than “recovered” has been evidence of low-level exposure to hydrocarbons based on measured metabolic response linked to oil exposure (cytochrome P450 induction). While this measure can identify exposure, it does not identify effects of hydrocarbon exposure on individuals or at a population level. It is reasonable to expect marine bird recovery at a population level within 2 to 5 years following a large oil spill. Populations of alcid birds, which are considered to be most sensitive to spilled oil, could take longer to recover, on the order of 10 years or longer.

#### 5.6.2.5.4 Marine Mammals

The ERA indicates that mammal habitat would be affected by spilled oil along the marine transportation route for all scenarios and seasonal conditions. The areas with a high to very probability of oiling can represent a substantial fraction of total amount of each habitat type with up to 60 per cent of the habitat affected in comparison to the overall habitat present within the RSA.

In the case of a 16,500 $m^3$ spill at the Strait of Georgia (Location D), Arachne Reef (Location E) and Race Rocks (Location G) sites, the maximum spatial extent of habitat with a high to very high probability of oiling ranges from: 2.2 per cent to 11 per cent of the available RSF habitat for BSF 1; 20 per cent to 36 per cent of available medium sensitivity habitat in the RSA for BSF 2; 42 per cent to 60 per cent of available high sensitivity habitat for BSF 3; and 13 per cent to 30 per cent of very high sensitivity habitat in the RSA (BSF 4). Comparable ranges for an 8,250 $m^3$ spill are: the maximum spatial extent of impacted habitat with a high to very high probability of oiling for 0.8 to 6 per cent for BSF 1; 16 per cent to 26 per cent for BSF 2; 27 per cent to 39 per cent for BSF 3; and 9.8 to 22 per cent of very high sensitivity available habitat in the RSA (BSF 4).

There is clearly potential for oiling of marine mammal habitat following an accidental spill of oil along the marine transportation route. The degree to which this potential is realized would depend upon the size of the oil spill, the efficacy of measures intended to promptly contain and recover spilled oil, the ability of oil spill responders to capture and treat oiled animals, and the intrinsic sensitivity of the animals to exposure. Animals that are essentially terrestrial species that could be exposed to oil accumulated along shorelines have generally low sensitivity to oiling, and it is unlikely that oiled individuals would die as a result of exposure. It is very unlikely that such exposure would result in a measurable effect at the population level.

While there is a relatively high probability of exposure for seals and sea lions (BSF 2) in the event of an oil spill, and some level of negative effect would be expected for animals exposed to oil, the effects would not likely be lethal, except in the case of weaker animals such as pups or older and diseased animals. There is also a high probability of exposure for whales (BSF 3). Again, while some level of negative effect would be expected for animals exposed to oil, the effects would not likely be lethal, except in the case of weaker animals such as calves or older and diseased animals, or animals that were exposed to heavy surface oiling and inhalation of vapours from fresh oil, as could occur in the immediate vicinity of the spill location. The killer whales that appear to have suffered the greatest level of negative effects following the EVOS belonged to a group that was exposed to fresh oil at the spill site, and although the fate of these animals remains uncertain, it seems likely that direct exposure, including inhalation of vapours, may have resulted in the death of some of these animals.

For mammals with very high sensitivity to oil exposure such as otters (BSF 4) there is a medium probability of exposure along the marine transportation route in the event of an accidental oil spill. Some level of negative effect would be expected for animals exposed to oil and exposure during the winter season would be more stressful than exposure during the summer, but in either case, the combination of hypothermia and damage to the gastro-intestinal system caused by oil ingested through grooming the fur would have the potential to cause death. Many sea otters died following the EVOS, and the sea otter population has been slow to recover, although river otters were deemed to have recovered within 10 years after the spill.

#### *5.6.2.6 HHRA for Location E: Arachne Reef*

Aboriginal communities along the marine shipping lanes, the Vancouver Island Health Authority (VIHA) and the Coast Guard have expressed an interest in understanding the potential human health effects that could result following a spill in a marine environment. This section summarizes findings from a qualitative HHRA completed for marine transportation spills (Qualitative Human Health Risk Assessment of Marine Terminal Transportation Spills Technical Report, Volume 8B, TR 8B-9).

The assessment of the potential human health impacts associated with accidents and malfunctions centered on a series of hypothetical spill scenarios, including a scenario involving a spill associated with a tanker collision at Arachne Reef in the Turn Point SOA (Location E). Details surrounding the spill scenario and the basis of its selection are provided in Section 5.4.4.

When discussing human health effects, the potential effects associated with short-term and long-term exposure to hydrocarbons are referred to as acute and chronic effects, respectively. The HHRA focused on potential health effects that could result from short-term inhalation exposure to chemical vapours released from oil released at the Arachne Reef (Location E) site. Its objective was to establish the overall likelihood, nature and severity of effects as part of a screening-level exercise. However, the approach followed differs from that adopted for the screening-level human health risk assessment of the routine pipeline and facilities operations (see Volume 5D). Routine operations consist of planned activities for which chemical exposures and any associated health risks can be anticipated and assessed on the basis of known or reasonably well-defined exposure scenarios. In contrast, spills represent low probability, unpredictable events for which the exposures and risks must be assumed for strictly hypothetical scenarios. Accordingly, rather than following a conventional risk assessment paradigm with an emphasis on quantifying the potential risks involved, the present assessment was designed to provide a preliminary indication of the prospect for people's health to be affected by a spill, together with an indication of the types of health effects, if any, that might be experienced. Results of this qualitative assessment determine whether or not a more comprehensive assessment is needed to provide further evidence to define the nature and extent of any health effects that people might experience and mitigation measures that could be applied to reduce risks to human health.

The HHRA considered the likelihood and extent to which people's health could potentially be affected by the Arachne Reef hypothetical spill scenarios based on the following factors:

- the volume of oil spilled;
- the types of chemicals contained in the spilled oil to which people could be exposed (see Section 5.4.2);

- the extent to which people could be exposed based on predictions of how the spilled oil and the constituent chemicals would likely disperse in the environment considering time of year, weather patterns, currents and tides, wave action, and the way that spilled oil would partition between air and water over time (see Section 5.4.4);
- the manner and pathways by which people might be exposed to the chemicals;
- the emergency response and other mitigation measures that will be taken to limit people's exposure to the chemicals in the event of a spill (see Section 5.7.3 and 5.5);
- the types of health effects known to be caused by the chemicals as a function of the type, amount and duration of exposure;
- the responsiveness and sensitivity of the people who could potentially be exposed to the chemicals; and
- the types of health effects that have been reported to occur among people following oil spill incidents.

For the Arachne Reef scenario, the HHRA focused on the chemicals that could be released from the surface of the spilled oil though volatilization, resulting in their presence in the air as vapours at or near the source, which would then disperse in a downwind direction. These chemicals would consist principally of lighter-end, volatile and semi-volatile hydrocarbons ($C_1$ to $C_{12}$), including both aliphatic and aromatic constituents. The latter constituents include BTEX as well as PAHs. Trace amounts of sulphur-containing chemicals and longer-chain, semi-volatile hydrocarbons ($C_{13}$ to $C_{21}$) also could be present. These chemicals represented the COPC that were examined as part of the assessment.

The assessment focused on the potential health effects that could occur among the general public, including people living near the spill location on islands in the channel as well as other individuals in the area (*i.e.*, fishers who might be in the area at the time of the incident or recreational users). It is expected that first responders and other response personnel arriving at the scene will be trained in emergency preparedness and response, will be equipped with appropriate personal protective equipment (PPE), will be oriented to the situation, and will take appropriate precautions to avoid physical contact with the spilled oil itself as well as to limit exposure to any chemical vapours that might be present. These measures will act to limit any potential health effects that could occur among the responders.

The Arachne Reef scenario HHRA focused on the potential human health effects that could result from inhalation exposure to chemical vapours released during the course of the incident, with an emphasis on exposures that might be received on a short-term or "acute" basis. The decision to focus the assessment on this particular type of exposure was based, in part, on the following:

- Concern over the potential health effects that could result if an accidental spill was to occur in a marine environment were expressed by stakeholders at various community meetings, including the potential health effects that might result from inhaling chemical vapours released during the course of the incident. These stakeholders included local island residents and Aboriginal communities. In addition, the VIHA was interested in understanding the potential human health effects that could occur from chemical exposures during a spill.

- In the event of a spill, the WCMRC would be responsible for carrying out spill response activities within the vicinity of Arachne Reef (Location E) as it falls within the WCMRC's Primary Area of Response (PAR) for the Port of Vancouver (see Figure 5.5.1; Section 5.5). Currently, for Tier 3 (2,500 tonnes) and Tier 4 (10,000 tonnes) spills inside the primary area of response, response times for equipment deployed on-scene are 18 and 72 hours, respectively (WCMRC 2012). These response times may improve as a result of proposed improvements WCMRC is currently considering as a result of the Project (see Section 5.5.2).

- Following a spill, the Oil Spill Response Plan (OSRP) submitted to Transport Canada by WCMRC would be activated and this includes information on geographical area of response, call-out procedures, health and safety program and response counter- (WCMRC 2012).

- The OSRP is designed to work within the framework of other federal, provincial and local emergency response plans, including the BC MOE Environmental Emergency Management Program which has an essential role in protecting human health (BC MOE 2013a, WCMRC 2012).

- The BC MOE recently prepared a Marine Oil Spill Response Plan (BC. MOE 2013b). This response plan provides details of the provincial response strategy including incident notification, escalation and support, response organization, Ministry roles and services and provincial support (BC MOE 2013b). The province of BC has a 24-hour reporting number for marine oil spills. If specific human safety and welfare conditions (*e.g.*, poisoning of water or food sources and/or supply, presence of toxic fumes or explosive conditions, need for evacuation) or specific environmental conditions are met, a marine oil spill becomes an "incident" which warrants consideration of invoking part or all of the response plan and whether to declare an environmental emergency. The Technical Specialist Unit falls under the Planning Section of the BC Marine Oil Spill Incident Management Team which, among other things, monitors air quality for hydrocarbons to measure risks to human health (BC MOE 2013b).

- The actions provided by the WCMRC and relevant government agencies, will serve not only to limit any opportunities for exposure of the general public to chemical vapours released from the spill in the short-term, but also to preclude any reasonable opportunity for exposure on a longer-term basis *via* inhalation and/or other exposure pathways such as ingestion of or incidental dermal contact with the spilled chemicals.

- In the event of a spill, and if warranted, local, provincial and/or federal regulatory authorities can implement controls to protect public health under the authority vested in ordinances, Acts and/or Regulations under which the regulatory authorities operate. Examples of such controls include closure of recreational or commercial fisheries, beach closures, the issuance of drinking water or food consumption advisories, and/or forced evacuation. These measures will further reduce the potential opportunities for exposure of people to the chemicals released during a spill on a short-term and long-term basis, with the former controls specifically limiting opportunity for exposure *via* ingestion or incidental skin contact.

- Based on the types of chemicals that might be encountered and their known health effects, the potential health effects would likely be dominated by irritation of the eyes and/or breathing passages, possibly accompanied by symptoms consistent with central nervous system involvement, such as nausea, headache, light headedness and/or dizziness. In this regard, a number of the COPC are capable of acting as irritants and central nervous system depressants. The effects could range from barely noticeable to quite noticeable, depending on the exposure circumstances and the sensitivity of the individuals exposed (see below). Odours might be apparent, dominated by a hydrocarbon-like smell, with some prospect for other distinct odours due to the presence of sulphur-containing chemicals in the vapour mix. The odours themselves could contribute to discomfort, irritability and anxiety. The exact nature and severity of any health effects will depend on several factors, including:

- The circumstances surrounding the spill, including the volume of oil spilled, the tidal patterns, time of year, and meteorological conditions in effect at the time. These circumstances will affect the extent to which chemical vapours are released from the surface of the spilled oil and the manner in which these vapours will disperse.

- A person's whereabouts in relation to the spill, including their distance from the source and their orientation to the spill with respect to wind direction. It is expected that exposures would be highest at distances closest to the source, declining with increasing distance. The prospect for health effects to occur as well as the severity of any effects will follow the same pattern. The prospect for health effects to occur also will be greatest downwind of the spill, with reduced, if any, prospect for effects at cross-wind or upwind locations.

- The timeliness of emergency response measures. Measures taken to either remove the hazard from the general public (*e.g.*, spill isolation, containment and mitigation) or remove individuals from the near spill area will reduce the exposures received and the prospect for health effects to occur. The sooner these measures can be implemented, the lower the likelihood of any effects.

- Once a spill has occurred, DFO (Department of Fisheries and Oceans) is notified. DFO along with other regulatory authorities such as Environment Canada and Canadian Food Inspection Agency (CFIA) will then assess the spill and based on location, size and proximity to human pathways (*e.g.,* finfish, shellfish and beach) they will determine if a closure is necessary. If they feel there is any potential that any of these potential human pathways will be affected, they will issue an emergency closure of that pathway.

- The person's sensitivity to chemical exposures. It is widely accepted that a person's age, health status and other characteristics can affect the manner and extent to which they respond to chemical exposures, with the young, the elderly and people with compromised health often showing heightened sensitivity.

A more focused and detailed HHRA to inform specific mitigation and emergency response plans will be completed and submitted to the NEB in early 2014.

## 5.7 Hypothetical Spill Scenario: Oil Spill from a Tanker at Arachne Reef

This section provides an assessment of the spill response enhancements presented in Section 5.5. In this case the results for a single spill event at Arachne Reef in the near Turn Point Special Operating Area are compared with and without spill response mitigation. This examination was collaboratively performed by EBA and WCMRC to refine and assess the spill response improvements presented in Section 5.5.2.

Unlike the spill modelling results presented in previous sections (5.4 and 5.6) which were stochastic results and run without any spill response intervention this section compares the results of a single specific spill with and without spill response intervention. The spill response intervention is based on the enhancements described in Section 5.5. Details of this assessment are included in Trans Mountain Expansion Project Oil Spill Response Simulation Study, Arnachne Reef and Westridge Marine Terminal (Volume 8C, TR 8C-12, S13).

### *5.7.1 Scenario Rationale, Methods and Description*

#### *5.7.1.1 Scenario Rationale*

The scenario considered is a credible worst case spill (16,500 $m^3$) near Turn Point, in Haro Strait, resulting from a tanker grounding incident with Arachne Reef (see Figure 5.5.2, Location E). As noted in Section 5.2.2, possible locations for an incident involving a Project-related tanker were selected by DNV as part of the hazard identification component of the quantitative risk assessment (TERMPOL 3.15, Volume 8C, TR 8C-12). Locations along the tanker shipping route were selected as possible sites for an incident involving a Project-related tanker due to complexity of passage resulting from high traffic and/or the narrowness of the passage.

It should be noted that groundings and collisions along the marine route for Project-related tankers have an extremely low probability, particularly in the Haro Strait due to the tanker being piloted by two experienced BC coast pilots and the ongoing use of a tethered tug through this part of the route. However, a hypothetical credible worst case scenario spill was examined so that appropriate oil spill response plans and procedures can be developed.

#### *5.7.1.2 Methods*

The approach undertaken for this hypothetical spill scenario combines the skills of operational organizations such as WCMRC and the skills of scientific numerical modellers (EBA). Through this leading-edge combination, the purpose is to demonstrate the pathway toward developing enhanced response capacity.

The approach meets the requirements of a systems approach, as recommend in the West Coast Spill Response Study (Nuka Research 2013). Elements of this systems approach are:

- analysis of the problem;

- considering and evaluating a number of solutions, and develop a blend of solutions;
- creative “outside the box” thinking to ensure that conventional approaches are challenged and determining if new ones have merit; and
- using a disciplined approach, keeping the important priorities in mind.

These elements were implemented through:

- Realistic environmental scenarios, based on high-accuracy numerical models for currents and oil spill behaviour used in the evaluation.
- The resources for mitigation were based on existing and proposed equipment stored in warehouses and caches in accordance with the Future Oil Spill Response Approach Plan, Trans Mountain Expansion Project, which has been prepared by WCMRC (Volume 8C, TR 8C-12, S12).

The oil spill simulations, which form the basis of the mitigation analysis, were conducted using SPILLCALC, a proprietary oil spill tracking model developed by EBA. Its complete description can be found in the EBA Technical Report, Modelling the Fate and Behaviour of Marine Oil Spills for the Trans Mountain Expansion Project (Volume 8C, TR 8C-12, S12). SPILLCALC uses surface currents that were hindcast using a proprietary three-dimensional hydrodynamic model, H3D. This model is derived from GF8 (Stronach *et al.* 1993) developed for Fisheries and Oceans Canada. H3D has been used on several studies along the BC coast. An extensive application of an operational version of this model to the St. Lawrence Estuary is described in Saucier and Chassée (2000). For the simulation described in this report, a 1,000 m resolution Regional Model was used. This model encompasses the Strait of Georgia - Juan de Fuca - Puget Sound system, extending out onto the shelf at the western end of Juan de Fuca. Figure 5.7.3.3 shows the modelled domain.

To enhance the level of preparedness for the increased traffic associated with the Project, WCMRC described enhancements to respond efficiently to a credible worst case oil spill from a laden Aframax tanker outbound to the Pacific Ocean from the Westridge Marine Terminal through the South Salish Sea (Section 5.5.2; Volume 8C, TR 8C-12, S12). Relying on the ability to cascade resources pre-staged along the shipping route, these proposed enhancements would substantially exceed the current legislated response thresholds detailed in the *Canada Shipping Act, 2001*. The increase in response capacity would follow a systems approach that not only includes additional equipment but also new bases, more personnel, 24 hours/day – 7 days/week - 365 days/year staffing at certain locations, and improved logistics. Figure 5.5.2 shows the proposed spill response equipment staging areas.

The mitigation modelling system combines two components:

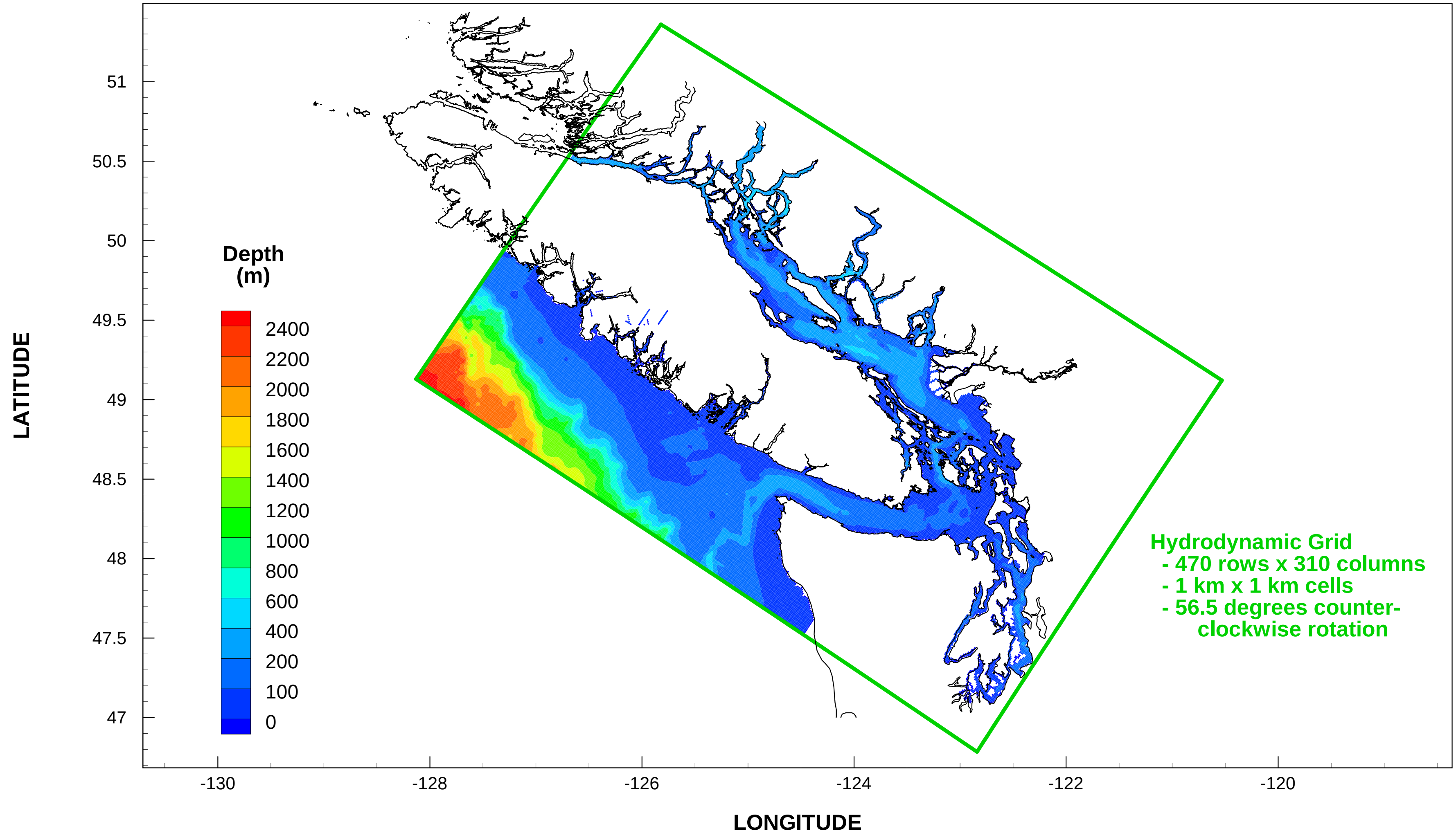
- a schedule of asset assignments (*i.e.,* equipment and staging locations), developed by WCMRC; and
- numerical simulations to evaluate the effect of these assets on the modelled spill, primarily in terms of reducing the amount of oil on the water, and to improve the mitigation strategy plan.

A schedule of asset assignments is constructed as an additional input file to the oil spill model SPILLCALC, listing the asset name, time of deployment, location of deployment, and volumetric capacity over a one-hour period. SPILLCALC steps through the spill evolution, and applies each of the assets at the time it is deployed, removing the specified quantity of oil that each asset can remove in one hour. The spill model computes the oil movement in the hours in which the assets for that hour are active, and produces a mitigated spill map, and a corresponding entry into the mass balance tables. This process is repeated for the length of the simulation, in this case 4 days. The 4 day simulation period was selected based on the slick thickness on water, which becomes too thin to be efficiently recoverable after the end of the fourth day. Thereafter, passive sheen management with sorbent products remains a viable but unquantifiable countermeasure for the response organization to employ.

Notes on the resources that were considered in the scenarios are:

- Primary and secondary containment, essentially sufficient boom to wrap the stranded vessel twice. This tactic is highly effective in containing the spread of oil and assisting in its recovery since the oil within the boom will be thick and fresh, hence amenable to skimming and pumping.

- Skimmers in common use within the WCMRC inventory were assigned to collect oil in the scenario.




**NOTES**

- Model grid was created in a Mercator projection true at 48 degrees 12 minutes N.

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# TRANS MOUNTAIN OIL SPILL STUDY

## Hydrodynamic Model Grid Domain

| PROJECT NO. | DWN | CKD | APVD | REV |
|---|---|---|---|---|
| V13203022 | DP | AH | JAS | 0 |

| OFFICE | DATE |
|---|---|
| EBA-VANC | November 7, 2013 |

**Figure 5.7.3.3**

#### *5.7.1.3 Scenario Description*

The waters between Moresby Island and Stuart Island mark the northern entrance to Haro Strait, which runs south-southeasterly between the Gulf Islands on the Canadian side and the San Juan Islands on the US side. Arachne Reef is situated at the northern end of Haro Strait, off to the west side of the Strait. It consists of three drying heads, and has a navigation light. A plausible but highly unlikely event would be a powered grounding of a laden tanker on Arachne Reef near Turn Point. Figure 5.5.2 shows a location map of the incident. The northern entrance to Haro Strait has the greatest level of navigation complexity for the entire passage of a Project-related tanker, as well as numerous vessels transiting the Strait. The location also has a very high environmental and socio-economic value with the potential to affect several distinct areas and habitats, including but not limited to Boundary Bay, the Gulf Islands and San Juan Islands, the Salish Sea, and the Juan de Fuca Strait. The event of a powered grounding of a laden Project-related tanker has low probability due to the proposed use of a tethered tug through this part of the route.

The hypothetical incident is given to have occurred at 22:00 on August 17, 2012 and was selected from the 368 independent simulations of the stochastic modelling for a summer spill event. The selection was based on the representativeness of the resulting spill in terms of environmental and human-health consequences. Specifically, the summer season was selected for the mitigation simulation, as warmer water and air temperatures would facilitate more rapid dissolution and/or volatilization of lighter pseudo-components into water or air, respectively. This is conservative, as the concentration in water or air would be increased by rapid dissolution and/or volatilization. At the same time, generally lower wind speeds during the summer would result in less wave action (hence, less vertical mixing of the water column, and higher concentrations of dissolved hydrocarbons in the surface water layer), as well as less dilution of vapours in air.

### *5.7.2 Transport and Fate*

The weathering processes, which can affect spilled oil in a marine environment, were described in detail in Section 5.4. This subsection describes what happens after the hypothetical incident occurs and oil is spilled from a Project-related tanker.

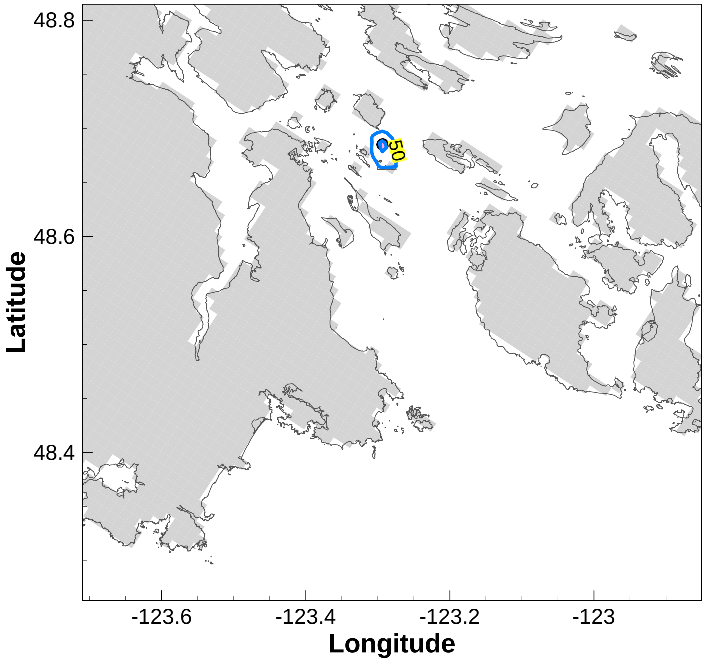
Figure 5.7.3.5 shows the "$P_{50}$" and "$P_{90}$" map after 6, 12, 24 and 48 hours. The $P_{50}$ contour indicates that there is a 50 per cent or greater probability for the area within the $P_{50}$ contour line to have been contacted by the oil. Similarly, the $P_{90}$ contour indicates that there is a 90 per cent or greater probability for the area within the $P_{90}$ contour line to have been contacted by the oil.

These maps were built based on the stochastic modelling described in the EBA Technical Report, Modelling the Fate and Behaviour of Marine Oil Spills for the Trans Mountain Expansion Project (Appendix 8C, TR 8C-12, S9). A total of 368 independent simulations were modelled during the summer period at Arachne Reef. Probability contours were then extracted, based on the combination of those 368 independent simulations.

Figure 5.7.3.6 shows the un-mitigated spill location, in terms of slick thickness as computed by SPILLCALC after 96 hours. Figure 5.7.3.7 shows the mass balance for the un-mitigated case. The key performance indicators (KPI) that will be used to evaluate the effectiveness of response activities are:

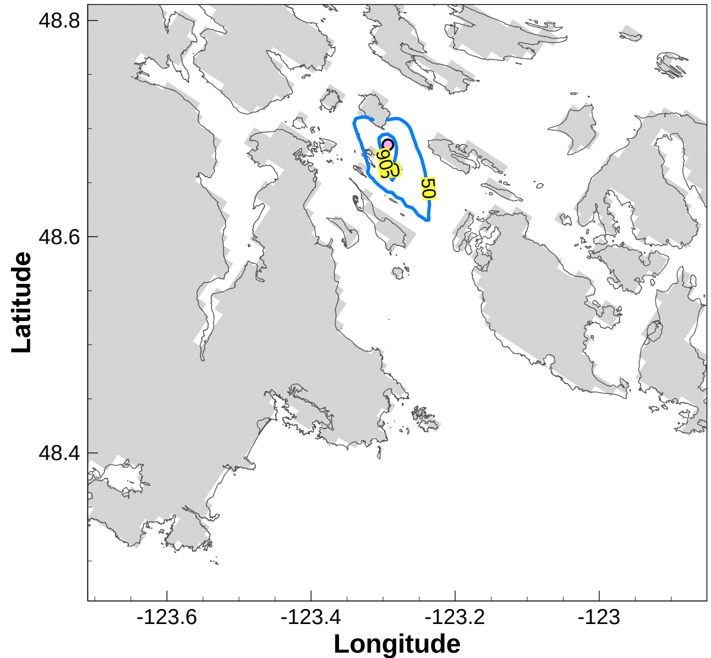
- reduce the extent and thickness of the slick remaining on the water after four days;

- reduce the quantity of oil on water after four days;
- reduce the quantity of oil reaching shore after four days;
- reduce the length of shoreline oiled; and
- account for any oil recovered, ensuring that it is only assessed as recovered once the simulation shows any oil that is contained in a secure tank on a skimmer, barge or supply vessel.



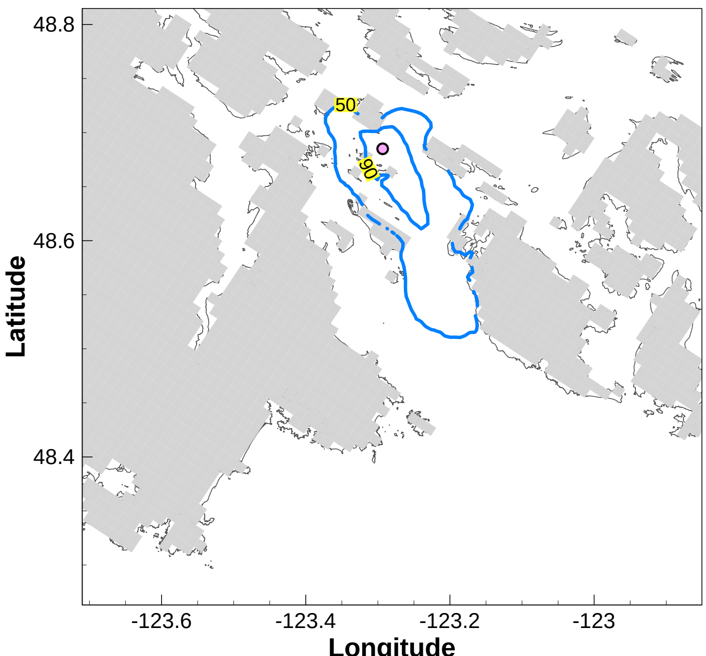

## $P_{50}$ and $P_{90}$ after 6 Hours

| | |
|---|---|
| Area within the $P_{50}$ Contour Line: | 8.3 $km^2$ |
| Area within the $P_{90}$ Contour Line: | 0.5 $km^2$ |
| Average Thickness within the $P_{50}$ Contour Line: | 217 um |
| Average Thickness within the $P_{90}$ Contour Line: | 342 um |
| Average Shore Oiled: | 3 km |



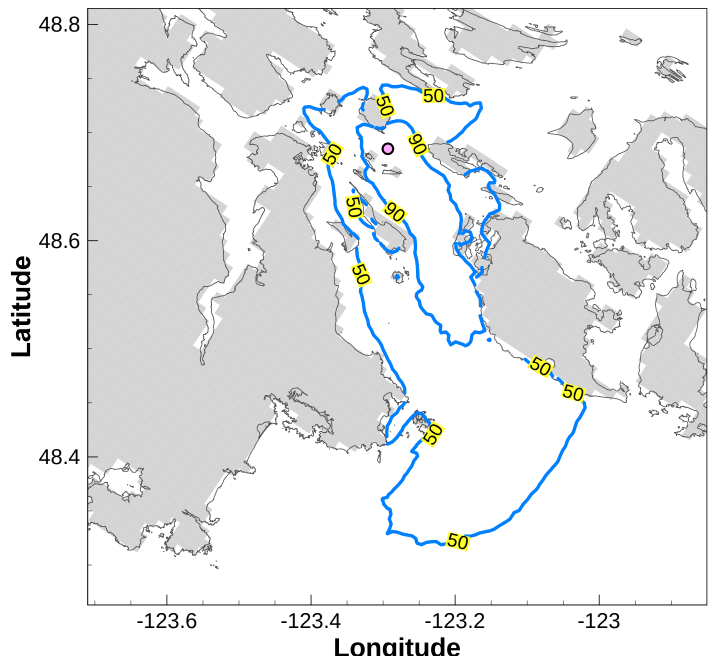

## $P_{50}$ and $P_{90}$ after 12 Hours

| | |
|---|---|
| Area within the $P_{50}$ Contour Line: | 47.3 $km^2$ |
| Area within the $P_{90}$ Contour Line: | 4.3 $km^2$ |
| Average Thickness within the $P_{50}$ Contour Line: | 94 um |
| Average Thickness within the $P_{90}$ Contour Line: | 245 um |
| Average Shore Oiled: | 11 km |




## $P_{50}$ and $P_{90}$ after 24 Hours

| | |
|---|---|
| Area within the $P_{50}$ Contour Line: | 196 $km^2$ |
| Area within the $P_{90}$ Contour Line: | 37.8 $km^2$ |
| Average Thickness within the $P_{50}$ Contour Line: | 36 um |
| Average Thickness within the $P_{90}$ Contour Line: | 78 um |
| Average Shore Oiled: | 36 km |




## $P_{50}$ and $P_{90}$ after 48 Hours

| | |
|---|---|
| Area within the $P_{50}$ Contour Line: | 646 $km^2$ |
| Area within the $P_{90}$ Contour Line: | 132 $km^2$ |
| Average Thickness within the $P_{50}$ Contour Line: | 10.5 um |
| Average Thickness within the $P_{90}$ Contour Line: | 26.7 um |
| Average Shore Oiled: | 85 km |

**NOTES**

Release Location

Probability of oil presence is the percentage of simulations in which oil was present at a given location.

$P_{50}$: after X hours, there is 50% or greater probability for the area within the $P_{50}$ contour line to have been contacted.

$P_{90}$: after X hours, there is 90% or greater probability for the area within the $P_{90}$ contour line to have been contacted.

Statistical results for each season based on independent spills occuring every 6 hours for three months.

Tracking time for each spill was 15 days.

The average thickness is based on a full coverage of each grid cell that contains oil and lies within the contour line.

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**TRANS MOUNTAIN OIL SPILL STUDY**

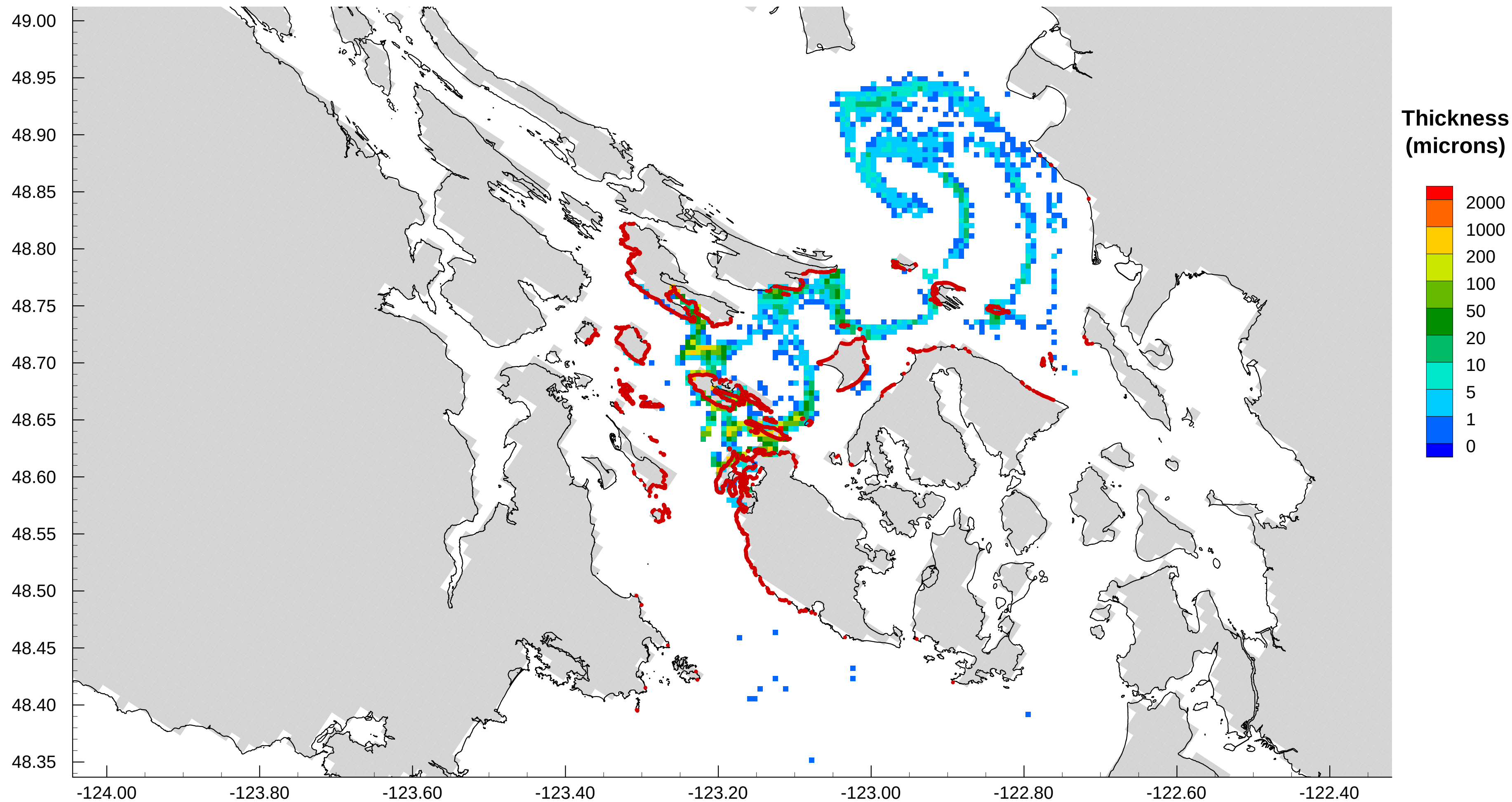
**Summer Stochastic Simulation**
**Arachne Reef (16,500 $m^3$)**
**$P_{50}$ and $P_{90}$ after 6 / 12 / 24 / 48 Hours**

| PROJECT NO. | DWN | CKD | APVD | REV |
|---|---|---|---|---|
| V13203022 | DP | JAS | - | 0 |

| OFFICE | DATE |
|---|---|
| EBA-VANC | November 6, 2013 |

**Figure 5.7.3.5**

**2012/08/21 22:00**




## NOTES

- The graph displays the thickness of the oil on water.
  The thickness of the oil is based on a uniform full coverage of the 500m x 500m model grid cell.

- The oil on shore is displayed as a red line, regardless of the volume retained by the shore.
  The red shorelines are a visual tool only, to indicate the shoreline being contacted by the oil.

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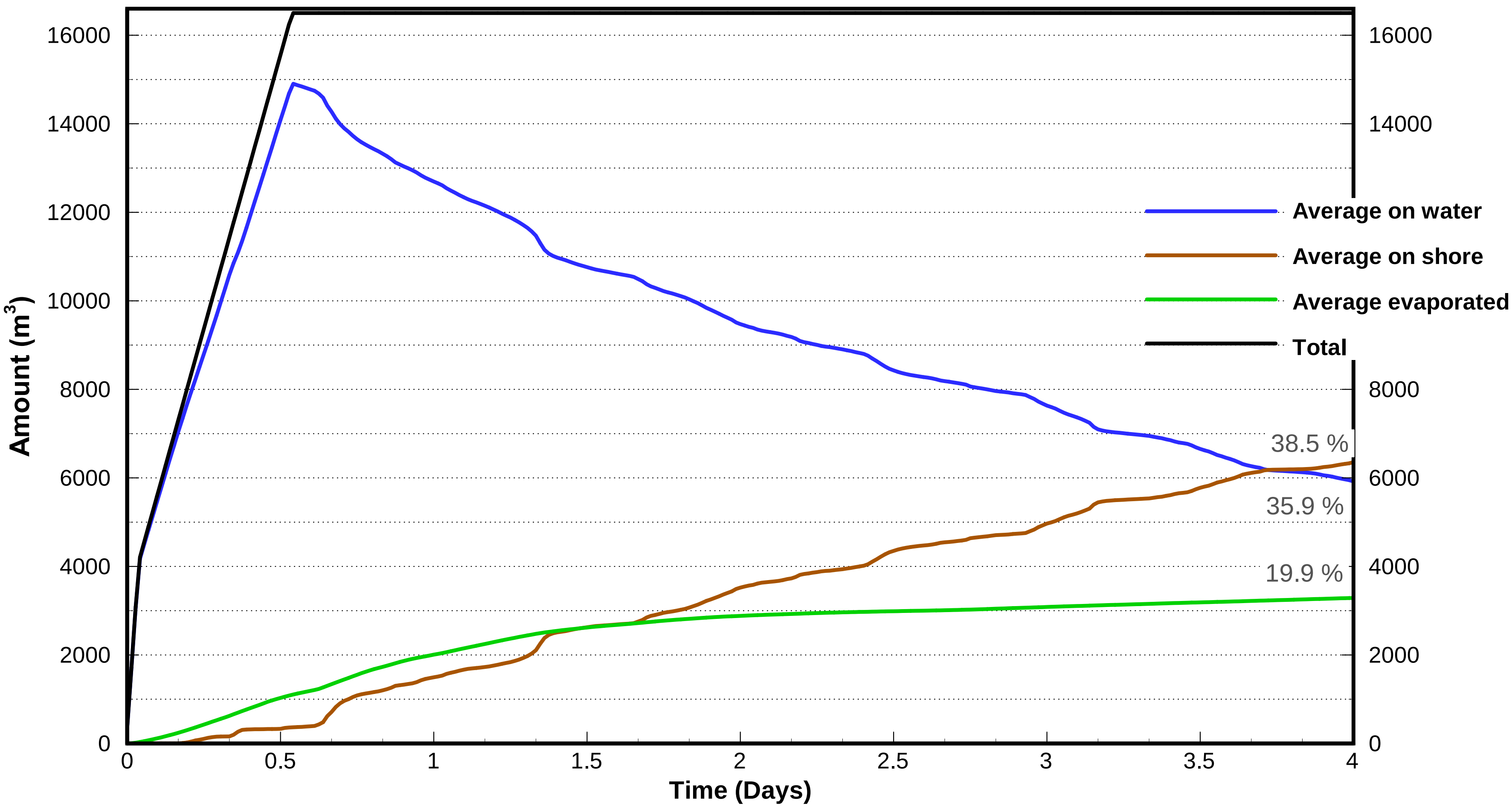
## TRANS MOUNTAIN OIL SPILL STUDY

**Unmitigated Simulation at Arachne Reef: August 17 2012, 10:00pm Oil Thickness after 96 Hours**

| PROJECT NO. | DWN | CKD | APVD | REV |
|---|---|---|---|---|
| V13203022 | AH | JAS | JAS | 0 |

| OFFICE | DATE |
|---|---|
| EBA-VANC | November 4, 2013 |

**Figure 5.7.3.6**




## NOTES

- Tracking time for the spill was 15 days.
- The major components of the mass balance are shown above.

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## TRANS MOUNTAIN OIL SPILL STUDY

**Unmitigated Simulation at Arachne Reef**
**August 17 2012, 10:00pm**
**Major Components of the Mass Balance**

| PROJECT NO. | DWN | CKD | APVD | REV |
|---|---|---|---|---|
| V13203022 | AH | JAS | - | 0 |

| OFFICE | DATE |
|---|---|
| EBA-VANC | November 4, 2013 |

**Figure 5.7.3.7**

### 5.7.3 Spill Response

Based on the modelled fate and transport of the spilled oil without any mitigation measures applied, EBA developed the following recommended response to the hypothetical spill for the Project.

#### *5.7.3.1 Establishing Outflow, Retention, and Escapement*

The Arachne Reef scenario is based on a total volume of 16,500 $m^3$ of oil released over 13 hours, the amount DNV calculated as a credible worst case oil spill for a partly loaded Aframax tanker (TERMPOL 3.15, Volume 8C, TR 8C-12). Resulting from the incident, 25 per cent of the impacted tank volume is assumed to be lost in the first hour (elapsed time from the beginning of the spill) with 1,000 $m^3$ of cargo assumed to flow out of the vessel every hour thereafter until the total spilled volume is reached. Primary containment booms, as the first line of defense, surround the tanker by the end of hour +4 (elapsed time); oil retention and escapement rates from the boom are time–varying due to the variable influences of: 1) currents; 2) entrainment loss; 3) critical accumulation failure; and 4) operational effects. At hour +7 (elapsed time), secondary containment is achieved reducing the escapement outside the double-boom system.

#### *5.7.3.2 Shipboard Emergency Measures*

Although shipboard emergency measures were not part of this scenario or factored into the model, for background information it is reasonable to assume that the tanker would have undertaken a certain number of procedures upon recognition that the tanker had run aground. These procedures are described in the Trans Mountain Expansion Project Oil Spill Response Simulation Study, Arachne Reef and Westridge Marine Terminal report (Volume 8C, TR 8C-12, S13).

#### *5.7.3.3 Response Plan*

The deployment of the available pieces of equipment over Day 1 for the initial response, and Day 2, 3, and 4 is described in the Trans Mountain Expansion Project Oil Spill Response Simulation Study, Arachne Reef and Westridge Marine Terminal report (Volume 8C, TR 8C-12, S13). The efficiency of the response was maximized through the addition of an offshore supply vessel (OSV) with 1,880 mt (2,000 $m^3$) of integral storage moored in the Sidney area.

A summary of recovery operations at the end of Day 1 reveals the following information:

- fourteen skimmers have performed 44 individual recovery sorties by the end of the day;
- during the first eight hours of the response, the OSV (with 1,880 mt of integral storage) has acted as a temporary storage bridge until the arrival of a large barge;
- in addition to the OSV, Barge #1 (5,000 mt) will be the only other dedicated storage unit during Day 1; and
- eight 40-tonne mini-barges were deployed throughout the day to extend the recovery times of certain skimmers.

A summary of recovery operations at the end of Day 2 reveals the following information:

- seventeen skimmers have performed 61 individual recovery sorties by the end of the day;
- in addition to the OSV (1,880 mt), Barge #1 (5,000 mt) and Barge # 3 (10,000 mt) will be used as dedicated storage units during Day 2; and
- twenty 40-tonne mini-barges were deployed throughout the day to extend the recovery times of certain skimmers.

A summary of recovery operations at the end of Day 3 and Day 4 reveals the following information:

- eighteen skimmers have performed 58 individual recovery sorties by the end of Day 3;
- eighteen skimmers have performed 48 individual recovery sorties by the end of Day 4;
- in addition to the OSV (1,880 mt), three barges (total storage capacity > 17,000 mt) will be used as dedicated storage units during Day 3 and Day 4; and
- twenty 40-tonne mini-barges were deployed throughout the day to extend the recovery times of certain skimmers.

#### *5.7.3.4 Simulation of Proposed Mitigation*

The removal of the oil inside the containment area and the removal of the oil lost at sea were modelled based on the response operation plan described in Volume 8C (TR 8C-12, S13). Four days of mitigation were modelled. After 96 hours (*i.e.,* 4 days), Figure 5.7.3.8 clearly shows that much less oil is left on water, compared to Figure 5.7.3.6, which shows the un-mitigated case.

Figure 5.7.3.9 shows the mass balance in the mitigated case. Recovery of the oil was conducted at sea and in the containment area. Of the total oil outflow from the tanker in this simulated accident, 44.5 per cent was recovered from the sea outside the boom and 18.6 per cent was recovered from within the containment area. Table 5.7.1 shows the mass balance in both unmitigated and mitigated cases.

**TABLE 5.7.1**

**MASS BALANCE COMPARISON**

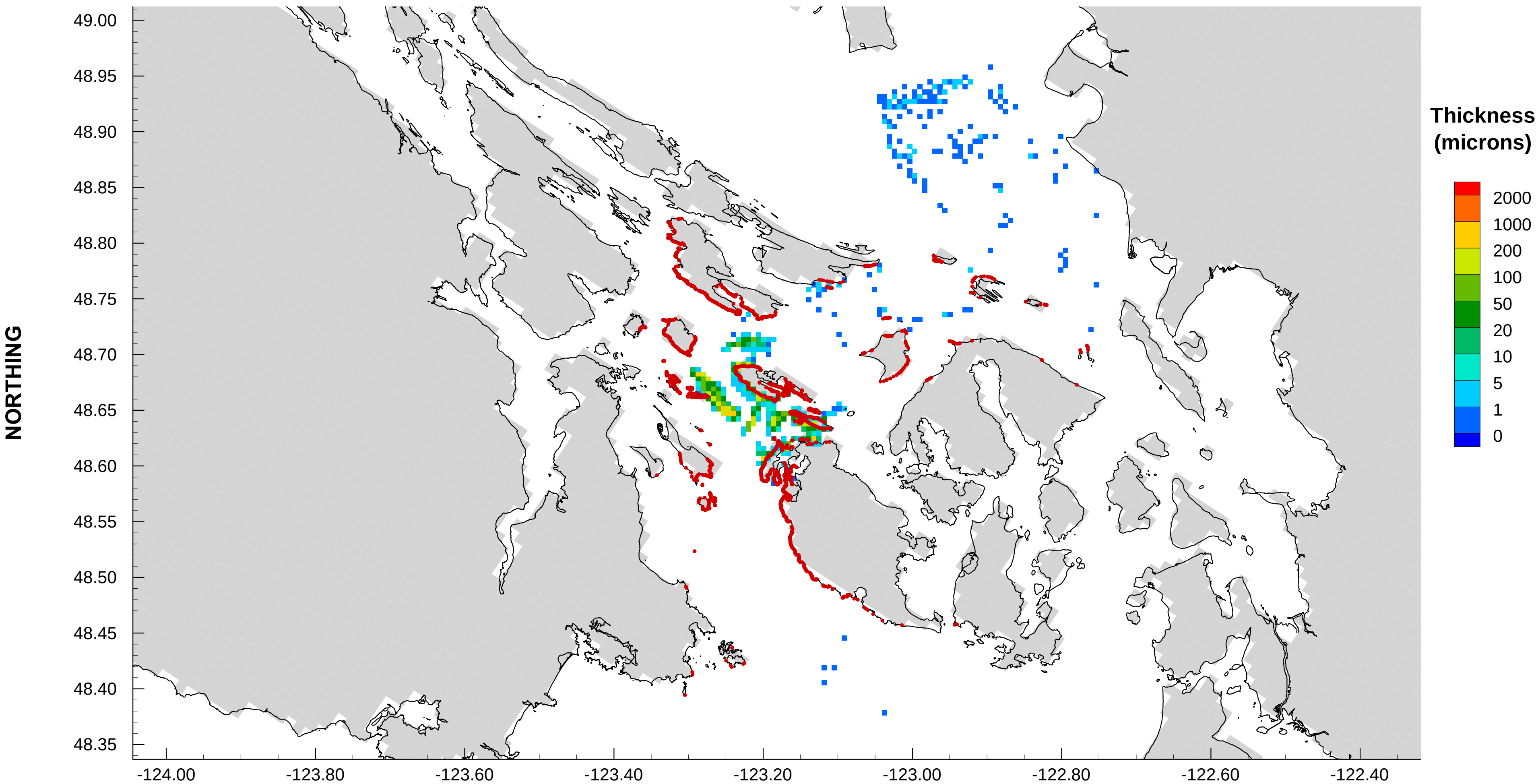
| Amount ($m_3$) | Unmitigated Case | Mitigated Case |
|---|---|---|
| On shore after 4 Days | 38.5% | 15.8% |
| On shore after 15 Days | 70.2% | < 24.6% |
| Left on water after 4 Days | 35.9% | 8.8% |
| Evaporated after 4 Days | 19.9% | 7.4% |
| Dissolved after 4 Days | 3.8% | 3.4% |
| Biodegraded after 4 Days | 1.9% | 0.5% |
| Inside the containment area but not yet recovered | N/A | 1% |
| Recovered from inside the containment boom | N/A | 18.6% |
| Recovered at Sea | N/A | 44.5% |

After 4 days, there is almost no oil inside the containment boom as a result of the recovery operations. Less than 10 per cent of the spilled oil is left on water. The fraction of spilled oil that contacted shorelines has been reduced from about 70 per cent in the unmitigated case after 15 days, to 25 per cent in the mitigated case (15 per cent of the spilled oil is on shore after 4 days in the mitigated case and 10 per cent is left on water, which is conservatively assumed to end up on shore).

The amount of oil recovered from the water surface during this model investigation represents somewhat more than half of the spill. This amount is very high compared to historical recoveries at large spill incidents. A few reasons explain this high rate of recovery:

- Proper planning when establishing the proposed level of capabilities, with the addition of equipment staging locations and the development of additional bases along the shipping route (Figure 5.5.2).
- Leading-edge tools, primarily an oil spill tracking model using surface currents from a three dimensional hydrodynamic model and waves from a two-dimensional wave model. In an actual spill event, remotely-sensed data would also be available to update information provided by such forecasting tools.
- Input vetting, variable level of synchronization among the different units unloading recovered oil into the storage barges.

**2012/08/21 22:00**




## NOTES

- The graph displays the thickness of the oil on water.
  The thickness of the oil is based on a uniform full coverage of the 500m x 500m model grid cell.

- The oil on shore is displayed as a red line, regardless of the volume retained by the shore.
  The red shorelines are a visual tool only, to indicate the shoreline being contacted by the oil.

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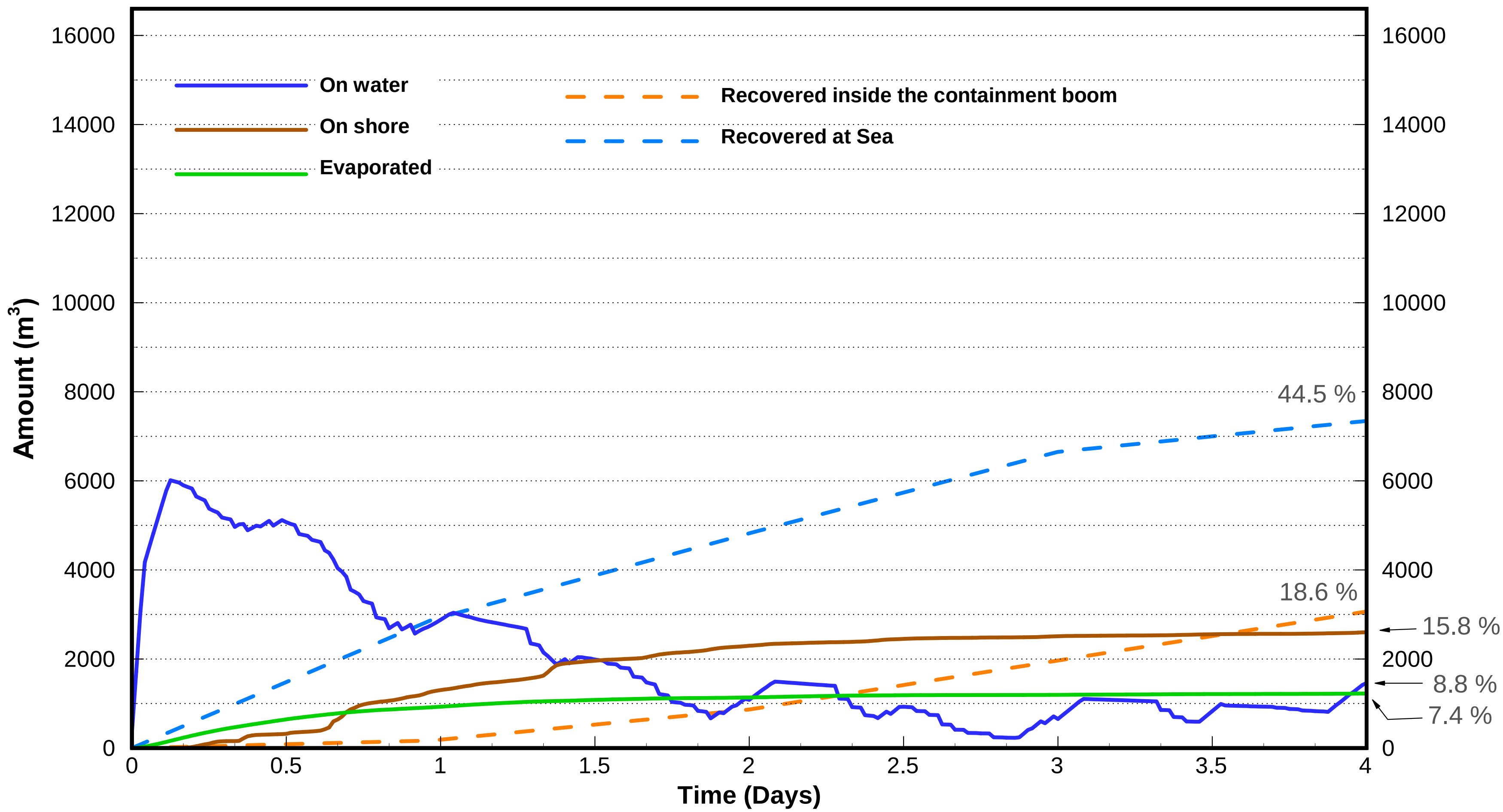
## TRANS MOUNTAIN OIL SPILL STUDY

**Mitigated Simulation at Arachne Reef: August 17 2012, 10:00pm Oil Thickness after 96 Hours**

| PROJECT NO. | DWN | CKD | APVD | REV |
|---|---|---|---|---|
| V13203022 | AH | JAS | JAS | 0 |

| OFFICE | DATE |
|---|---|
| EBA-VANC | November 4, 2013 |

**Figure 5.7.3.8**




## NOTES

- Tracking time for the spill was 4 days. The total amount of oil released was 16,500 $m^3$.
- The major components of the mass balance are shown above.

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# TRANS MOUNTAIN OIL SPILL STUDY

## Mitigated Simulation at Arachne Reef
## August 17 2012, 10:00pm
## Major Components of the Mass Balance

| PROJECT NO. | DWN | CKD | APVD | REV |
|---|---|---|---|---|
| V13203022 | AH | JAS | - | 0 |

| OFFICE | DATE |
|---|---|
| EBA-VANC | November 4, 2013 |

**Figure 5.7.3.9**

### *5.7.4 Summary and Conclusions*

It is Trans Mountain's view that the modelling of a hypothetical oil spills involving the credible worst case and smaller spills from a Project-related tanker has been effective to identify where improvements to the existing oil spill preparedness and response capability is necessary to minimize the risk of environmental and socio-economic effects described here. The numerical modelling helped Trans Mountain and WCMRC appreciate the gap between the current mitigation capabilities and the proposed future capabilities, with the improvement that the additional equipment could provide. The understanding of the behaviour of the oil in a marine environment was critical in assessing the mitigation strategy; the approach proved the importance of increasing the number of response bases, the proximity of the different equipment staging locations being key to improved effectiveness. The benefit of improved oil spill preparedness and response is that the volume of oil recovered is much greater than most historical cases.

The mitigation measures simulated in the EBA report, Trans Mountain Expansion Project Oil Spill Response Simulation Study, Arachne Reef and Westridge Marine Terminal report (Volume 8C, TR 8C-12, S13), affirm the premise that oil spill recovery at sea can be effective given adequate equipment, access to equipment staging locations, a timely response, amendable weather conditions, access to good environmental and spill information (through the combination of a 24 hours/day, 7 days/week numerical forecast system and remote sensed data), and the ability to identify and correct inefficiencies before they are replicated throughout the response system. All of the above functionalities and systems contribute to a highly effective and informed ICS system.

Importantly, a good numerical model, especially one that has been fully tuned and validated to the hypothetical spill location, is an ideal tool for forecasting and for planning resource deployment. Remotely sensed data adds to the functionality of the model. In order to meet the expectations of regulatory agencies, government agencies, Aboriginal communities, and the public, and to comply with legislation, it is crucial to implement leading edge technologies as part of the response system, to support the existing planning and training phases.

# 6.0 CONCLUSIONS

Trans Mountain Pipeline ULC 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 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 TMPL system.

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; and
- three new berths at the Westridge Marine Terminal in Burnaby, BC, each capable of handling Aframax class vessels.

Work proposed at Westridge includes a 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), followed by the deactivation and demolition of the existing berth.

Application is being made pursuant to Section 52 of the *NEB Act* for the proposed 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 CPCN for construction and operation of the Project. Subject to the outcome of the NEB Hearing process, Trans Mountain plans to begin construction in 2015 and go into service in 2017.

Trans Mountain acknowledges that the proposed Project would result in an increase in tanker traffic transiting the Salish Sea Region as tankers enter from the Pacific approaching or leaving Westridge Marine Terminal. The Salish Sea includes Vancouver Harbour, the Strait of Georgia, Boundary Pass, Haro Strait, and the Strait of Juan de Fuca.

Currently, in a typical month, five vessels are loaded with heavy crude oil, primarily diluted bitumen, at the Westridge Marine Terminal. The expanded system will be capable of serving up to 34 Aframax class vessels per month, with actual demand influenced by market conditions.

Trans Mountain recognizes that this increase in traffic volume corresponds to an increase in the probability of an accidental oil spill from a laden tanker leaving the Westridge Marine Terminal. In addition, Trans Mountain acknowledges that the Project-related increase in tanker traffic may also result in potentially adverse environmental and socio-economic effects.

Although Trans Mountain is not legally responsible for the operation of the tankers calling at the Westridge Marine Terminal, Trans Mountain continues to be an active participant in the maritime community, supporting, and sometimes leading, key initiatives to improve the safety and environmental performance of marine transportation in the Salish Sea Region.

In consideration of the potential effects to the marine environment from the proposed increase in tanker traffic as a result of the Project, Trans Mountain extended its stakeholder engagement program to include coastal communities, beyond the pipeline terminus at Westridge Marine Terminal. Trans Mountain engaged communities on Vancouver Island and the Gulf Islands along established marine shipping corridors transited by oil tanker traffic, as well as communities in and around PMV.

The Project team received feedback from public open houses, workshops, one-on-one meetings, public presentations, online discussion and comment forms that have helped shape aspects of the Project. A summary of the input received through the stakeholder engagement program related to marine issues is provided in Table 3.1.3 of Volume 8A. Overall, engagement activities provided feedback on the following:

- determining the scope and nature of the Environmental and ESA;
- identifying potential mitigation measures to reduce risk, and environmental and socio-economic effects; and
- identifying potential local or regional benefits associated with the Project.

Since May 2012, Trans Mountain has also engaged with Aboriginal communities that may be affected by the increase in Project-related marine vessel traffic based on their traditional and cultural use of marine resources to maintain a traditional lifestyle. Of the 27 marine and inlet Aboriginal communities initially engaged on the Project with Trans Mountain, 20 of these communities have been identified as having an interest in the Project or having interests potentially affected by the increased Project-related marine vessel traffic. In addition to engagement activities, Trans Mountain has initiated TMRU studies with the Aboriginal communities that were interested in participating.

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

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

- potential environmental effects of spills on the marine environment and the related effects to traditional activities;
- increases of Project-related vessel traffic on traditional hunting and fishing areas, travelways and sacred areas;
- rehabilitation and protection of the Salish Sea;
- effect of increased vessel traffic through Burrard Inlet;
- additional economic incentives including preferred procurement opportunities, revenue sharing, community enhancement opportunities and equity participation; and
- ongoing respectful and meaningful engagement including capacity funding and TMRU study funding.

Results of the engagement have been considered and incorporated throughout the marine transportation assessment, including the mitigation measures and effects assessment.

With the interests from Aboriginal communities and stakeholders in mind, and as part of this Application to the NEB, Trans Mountain undertook an environmental and socio-economic assessment to identify potential adverse environmental and socio-economic effects associated with the increase in tanker traffic, and measures to mitigate these effects. As well, Trans Mountain voluntarily initiated a voluntary TERMPOL Review Process. This process, led by Transport Canada, results in an assessment of the effects on navigational safety that may result from the proposed increase in Project-related tanker traffic along with recommendations to ameliorate these effects where necessary.

Recognizing that there has been and continues to be tanker traffic carrying oil transiting the Salish Sea Region and calling at the Westridge Marine Terminal, Trans Mountain focused the ESA and TERMPOL studies on the change in tanker traffic that would result from the Project, specifically, the change from 5 tankers per month calling at the Westridge Marine Terminal to the equivalent of 34 Aframax tankers per month.

The ESA addressed the NEB's *List of Issues* (July 29, 2013) for the Project (NEB 2013a), in particular the issue related to marine transportation:

"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."

The ESA considered the mandatory factors listed in Section 19(1) of the *CEA Act, 2012*, the factors listed in the NEB Filing Manual (NEB 2013c), and pertinent issues and concerns identified through consultation and engagement with Aboriginal communities, landowners, regulatory authorities, stakeholders and the general public. The ESA also considered 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 2013b), effectively determining the scope of the ESA and the factors to be assessed.

Ten environmental and socio-economic elements potentially interacting with the increased Project-related marine vessel traffic were identified for the purpose of assessing potential effects. These elements included:

- marine sediment and water quality;
- marine air emissions;
- marine GHG emissions;
- marine acoustic environment;
- marine fish and fish habitat;
- marine mammals, marine birds;
- marine species at risk;
- traditional marine resource use;
- marine commercial, recreational, and tourism use; and
- human health risk assessment.

In addition, potential accidents and malfunctions were assessed, as well as the effects of the environment on the Project, and cumulative environmental and socio-economic effects.

Most of the potential environmental and socio-economic residual effects that could arise from increased Project-related marine vessel traffic were considered to be long-term in duration (*i.e.*, lasting for the operational life of the Project), generally of low to medium magnitude and periodic or accidental in nature. There were no situations identified that would result in a significant environmental or socio-economic effect, as defined in Section 4.3, except the potential effect of sensory disturbance of southern resident killer whales and the related effect on traditional marine resource use by Aboriginal communities. Even though the Project contribution to overall sensory disturbance effects would be small, the potential effect of the increase in Project-related marine vessel traffic was determined to be to be high magnitude, high probability and significant but immediately reversible for southern resident killer whales.

DFO's *Recovery Strategy for Northern and Southern Resident Killer Whale* states that: "Both physical and acoustic disturbance from human activities may be key factors causing depletion or preventing recovery of resident killer whale populations" (DFO 2011a). Based on available scientific knowledge, it was concluded that past and current activities (including all forms of mortality, high contaminant loads, reduced prey, and sensory and physical disturbance) have resulted in significant adverse cumulative effects to the southern resident killer whale population. The recent historical decline of the southern resident killer whale population and its current status as endangered support this conclusion. However, given the current state of knowledge, and the ability of threats to interact with one another, it is not possible to completely partition how each threat may be affecting the population.

With or without the Project, the southern resident killer whale population continues to be adversely affected by sensory disturbance caused by all types of marine vessel traffic. The sensory disturbance associated with the Project-related increase in tanker traffic, as stated previously, is a small contribution to existing environmental conditions.

PMV is in the midst of developing a program to look at the current levels of underwater noise in the Strait of Georgia and surrounding waters and to consider options for reducing potential environmental effects of noise from marine vessel traffic on marine mammals. This program will be a collaborative effort, led by PMV, and supported by Transport Canada, DFO, and the CCG. Non-governmental organizations involved in marine-related research will also be invited to collaborate. This initiative will also involve the Chamber of Shipping and Coastal Pilots as key stakeholders, as well as other major marine shipping industry representatives. Trans Mountain is also supportive of opportunities for Aboriginal communities to participate in this initiative.

The program will involve the deployment of a network of hydrophones in the Strait of Georgia and Haro Strait that will be used to measure the acoustic signatures of vessels and to monitor the activities of southern resident killer whales and other cetaceans. Data collected through the program will contribute to the development of mitigation measures aimed at reducing acoustic disturbance to marine mammals. PMV is expected to release more details on the program in early 2014.

Trans Mountain strongly supports this regionally-focused collaborative approach to developing solutions that would be applied to the marine transportation industry as a whole. Trans Mountain met with PMV in late 2013 and expressed its interest in contributing to the development and implementation of the proposed program. Trans Mountain will work with PMV in early 2014 to determine how to participate in this initiative to mitigate industry-wide effects on the southern resident killer whale population and other marine mammals.

Through its extensive engagement activities, Trans Mountain understands that a spill of oil into the marine environment, arising from an incident involving a tanker is a major concern for Aboriginal communities, government and regulatory agencies, the public, and the maritime community. Trans Mountain recognizes that an unmitigated oil spill from a tanker could have immediate to long-term effects on the biophysical and human environment of the Salish Sea.

In light of the increased risk related to the Project and as part of the TERMPOL Review Process, Trans Mountain commissioned a number of studies to understand the effect of the Project on marine navigational safety and management, and to understand what would happen if there were an accident with a Project-related tanker and heavy crude oil were spilled in the marine environment.

An examination of global casualty data indicates there has been an increase in marine safety and subsequent decline in the number of marine vessel incidents, in particular accidents related to oil tankers and specifically, incidents resulting in the release of oil in a marine environment. With respect to accidental oil spills from tankers transiting the West Coast there were no reported spills from oil tankers in the 2001-2009 period of CCG collecting this type of data. Despite the existing safety record for tanker traffic on the West Coast, the increase in Project-related tankers will increase the probability that an accident could occur.

To understand the incremental risk related to the increase in tanker traffic created by the Project, Trans Mountain contracted Det Norske Veritas (DNV) to conduct a quantitative risk assessment. DNV evaluated the existing marine and shipping network of the Burrard Inlet and Salish Sea to identify:

- the possible types of incidents that could result in an oil spill from a laden tanker;
- the navigational hazards along the route a laden oil tanker would transit between the Westridge Marine Terminal and the Pacific Ocean;
- the navigational risk controls currently that are in use in the Salish Sea region and which have been effective at reducing the frequency of navigational incidents;
- the possible types of incidents that could result in an oil spill from a laden tanker;
- the hypothetical accident locations along the previously mentioned tanker route that could result in an oil spill from a laden tanker;
- the potential for enhanced navigational risk controls to reduce the probability of an oil spill from a laden tanker; and
- the probability and consequences of a credible worst case and smaller accidental oil spill (*i.e.,* a "mean-case" oil spill) from a laden tanker.

From the risk assessment DNV concluded the following:

- If the Project did not go into operation by 2018, there would still be a risk of an oil spill from a laden tanker transiting the Salish Sea Region. DNV calculated that the probability of any size of an oil spill would be 1 in 309 years and the probability of a credible worst case oil spill (*i.e.,* 16,500 $m^3$ of heavy crude oil released) from a laden tanker would be 1 in 3,093 years.

- If the Project were approved and was operational by 2018, but no additional mitigation measures were implemented, DNV calculated that the probability of any size of an oil spill from a laden Project-related tanker would be 1 in 46 years. DNV calculated the probability of a credible worst case spill from a laden Project-related tanker would be 1 in 456 years.
- If the Project were approved and was operational by 2018, and additional mitigation measures were implemented, DNV calculated that the probability of any size of an oil spill from a laden Project-related tanker would be 1 in 237 years. DNV calculated the probability of a credible worst case spill from a laden Project-related tanker would be 1 in 2,366 years.

DNV recommended to Trans Mountain two key measures to improve navigational safety for Project-related tankers, thus reducing the probability of an accidental oil spill from a laden tanker. These two measures included additional tug escort and a Moving Safety Zone around laden tankers. As noted in the bullets above, DNV concluded that, with the implementation of these two key measures, the risk of a credible worst case oil spill from a Project-related tanker would not be substantially more than it is today, without the Project.

Through its updated Tanker Acceptance Criteria, Trans Mountain will require additional tug escort for Project-related tankers for the entire transit between Westridge Marine Terminal and the Pacific Ocean. As well, Trans Mountain is seeking endorsement for the Moving Safety Zone from the Joint Coordinating Group of the CVTS. Lastly, Trans Mountain is seeking endorsement from Transport Canada for both of the proposed additional navigational control measures, both of which could be implemented prior to the operation of the Project and could potentially be applied to all tankers transiting the Salish Sea furthering reducing the probability of a collision.

Although Trans Mountain is not directly and legally responsible for the operation of the vessels calling at the Westridge Marine Terminal, it is an active member in the maritime community and works with maritime agencies to promote best practices and facilitate improvements focussing on the safety, efficiency, and environmental standards of tanker traffic in the Salish Sea. Trans Mountain is a shareholder and member of the Western Canadian Marine Response Corporation (WCMRC) and works closely with WCMRC and other members to ensure that WCMRC remains capable of responding to any oil spill from vessels transferring product or transporting it within their area of jurisdiction.

Trans Mountain continues to work with WCMRC to identify improvements to the existing oil spill response preparedness and response capacity for the Salish Sea region. Trans Mountain recognizes there are complementary initiatives currently underway, led by the BC Government and by the Federal Tanker Expert Safety Panel, which may also result in improvements to the existing emergency preparedness and response capacity in this region. Trans Mountain is supportive of these efforts and will continue to play an active role to support and work with WCMRC, regulatory agencies, Aboriginal groups, and to implement requisite enhancements.

Trans Mountain acknowledges that it is not enough to simply identify the risks and environmental and socio-economic effects of the Project-related increase in tanker traffic; Trans Mountain will continue to play an active role in sharing this information and facilitating the discussion on how to mitigate Project-related environmental and socio-economic effects, increased risks in the marine environment, and to improve existing emergency preparedness and response measures in preparation for the Project.

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# 8.0 APPENDICES

# Appendix A Trans Mountain Submission to the Federal Tanker Safety Expert Panel, June 21, 2013

# Trans Mountain Pipeline
# Submission to the Tanker Safety Expert Panel

June 21, 2013

TRANSMOUNTAIN

CELEBRATING 60 YEARS OF SERVICE 1953 to 2013

KINDER MORGAN CANADA

**Trans Mountain Pipeline (Kinder Morgan Canada)**

**Submission to the Tanker Safety Expert Panel**
**June 21, 2013**

**Via email:** tsep-cesnc@tc.gc.ca

**For more information please contact:**

**info@transmountain.com**

**www.transmountain.com**

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*Inside the Westridge Marine Terminal – May 2013.*

## Executive Summary

Kinder Morgan Canada (KMC), operator of the Trans Mountain Pipeline (TMPL), is pleased to make this submission to the Tanker Safety Expert Panel.

As a company that safely and responsibly moves petroleum products every day – and has done so for the last six decades – we fully support the Panel's review of Canada's current tanker safety system and the Panel's objective to propose further measures to strengthen the system. We see the Panel's work and recent changes announced by the Government of Canada as important steps to the continued review and enhancement of tanker safety in Canadian waters.

Since we announced our proposal to expand the Trans Mountain Pipeline system more than a year ago (in April 2012), we've been engaging with communities along the pipeline route and marine shipping corridor.

Whether it's on the land or on the water, overall safety has been a major topic of these conversations. We believe that the Panel's review is an important step to ensure public confidence in the regulatory and public safety regime in place for tanker movements in Canadian coastal waters.

A 60-year record of crude oil tanker safety on the south coast doesn't just happen. This has been achieved because the safety regime in which tankers operate has continuously improved and changed significantly over those six decades in response to advances in technology, training and learning from other jurisdictions and incidents. But the industry and the regulators cannot rest on past accomplishments and should continuously seek opportunities for improvement.

We believe a Canada-wide review of the existing spill response structure is timely.

Ensuring tanker safety is a goal shared by many companies, organizations and governments. As one of those participants and as part of our existing operations, Trans Mountain has consistently worked to bring parties to the table to advance opportunities to improve the safety and efficiency of tanker traffic. Our company brings to the table the expertise and approach necessary to build and safely operate a crude oil pipeline and we support the associated tanker safety review activities.

When the Government of Canada announced the creation of the Tanker Safety Expert Panel, the Honourable Denis Lebel, Minister of Transport, Infrastructure and Communities stated that the current tanker safety system has served the country well for many years, but it must be strengthened to meet Canada's future needs. Kinder Morgan is looking look forward to working with the government on implementing future safety measures

For Trans Mountain's proposed expansion project, we have initiated contact with landowners, engagement with Aboriginal Peoples, public consultation and discussion with communities, and communications with regulatory authorities. These efforts will continue through all phases of our proposed project.

Our engagement activities have included public information sessions, workshops, meetings with community leaders and online discussions. Of all the feedback we've received so far, risk and safety – particularly pipeline safety and marine safety – have been the primary concerns. These include tanker safety, spill response capacity and the liability for spills.

This input will be used to guide the development of studies, plans and design for our proposed expansion project. While our strict obligation for tanker safety ends once the tankers leave the Westridge Marine Terminal in Burnaby, BC, we are very concerned that the tanker safety aspect of the transportation chain is well understood, managed and critically assessed. We are taking action by:

- Working closely with the maritime community
- Working to improve local mapping and preparedness
- Working with Western Canada Marine Response Corporation (WCMRC) to establish planning standards to address our proposed expansion

We are listening to people who have participated in our engagement process – and we are learning. Their feedback is helping make our proposed project better.

## Background

The Trans Mountain Pipeline System (TMPL) was established almost 60 years ago and currently has a capacity of 300,000 barrels per day (bbl/d). The TMPL system transports a range of crude oil and petroleum products from western Canada to locations in central and southwestern British Columbia (BC), Washington and to offshore markets via its Westridge Marine Terminal.

The Westridge Marine Terminal is the only marine petroleum product or crude oil loading facility that is connected to a pipeline system on the West Coast of Canada. It is the only facility that provides access for Canadian oil production to markets in the Pacific Rim: California, Washington State and Asia.

In response to growing market demand and customer contractual commitments, Trans Mountain proposes to expand the existing TMPL system from 300,000 bbl/d to 890,000 bbl/d. If approved, the proposed expansion will complete the twinning of the pipeline in Alberta and BC with:

- 981 km of new buried pipeline
- New and modified facilities such as pump stations and tanks
- Additional tanker loading facilities at the Westridge Marine Terminal in Burnaby, BC

If approved, the project will result in an increase in tanker traffic from the Westridge Terminal. Figure 1 shows the location of the Westridge Marine Terminal within Vancouver Harbour.

Rules for allocation of the existing pipeline capacity are approved by the National Energy Board (NEB); of the 300,000 bbl/d available today 75,000 is allocated for the marine terminal.

Typically, five tankers per month are loaded with crude oil. Tanker traffic consists of a mix of Panamax and partially-laden Aframax vessels. The expanded system would be capable of serving up to 34 partially-laden Aframax vessels per month. The maximum size of vessels served at the terminal is not forecast to change as part of the project. Similarly, the primary cargo for future traffic will likely continue to be heavy crude oil, primarily diluted bitumen. We forecast that of the 890,000 bbl/d capacity of the expanded system, up to 630,000 bbl/d may be delivered to the Westridge Marine Terminal.

In addition to tanker traffic, the terminal also loads about two barges with crude oil per month and receives about one barge of jet fuel per month into a separate pipeline system that serves Vancouver International airport (YVR). Barge activity is not expected to change as a result of the expansion.

The project can be characterized as an expansion within the existing footprint for petroleum transportation. The pipeline will be twinned primarily within the existing corridor (or right-of-way) and the resulting increase of tanker traffic will transit via the same shipping lanes that are used today for tankers and other large vessels calling in Vancouver and Washington State. Figure 2 shows the established marine routes used by ships that call in the Salish Sea including tankers for the Westridge Marine Terminal.

Based on AIS (Automatic Identification System) data recorded by the Marine Exchange in Seattle, Washington, there are approximately 6,000 large commercial vessels that come to the Salish Sea headed to Vancouver or Washington State ports annually. Of these vessels, about 600 are tankers – 60 of which call at the Westridge Marine Terminal each year. If our proposed expansion project is approved, the number of tankers calling on the Westridge Marine Terminal would increase to about 350 per year. See Appendix 5 for 2011 data showing vessel movements in the Juan de Fuca and Haro Straits.

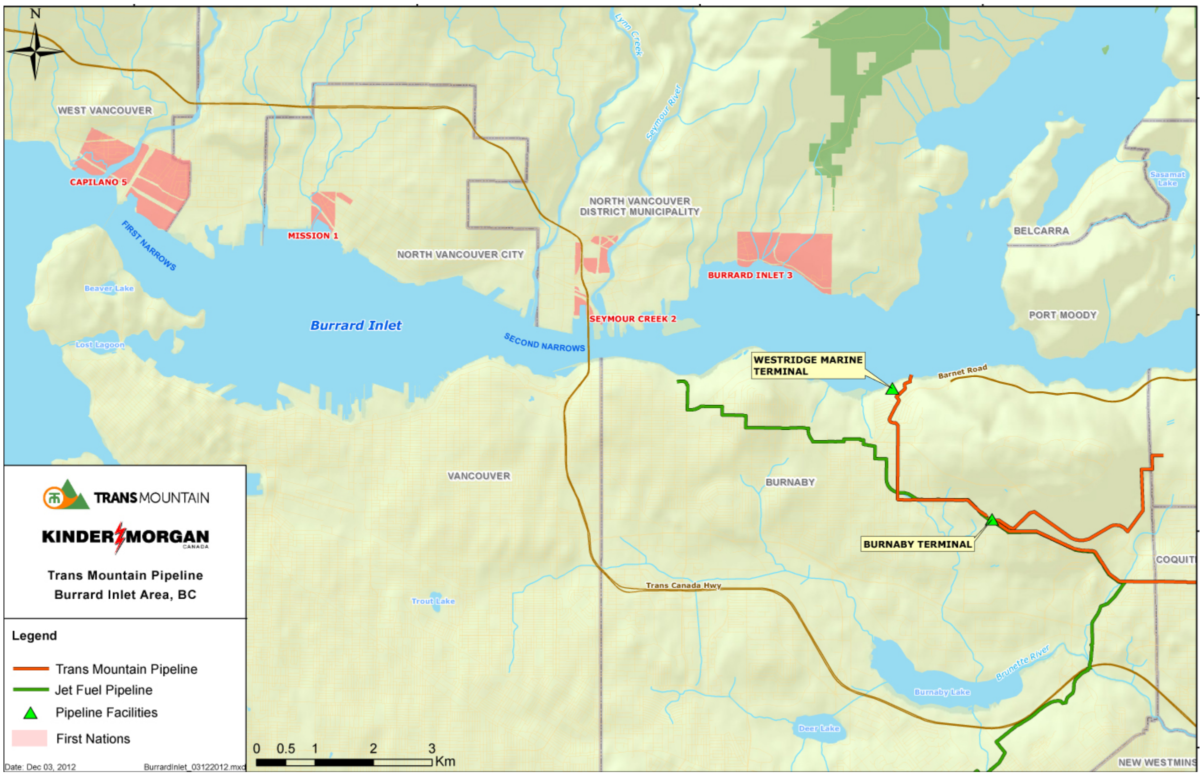


*Figure 1: This map shows the location of the Westridge Marine Terminal in Burrard Inlet.*

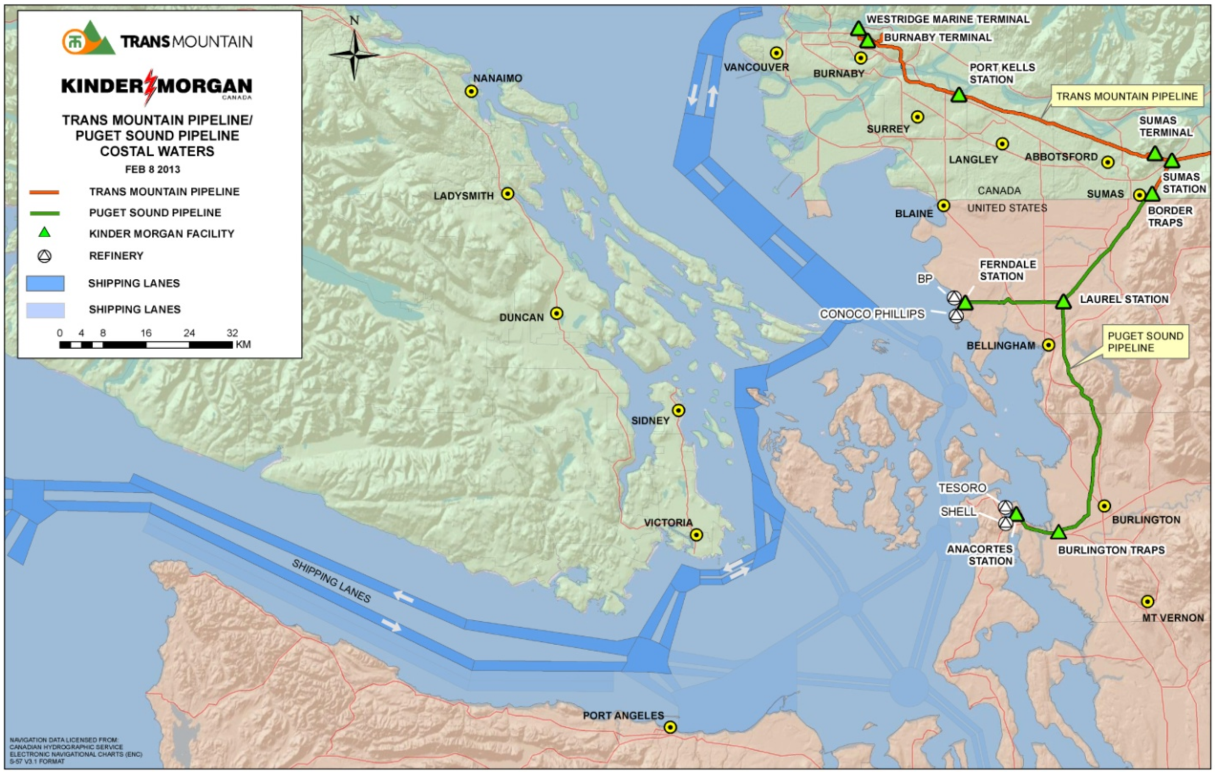


*Figure 2: This map shows the shipping lanes used by tankers transiting Canadian waters, both inbound and outbound to the Westridge Marine Terminal.*

More information about the management of tankers calling at our marine terminal and management of the terminal itself is included in this submission.

- Appendix 1, Journey of a Tanker, provides a summary of the oversight for tankers calling at the Westridge Marine Terminal.
- Appendix 2 provides a detailed description of the Westridge Marine Terminal.
- Appendix 3 provides an overview of the operations at Westridge Marine Terminal.
- Appendix 4 provides a detailed description of the emergency response system at Westridge Marine Terminal.

## Trans Mountain in the Local Maritime Community

While our regulatory and operational obligations end at the Westridge Marine Terminal, we have a history of co-operative involvement in the maritime community working to ensure the safety and efficiency of Westridge-bound tanker traffic.

Trans Mountain was an early adopter of the Incident Command System (ICS) of emergency response management. Trans Mountain's employees are trained in ICS and this is reflected in our response plans including the plan for the Westridge Marine Terminal.

We were an early adopter of tug escorts for loaded tankers through Vancouver Harbour.

We are a founding member and part owner of Western Canada Marine Response Corporation (WCMRC)

We continue to work with the maritime community on various initiatives to improve safety, including the recent Port Metro Vancouver (PMV) led process to improve safety and efficiency of transit through the Second Narrows of Burrard Inlet. In addition, we have worked with local organizations on the following initiatives:

- Participated in PMV's review of the Second Narrows Movement Restriction Area Procedures (2004-2010)
- Contribution for expert review of escort techniques (2007)
- Contribution and logistics for live trial (2007)
- Contribution for improved pilotage equipment (2009)
- Support for joint Pilot and Tug Master training (2009)
- Support for improved Navigational Aids (2010)
- Contribution for British Columbia Institute of Technology Marine Simulator Upgrade (2011)

## Regulatory Process

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

*NEB Section 52 Application*

The proposed Trans Mountain Expansion Project will require a certificate pursuant to Section 52 of the National Energy Board Act (NEB Act) to permit construction and operation of the pipeline expansion system. Trans Mountain expects to file its application for this certificate with the NEB in late 2013.

Although regulation and authorization of marine transportation is not specifically within the jurisdiction of the NEB, its review will consider the effects of the project on the environment. Therefore, Trans Mountain will include, in its Facilities Application, an assessment of the environmental and socio-economic effects of expanded marine transportation for normal operations as well as for accidents and malfunctions.

*TERMPOL*

We have requested a TERMPOL (Technical Review Process of Marine Terminal Systems and Transshipment Sites) review of the marine aspects of the project. This review will consider the ship's berth, the marine terminal infrastructure as well as the defined tanker transit route.

TERMPOL is an operational review process led by a federal interdepartmental committee that is tasked with reviewing the navigational risks associated with the location and operation of the marine terminals for oil tankers and other cargoes identified by Transport Canada. The intent of the TERMPOL is to ameliorate elements of a project proposal that could threaten the integrity of a ship's hull and its cargo containment system and, consequently, the environment near the ship while it is navigating waters under Canadian jurisdiction.

The following studies are being prepared by Trans Mountain for the TERMPOL review committee and submitted with our application to the NEB:

- Ship design and operation
- Navigational and physical characteristics of the approaches to the terminal
- Terminal design and infrastructure
- Environmental impact
- Risk and accident analysis along the transit route and at the terminal and the related mitigating measures
- Pollution prevention program
- Contingency plans

## Project Schedule

Trans Mountain will submit its studies to the TERMPOL committee in late 2013. A report from the committee is expected in early 2014.

We will submit our application to the NEB in late 2013, which will be followed by a review process through 2014 and into 2015.

If the NEB grants a certificate for the project in late 2015, construction activities would be scheduled to start as early as possible in 2016 and end by fall 2017.

The expanded Trans Mountain Pipeline system could start service in December 2017.

*Figure 3 shows the project schedule.*

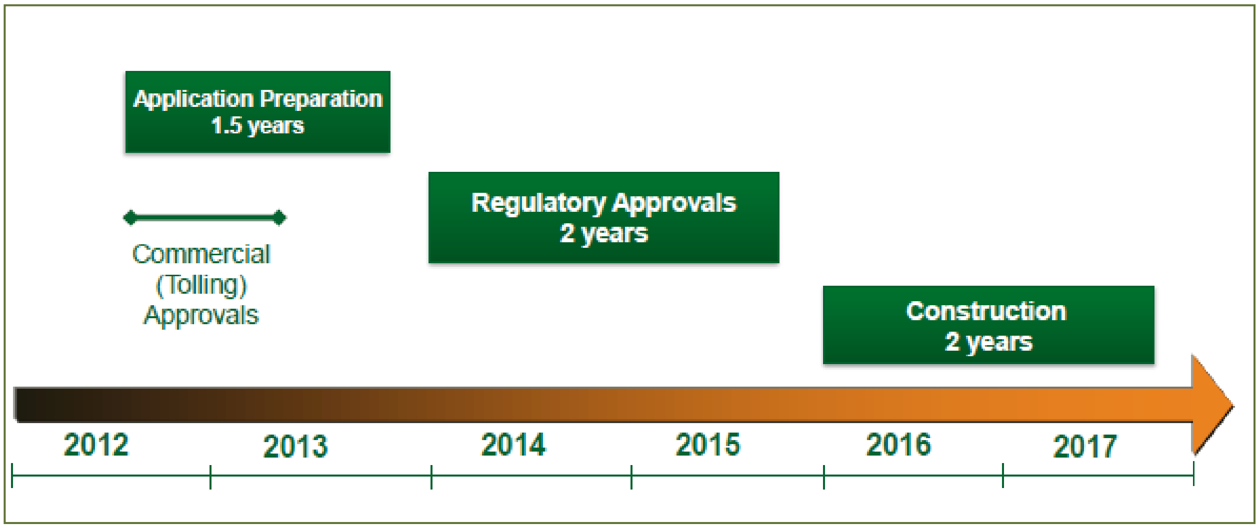


*Figure 3: The proposed project schedule for the Trans Mountain Expansion Project.*

## Engagement

Trans Mountain has embarked on an open and extensive engagement process on all aspects of the proposed Trans Mountain Expansion Project along the route between Strathcona County, Alberta (near Edmonton) and Burnaby, BC and the marine corridor.

For our project, we have initiated contact with landowners, engagement with Aboriginal Peoples, public consultation and discussion with communities, and communications with regulatory authorities. These efforts will continue through all phases of the project.

Since the proposed project was announced, our engagement program included a series of 37 public information sessions held between October 2012 and January 2013 in 30 communities along the pipeline corridor and marine corridor.

In addition to the public information sessions, our engagement efforts include ongoing meetings with various organizations, governments at all levels and community groups. We have a robust digital engagement tool where people can have their say at www.transmountain.com/talk.

*Feedback – Marine*

Of all the feedback we've received from our discussions so far, risk and safety — particularly pipeline safety and marine safety — have been the primary concerns.

In terms of tanker movements in the waters off BC's coast, public feedback gathered in our engagement process indicates the tanker safety regime in Canada is not well understood or appreciated. In particular, we have found that people ask questions about the relative roles of Transport Canada, the Canadian Coast Guard (CGC) Port Metro Vancouver (PMV), Pacific Pilotage Authority (PPA), Environment Canada, the Government of British Columbia and industry.

Through our engagement activities, we have heard concerns about:

- Tanker safety
- Spill response capacity
- The liability for spills

Throughout our ongoing engagement process, we will continue to address these concerns and provide relevant, timely and accurate information about tanker safety and spill response.

See Appendix 6 for a summary of some of the specific tanker and marine transportation comments and concerns we received from our public information sessions.

*Between October 2012 and January 2013, Trans Mountain held 37 public information sessions in 30 communities along the pipeline and marine corridors to introduce the proposed project and gather feedback. More than 2,200 people attended these sessions. They had an opportunity to meet with project staff and ask questions on all aspects of the proposed project.*

*Environmental and Socio-Economic Assessment Workshops*

Workshops about the Environmental and Socio-economic Assessment (ESA) for the Trans Mountain Expansion project were held in spring 2013. The focus of these ESA Workshops was to present a proposed approach to the completion of the project ESA and to seek input from stakeholders regarding the study approach, methodology and regions.

The engagement team held regional ESA workshops in early March in Edmonton, Alberta, Kamloops, BC and Surrey, BC. The workshops targeted local and regional subject matter experts from municipal, federal and provincial governments, local ENGOs (environmental non-governmental organizations) and other interest groups. 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. Input was solicited online for two weeks after each workshop.

Feedback received at these sessions was shared with the relevant project team environmental disciplines and will be considered in setting the scope and methodologies for the project ESA.

*Marine Workshops*

On May 22 and 23, 2013, we hosted two marine workshops in Vancouver and Victoria with regional stakeholders and First Nations representatives from Burrard Inlet, Vancouver Island and the Gulf Islands.

More than 50 people attended the workshops to review project details and the expansion project's approach to the marine studies for the risk assessment and the Environmental and Socio-economic Assessment. Stakeholders in attendance included stewardship groups, regional emergency planners, municipal environmental officers, local chambers of commerce, tourism and recreational user groups, commercial fisheries, marine industries and local First Nations.

**Aboriginal Engagement**

The Aboriginal engagement program for the project is focused on discussions with more than 100 Aboriginal groups that might have an interest in the project or have Aboriginal interests potentially affected by the project. Engagement activities started with these groups in April 2012. See Appendix 7 for a list of Aboriginal groups that fall within the BC coastal region of the proposed pipeline expansion project.

Since April 2012, Trans Mountain's Aboriginal Engagement Team has conducted more than 3,100 engagement activities using a variety of communication tools, including face-to-face meetings, phone conversations, letters and emails.

Although the Aboriginal engagement program is in its early stages, preliminary discussions with Aboriginal groups have identified some areas of interest and potential concern. On marine transportation and environment topics, the following areas of interest have surfaced in discussions with Aboriginal groups:

- Environmental impact of spills on the marine environment
- Clarification on dredging in proximity to the Westridge Marine Terminal
- Impact of increased tanker traffic through Burrard Inlet
- Clarification on the size of tankers

We will continue our engagement with Aboriginal groups following the submission of our application to the NEB, and will continue engagement through the regulatory process and into project development and operations. Trans Mountain will also continue its liaison with the Crown through the full project and provide updates regarding Trans Mountain's engagement activities with Aboriginal groups.

**BC Government's Five Conditions**

On July 23, 2012, the Government of British Columbia outlined five minimum requirements that must be met for the province to endorse the construction and operation of new heavy oil pipelines within its borders. One of BC's conditions calls for a world-leading system of marine oil spill preparedness and response.

We acknowledge the link between our pipeline operations on land and the marine issues associated with oil tankers on the south coast of British Columbia.

We are a company that safely and responsibly moves petroleum products every day – and has done so for the last six decades. This record is thanks to a culture of safety within Trans Mountain, the network of safety and response organizations in the marine community and the regulations and requirements established to ensure safe transit of oil tankers in the local waters.

When it comes to marine safety, Kinder Morgan Canada (KMC) also stands with BC in advocating for the necessary level of federal funding and response capabilities. At the same time, we believe companies must also pay their fair share, as it is companies that are liable for potential spills – not communities.

## Trans Mountain – Listening and Taking Action

Along the project's marine corridor, the Trans Mountain team is conducting studies for its environmental assessment. This part of the assessment will consider the potential environmental impacts on the marine corridor of the proposed expansion of the Westridge Marine Terminal from increased marine tanker traffic, as well as ways to reduce or avoid these impacts. Feedback received is helping to determine the scope of the marine studies, as well as the evaluation of potential impacts to local marine users and communities.

***We continue to work closely with the maritime community***

While Trans Mountain's strict obligation for tanker safety ends once the tankers leave the Westridge Marine Terminal, we are very concerned that this aspect of the transportation chain is well managed. As such, we continue to work with agencies in the maritime community to advance opportunities to improve the safety and efficiency of tanker traffic.

In this regard, we have had the opportunity to review and comment on the submissions to the Tanker Safety Expert Panel from the British Columbia Chamber of Shipping and the Western Canada Marine Response Corporation (WCMRC). Rather than repeat the information provided to the panel by these organizations, we wish to provide our general endorsement of the WCMRC positions.

Similarly, to address the apparent lack of public awareness of the tanker safety regime and to support continued improvement, we are working with Port Metro Vancouver to support its effort to establish a central collaborative body to become the leading source of information on best practices for marine transportation of liquid bulk commodities on Canada's Pacific Coast. The mandate of this body would be to promote and facilitate research and regulatory frameworks that deliver the highest standards in the safe and sustainable shipment of Canada's energy and liquid bulk commodities

***We are conducting studies to better understand the risk of current and proposed operations***

For our NEB application and TERMPOL studies, we are conducting a Quantative Risk Assessment. Based on an assessment of marine traffic and hazards and mitigation in the Salish Sea, this study will estimate the probability that an incident may result in a spill. Based on an assessment of incident types and tanker construction, the study will also provide a probabilistic estimate of the volume that might be released from an incident. This will be used to determine a probable worst-case scenario for spill trajectory modelling.

The spill trajectory modelling will, in turn, rely on the results of recently-completed fate and behaviour tests Trans Mountain has conducted to document the behaviour of diluted bitumen on brackish water comparable to Vancouver Harbour and the Salish Sea.

The risk assessment will focus on the incremental change in risk that could result from the NEB's approval of our project. Since the project does not involve a change in vessel size nor the cargo, the incremental change in risk arises from a higher probability of an incident due to increased residence time and transit frequency.

While this information is required for our NEB and TERMPOL reviews, it will also be used in our work with the WCMRC.

***We are working to improve local mapping and preparedness***

Trans Mountain is working with WCMRC to create a demonstration project for a coastal marine response GIS system. We have undertaken a project to collect, update and store information about the shoreline and backshore environment in the vicinity of the Westridge Marine Terminal.

The type of data collected, and the way it is organized, is specifically designed to meet the needs of the SCAT (Shoreline Cleanup Assessment Technique) process and the shoreline protection and cleanup response functions in the unlikely event of a future oil spill. This is information about the shoreline that is needed to support best-practice shoreline response decision making. In this case, Kinder Morgan Canada has decided to be proactive and to collect such information in advance. This will both improve preparedness planning and will also ensure we have the knowledge of the environment to make sound decisions from the very beginning of any potential environmental emergency.

This SCAT information will be provided to WCMRC as part of a demonstration project for a coastal response mapping system. This project will compile response information and geographic response plans for the Westridge area into a GIS structure that could be expanded to cover the tanker transit route through the Salish Sea and other areas.

***We are working with WCRMC to establish planning standards to address our proposed expansion***

In an effort to address public concern for the adequacy of the existing spill response regime, we are working with WCMRC to establish planning standards to accommodate our proposed expansion. We believe these planning standards should be based on the following principles:

- **Augment capacity within the existing regime.** Where the need exists for additional response capacity, it should be met through an expansion of WCMRC's resources.

- **Response capacity should reflect the risks.** Response capacity should be established based on consideration of probability and consequence with particular consideration to predicted spill volumes, material fate and behavior, and geographic setting including sensitive areas.

- **Investments should benefit affected communities.** Where new investment in response capacity is required, Kinder Morgan Canada will seek to maximize the benefit to First Nations and other communities along the transit route. Benefits may consist of capacity building, capital investment, training and provision of ongoing services.

Using these principles, Trans Mountain and WCRMC will develop planning standards to accommodate the proposed expansion. These standards will then be used to develop an operational plan that will describe the type and extent of response resources necessary along the transit route in the Salish Sea

## Lines of Inquiry

In this section, we address the themes contained in the Panel's *Consultation Guidance Document.*

***World Class***

The term "world class" is used throughout the Tanker Safety Expert Panel's guidance document and is also used by the BC Government in its heavy oil policy paper: *Requirements for British Columbia to Consider Support for Heavy Oil Pipelines*.

This term is an effective means to express a worthy objective which we support. However, it must be recognized that because of differences in geographic, commercial, technical and political settings around the world, there is no single formula or example of "world class" that can be copied from another regime and directly applied to the Canadian context.

We believe Canada should seek to establish a leading regime for spill response. However, if it is to be successful, it cannot be a formulaic exercise without considerations to unique conditions in Canada and its maritime regions. We can be guided by the best of other regimes to establish principles appropriate for a Canadian setting.

***General***

*Today's Needs and Future Requirements*

We believe that, aside from specific concerns identified by the Auditor General, the existing regime is working reasonably well. We believe that the Canadian regime contains the elements of a world-class system. We believe that oil spill preparedness for large commercial vessels, including tankers, has evolved on the West Coast to meet – and in many ways – exceed the regulatory requirements of the existing regime.

It has been nearly three decades since the current regime was created. We are not aware of any comprehensive review since its inception.

We think periodic reviews are appropriate and the current effort is timely, especially given changes in the volume of West Coast energy exports currently under consideration.

As described earlier in this submission, we have heard concern about the adequacy of the existing regime and we are working with WCMRC to identify enhancements to accommodate the increased traffic that would result from our proposed pipeline expansion project. While industry is willing to invest in enhanced West Coast response capacity, doing so in the absence of well-considered regulation may diminish the perceived adequacy of this investment. Industry is willing to invest in improvements but if the regime is to be accepted by the public, government must set the bar.

Canada's coastline is monumental in both its extent and its diversity. While the current regulation is effective in ensuring a basic tiered response to protect all waters south of 60° N latitude, only response time is varied to address areas at higher risks. Higher risks may be due to higher-than-average probability, consequence, or both. For example, probability may vary because of the volume of shipping and consequence may vary due to cultural or environmental sensitivities.

The fixed requirements that define the 10,000 tonne capacity are somewhat generic and may not always be sufficient to address local sensitivities. While maintaining a basic level of coverage for all waters within each Geographic Area of Response, the regulations should provide a means of identifying areas needing enhanced response capacity and establish a process for deriving risk-based planning standards for these enhanced response areas. WCMRC's current capacity is generally in excess of the regulated planning standards.

*Public-Private Response Model*

Canada's regime for large vessels and tankers reflects the polluter pay principle and the public-private partnership model both of which are fundamental components of other world-class regimes.

We believe this is a sensible model for Canada as capacity is funded and maintained by those that create the risk. We believe the role of the industry-funded response organization on the West Coast is clear and that it is functioning effectively.

Recent reports by the Auditor General suggest that the Canadian Coast Guard (CGC) is unable to demonstrate the ability to fully achieve its role under the existing regime. Of particular concern is the need for CCG to adopt the Incident Command System (ICS) of emergency management and provide training to those who would be involved in fulfilling the role of the Coast Guard as the federal monitoring agency and potentially as incident commander under some circumstances.

Through our public consultation efforts, we have learned that the existing regime is not well understood by the public, particularly the multi-agency nature of responsibilities assigned to CCG, Environment Canada, ports, responsible organizations and vessel and terminal operators. We have found that the distributed nature of roles within the regime leads to a perception that it is not well co-ordinated and may be ineffective. While we do not share this view, we find it is compounded by the lack of a co-ordinated and comprehensive explanation of the role of governments. We believe there is a need for public awareness of tanker management practices. We hope that initiatives such as the centre of excellence proposed by Port Metro Vancouver will help fulfill the need for a central and active source of information about the regime, separate from the proponents of West Coast pipeline access projects.

*Future Trends*

The single most important emerging trend is the changing global demands for Canadian energy production. While Canada has among the highest reserves of petroleum in the world, we do not have the material capacity to trade with any nation other than the United States.

While the US will continue to be our most important trade partner, current global market and geo-political conditions demonstrate why Canada needs to seek access to world markets. Canadian production is being sold at a discount relative to world markets and increased US production is forecast to diminish that country's demand for imported energy. When compared to other countries with significant energy reserves, Canada is unique in its inability to access global markets.

Ensuring maximum value for Canadian energy exports requires access to tidewater markets in the Pacific Rim. To do this responsibly requires a robust regime for environmental protection including marine spill response.

*Regional Advisory Councils (RAC)*

We believe the concept of citizen input on the performance and adequacy of response capability is part of a world-class regime and that this function as embodied by the RAC should be maintained or enhanced in any future regime. In addition to the role currently provided by the RAC, we believe that the centre of excellence concept proposed by Port Metro Vancouver offers a means to enhance public and Aboriginal involvement on the West Coast.

*Standardization*

While standardization is an important aspect of the regime and is necessary to ensure there is a basic level of protection for all coastal areas, the regime should also provide a means to establish enhanced regulatory requirements where concern for specific risks warrant. Similarly, the fee structure for funding the response organizations should allow flexibility to ensure that costs are fairly allocated across the services provided by response organizations.

***Preparedness***

*Adequacy*

Since the regime was established in the 1990s, the capacity of WCRMC has continued to evolve. Today, it significantly exceeds that of the regulated planning standards. Looking forward, we believe it is necessary for the regulated planning standards to provide a standardized level of protection for all Canadian waters south of 60° N while providing a means to sanction enhanced response capacity for areas where specific risks exist.

For response to vessels and oil-handling facilities, we believe the current WCMRC is functioning well. Where the need exists for additional response capacity, it should be met through an expansion of WCMRC's resources.

For areas where enhanced response capacity is needed, this should be established based on consideration of probability and consequence, with particular consideration to predicted spill volumes, material fate and behavior and geographic setting, including sensitive areas. The regime should be modified to provide means for identification and sanction of risk-based response planning standards for enhanced response areas.

Whether through the private response organizations such as WCMRC, or through the public efforts where new investment in response capacity is required, opportunities to maximize the benefit to First Nations and other communities affected by the possible risks with marine traffic should be sought.

*Co-ordination between Governments*

As an operator of an oil-handling facility, we recognize the value of clear and consistent regulation. We are committed to meeting or exceeding standards established by the agencies that regulate our operations. Both the Government of Canada and the Government of BC are currently conducting reviews of the marine spill response regime. The effectiveness of these reviews and any resulting recommendations will be enhanced to the degree that they lead to harmonization of regulation and co-ordination of the regulatory agencies involved.

When exercising our response plans, we find it beneficial to include the regulators, First Nations, local governments and other key stakeholders that might form a unified command under ICS in a real event. Established relationships and efficient communication are critical aspects of an efficient response that are best achieved through regular interaction.

While these opportunities exist under the current regime, there may be opportunities to further entrench this type of co-ordination through:

- Establishing a pool of ICS-trained resources from the entities provided memberships by the response organization. In some regimes, members are required to contribute resources in addition to a fee for response arrangements.
- Day-to-day co-location of those with maritime emergency management responsibilities in a single, multi-agency centre with space for emergency response and training.

*Risk Information*

In addition to risk-based planning standards for areas of enhanced response described above, risk information can be used to inform plans for specific geographic areas. We are currently working with WCMRC to create a GIS system to house such plans and other response information such as:

- Identification of local l resources and infrastructure pertinent to response operations
- Identification of environmental and cultural sensitivities
- Pre-plans to address these issues including Shoreline Assessment Cleanup Techniques (SCAT) for the area that could be effected by a spill from our Westridge Marine Terminal

In addition to a contribution towards the GIS setup, we are conducting the SCAT assessment and providing the data for inclusion into the GIS system. In addition to providing a working system for response in the vicinity of our terminal, this system is intended to be a demonstration project – a working prototype that could be scaled up by WCMRC to provide mapping for other areas of the coast where enhanced response capability is required.

While WCMRC is capable of developing a working GIS system for West Coast response information, sanction for the sensitivities and priorities incorporated within the system should be provided by government.

***Response***

*Diluted Bitumen*

We have been transporting diluted bitumen in the Trans Mountain Pipeline and loading it at the Westrdige Marine Terminal since the late 1980s when the NEB approved a previous system expansion, in part, for this purpose. Diluted bitumen transported in the Trans Mountain system must meet the quality standards of the NEB-approved pipeline tariff, which includes a limit on maximum density of 940 kg/m3 and a maximum viscosity of 350 cst. Our experience with diluted bitumen suggests that it behaves like other heavy crude oils with these fluid properties.

Due to public concern over the fate and behaviour of diluted bitumen in the marine environment and as part of the work to prepare our expansion application to the NEB, we have recently conducted large-scale tests of two typical diluted bitumen products. These tests were open by invitation to a wide range of regulatory bodies and stakeholders identified through our consultation efforts.

Attendees included Transport Canada, the Canadian Coast Guard, Environment Canada and the US Coast Guard. These tests included scientific assessment of weathering mechanism and toxicity as well as practical tests to determine the effectiveness of conventional skimming equipment, in-situ burning, dispersants and beach-cleaning agents. Results of these tests will be included as part of our application to the NEB. The results will also be available to WCMRC, which participated in the program.

Although these tests were intended as comprehensive opportunities to better understand the fate and behaviour of dilbit, petroleum in general, and other products not included in the MARPOL listing, will remain. Through our experience planning and executing these tests, we found there is a lack of dedicated testing facilities. We believe there’s an opportunity to create a testing facility that could be maintained and operated by WCMRC.

*Role of Canadian Coast Guard*

For response to oil spills from commercial vessels or tankers, the Canadian Coast Guard's role as the federal monitoring agency is appropriate. However, since this service provided by the response organization and other co-ordinating agencies will be structured based on ICS, it is necessary for Coast Guard staff to be capable of taking leadership of a significant spill in case the responsible party is not performing or abdicates its responsibility.

***Tanker Safety Panel***

*Alternate Response Techniques*

While the existing planning standards focus on mechanical recovery, other response measures including the use of dispersants and in-situ burning exist and have proven effective in minimizing environmental harm in the event of a spill. However, the effectiveness of these measures can diminish as weathering of the oil progresses. While these methods are not appropriate in all cases, having conditional pre-approval for their use would avoid delays that diminish their effectiveness in situations when they offer a desirable means of diminishing environmental harm. Response organizations should be empowered with conditional pre-approvals for in-situ burning, the use of dispersants and beach-cleaning agents.

# Appendices

## Appendix 1 Journey of a Tanker

Marine transportation in Canadian waters is authorized and regulated through the *Canada Shipping Act* and related legislation and regulations administered by Transport Canada and the Canadian Coast Guard (CCG).

Before coming to Canada, tankers are required to meet high standards of design and construction:

- Tankers are built according to regulations established by the International Maritime Organization and adopted by their flag state.
- Ship construction and repairs are inspected and documented by a classification society to ensure construction meets these regulations and specifications.
- Tankers are built with double hulls and segregated cargo holds to reduce the possibility of cargo spills and to minimize any potential spill volume, if an accident were to occur.

On an ongoing basis throughout operations, tankers are:

- Inspected by their flag state and by classification societies.
- Vetted by charterer and insurers.
- Inspected in other ports of call by other nations, including those that are signatories to the conventions on port state control (a ship inspection program) to which Canada is also a member.

Upon coming to Canada, tankers are scrutinized to ensure they are compliant with Canadian and Trans Mountain requirements. These requirements include:

- Vessels proposed by a pipeline shipper to receive a cargo at the Westridge Marine Terminal are pre-screened by the Trans Mountain loading master using industry databases and the company's own records before being accepted for scheduling purposes.

- Section 168 of the *Canada Shipping Act* requires that the ship must have an arrangement with a Transport Canada certified response organization (e.g. WCMRC) for spill response service before entering Canadian waters.

- A vessel must contact the CCG for permission to enter Canadian waters before entry.

Upon arrival in Canadian waters, tankers must follow strict communications and guidance protocols:

- The CCG and US Coast Guard (USCG) monitor ship traffic through the Juan de Fuca Strait and the Salish Sea. Four traffic zones are monitored:

- Tofino traffic (entrance to Juan de Fuca Strait, CCG)
- Seattle traffic (Juan de Fuca Strait, USCG)
- Victoria traffic (Salish Sea, CCG)
- Vancouver traffic (Vancouver Harbour, CCG)

- The ship remains in communication with Marine Communications and Traffic Services (MCTS) and the ship's position is monitored throughout the transit. It is handed off between traffic zones as it moves from one to the other. A combination of radar, automatic information system and direct radio communication is used to co-ordinate safe conduct of the vessel with other masters and pilots. Currently, there is no US or Canadian pilotage requirement for transit through the Juan de Fuca Strait.

- The PPA is the federal organization responsible for the administration of the Pilotage Act on the West Coast. The BC Coast Pilots Association is the organization that provides service under the Pilotage Act and Transport Canada (Canada Shipping Act, 2001). All large foreign vessels are required to have a licensed pilot when in local waters. When loaded, tankers are required to have two pilots. The pilot advises the vessel master on safe navigation and is responsible for safe conduct of the vessel while in pilotage waters.

- Empty tankers headed for the Westridge Marine Terminal pick up a pilot at the Victoria pilot station near Brotchie Ledge.

- Under the pilot's guidance, and with supervision from MCTS, the ship navigates through established shipping lanes to the PMV. Ships to and from the Westridge Marine Terminal transit the Juan de Fuca Strait, Haro Strait and Boundary Pass.

- Empty tankers inbound to the Westridge Marine Terminal do not require tug escort. Laden tankers do require tethered tug escort.

When a ship enters into the PMV’s jurisdictional area (within line between Point Atkinson and the US border), a series of established operating rules and protocols apply:

- The PMV rules for conduct of shipping within its jurisdictional area, as documented in the Harbour Operations Manual.

- The PMV operations assign an anchorage for the vessel based on availability and operational requirements. A vessel may anchor at designated locations in English Bay or designated locations off the Westridge Marine Terminal, depending on timing of tides, the Westridge Marine Terminal loading schedule and the ship's own requirements for provisioning or maintenance. In some cases, the ship might proceed directly to the berth.

- When in port, the cargo owner arranges for an agent to assist the vessel with local logistical requirements and interaction with local authorities.

- Pilots leave the ship when it is at anchor, but are aboard anytime it moves, even if just from anchor to dock or back.

- The ship is inspected by Transport Canada on its first arrival in Canada and once per year after that. This might occur at anchor or alongside the Westridge Marine Terminal. Canada is a signatory to both the Paris and Tokyo memorandums of understanding (MOU), conventions on international coordination of inspection requirements. Canada has adopted the MOU requirements into the Canada Shipping Act. Under these MOUs, Transport Canada has access to inspection records from inspections by other signatory jurisdictions and shares Canadian results. Convention entities publish annual reports ranking performance of flag states, which are used as a basis to accept or deny entry of vessels.

When a tanker berths at the Westridge Marine Terminal:

- The ship is assisted by docking tugs and made fast at the Westridge Marine Terminal dock.

- The Trans Mountain loading master boards the vessel to conduct a physical inspection and to conduct a ship-shore safety meeting with the master and terminal operators.

- The loading facility is operated in accordance with regulations established by NEB, Transport Canada and others, as required.

- A boom is deployed to enclose the ship and terminal. A second boom is on hand as a backup in case of emergency. WCMRC moors a skimming vessel at Trans Mountain's utility dock west of the loading dock.

- Loading arms and vapour recovery lines are connected to the tanker. The Westridge vapour destruction system is started and loading commences. Loading typically takes 24 to 36 hours depending on the size of the vessel.

- The Trans Mountain loading master is on board throughout the process, monitoring the condition of ship and crew. The loading master has the authority to stop the loading process if any concerns arise.

- The loading master also provides shipside contact for communication with the terminal.

- Terminal operating procedures include an ERP. Terminal staff are trained in emergency response and regular exercises are held to practice these procedures.

- As required by Transport Canada, Trans Mountain has an arrangement with WCMRC for marine spill response services. WCMRC has spill response equipment staged on the water in Vancouver Harbour and a main base of operations nearby in Burnaby. Similarly, WCMRC maintains equipment caches on Vancouver Island for response in the Salish Sea.

When loading is complete and the vessel departs:

- The loading master stays on board until pilots come to move the vessel away from the dock.

- The ship is cast off and typically goes to anchorage to wait for tide for the Second Narrows transit, as required by the PMV's *Harbour Operations Manual*.

- Two PPA pilots come aboard to assist the tanker in safely navigating out of Canadian waters.

- The PPA requires loaded tankers to have two BC Coast Pilots on board, one to ensure safe conduct of the vessel and one to monitor the bridge crew and ship's systems.

- The PMV's *Harbour Operations Manual* defines the Second Narrows movement restricted area (MRA) and the rules for MRA transits, including tanker size restrictions and tug escort requirements, and speed restrictions. Only one vessel at a time is allowed in the Second Narrows MRA and First Narrows. The MCTS monitors the tanker's progress and other vessel traffic in the harbour.

- Before the transit begins, MCTS declares a clear narrows and the Canadian National Railway is contacted to raise their rail bridge.

- The PMV rules require that two large tugs are tethered to the stern and at least one smaller tug on the bow for the Second Narrows MRA transit. Only the two large tugs tethered to the stern are required for the transit through the remainder of the harbour.

- After clearing the First Narrows, the escort tugs fall away and the ship transits without escort until it approaches East Point on Saturna Island.

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- The PPA has established escort requirements for the Salish Sea (Boundary Pass and Haro Strait). The PPA requires a single large tug tethered 1.5 nautical miles before East Point until Race Rocks off Victoria.

- The two onboard BC Pilots disembark at the Victoria Pilot Station (Brotchie Ledge).

- The tugs leave the vessel at Race Rocks as the vessel enters the Juan de Fuca Strait.

- No pilotage or escort is required through the Juan de Fuca Strait. However, as with inbound transits, the tanker and all other traffic are monitored by the MCTS.

- US industry funds a rescue tug at Neah Bay to assist any ships in distress in the Juan de Fuca Strait.

- Upon clearing the Juan de Fuca Strait, the ship continues to its destination.

# Appendix 2 Westridge Marine Terminal Description

The Westridge Marine Terminal is located on the south shore of Burrard Inlet, east of the Second Narrows in the City of Burnaby, within the jurisdiction of the Port Metro Vancouver (PMV). See Figure 1 on page 7 which shows the location of the terminal within Vancouver Harbour. The Westridge Marine Terminal is used for:

- Loading synthetic or crude oil onto Aframax or Panamax class tankers and barges
- Off-loading jet fuel from tankers and barges

Jet fuel received at the terminal is delivered to Vancouver International Airport by Trans Mountain's affiliate, Trans Mountain (Jet Fuel) Inc. In addition to the dock, the Westridge Marine Terminal also has three tanks, containing a total volume of 45,950 m3 (289,000 bbl), currently being used for staging jet fuel.

The PMV manages vessel traffic in accordance with its *Harbour Operations Manual* available at:

http://www.portmetrovancouver.com/en/users/marineoperations/navigation.aspx

The immersed depth (i.e., draft) of loaded vessels transiting the Second Narrows is limited to 13.5 m, under the current operating rules. Furthermore, the PMV's *Harbour Operations Manual* also limits laden tanker transits to near slack water during daylight hours, and requires a minimum of 10 per cent under-keel clearance over a channel width of 2.85 times the beam of the vessel.

The requirement to maintain underkeel clearance at the edges of the channel (channel width) is typically the limiting factor in determining the allowable draft of the vessel. An assessment of available tidal windows over the 19-year tidal cycle shows that a draft of 11.75 m on a 44 m beam Aframax tanker is sufficient to ensure sustainable takeaway capacity from the Westridge Marine Terminal. For a 44-m beam Aframax tanker, the 11.75 m draft corresponds to a heavy oil capacity of 87,400 m3 (550,000 bbl) and a light oil capacity of about 92,200 m3 (580,000 bbl).

These capacities have been used to determine the post-expansion estimate of 34 Aframax tanker loadings per month. Depending on the available tides, the actual draft of laden tankers will be up to 13.5 m.

While loadings at the Westridge Marine Terminal fluctuate based on market conditions, currently five tankers and three barges are typically handled each month (i.e., two barges outbound with crude oil shipments and one inbound with jet fuel). It is expected that this will increase up to the equivalent of 34 partially loaded Aframax tankers (with an 11.75-m draft) and three barges, an increase of about 30 vessels per month. Crude oil and jet fuel barge traffic is not expected to increase because of the project. Jet fuel receipts will not change because of the project.

Vessels bound for the Westridge Marine Terminal currently account for about three per cent of the total traffic in the PMV's jurisdiction. Because of the expanded TMPL system, vessel movement and loading facilities are expected to account for 14 per cent of the total traffic in the

PMV based on current activity, which represents an increase of about 11 per cent over current traffic levels.

Preliminary design of the additional facilities at the Westridge Marine Terminal is currently underway. These plans include constructing two new docks:

- One dock with two berths for Aframax and Panamax tankers and oil barges
- One dock with one operational berth for Panamax tankers and barges (oil and jet fuel)

In addition, the plans include construction of a utility dock with multiple berths for pilot launches, tugs, spill response vessels and equipment.

The dock facilities at the Westridge Marine Terminal were constructed in 1957 and will require significant upgrades or reconstruction before 2020. If cost-effective upgrading can be done to the existing dock while it is operational, this will replace the need for a single berth face dock. Otherwise, the existing dock will be removed and replaced.

The exact configuration of the new docks has yet to be determined, and depending on their location some nearshore dredging might be necessary to accommodate construction of the new docks.

The Westridge Marine Terminal docks will be equipped with:

- Fender and mooring structures
- Vessel access towers
- Delivery and receipt pipeline systems
- Loading and unloading arms
- Vapour recovery systems and fire-suppression systems, similar to those that currently exist at the terminal

Additional tanker support systems that are being considered include refueling from barges and using shore power to limit generator use. Currently, only five per cent of the international tanker fleet is equipped to take shore power, so it might not be feasible to enforce the use of shore power at this time.

*Photo of the Westridge Marine Terminal in the 1950s.*

## Appendix 3 Westridge Marine Terminal Operation

All vessels visiting the Westridge Marine Terminal are vetted by KMC to ensure they meet Trans Mountain's vessel quality criteria. In addition to Trans Mountain's own vessel screening and inspection program, tankers docking at the Westridge Marine Terminal will meet all applicable local and international rules and regulations, and will be inspected by Transport Canada for compliance. The PMV manages vessel traffic within the harbour in accordance with their *Harbour Operations Manual*.

The Canadian Coast Guard (CCG) (a Special Operating Agency of the Department of Fisheries and Oceans Canada [DFO]) monitors vessel movements within Canadian waters, including PPA mandated areas. The PPA ensures safe conduct of vessels in mandated pilotage areas, which includes the shipping corridor between Westridge and Vancouver Island. Where designated vessel traffic lanes exist, the vessels will normally follow those lanes.

In addition to inspections conducted by Transport Canada and other agencies, Trans Mountain conducts a physical inspection of each vessel before it is allowed to berth at the Westridge Marine Terminal. At the Westridge Marine Terminal, all vessel screening and loading operations have been and will continue to be supervised by Trans Mountain's loading master, who has tanker command experience and is on board during all vessel loadings. The loading master's key responsibilities are:

- Screening, inspection and acceptance of tankers
- Continuously monitoring the condition of each vessel and its crew while berthed at the terminal
- Supervising loading operations to ensure safety and conduct, in accordance with Trans Mountain's procedures and applicable regulations
- Taking actions necessary to ensure the safety and protection of the environment, including refusal to berth, interrupting loading or casting-off of the vessel
- Monitoring the performance of the ship and its crew and to ensure effective communication between terminal staff and the vessel's officers and crew

*Westridge Marine Terminal – Current.*

## Appendix 4 Emergency Preparedness and Response Program

Trans Mountain has in place a comprehensive emergency preparedness and response program in accordance with the EHS policy and Section 32 of the NEB *Onshore Pipeline Regulations, 1999*. The emergency preparedness and response program (ERP) consists of:

- A response management system
- Training and spill response exercises
- Spill response resources for the pipeline and for the Westridge Marine Terminal

**Emergency Response Plan**

Trans Mountain maintains a geographically based ERP that includes:

- Information pertaining to notification requirements
- Emergency checklists and contacts
- Response team organization
- Facilities and pipeline information
- Material safety data sheets
- Health and safety plans
- Route maps depicting control points and environmentally sensitive areas

The ERP, including field guides containing route maps and critical initial response procedures, has been provided to key field operations and maintenance personnel. A project-specific ERP will be prepared for construction and commissioning activities. The existing operations ERP will be revised to reflect the response requirements of the expanded system in advance of starting operations.

**Response Management System**

Since 1990, Trans Mountain has been delivering its community awareness and emergency response program to emergency services organizations and government agencies along the TMPL system corridor.

The objectives of the program are to familiarize first responders with the pipeline location, explain the properties of the pipeline's contents and promote information exchange and co-ordination of response efforts in the event of an incident. As part of the response management system, Trans Mountain staff members are trained in the emergency response procedures and conduct regular emergency exercises, some of which include local first responders. Trans Mountain also has standing agreements for contract resources to provide response equipment and labour, air and human health monitoring, environmental assessment and emergency management.

Trans Mountain has adopted the incident command system (ICS) as the basic response structure for its emergency response teams. The ICS, developed in the US almost 30 years ago, is now the system preferred by emergency response organizations around the world to handle a wide variety of emergency situations, including oil spills.

### Training and Spill Response Exercises

Emergency response training is provided to head office and field personnel to promote readiness in the event of a spill. The training includes classroom instruction on the ICS, with general knowledge of the system and procedures, and more specific training for individuals with specific roles in the event of an emergency. Regularly scheduled ICS training is used to ensure that Trans Mountain employees, government personnel and first responders (e.g., local fire departments and police detachments) are trained to fulfill the key ICS roles. A combination of tabletop and field deployment exercises are used to simulate an emergency and to ensure that employees are fully trained in activation of the emergency response plans and are familiar with the deployment and capability of the equipment used. Trans Mountain will revise its ICS for the expanded operation before the start of pipeline commissioning.

### Spill Response Resources

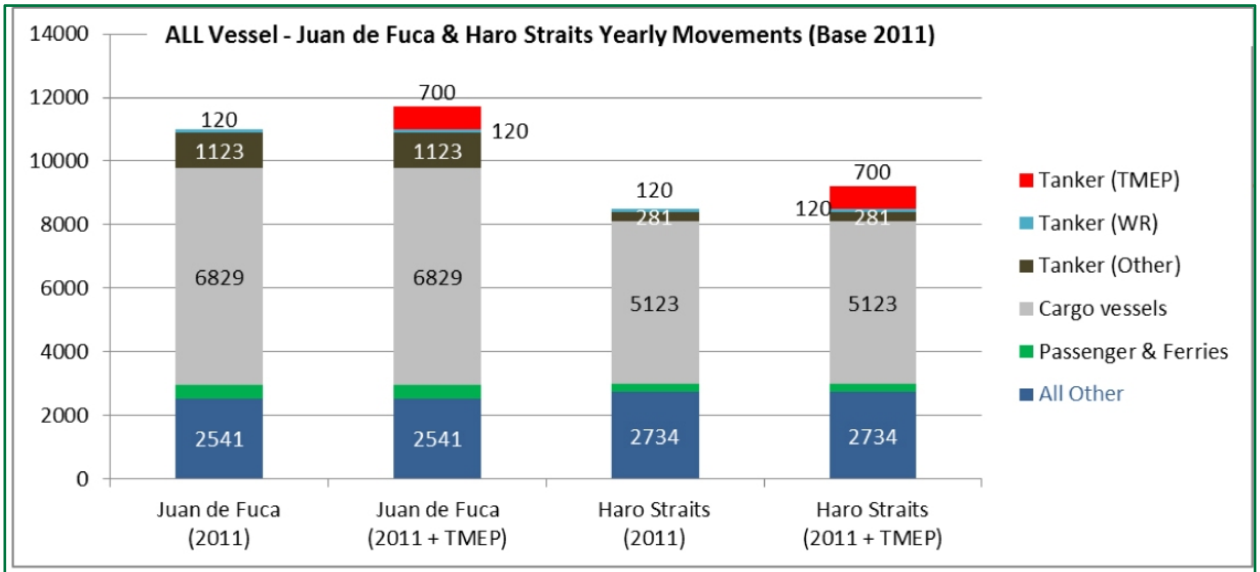
If an incident occurs at the Westridge Marine Terminal, the presence of the Trans Mountain loading master on board the vessel ensures an immediate co-ordinated response. The loading master has command experience and remains on board the tanker throughout the loading operation to monitor the performance of the vessel and its crew and to ensure effective communication between the terminal staff and the vessel's officers and crew.

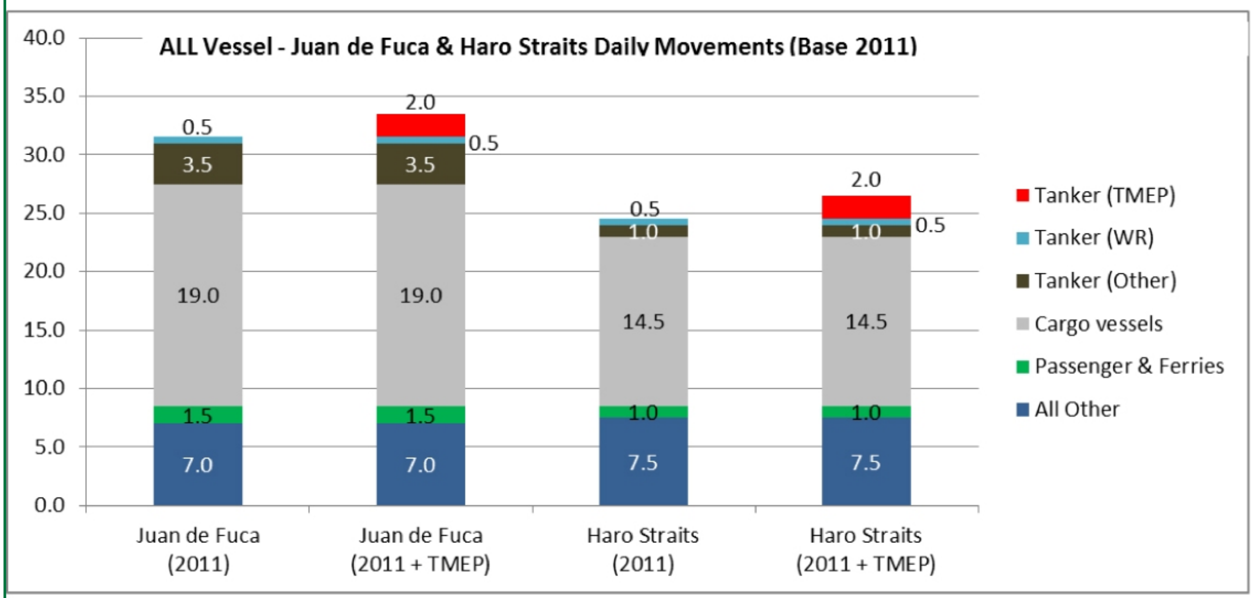
Once a vessel is secured alongside the dock it is encircled by a containment boom. This is as a precautionary measure to confine potential spills to the immediate area of the terminal and to facilitate rapid response and recovery. Trans Mountain also maintains a secondary boom and a boat at the terminal for immediate deployment in the event of an incident.

In addition to its own equipment, and as required by the *Canada Shipping Act*, Trans Mountain is a member of Western Canada Marine Response Corporation (WCMRC) and is contracted with the corporation to provide spill response services for the Westridge Marine Terminal. WCMRC's main operating base is located in Burnaby near the Westridge Marine Terminal and it maintain several response vessels on the water in Vancouver Harbour to ensure a prompt response, including a skimming vessel kept at the Westridge Marine Terminal.

Trans Mountain maintains an Emergency Preparedness and Response Plan for the Westridge Marine Terminal that would be used to manage the response to a spill. This plan will be evaluated for its suitability to the expanded operation and will be revised as necessary to ensure the safety of people and the environment. This plan forms the basis for regular emergency response training and exercises that are conducted with terminal staff and other agencies. Trans Mountain works closely with the PMV, Transport Canada, the Pacific Pilotage Authority (PPA) and other agencies to ensure the safety and efficiency of vessels calling at the Westridge Marine Terminal. In 1976, Trans Mountain was a founding member of the spill response cooperative that has become WCMRC and continues to be a part owner of the organization.

# Appendix 5 Traffic Analysis – Juan de Fuca and Haro Straits




*This diagram is based on AIS (Automatic Identification System) 2011 data recorded by the Marine Exchange in Seattle, Washington.*

## Appendix 6 Discussion Topics (Marine) at Information Sessions

In the BC Lower Mainland, we held six public information sessions in communities along the project's marine corridor. A combined total of 482 people attended these sessions (November 2012) in Vancouver (three sessions), North Vancouver, West Vancouver and on Bowen Island.

This table summarizes the most common questions and discussion topics raised at the BC Lower Mainland sessions related to marine transportation of oil.

| Key Topics of Interest or Concern | Comment Summary |
|---|---|
| Marine Spills | • Potential impact of spill on biodiversity of Fraser Delta ecosystem and Burrard Inlet<br>• Increased risk of spill with increased tanker traffic<br>• Providing perspective through the evaluation of spill risk in context of other risks<br>• Methods of reducing the risk of a spill<br>• Implications of the closure of the Kitsilano Coast Guard worst-case spill scenario<br>• Impacts of a spill of bitumen versus refined products<br>• Proportion of product that can be cleaned up following a spill<br>• Environmental impact of a spill in Vancouver Harbour<br>• Exxon Valdez as an example of the longevity of environmental effects<br>• Impacts of a spill on human health and quality of life in coastal areas<br>• Carcinogenic effects of products<br>• Threat to the regenerated herring fishery and newly returned resident whale populations<br>• Work with the community to address concerns about oil spill impacts<br>• Liability for marine spills<br>• Ability to recover costs from responsible parties<br>• Cleanup costs that will be paid by taxpayers<br>• Increase in spill response capacity to cover increase in tanker traffic |
| Marine Tankers | • Tanker size and volume<br>• Storage of oil onboard tankers<br>• Safety features such as double hull<br>• Tanker navigation in harbour and through narrows<br>• Tanker navigation in shipping lanes through the Gulf Islands<br>• BCIT training facility for tanker pilots<br>• Process for loading tankers and potential for small spills<br>• Ability of Vancouver Harbour to safely accommodate more tankers<br>• Increased risk of spill due to increased number of tankers<br>• Improvements to tanker design, construction and operation<br>• Investment in clean technology and research and development to improve tankers<br>• Sonar to detect whales and deter them from coming near vessels<br>• Inspections of tankers prior to loading<br>• Records to show each tanker's safety history<br>• Kinder Morgan Canada's involvement in tanker safety and spill prevention<br>• Tugboat escorts in Burrard Inlet and at Saturna Island<br>• Need to alleviate concerns about the impacts of tanker traffic on pleasure craft use |

| | |
|---|---|
| | • Comparison of the number of tankers travelling south to Puget Sound and the number going to<br>• Burrard Inlet after the proposed expansion<br>• Comparison of Canadian and US tanker management<br>• Dredging of Burrard Inlet (i.e., is it necessary and whose decision would it be?)<br>• Possibility for tanker size to increase if dredging occurs in the future, and the ability of Kinder Morgan Canada to influence this<br>• Impacts of dredging on tides and on West Vancouver's shoreline near Ambleside |
| Bitumen | • Properties of bitumen and dilbit, including corrosiveness<br>• Possibility that bitumen will sink in the event of a marine spill<br>• Ability to clean up spilled bitumen and dilbit<br>• Human health impacts related to spilled bitumen and dilbit<br>• Possibility to refine more products in Alberta so that dilbit and bitumen don't need to be transported by tankers<br>• Possibility for a bitumen research facility at BCIT |

In the BC coastal regions, we held six public information sessions in communities along the project's marine corridor (December 2012 and January 2013). A combined total of 695 people attended these sessions which took place in Nanaimo, Victoria, West Shore, Saanichton, Sooke and on Salt Spring Island.

This table summarizes the most common questions and discussion topics raised at the BC coastal sessions related to marine transportation of oil.

| Key Topics of Interest or Concern | Comment Summary |
|---|---|
| Marine Spills | • Risk of a spill<br>• Increased risk with increased volumes of oil<br>• Spill response times<br>• WCMRC equipment locations and response capacity<br>• Proportion of product that could be cleaned up in the event of a spill<br>• Liability regime in Canada in the event of a spill<br>• Cross-border responsibilities<br>• Adequacy of $1.3 billion to cover the costs of a spill<br>• Ability to collect insurance from responsible parties<br>• Impacts to coastline in the event of a spill<br>• Protection of fragile marine environment<br>• Fate and effects of spilled products |
| Marine Tankers | • Tanker volumes and numbers<br>• Safety of tanker design and operation<br>• Double hull construction<br>• Adequacy of existing shipping lanes to accommodate increase in tanker traffic<br>• Potential for unsafe conditions in harbour as a result of increased tanker traffic<br>• Pilotage of tankers and escort tugboats<br>• Impact of increased tanker traffic on orca populations |

## Appendix 7 Marine Aboriginal Engagement

Trans Mountain's Aboriginal Engagement team is talking with Aboriginal groups that have traditional rights in coastal and marine areas. The list may evolve as the engagement proceeds. The list includes:

- Cowichan Tribes
- Esquimalt Nation
- Halalt First Nation
- Hwlitsum First Nation
- Lyackson First Nation
- Malahat First Nation
- Musqueam
- Pacheedaht First Nation
- Pauquaching First Nation
- Penelakut First Nation
- Scia'new Indian Band (Beecher Bay)
- Semiahmoo
- Snaw-Naw-As (Nanoose)
- Snuneymuxw First Nation
- Songhees Nation
- Squamish
- Stz'uminus First Nation (Chemainus)
- T'Sou-ke First Nation
- Tsartlip First Nation
- Tsawwassen
- Tsleil-Waututh
- Twawout First Nation
- Tseycum First Nation

# Appendix B Marine Vessel Types

Plate 1 General cargo vessels

Plate 2 Dry-bulk cargo vessels (bulk carriers)


Plate 3 Container cargo vessels


Plate 4 Tankers (http://www.shipspotting.com/gallery/photo.php?lid=1312298 Accessed: November 2013)

Plate 5 Tugs

Plate 6 Passenger vessels and pleasure craft


Plate 7 Government vessels and warships


Plate 8 Commercial passenger ferries

Plate 9 Floatplanes


Plate 10 Commercial fishing vessels

# Appendix C Summary of Outcomes of the Public Consultation Program

## TABLE 3.1.3

## INTERESTS OR CONCERNS – MARINE AIR AND GHG EMISSIONS

| Summary of Interest or Concern | Response Summary | Where Issue is Addressed |
|---|---|---|
| Degradation of air quality from increased tanker traffic<br><br>Increase in GHG emissions/climate change from tanker activity. | All vessels calling PMV are required to comply with international and local regulations on the types of engines (both propulsion and generators) that they are fitted with. Engines are required to meet strict exhaust emission requirements set by the IMO and carry certificates from IMO to demonstrate compliance. Regular surveys and inspections are conducted by local authorities to verify compliance and that engines are maintained to ensure their continued adherence to IMO standards.<br><br>There is an ongoing internationally mandated process underway to improve the type of fuel used by ships. Vancouver is within the North American Emissions Control Area (as are Seattle, San Francisco and Los Angeles) which applies stringent engine emission standards and fuel sulfur limits to all ships entering or plying within 200 miles of the BC coast. Mandated further improvement in fuel standards take effect in 2015 and 2020, which period straddles the Project's 2018 coming into operation schedule.<br><br>In addition, every ocean going commercial vessel is currently required by the IMO to have in place a Shipboard Energy Efficiency Management Plan. A Shipboard Energy Efficiency Management Plan is intended to improve a ship's operational and energy efficiency to reduce fuel consumption and air emissions.<br><br>All of the above factors help prevent degradation of air quality in the region caused by marine transport traffic. Trans Mountain, as part of pre-arrival checks shall only accept modern vessels that comply with all of the above international requirements to load at the Westridge Marine Terminal. | Volume 3A – Public Consultation, Volume 8A – Marine Transportation, Section 4.0 |

## TABLE 3.1.4

## INTERESTS OR CONCERNS – MARINE ACOUSTIC ENVIRONMENT

| Summary of Interest or Concern | Response Summary | Where Issue is Addressed |
|---|---|---|
| Effects on residents from ship anchorage | The marine transportation acoustic environment assessment considers increased frequency of noise events like ship anchors being raised and lowered and vessel horns. The types of noise events are not expected to change from existing vessel operations; however, the frequency may increase. | Volume 8A – Marine Transportation, Section 4.0 |

## TABLE 3.1.5

## INTERESTS OR CONCERNS – MARINE MAMMALS

| Summary of Interest or Concern | Response Summary | Where Issue is Addressed |
|---|---|---|
| Effects of increased tanker traffic, underwater noise and pollution on orca populations (*i.e.*, southern resident killer whale) | The marine mammals assessment considers the effects of increased underwater noise on southern resident killer whales and modeling has been conducted. Trans Mountain is investigating potential mitigation options such as acting as an active participant in a joint industry-government advisory group that would be charged with determining and/or developing effective mitigation measures to reduce potential effects of underwater noise on marine mammals in the region. | Volume 8A – Marine Transportation, Section 4.0 |

## TABLE 3.1.6

## INTERESTS OR CONCERNS – MARINE COMMERCIAL, RECREATIONAL AND TOURISM USE

| Summary of Interest or Concern | Response Summary | Where Issue is Addressed |
|---|---|---|
| Effects of tanker traffic on pleasure craft use<br>Comparison of the number of tankers travelling south to Puget Sound and the number going to Burrard Inlet after the proposed expansion | Every month, PMV currently handles 250 vessels of all types. At present, the Westridge Marine Terminal handles approximately eight vessels per month (five of which are tankers) — representing less than three per cent of the total traffic in PMV. Should the proposed expansion be approved, the number of vessels, including tankers and barges, being loaded at the Westridge Marine Terminal could increase to approximately 37 per month (34 of which could be tankers) in 2018, or about 14% of today's total PMV vessel traffic. The expansion is expected to increase traffic to roughly 8-10% around Puget Sound.<br>The marine ESA considers the potential effects of increased Project-related marine vessel traffic on recreational users (Section 4.3.11). | Volume 3A – Public Consultation,<br>Volume 8A – Marine Transportation, Section 4.0 |
| Comparing the need for oil export with the risks to the environment and Vancouver's coastal way of life | Trans Mountain recognizes that risk assessments are important to municipalities and stakeholders. Risk communications to stakeholders will be a component of the engagement programs. Trans Mountain commissioned a quantitative risk assessment as part of the TERMPOL Review Process. The results of the quantitative risk assessment are presented in Section 5.0, Volume 8A. | Volume 3A – Public Consultation,<br>Volume 8A – Marine Transportation, Section 5.0 |
| Potential for more safety-related jobs in Vancouver Harbour | Trans Mountain plans to maximize local, regional and Aboriginal employment opportunities by working with communities and industry associations in the vicinity of the Project. | Volume 3A – Public Consultation<br>Volume 5B, Sections 5.7 and 7.2.7 |

## TABLE 3.1.6

## INTERESTS OR CONCERNS – MARINE COMMERCIAL, RECREATIONAL AND TOURISM USE (continued)

| Summary of Interest or Concern | Response Summary | Where Issue is Addressed |
|---|---|---|
| Trans Mountain investment in local initiatives such as herring and bird population restoration projects | As a long-time industry and community member, Trans Mountain is committed to working with residents, regulatory authorities and other stakeholders on environmental initiatives.<br>Kinder Morgan Canada Inc., as the operator of TMPL, and the Kinder Morgan Foundation have funded many local environmental education initiatives since 2006, benefiting schools, local stream keepers and other stewardship groups, Trans Mountain continues to engage with these groups regarding the Project.<br>Kinder Morgan Canada Inc. funded a foreshore restoration project near Westridge Marine Terminal in 2007, which involved the creation of an artificial reef where boulders and rip-rap were placed. This project was managed by the Pacific Wildlife Foundation. | Volume 3A – Public Consultation |
| Adequacy of existing shipping lanes to accommodate increase in tanker traffic | The existing shipping lanes are used by marine vessel traffic for recreational, commercial, tourism and passenger transit on a daily basis. The expected increased Project-related marine vessel traffic is not anticipated to pose a capacity problem for the internationally regulated shipping lanes. | Volume 3A – Public Consultation,<br>Volume 8A - Marine Transportation |
| Tanker navigation in harbour and through narrows<br>Tanker navigation in shipping lanes through the Gulf Islands | PMV has worked closely with PPA and the marine industry and government stakeholders over the past five years to develop new ways to further strengthen existing safety procedures when escorting all vessels through the Second Narrows.<br>The review included comprehensive simulation exercises and live trials with an Aframax vessel. This led to a number of modifications to the procedures in place, and a higher standard of safety. The new procedures involve new tug escort requirements, installation of new aids to navigation, and development of an enhanced training program for tug captains and ship pilots.<br>These procedures and additional aids to navigation are now in place. The new, innovative procedures further strengthen navigational safety within PMV controlled waters. Information on procedures through the Second Narrows can be found through PMV (2013). | Volume 3A – Public Consultation, Volume 8A- Marine Transportation, Section 5.0 |

## TABLE 3.1.7

## INTERESTS OR CONCERNS – MARINE NON-SPILL ACCIDENTS AND MALFUNCTIONS

| Summary of Interest or Concern | Response Summary | Where Issue is Addressed |
|---|---|---|
| Increased tanker traffic increases the risk of groundings as well as the spread of invasive species and stresses on the environment | Tankers calling at the Westridge Terminal are required to follow all regulations in PMV and in BC waters, including safety regulations, pilotage requirements and ballast water exchange requirements. The marine transportation environmental assessment considers the possibility of a grounding event as well as the spread of invasive species and other potential accidents and malfunctions (see also Volume 5A Section 7.6). | Volume 8A – Marine Transportation, Section 4.0, 5.2 |

## TABLE 3.1.8

## INTERESTS OR CONCERNS – MARINE SPILLS

| Summary of Interest or Concern | Response Summary | Where Issue is Addressed |
|---|---|---|
| Records of each tanker's safety history<br><br>Trans Mountain's history of spill events | Kinder Morgan Canada Inc., as the operator of TMPL, is committed to transparency involving any and all spills that have occurred along its pipelines, or on vessels carrying KMC transported product. Spills are reported, and available for public knowledge.<br><br>Kinder Morgan Canada Inc., as the operator of TMPL, understands the safety of the BC coastline is paramount. All 900 tankers that have ever loaded and sailed from the Westridge Marine Terminal in Burnaby have done so without a single spill.<br><br>There is a network of safety and response organizations in the marine community as well as regulations and requirements established to ensure safe transit of oil tankers in BC waters. When it comes to marine safety, Kinder Morgan Canada Inc. also stands with BC in advocating for the necessary level of federal funding and response capabilities. | Volume 3A – Public Consultation, Volume 8A – Marine Transportation, Section 5.0 |
| Exxon Valdez spill as an example of the longevity of environmental effects | As a result of the Exxon Valdez crude oil spill in the Gulf of Alaska in 1989, the Government of Canada appointed the Public Review Panel on Tanker Safety and Marine Spill Response Capacity (Brander-Smith Panel) and adopted a large number of its recommendations. In the 24 years since the Exxon Valdez incident, many safety improvements have been undertaken by government and the tanker industry.<br><br>Bills such as C-16 in Canada have given authorities the power to prosecute sub-standard persons/organizations (including Chief Executive Officers [CEO]), if found polluting Canadian waters. The initiatives above have contributed to improved safety standards, a measureable reduction in tanker incidents and oil spills, including mystery spills.<br><br>The Westridge Marine Terminal has been operated responsibly for 60 years on the BC coast and Kinder Morgan Canada Inc. takes spill response seriously. 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 the oil), and dispersion (use of dispersing agents to dilute and disperse the oil reducing its concentration). Trans Mountain has also conducted studies to learn about the effects of the increased tanker traffic that would result from the Project. | Volume 8A – Marine Transportation, Section 5.0 |
| Liability regime in Canada in the event of a spill | Ship-source spill: If oil were released from a vessel, the vessel owner would be the Responsible Party. In addition to the ship owner's insurance, there are a variety of funding sources available to cover the costs of cleaning up such a spill. See below for more details about these sources.<br><br>Although liability for such spills would not fall to the marine terminal owner, Trans Mountain has established programs to reduce the potential for ship-source spills. Vessels must pass a rigorous screening process set out by international and local governing bodies and Trans Mountain before being allowed to accept oil from the Westridge Marine Terminal. By ensuring that only the safest vessels are filled at Westridge, Trans Mountain reduces the risk of a ship-source oil spill. | Volume 3A – Public Consultation,<br><br>Volume 8A - Marine Transportation, Sections 1.0 and 5.0 |

**TABLE 3.1.8**

**INTERESTS OR CONCERNS – MARINE SPILLS (continued)**

| Summary of Interest or Concern | Response Summary | Where Issue is Addressed |
|---|---|---|
| Liability for marine spills.<br>Ability of those affected by an oil spill recover costs from responsible parties.<br>Ability to collect insurance from responsible parties | In Canada, liability and compensation for ship-source oil spill pollution are governed by the *Canada Shipping Act* and MLA. Both acts reflect Canada's commitment to international conventions administered by the IMO, such as those regarding the IOPC Funds.<br>Conventions limit the liability of the Responsible Party (ship owner) and establish sources of funding for clean up and compensation for damages. Up to $1.312 billion is available for an individual spill. | Volume 8A – Marine Transportation, Sections 1.0 and 5.0 |
| Adequacy of $1.3 billion to cover the costs of a spill | The cost of cleaning up an oil spill is difficult to estimate, as it depends on a variety of factors such as the type of oil, amount of oil, spill location (at sea versus near shore), potential environmental and socio-economic effects, weather, ocean conditions, rate of spill and efficiency of response operations.<br>Since Canada's Ship-source Oil Fund was implemented in 1989, no Canadian spill has exhausted all sources of cleanup funding. See http://www.transmountain.com/marine-spill-liability for more information. | Volume 3A – Public Consultation,<br>Volume 8A - Marine Transportation, Sections 1.0 and 5.0 |
| Comparison of Trans Mountain's spill response regime to other regimes worldwide - will BC's five requirements mean more resources will need to be added to what is currently in place?<br>Increase in spill response capacity to cover increase in tanker traffic | Trans Mountain is supportive of BC's 5 Conditions and the work of the Federal Tanker Safety Expert Panel that is assessing Canada's oil spill response regime.<br>Kinder Morgan Canada Inc. has an existing spill response plan for the Westridge Marine Terminal that is exercised regularly. With respect to the Project, Trans Mountain believes it compares well against other terminal response plans available in Canada and other jurisdictions globally. The plan will be expanded in keeping with the terminal expansion and increased Project-related marine vessel traffic to the Westridge Marine Terminal. WCMRC is a federally certified oil spill response organization and is responsible for providing spill response to all marine commercial vessels and oil handling facilities along the BC Coast. WCMRC is undertaking a benchmarking exercise against other global spill response organizations as well as assessing any increased need for spill response as a result of TMEP. If more resources are required either as a result of WCMRC's recommendations or from the Federal Tanker Safety Expert Panel, they will be made available well in advance of the operation of the Project. | Volume 8A – Marine Transportation, Section 5.0 |
| Interaction between PMV and WCMRC and response capacity | WCMRC is comprised of a team of spill response professionals and is funded through fees charged for mandatory spill response memberships and fees charge on petroleum loaded within WCMRC's area of response.<br>Their ability to effectively manage and direct spill response activites reduces the negative effects oil can have on the surrounding environment.<br>In the event of a spill, WCMRC personnel immediately respond with strategies and countermeasures. WCMRC maintains equipment caches of containment booms, skimmers and vessels. Incident Command team members, supervisors, vessel skippers and crew, technical assistance personnel, advisors and others, are pooled both from within WCMRC and from its network of partners across Canada, the US and around the world. | Volume 8A – Marine Transporation, Section 5.0 |

## TABLE 3.1.8

## INTERESTS OR CONCERNS – MARINE SPILLS (continued)

| Summary of Interest or Concern | Response Summary | Where Issue is Addressed |
|---|---|---|
| Implications of the closure of the Kitsilano Coast Guard<br>Worst case spill scenario | A worst case event with total loss of all oil cargo from a tanker is an extremely unlikely event. In case of an oil spill, through its environmental response program, the CCG is responsible for monitoring and directing the clean up of ship-sourced spills of oil and other pollutants into Canadian waters. The actual response operation is carried out by WCMRC. CCG responsibilities include monitoring clean up efforts by polluters and managing cleanup efforts when polluters are unknown, or unwilling or unable to respond to a marine pollution incident. | Volume 3A – Public Consultation,<br>Volume 8A – Marine Transportation, Section 5.0 |
| Increased risk of spill with increased tanker traffic<br>Ability of Vancouver Harbour to safely accommodate more tankers<br>Process for loading tankers and potential for small spills<br>Providing perspective through the evaluation of spill risk in context of other risks<br>Process for loading tankers and potential for small spills | Marine vessels have been loaded at the Westridge Marine Terminal since 1956 without a single spill from tanker operations. Close collaboration with organizations such as the PPA, government organizations (Transport Canada and CCG) and PMV ensure that tankers navigate BC waters safely and are guided in and out of the port by highly-trained and qualified pilots. The number of vessels, including tankers and barges, being loaded at the Westridge Marine Terminal could increase to approximately 37 per month (34 of which could be tankers) in 2018, or about 14% of today's total PMV vessel traffic. Currently Westridge Marine Terminal-related traffic makes for roughly 3% of tanker traffic through the port. Tankers are held to strict internationally accepted construction, operation, and maintenance quality standards mandated by IMO and *Canada Shipping Act* and verified by Class Societies. Additionally, WCMRC marine-based spill response plans ensure quick action in the event of a spill. | Volume 3A – Public Consultation,<br>Volume 8A – Marine Transportation, Section 5.0 |
| Spill response times | In the event of a spill on land, several different groups co-ordinate efforts to react quickly and effectively. Kinder Morgan Canada Inc., as the operator of TMPL and the Westridge Marine Terminal, uses the Incident Command System. This system allows for seamless coordinated action with regulatory authorities and Aboriginal communities Kinder Morgan Canada Inc. would then activate response personnel and procedures and notify regulatory agencies. Kinder Morgan Canada Inc. has backup power supplies at all of the stations that can safely perform the shut down functions, including in the event of a power failure.<br>If an oil spill occurs in the marine environment, multiple organizations quickly take co-ordinated action to mitigate public and environmental effects. WCMRC is the Response Organization on the West Coast with the capacity to respond and clean-up an oil spill in the marine environment. | Volume 3A – Public Consultation,<br>Volume 8A - Marine Transportation, Section 5.0 |
| Cross-border responsibilities | If an oil spill occurs in the marine environment, multiple organizations quickly take co-ordinated action to mitigate public and environmental effects. The WCMRC has mutual aid agreements with emergency response organizations in the State of Washington. | Volume 3A – Public Consultation,<br>Volume 8A - Marine Transportation, Section 5.0 |

## TABLE 3.1.8

## INTERESTS OR CONCERNS – MARINE SPILLS (continued)

| Summary of Interest or Concern | Response Summary | Where Issue is Addressed |
|---|---|---|
| Tugboat escorts in Burrard Inlet and at Saturna Island<br><br>Pilotage of tankers and escort tugboats | Although Trans Mountain is not directly responsible for the operation of marine traffic, Trans Mountain is committed to working with the marine industry to ensure the safe movement of vessels that travel in BC waters and call on the Westridge Marine Terminal in Burnaby. Tug escorts are used in Burrard Inlet and through Haro Strait, as required by the CCG. Trans Mountain will require that all Project-related tankers calling at the Westridge Marine Terminal have mandatory tug escort for the entire route between the Westridge Marine Terminal and the Pacific Ocean.<br><br>Two qualified Canadian pilots are on board all tankers leaving the Westridge Marine Terminal. | Volume 3A – Public Consultation,<br><br>Volume 8A – Marine Transportation, Section 5.0 |
| Proportion of product that can be cleaned up following a spill | In some situations, it is not possible to remove or fully remediate the effects of a spill. These situations may occur due to limited access to the area or in situations when trying to remediate the area will result in more harm (disturbance/damage) than good. In these situations, a Risk Management Plan will be developed and a Long Term Monitoring Program will be implemented to ensure that contamination is not migrating (moving) and is not a threat or risk to the public or environment. As with the remediation process, and other agencies or affected stakeholders and Aboriginal communities will be involved in the assessment of risk and development of a Long Term Monitoring Program. | Volume 3A – Public Consultation,<br><br>Volume 8A – Marine Transportation, Section 5.0 |
| Environmental effects as well as human health risk of a spill in Vancouver Harbour and other coastal areas. | In support of the ESA for the Project, Trans Mountain has commissioned a human health risk assessment (HHRA), the principal aim of which is to identify and understand the potential short-term and long-term health risks, including carcinogenic risks, to people exposed to the chemicals that could be released to the environment from a marine spill. | Volume 3A – Public Consultation,<br><br>Volume 8A – Marine Transportation, Section 5.0 |
| Possibility that bitumen will sink in the event of a marine spill<br><br>Whether bitumen and diluted bitumen can be cleaned up if spilled | With a maximum density of 0.94, diluted bitumen transported on the Trans Moutnain pipeline is lighter than fresh water (density 1.00) and seawater (density 1.02).<br><br>Research is taking place to quantify how the diluted bitumen reacts over time in water, with wave action, with fast-moving currents, with different sediment levels and with various other factors. Trans Mountain has commissioned its own study of this issue, the results of which are summarized in Section 5.0, Volume 8A. Other studies have recently been conducted or are underway, including the SL Ross study (Meso-scale Weathering of Cold Lake Bitumen/Condensate Blend) that was prepared for a Joint Review Panel submission by Enbridge Northern Gateway Project and the anticipated Natural Resources Canada look into the weathering effects of diluted bitumen on water.<br><br>In the case of any spill, response time is critical. A rapid response means that the spilled product has less time to disperse and to weather, ultimately making the cleanup process more efficient and more predictable. WCMRC has examined its emergency response capacity in light of the Project-related increase in tankers and Trans Mountain is working with WCMRC to ensure this capacity would be in place prior to the operation of the Project. | Volume 3A – Public Consultation,<br><br>Volume 8A – Marine Transportation, Section 5.0<br><br>Volume 8C – TERMPOL Study Reports |

**TABLE 3.1.8**

**INTERESTS OR CONCERNS – MARINE SPILLS (continued)**

| Summary of Interest or Concern | Response Summary | Where Issue is Addressed |
|---|---|---|
| Protection of fragile marine environment: "effects of an oil spill would be long term, chronic and catastrophic"<br><br>Potential impact of spill on biodiversity of Fraser Delta ecosystem and Burrard Inlet | The long term monitoring report related to the 2007 incident on the TMPL system at Inlet Drive was shared with key stakeholders and posted to transmountain.com. An ESA of the marine transportation and the effects of the Project-related increased vessel traffic has been completed (see Section 4.0, Volume 8A). The marine studies covered a wide-range of topics including: marine sediment and water quality; marine fish and fish habitat; marine air and GHG emissions; marine acoustic environment; marine birds; marine mammals; marine species at risk; traditional marine resource use; marine commercial, recreational and tourism use; human health and ecological risk assessments; accidents and malfunctions; and changes to the Project caused by the environment (*e.g.*, seismicity, climate change). | Volume 3A – Public Consultation,<br><br>Volume 8A - Marine Transportation, Section 5.0 |
| Safety features such as double hull<br><br>Methods of reducing the risk of a spill | The implementation of double-hull construction using special shipbuilding grade steel offers increased environmental protection and better protection against breaches during collisions and grounding. Further, within the tanker there are segregated cargo tanks, so if a breach does occur the potential leak is limited to the product within the affected cargo tank. All tankers in local waters are double hulled and have a number of compartments.<br><br>Tankers are the most scrutinized vessels in the shipping industry. The international tanker inspection regime includes both mandatory regulatory inspections as well as regular inspections by private customers like Trans Mountain who are all united in their efforts to ensure the safety of marine transportation of oil cargoes. Tanker construction has evolved to meet the standards of IMO, Flag State and Class Society requirements. Various modern build features include double hulling, back-up power generators, improved agility and brake horsepower capacity, high quality corrosion control, collision-avoidance radar navigational instruments. Additionally, cargo tanks are maintained in an inert condition (oxygen content less than 5% volume), which removes any danger of fire or explosion in the tank.<br><br>One of the most effective ways to reduce the risk of a spill is to prevent a collision or grounding of a laden oil tanker. The existing marine navigation management regime is detailed in Section 5.0, Volume 8A, as well as potential improvements to address the increased risk resulting from Project-related tankers. | Volume 3A – Public Consultation, Volume 8A – Marine Transportation, Section 5.0 |
| Inspections of tankers prior to loading | Transport Canada is mandated to inspect tanker vessels on their first call to Westridge and annually thereafter. Canada is a signatory to international agreements that provide inspections conducted in other ports by other countries. Trans Mountain screens vessels proposed by pipeline shippers before accepting them for scheduling purposes and conducts a physical inspection before loading. The Trans Mountain Loading master remains on board throughout the loading process to monitor the ships systems and crew and to ensure efficient communication between the ship and terminal staff. | Volume 3A – Public Consultation,<br><br>Volume 8A – Marine Transportation, Section 1.0 |

## TABLE 3.1.8

## INTERESTS OR CONCERNS – MARINE SPILLS (continued)

| Summary of Interest or Concern | Response Summary | Where Issue is Addressed |
|---|---|---|
| Stakeholder involvement in the Emergency Response Plans for local shorelines<br>Work with the community to address concerns about oil spill effects | Information sessions and public presentations provide opportunities for public input and queries. Trans Mountain uses information collected at engagement sessions in addressing issues. Trans Mountain is committed to earning the trust and confidence of local population. Trans Mountain will continue to address questions from the public about the effects of an accidental oil spill in the marine environment and related to the roles and responsibilities for emergency preparedness and response. Comments and concerns gathered as part of the stakeholder engagement program have have been incorporated in the application, where appropriate. | Volume 3A – Public Consultation |

## TABLE 3.1.9

## SUMMARY OF CONSULTATION ACTIVITIES RELATED TO MARINE AIR AND GHG 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 |
|---|---|---|---|---|---|---|---|
| **Federal Consultation** | | | | | | | |
| Environment Canada (EC) | Roxanne Vingarzan, Head (Air Quality Science Unit) | Meeting | November 21, 2012 | Project introduction.<br>Air quality and GHG assessment approach. | Requested addition of air quality monitoring stations for inclusion in baseline assessment.<br>Requested model evaluation.<br>Recommended assessment for secondary ozone, particulate matter and visibility. | Air quality monitoring stations added.<br>Model evaluation added.<br>Assessment for secondary ozone, particulate matter and visibility added. | Sections 4.3.3 and 4.3.4 Marine Transportation,<br>Air Quality and GHG - Marine Transportation Technical Report, Volume 8B |
| **Provincial/Local Consultation – BC** | | | | | | | |
| BC Ministry of Environment and Metro Vancouver | Ali Ergudenler, Senior Engineer (Air Quality Policy and Management Division) | Meeting | November 20, 2012 | Project introduction.<br>Air quality and GHG assessment approach. | Requested assessment for odour as per Odour Management Policy currently being drafted.<br>Requested discussion of Project impact on overall climate change.<br>Recommended assessment for secondary particulate matter and ozone. | Assessments for secondary particulate matter and ozone added.<br>Discussion of Project impact on overall climate change added. | Sections 4.3.3 and 4.3.4 Marine Transportation,<br>Air Quality and GHG - Marine Transportation Technical Report, Volume 8B |

## TABLE 3.1.9

## SUMMARY OF CONSULTATION ACTIVITIES RELATED TO MARINE AIR AND GHG EMISSIONS (continued)

| 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 |
|---|---|---|---|---|---|---|---|
| **Provincial/Local Consultation – BC** | | | | | | | |
| Fraser Valley Regional District | Alison Stewart, Senior Planner (Strategic Planning and Initiatives) | Meeting | November 20, 2012 | Project introduction.<br>Air quality and GHG assessment approach. | Requested assessment for secondary ozone and particulate matter. | Assessment for secondary particulate matter and ozone added. | Sections 4.3.3 and 4.3.4 Marine Transportation,<br>Air Quality and GHG - Marine Transportation Technical Report, Volume 8B |
| 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. | Sections 4.3.3 and 4.3.4 Marine Transportation,<br>Air Quality and GHG - Marine Transportation Technical Report, Volume 8B |

## TABLE 3.1.10

## SUMMARY OF CONSULTATION ACTIVITIES RELATED TO MARINE 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 |
|---|---|---|---|---|---|---|---|
| Port Metro Vancouver | Jason Smith, Project Director, TERA | Meeting | November 21, 2012 | Marine - Air Emissions/GHG<br>Marine - Contaminated Sediments<br>Marine - Dredging<br>Marine - Spills - Environmental Impact<br>Marine - Spills - Safety<br>Marine - Tanker traffic<br>Nuisance - Noise<br>Terrestrial - Acoustic Environment | Concerned with noise and light emissions from additional hoteling and anchorage of marine vessels in the Burrard Inlet and Gulf Islands | Provide comments and input on the ESA. Approach for sections describing the assessment of these potential impacts. | Section 4.3.5 Marine Transportation,<br>Marine Noise (Atmospheric) - Marine Transportation Technical Report, Volume 8B |
| City of Burnaby | Paul VanVelzen, ESA Writer TERA | Meeting | February 14, 2013 | Regulatory - NEB process<br>Regulatory - Port Metro Vancouver EA process<br>Routing - Existing Pipelines<br>Routing - Roadway<br>Routing - Water Crossings<br>Socio-Econ. Marine - Human Health<br>Socio-Econ. Terrestrial - Human Health | Provided an overview of and sought feedback about the Environment and Socio-Economic Assessment, provided routing update and an update on stakeholder engagement plans for Phase 3. | Follow-up with timing around ESA, follow-up required on accidents and malfunctions module, and routing Westridge line suggestion to move existing line to new ROW. | Section 4.3.5 Marine Transportation,<br>Marine Noise (Atmospheric) - Marine Transportation Technical Report, Volume 8B |

**TABLE 3.1.11**

**SUMMARY OF CONSULTATION ACTIVITIES RELATED TO MARINE RESOURCES**

| 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 |
|---|---|---|---|---|---|---|---|
| **Federal Consultation** | | | | | | | |
| Fisheries and Oceans Canada (DFO) | Brenda Andres, EA Analyst, EA and Major Projects Unit | Meeting | September 14, 2012 | Project introduction.<br>Overview of assessment methodology for marine resources.<br>Marine LSA/Marine RSA boundaries. | No concerns with proposed approach were raised. | Agreed to schedule another meeting with DFO in 2013. | Sections 4.3.6 and 4.3.7 Marine Transportation,<br>Marine Resources - Marine Transportation Technical Report, Volume 8B |
| Canadian Wildlife Service (CWS) /EC | 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/EC with list of marine resources indicators for further consideration. | Sections 4.3.6 and 4.3.7 Marine Transportation,<br>Marine Resources - Marine Transportation Technical Report, Volume 8B |
| DFO | David Pehl | Meeting | September 25, 2013 | Project introduction.<br>Marine resources indicators.<br>Key issues/effects for marine resources.<br>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 for the pipeline and facilities assessment. | Sections 4.3.6 and 4.3.7 Marine Transportation,<br>Marine Resources - Marine Transportation Technical Report, Volume 8B |
| **Stakeholders and Aboriginal Communities** | | | | | | | |
| Members of the public, Aboriginal communities, local recreation and nature groups, ENGOs, environmental consultants | Various local contacts | Open Houses and ESA Workshops | August 2012 to October 2013 | Project introduction.<br>Marine resources indicators and key issues/effects for Westridge Marine Terminal expansion and Marine Transportation.<br>LSA/RSA boundaries for marine effects assessment. | Wake effects on shoreline habitats.<br>Underwater noise on marine mammals.<br>Vessel strikes to marine mammals.<br>Oil spill effects on marine resources.<br>Introduction of invasive species. | Consideration of issues/concerns raised by members of the public and Aboriginal communities in the ESA. | Sections 4.3.6 and 4.3.7 Marine Transportation,<br>Marine Resources - Marine Transportation Technical Report, Volume 8B |

## TABLE 3.1.12

## 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 |
|---|---|---|---|---|---|---|---|
| **Federal Consultation** | | | | | | | |
| 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. EC noted that field work to assess current marine bird biodiversity and habitat use would be of value. | Section 4.3.8 Marine Transportation, Marine Birds - Marine Transportation Technical Report, Volume 8B |
| **Stakeholders and Aboriginal Communities** | | | | | | | |
| Public Stakeholders: local nature and recreational groups, NGOs, environmental consultants, oil response experts, Aboriginal communities | Various local contacts | Workshop | May 22 to 23, 2013 | Project Introduction and discussion of environmental effects from routine shipping and oil, oil spill modelling and oil spill response | Effects of the additional vessel traffic on ecological and socio-economic resources including marine animals and traditional use within local and regional habitats | Consideration of effects to waterfowl species as expressed by Aboriginal communities, reconsideration of indicator species that are present/not present within the Marine RSA. | Section 4.3.8 Marine Transportation, Marine Birds - Marine Transportation Technical Report, Volume 8B |

## TABLE 3.1.13

## SUMMARY OF CONSULTATION ACTIVITIES RELATED TO TRADITIONAL MARINE RESOURCE USE

| 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 |
|---|---|---|---|---|---|---|---|
| **Stakeholders and Aboriginal Communities** | | | | | | | |
| Members of the public, Aboriginal communities, local recreation and nature groups, ENGOs, environmental consultants | Various local contacts | Open Houses and ESA Workshops | August 2012 to October 2013 | Project Introduction and discussion of environmental effects from routine shipping and oil, oil spill modelling and oil spill response | Effects of the additional vessel traffic on ecological and socio-economic resources including marine animals and traditional use within local and regional habitats | Consideration of issues/concerns raised by members of the public and Aboriginal communities in the ESA. | Section 4.3.10, Marine Transportation Traditional Marine Resource Use – Marine Transportation Technical Report, Volume 8B |

## TABLE 3.1.14

## SUMMARY OF CONSULTATION ACTIVITIES RELATED TO MARINE COMMERCIAL, RECREATIONAL AND TOURISM USE

| 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 |
|---|---|---|---|---|---|---|---|
| **Federal Consultation** | | | | | | | |
| PMV | Jennifer Natland, Manager Development Strategies<br>Sarah McPherson, Manager Project Communications<br>Carrie Brown, Manager Environmental Programs | Meeting | April 9, 2013 | Project and ESA review.<br>Overview of Socio-Economic Assessment.<br>Regional Study Areas (RSA) boundaries.<br>MCRTU data collection and issues scoping. | Requested information on provision of additional community investments.<br>Would like application to be logically structured so it is easy to find all sections pertinent to PMV.<br>Asked if methodology for analysis of economic benefits of tanker traffic is logical.<br>Requested clarification of the RSA for MCRTU related to Westridge Marine Terminal assessment and tanker traffic assessment. | Follow-up with PMV as the Project proceeds. | Section 4.3.11 Marine Transportation,<br>Section 5.0, Marine Commercial, Recreational and Tourism Use - Marine Transportation Technical Report , Volume 8B |
| PMV | Jennifer Natland, Manager Development Strategies | Email correspondence | July 12, 2013 to July 16, 2013 | Project and ESA overview.<br>Questions about MCRTU in PMV: anchorage regulations, small vessel numbers, log handling activities, recreational waterfront management. | Requested to remain informed as the Project proceeds. | Follow-up with PMV, as appropriate, as the Project proceeds. | Section 4.3.11 Marine Transportation,<br>Section 5.0, Marine Commercial, Recreational and Tourism Use - Marine Transportation Technical Report, Volume 8B |

## TABLE 3.1.14

## SUMMARY OF CONSULTATION ACTIVITIES RELATED TO MARINE COMMERCIAL, RECREATIONAL AND TOURISM USE (continued)

| 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 |
|---|---|---|---|---|---|---|---|
| **Federal Consultation** | | | | | | | |
| DFO | Dan Clark, Management Biologist Shellfish | Email correspondence | October 10, 2013 | Project Introduction.<br>MCRTU questions: key areas of use, access routes.<br>Specific/general concerns related to Project. | Requested maps of fishing information and shipping lanes. | Socio-economic team to send appropriate maps when available. | Section 4.3.11 Marine Transportation,<br>Section 5.0, Marine Commercial, Recreational and Tourism Use - Marine Transportation Technical Report, Volume 8B |
| **Provincial Consultation – BC** | | | | | | | |
| Tourism BC | Krista Morten, Manager, Policy and Legislation<br>Carol Jenkins, Senior Tourism Development Officer | Meeting | September 25, 2012 | Project introduction.<br>Overview of Socio-Economic Assessment.<br>RSA boundaries.<br>Land and resource use data collection and issues scoping. | Consultation with tenure holders and tourism operators is important.<br>Discussions with BC Parks should occur.<br>Discussed tourism businesses that support tenured operators.<br>Concerns mentioned regarding: tenured operators; viewsheds; noise pollution; light pollution; water quality.<br>Discussed the general perception of BC as a tourism destination.<br>Discussed competing land uses. | Follow-up with Tourism BC as the Project proceeds. | Section 4.3.11 Marine Transportation,<br>Section 5.0, Marine Commercial, Recreational and Tourism Use - Marine Transportation Technical Report, Volume 8B |

## TABLE 3.1.14

## SUMMARY OF CONSULTATION ACTIVITIES RELATED TO MARINE COMMERCIAL, RECREATIONAL AND TOURISM USE (continued)

| 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 |
|---|---|---|---|---|---|---|---|
| **Other Consultation – BC** | | | | | | | |
| Vancouver Whale Watch | Cedric Towers, Owner/Operator and VP, Pacific Whale Watch Association (PWWA)<br>(representing personal views, not views of PWWA) | Meeting | July 9, 2013 | Project Introduction (Marine).<br>MCRTU questions: key use areas, access routes.<br>Specific/general concerns related to Project. | Traffic in Haro Strait is already very busy and loud, and there may be a noise threshold for whales.<br>A spill would destroy the whales' habitat and the whale-watching industry. | Follow-up with Vancouver Whale Watch, as appropriate, as the Project proceeds. | Sections 4.3.7 and 4.3.11 Marine Transportation,<br>Section 5.0, Marine Commercial, Recreational and Tourism Use - Marine Transportation Technical Report, Volume 8B |
| BC Marine Trades Association | BCMTA Board of Directors | Meeting | July 9, 2013 | Project Introduction.<br>Overview of socio-economic assessment.<br>MCRTU questions: key areas of use, access routes.<br>Specific/general concerns related to Project. | Request assurance of detailed precautions that Project-related tankers will take to prevent spills.<br>Specific questions about pilotage and tug requirements. | Trans Mountain team member to follow up with response to questions raised at the meeting. | Section 4.3.11 Marine Transportation,<br>Section 5.0, Marine Commercial, Recreational and Tourism Use - Marine Transportation Technical Report, Volume 8B |
| Tourism Vancouver | Walt Judas, VP Marketing Communications and Member Services | Meeting | July 9, 2013 | Project Introduction.<br>Overview of socio-economic assessment.<br>MCRTU questions: key areas of use, access routes.<br>Specific/general concerns related to Project. | Pipeline – pump station and valve placement.<br>Members would want detailed assurances that risks have been appropriately mitigated.<br>Spill would have disastrous effect on tourism. | Trans Mountain team members to arrange follow-up meeting. | Section 4.3.11 Marine Transportation,<br>Section 5.0, Marine Commercial, Recreational and Tourism Use - Marine Transportation Technical Report, Volume 8B |

## TABLE 3.1.14

## SUMMARY OF CONSULTATION ACTIVITIES RELATED TO MARINE COMMERCIAL, RECREATIONAL AND TOURISM USE (continued)

| 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 |
|---|---|---|---|---|---|---|---|
| **Other Consultation – BC** | | | | | | | |
| Sport Fishing Institute of BC (SFIBC) | Owen Bird, Executive Director | Meeting | July 12, 2013 | Project Introduction.<br>Overview of socio-economic assessment.<br>MCRTU questions: key areas of use, access routes.<br>Specific/general concerns related to Project. | Increased risk of oil spills from increased tankers.<br>“Close calls” between transiting tankers and small fishing vessels, especially at Constance and Swiftsure Banks (Juan de Fuca Strait). | Follow-up with SFIBC, as appropriate, as the Project proceeds. | Section 4.3.11 Marine Transportation,<br>Section 5.0, Marine Commercial, Recreational and Tourism Use - Marine Transportation Technical Report, Volume 8B |
| Area H Salmon Trollers Association | Peter Sakich, Area H Representative | Email correspondence and phone calls | July 4, 2013 to<br>July 29, 2013 | Project Introduction.<br>MCRTU questions: key areas of use, access routes.<br>Specific/general concerns related to Project. | How best to include all salmon fisheries (troll, seine, gillnet) in consultation as all share same fishing area. | Follow-up with salmon fishing interests, as appropriate, as the Project proceeds. | Section 4.3.11 Marine Transportation,<br>Section 5.0, Marine Commercial, Recreational and Tourism Use - Marine Transportation Technical Report, Volume 8B |
| Pacific Coast Fishermen’s Mutual Marine Insurance Co. | Lee Varseveld, General Manager & Secretary | Email correspondence | July 17, 2013 to August 2, 2013 | Project Introduction.<br>MCRTU questions: key areas of use, access routes.<br>Specific/general concerns related to Project. | Details of the planned increase in marine traffic Changes in shipping routes.<br>Risk mitigation measures.<br>Improvements in spill response capabilities. | Follow-up with commercial fishing interests, as appropriate, as the Project proceeds.<br>TMEP Stakeholder Engagement team will follow-up directly (October 10, 2013). | Section 4.3.11 Marine Transportation,<br>Section 5.0, Marine Commercial, Recreational and Tourism Use - Marine Transportation Technical Report, Volume 8B |

## TABLE 3.1.14

## SUMMARY OF CONSULTATION ACTIVITIES RELATED TO MARINE COMMERCIAL, RECREATIONAL AND TOURISM USE (continued)

| 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 |
|---|---|---|---|---|---|---|---|
| **Other Consultation – BC** | | | | | | | |
| Salmon Area A Seine | Chris Cue | Cc'd on email from Peter Sakich | July 17, 2013 | Project Introduction.<br>MCRTU questions: key areas of use, access routes.<br>Specific/general concerns related to Project. | How best to include all salmon fisheries (troll, seine, gillnet) in consultation as all share same fishing area. | Follow-up with salmon fishing interests, as appropriate, as the Project proceeds. | Section 4.3.11 Marine Transportation,<br>Section 5.0, Marine Commercial, Recreational and Tourism Use - Marine Transportation Technical Report, Volume 8B |
| Salmon Area B Seine | Chris Ashton | Cc'd on email from Peter Sakich | July 17, 2013 | Project Introduction.<br>MCRTU questions: key areas of use, access routes.<br>Specific/general concerns related to Project. | How best to include all salmon fisheries (troll, seine, gillnet) in consultation as all share same fishing area. | Follow-up with salmon fishing interests, as appropriate, as the Project proceeds. | Section 4.3.11 Marine Transportation,<br>Marine Commercial, Recreational and Tourism Use - Marine Transportation Technical Report, Volume 8B |
| Salmon Area H Trollers | Dane Chauvel | Cc'd on email from Peter Sakich | July 17, 2013 | Project Introduction.<br>MCRTU questions: key areas of use, access routes.<br>Specific/general concerns related to Project. | How best to include all salmon fisheries (troll, seine, gillnet) in consultation as all share same fishing area. | Follow-up with salmon fishing interests, as appropriate, as the Project proceeds. | Section 4.3.11 Marine Transportation,<br>Marine Commercial, Recreational and Tourism Use - Marine Transportation Technical Report, Volume 8B |
| Area D Salmon Gillnetters Association | Ryan McEachern | Cc'd on email from Peter Sakich | July 17, 2013 | Project Introduction.<br>MCRTU questions: key areas of use, access routes.<br>Specific/general concerns related to Project. | How best to include all salmon fisheries (troll, seine, gillnet) in consultation as all share same fishing area. | Follow-up with salmon fishing interests, as appropriate, as the Project proceeds. | Section 4.3.11 Marine Transportation,<br>Marine Commercial, Recreational and Tourism Use - Marine Transportation Technical Report, Volume 8B |

## TABLE 3.1.14

## SUMMARY OF CONSULTATION ACTIVITIES RELATED TO MARINE COMMERCIAL, RECREATIONAL AND TOURISM USE (continued)

| 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 |
|---|---|---|---|---|---|---|---|
| **Other Consultation – BC** | | | | | | | |
| Salmon Area E Gillnet | Darrel McEachern | Cc'd on email from Peter Sakich | July 17, 2013 | Project Introduction. MCRTU questions: key areas of use, access routes. Specific/general concerns related to Project. | How best to include all salmon fisheries (troll, seine, gillnet) in consultation as all share same fishing area. | Follow-up with salmon fishing interests, as appropriate, as the Project proceeds. | Section 4.3.11 Marine Transportation, Marine Commercial, Recreational and Tourism Use - Marine Transportation Technical Report, Volume 8B |
| Salmon Area H Troller | Steve Johanson | Cc'd on email from Peter Sakich | July 17, 2013 | Project Introduction. MCRTU questions: key areas of use, access routes. Specific/general concerns related to Project. | How best to include all salmon fisheries (troll, seine, gillnet) in consultation as all share same fishing area. | Follow-up with salmon fishing interests, as appropriate, as the Project proceeds. | Section 4.3.11 Marine Transportation, Marine Commercial, Recreational and Tourism Use - Marine Transportation Technical Report, Volume 8B |
| Pacific Halibut Management Association | Chris Sporer, Executive Director | Email correspondence | July 4, 2013 to October 1, 2013 | Project Introduction. MCRTU questions: key areas of use, access routes. Specific/general concerns related to Project. | Risk of oil spills. Concentration of vessels in other areas already occupied by fishers. Contingency fund for financial, livelihood loss. Potential for gear conflict with transiting vessels. | Set up future meeting with fishers. | Section 4.3.11 Marine Transportation, Marine Commercial, Recreational and Tourism Use - Marine Transportation Technical Report, Volume 8B |

## TABLE 3.1.14

## SUMMARY OF CONSULTATION ACTIVITIES RELATED TO MARINE COMMERCIAL, RECREATIONAL AND TOURISM USE (continued)

| 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 |
|---|---|---|---|---|---|---|---|
| **Other Consultation – BC** | | | | | | | |
| Pacific Prawn Fishermen's Association | Chris Sporer, Executive Director | Email correspondence | July 4, 2013 to September 30, 2013 | Project Introduction.<br>MCRTU questions: key areas of use, access routes.<br>Specific/general concerns related to Project. | Risk of oil spills.<br>Oil spill causing displacement of fishers and concentration in other areas already occupied by fishers.<br>Contingency fund for financial, livelihood loss.<br>Potential for gear conflict with transiting vessels. | Set up future meeting with fishers. | Section 4.3.11 Marine Transportation,<br>Marine Commercial, Recreational and Tourism Use - Marine Transportation Technical Report, Volume 8B |
| Crab Sectoral Committee | Kelvin Campbell, Area H Representative | Email correspondence | July 3, 2013 to July 4, 2013 | Project Introduction.<br>MCRTU questions: key areas of use, access routes.<br>Specific/general concerns related to Project. | Risk of oil spills.<br>Oil spill causing displacement of fishers and concentration in other areas already occupied by fishers.<br>Contingency fund for financial, livelihood loss.<br>Potential for gear conflict with transiting vessels. | Follow-up with crab fishing representatives, as appropriate, as the Project proceeds. | Section 4.3.11 Marine Transportation,<br>Marine Commercial, Recreational and Tourism Use - Marine Transportation Technical Report, Volume 8B |
| Pacific Coast Shrimpers Cooperative Association | Lorne Clayton, Executive Director | Email correspondence | July 3, 2013 | Project Introduction.<br>MCRTU questions: key areas of use, access routes.<br>Specific/general concerns related to Project. | None received so far. | Follow-up with shrimp trawl fishers, as appropriate, as the Project proceeds. | Section 4.3.11 Marine Transportation,<br>Marine Commercial, Recreational and Tourism Use - Marine Transportation Technical Report, Volume 8B |

**TABLE 3.1.14**

**SUMMARY OF CONSULTATION ACTIVITIES RELATED TO MARINE COMMERCIAL, RECREATIONAL AND TOURISM USE (continued)**

| 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 |
|---|---|---|---|---|---|---|---|
| **Other Consultation – BC** | | | | | | | |
| Pacific Prawn Fishermen's Association | Chris Sporer, Executive Director | Meeting | October 1, 2013 | Project overview.<br>Issues, concerns related to Project. | Risks of oil spills.<br>Contingency fund for financial, livelihood loss. | Send route with fisheries information. Mr. Sporer to distribute to members for comment. | Section 4.3.11 Marine Transportation,<br>Marine Commercial, Recreational and Tourism Use - Marine Transportation Technical Report, Volume 8B |
| Pacific Halibut Management Association | Chris Sporer, Executive Director | Meeting | July 4, 2013 to October 1, 2013 | Project Introduction.<br>MCRTU questions: key areas of use, access routes.<br>Specific/general concerns related to Project. | No effects considered likely from increased vessel traffic in shipping lanes to halibut fishery.<br>Concerns over risk of oil spills.<br>Contingency fund for financial, livelihood loss. | None | Section 4.3.11 Marine Transportation,<br>Marine Commercial, Recreational and Tourism Use - Marine Transportation Technical Report, Volume 8B |

## TABLE 3.1.15

## SUMMARY OF CONSULTATION ACTIVITIES RELATED TO THE HUMAN HEALTH RISK ASSESSMENT

| 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 |
|---|---|---|---|---|---|---|---|
| **Federal Consultation** | | | | | | | |
| Health Canada (BC Region) | Dr. Carl Alleyne, BC Regional Environmental Assessment Coordinator<br>Dr. Gladis Lemus, BC Regional Manager | Meeting | January 28, 2013 | Project introduction.<br>Discussion of the planned HHRA methodology. | Health Canada advised that they will be directing particular attention to Aboriginal health.<br>Health Canada expressed an interest in knowing the potential health effects associated with accidents and malfunctions.<br>Health Canada will be interested in knowing the potential short-term as well as long-term health effects associated with the Project, with consideration given to all relevant exposure pathways. | None | Section 4.3.12 Marine Transportation, Screening Level Human Health Risk Assessment of Marine Transportation, Volume 8B |

**TABLE 3.1.15**

**SUMMARY OF CONSULTATION ACTIVITIES RELATED TO THE HUMAN HEALTH RISK ASSESSMENT (continued)**

| 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 |
|---|---|---|---|---|---|---|---|
| **Provincial/Local Consultation - BC** | | | | | | | |
| Fraser Health Authority (FHA) | Dr. Paul Van Buynder,<br>Chief Medical Health Officer<br>Dr. Nadine Loewen, Medical Health Officer<br>Dr. Goran Krstic, Human Health Risk Assessment Specialist, Health Protection<br>Tim Shum, Regional Director | Meeting | January 28, 2013 | Project introduction.<br>Discussion of the planned HHRA methodology. | FHA and VCHA expressed an interest in knowing whether any long-term monitoring of health is planned.<br>FHA and VCHA expressed an interest in knowing the historical effects of the Legacy Line.<br>FHA and VCHA expressed an interest in knowing the potential health effects associated with a spill to an urban environment.<br>FHA and VCHA will be interested in knowing the potential short-term as well as long-term health effects associated with the Project, with consideration given to all relevant exposure pathways. | None | Section 4.3.12 Marine Transportation, Screening Level Human Health Risk Assessment of Marine Transportation, Volume 8B |
| Vancouver Coastal Health Authority (VCHA) | Dr. Patricia Daly, Chief Medical Health Officer<br>Dr. James Lu, Medical Health Officer, Richmond Public Health<br>Dr. Richard Taki, Regional Director, Health Protection | | | | | | |
| Fraser Valley Regional District (FVRD) | Alison Stewart, Senior Planner, Strategic Planning and Initiatives | Telephone call | March 20, 2013 | Project introduction.<br>Discussion of the planned HHRA methodology. | FVRD expressed an interest in knowing the potential effects of the Project on air quality, and subsequently human health, in the FVRD.<br>From a health perspective, Ms. Stewart indicated that the FVRD would be taking their direction from FHA. | None | Section 4.3.12 Marine Transportation, Screening Level Human Health Risk Assessment of Marine Transportation, Volume 8B |

## TABLE 3.1.15

## SUMMARY OF CONSULTATION ACTIVITIES RELATED TO THE HUMAN HEALTH RISK ASSESSMENT (continued)

| 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 |
|---|---|---|---|---|---|---|---|
| **Provincial/Local Consultation - BC** | | | | | | | |
| Vancouver Island Health Authority (VIHA) | Dr. Paul Hasselback, Medical Health Officer<br>Dr. Charmaine Enns, Medical Health Officer | Telephone call | September 17, 2013 | Project introduction.<br>Discussion of the planned HHRA methodology. | VIHA expressed an interest in knowing whether a tanker spill would be included in the HHRA.<br>FHA and VCHA will be interested in knowing the potential short-term as well as long-term health effects associated with the Project-related increase in marine vessel traffic. | VIHA requested further information regarding the marine transportation component of the Project. | Section 4.3.12 Marine Transportation, Screening Level Human Health Risk Assessment of Marine Transportation, Volume 8B |

# Appendix D Marine Aboriginal Engagement PowerPoint Presentation

# TRANS MOUNTAIN EXPANSION PROJECT

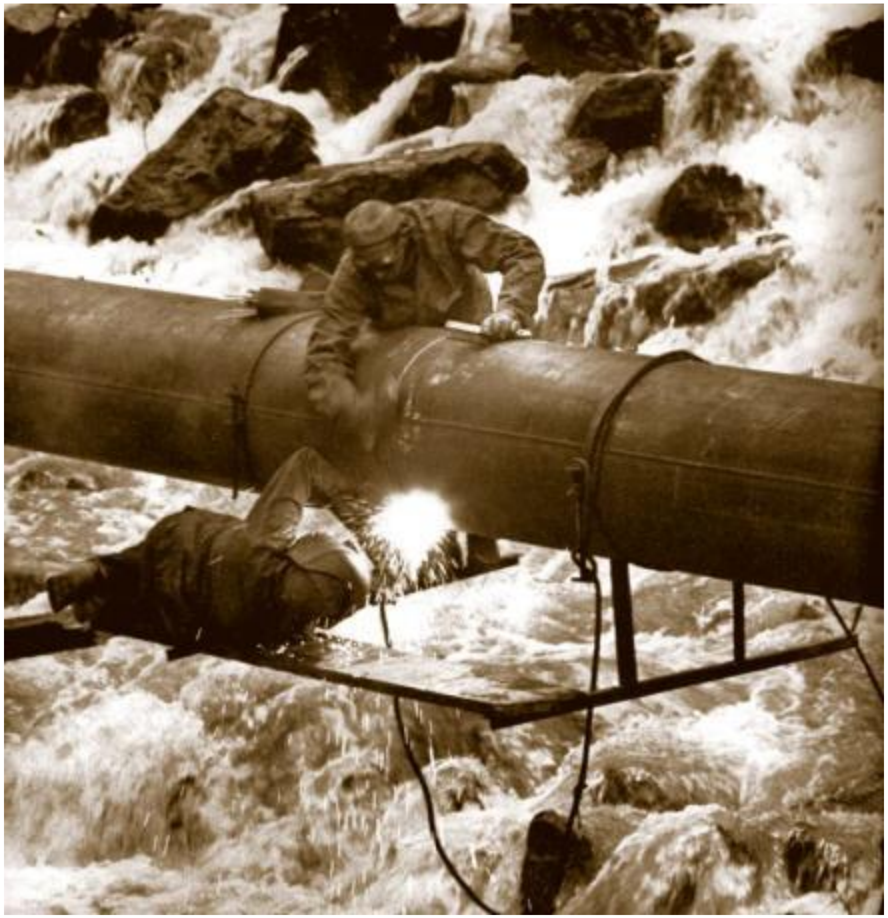
**PRESENTATION TO ESQUIMALT NATION – JULY 30, 2013**

# Trans Mountain Pipeline – 60 Years of History

# Origin

- Conceived in 1950 as a strategic asset for a reliable energy supply to the defensive strength of Canada and the United States

# Building



- The Trans Mountain Pipeline was built in 1952
- Extraordinary engineering accomplishment
- Line crosses Rockies and mountains in Central BC
- Crosses under Fraser River into Burnaby

# Operation

- First oil flowed through the 1,150-kilometre line on October 17, 1953
- Initial capacity was 150,000 barrels per day with four pump stations along the line and a marine loading dock
- Trans Mountain is part of more than 100,000 km of underground pipeline in Canada that transport daily crude and natural gas production

# Today

- About 30 per cent of the system has been twinned
- Moves crude oil and refined petroleum products
- Current capacity is 300,000 barrels per day
- Kinder Morgan Canada does not own the products that are transported
- Products belong to customers
- Westridge Marine Terminal in Burnaby: only western Canadian marine loading facility connected to a federally-regulated pipeline

# PIPELINE SAFETY AND EMERGENCY RESPONSE

# Pipeline Safety

- Pipelines remain the safest and most efficient method for transporting petroleum products
- We will take every possible action to prevent a spill
- Programs in place to protect and inspect Trans Mountain Pipeline
- As long as pipelines are properly maintained, their lifespan is indefinite
- Pipeline integrity management includes regular inspection, maintenance and repair programs managed by a dedicated Technical Services group

# Pipeline Maintenance and Damage Prevention

- The pipeline has protective coatings and a cathodic protection system to prevent rust and corrosion
- Technology is used to detect changes in pipeline condition and wall thickness
- The pipeline is marked and signage along the line is maintained
- We conduct regular aerial and ground patrols of the pipeline to look for any irregularities or unauthorized activities along the pipeline corridor

# “One Call” Program

Call Before You Dig / BC One Call

**1 800 474-6886**

A centralized agency to call to find out what is buried on a site and where not to dig.

# Preparing for an Emergency

- Control Centre Operations staff operate and monitor the pipeline 24/7 year round from a Control Centre in Edmonton
- The Supervisory Control and Data Acquisition (SCADA) system monitors the pressures and operating conditions of the pipeline
- Information is transferred from SCADA to the Leak Detection system in real time
- If pipeline flow or pressure changes outside of prescribed norms, an alarm will alert the operator
- Automated valves can be used to shutdown the system, if necessary to isolate sections of the pipeline for investigation

# Emergency Response

- Trans Mountain staff, combined with trained responders and contractors, provide for 24/7 response management
- Trans Mountain is responsible for cleanup and remediation of incidents  related to its operations along the pipeline corridor
- Incident Command System outlines roles and responsibilities
- Emergency response equipment is located at strategic locations along the pipeline

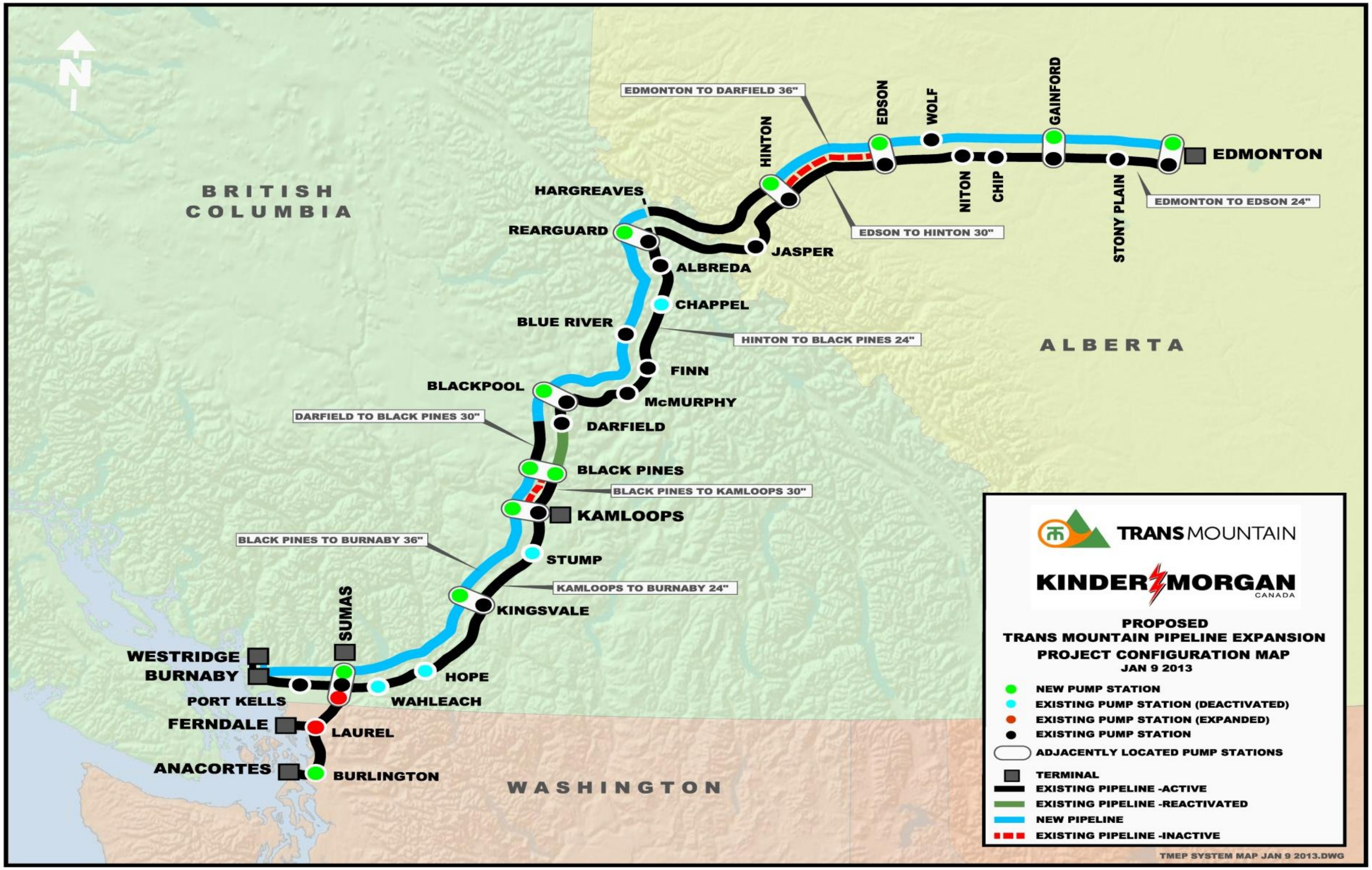
# Proposed Expansion Project

- Commitments received from customers during recent Open Season process, held from October 2011 to April 2012, including a supplemental Open Season process that concluded in January 2013.
- Binding support from a diverse group of customers: signed 15 & 20 year contracts for additional capacity
- The proposed expansion to increase capacity to up to 890,000 barrels per day (as of January 10, 2013)

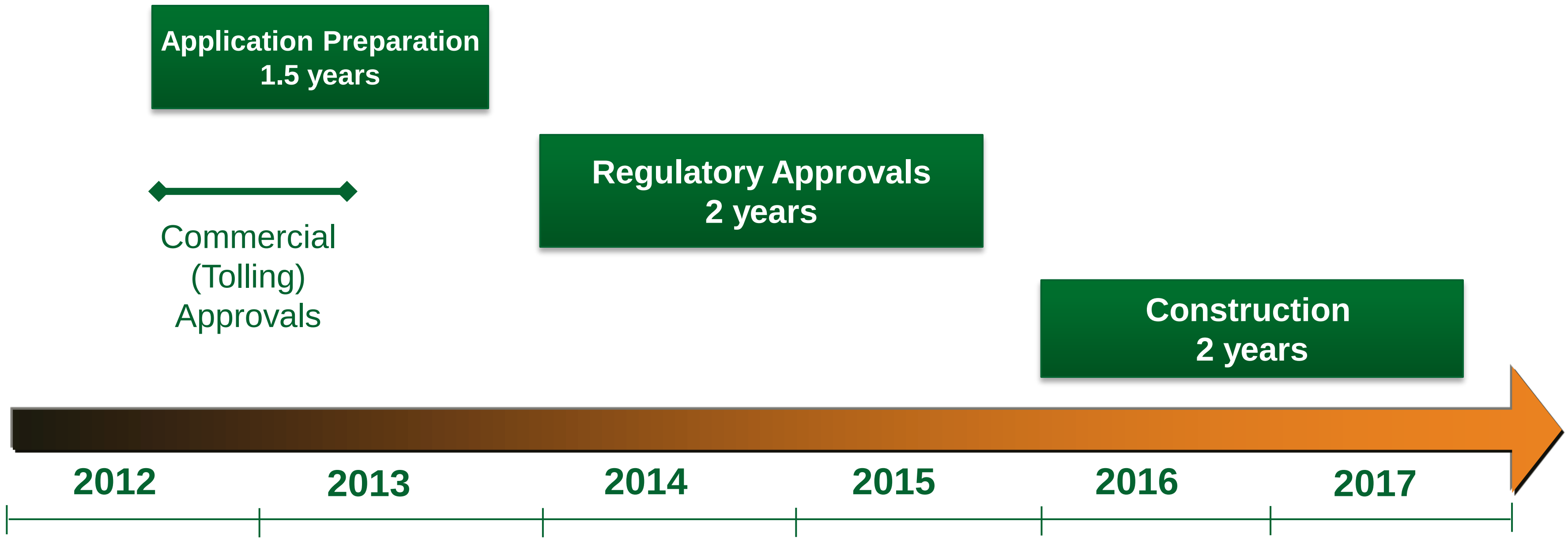
# Scope of Expansion Project

- Extra capacity to be handled by 36-inch pipe in the twinned pipeline expansion project
- Approx. 980 km of new pipe
- The size of the right-of-way and equipment used for construction remains the same
- 11 new pump stations
- 21 new storage tanks at existing facilities in Burnaby, Sumas and Edmonton
- Expansion of Westridge Marine Terminal in Burnaby
- New pipeline capacity between Burnaby Terminal and Westridge Marine Terminal

# Project Configuration Map



# Trans Mountain Expansion Schedule



# National Energy Board

- Two applications involving a process established by the National Energy Board (NEB)
- Toll Application filed June 29, 2012
  - Commercial matters pertaining to the tolls that would be charged to the shippers using the proposed expanded pipeline
  - Decision expected by end of May 2013
- Facilities Application (late 2013)
  - Seeks approval to build and operate the necessary facilities for the proposed expansion project

# PIPELINE ROUTING

# Determining the Route

- Detailed planning is underway for the proposed approximately 980 kilometres of twinned pipeline
- Where practical, the routing of the proposed expansion will remain within the existing Trans Mountain Pipeline right-of-way
- Land use changes over the last 60 years may result in deviation from existing right-of-way corridor
- Focus on building the expanded pipeline safely
- Minimize impacts to Aboriginal groups, landowners and neighbours
- Minimize environmental impacts such as water crossings, high-quality wetlands and culturally-sensitive locations
- Coordinate with municipalities, utility companies and other stakeholders to route the expansion on previously-developed land and in transportation corridors

TRANSMOUNTAIN

# ENVIRONMENTAL FIELD PROGRAMS

KINDER MORGAN CANADA INC.

# Overview of Field Programs

- Wildlife
- Vegetation (includes Terrain Ecosystem Mapping)
- Wetlands
- Fish and Fish Habitat
- Groundwater Resources
- Soils
- Heritage Resources (includes archaeology and palaeontology)
- Noise and Air Emissions
- Traditional Knowledge Studies

# Current Status

TRANSMOUNTAIN

- Comprehensive studies and engagement program for the proposed expansion are well underway
- Field Studies underway along the existing right-of-way corridor
- Engagement with landowners, Aboriginal groups, communities and stakeholders

KINDER MORGAN CANADA INC.

# TMEP Marine Traffic

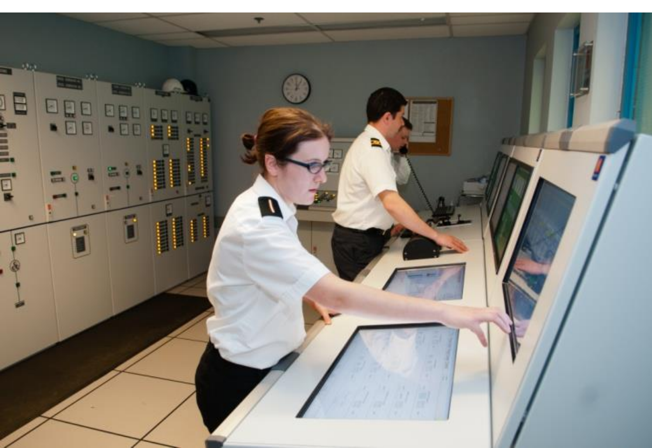
- Estimated increase from 5 tankers currently to 34 per month on average
- Proposed expansion will use the same-sized classes of tankers currently used
- Aframax tankers will continue to be loaded at about 90% of capacity
- Dredging of Second Narrows not required for project, nor is it being proposed

# Tankers

- **Construction** – Tankers are all doubled hull construction
- **Modern** – maximum age of tanker allowed is 10-15 years
- **High standards for regulation** - tankers are subject to the most stringent regulatory requirements
- **Coast Guard Oversight** - Vessels required to notify 96 hours prior to arrival in Canadian waters.
- **Approval needed every entry** - Ship requires approval to enter Canadian waters from Canadian Coast Guard
- **Ships are vetted for berth at Westridge –** looks at ships particulars and inspection reports. Ships with outstanding deficiencies are declined

# Safe Tanker Operations

- **Two pilots** – qualified Canadian pilots on board when vessels move between Westridge to Victoria Pilot Station with two on departure
- **Ship is escorted** through Boundary Pass and Haro Straight by a tethered tug - 2 miles north of East Point to the vicinity of Brotchie Ledge. The Escort Tug must remain in attendance with the Tanker until in the vicinity of Race Rocks
- **Escort tugs** – tankers tethered to escort tugs capable of controlling the ship in the event of systems failure
- More at: www.cosbc.ca



# Marine Response – West Coast Marine Response Corporation


- **Mandate:**
  - **Transport Canada certified Response Organization**
  - **Prepared to mitigate the impact of oil spill**
  - **Protection of wildlife and environmental**
  - **Public safety of both the responders and the public.**

- **Regulatory authority:**
  - **Canada Shipping Act (1995)**
    - **Amended to include regulations to protect all navigable waters and placed restrictions on tankers/barges of 150 tonnes and greater**

- **Live, 24/7 response management:**
  - **Training and guiding of personnel involved in response**
  - **Fill Incident Command System (ICS) organizational requirements as needed.**
  - **Support in incident management roles and in the on-water recovery.**

- **24 full time staff with 500 available trained responders**

TRANSMOUNTAIN

# ABORIGINAL ENGAGEMENT APPROACH, SHARING KNOWLEDGE AND BENEFITS

KINDER MORGAN
CANADA INC.

# Engagement Principles

- **Meaningful Consultation** – Ensure meaningful consultation is conducted with Aboriginal groups affected by the Project
- **Capacity Funding** – Provide capacity funding, as appropriate, to those Aboriginal groups who wish to engage in the consultation process
- **Respectful Working Relationship** – Ensure that all engagement is conducted in a respectful, transparent and collaborative manner in order to develop a long term working relationship based on respect and mutual benefit
- **Impact Assessment** – Assess potential adverse impacts and develop mitigation or accommodation measure as required
- **Reach Understandings** – Strive to reach understanding or agreements that provide training, employment, contracting opportunities and other benefits.

# Approach to Aboriginal Engagement

- More than100 Aboriginal communities potentially affected by TMEP
- **Five regions** – 1) Alberta, 2) BC Border to Kamloops, 3) Kamloops to Hope, 4) Hope to Burnaby Terminal/Burrard Inlet, and 5) Marine Corridor
- Engagement team with Field leads – Environmental team – TERA Environmental

# Impacts and Opportunities

- We seek to build on existing relationships. We believe the participation of Aboriginal groups in TMEP will make our project better

- We seek to learn from your community what the potential impacts of TMEP may be in your territory and to work alongside you to mitigate those impacts to the greatest extent possible

- We are looking for your input through meaningful discussion, as to how you can see appropriate community benefits from TMEP

# Building Capacity

- KMC is prepared to support reasonable capacity funding proposals and Aboriginal participation in TEK field work and TLU studies
- These agreements provide a first step to identifying impacts and providing opportunities
- Training, Skills development and job opportunities are important, particularly for youth
- We look forward to Aboriginal participation in our environmental programs and future contract opportunities.

# Enriching our Supply Chain

- KMC is developing a procurement policy that would allow direct award of some contracts
  - i.e. safety, quality, schedule and costs
- Our goal is to have this policy in place in the near future
- Aboriginal participation in our procurement strategy is a key element of this new policy

# Mitigation Measures & Mutual Benefits

- Mutual benefits agreements will be considered as part of a full discussion on adverse effects and mitigation.

# Conclusion

- We’re talking with people along the route and marine corridor
- We can be reached at
  - E-mail: info@transmountain.com
  - Phone: 1.866.514.6700
  - Website: www.transmountain.com

*We are committed to respectful, transparent and collaborative interactions with communities to develop long-term, effective relationships.*

# Appendix E Interests or Concerns Identified Through Engagement Activities with Aboriginal Communities for the Project

Table 3.3.1 Summary Of Interests Or Concerns Identified Through Engagement Activities With Aboriginal Communities For The Project

## TABLE 3.3.1

## 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 |
|---|---|---|---|
| Oil spill response strategy | Cowichan Nation Alliance<br><br>Tsleil-Waututh Nation | Trans Mountain is supportive of BC's 5 Conditions and the work of the Federal Tanker Safety Expert Panel that is assessing Canada's oil spill response regime.<br><br>Kinder Morgan Canada Inc. has an existing spill response plan for the Westridge Marine Terminal that is exercised regularly. With respect to the Project, Trans Mountain believes it compares well against other terminal response plans available in Canada and other jurisdictions globally. The plan will be expanded in keeping with the terminal expansion and increased Project-related marine vessel traffic to the Westridge Marine Terminal.<br><br>WCMRC is a federally certified oil spill response organization and is responsible for providing spill response to all marine commercial vessels and oil handling facilities along the BC Coast. WCMRC is undertaking a benchmarking exercise against other global spill response organizations as well as assessing any increased need for spill response as a result of TMEP. If more resources are required either as a result of WCMRC's recommendations or from the Federal Tanker Safety Expert Panel, they will be made available well in advance of the operation of the Project. If an oil spill occurs in the marine environment, multiple organizations quickly take co-ordinated action to mitigate public and environmental impacts. | Section 5.0 – Risk Assessment and Spill Management |
| Overseas shipping resulting in transfer of pollution like ballast water or invasive species being dumped into the ocean | Ts'elxweyeqw Tribe Management Limited | Trans Mountain tankers are required to follow all regulations in PMV and in BC waters, including safety regulations, pilotage requirements and ballast water exchange requirements. The marine transportation environmental assessment considers the possibility of a grounding event as well as the spread of invasive species and other potential accidents and malfunctions (Section 4.3.13) (see also Volume 5A Section 7.6). | Section 4.0 – Marine Transportation Assessment<br><br>Volume 5A – Biophysical Assessment |
| Update on current tanker loading operations | Tsleil-Waututh Nation | KMC has loaded marine vessels since 1956 without a single spill from vessel operations. Close collaboration with organizations such as the PPA, government organizations (Transport Canada and CCG) and PMV ensure that tankers navigate BC waters safely and are guided in and out of the port by highly-trained and qualified pilots. The number of vessels, including tankers and barges, being loaded at the Westridge Marine Terminal could increase to approximately 37 per month (34 of which could be tankers) in 2018, or about 14% of today's total PMV vessel traffic. While this is a big increase in capacity for Trans Mountain, this is not a dramatic increase in tanker traffic for the Port. Currently Trans Mountain makes for roughly 3% of tanker traffic through the port. Tankers themselves are held to strict internationally accepted build, manning, maintenance and operating quality standards mandated by IMO and *Canada Shipping Act* and verified by Class Societies. Additionally, WCMRC marine-based spill response plans ensure quick action in the event of a spill. | Section 5.0 – Risk Assessment and Spill Management |

## TABLE 3.3.1

## SUMMARY OF INTERESTS OR CONCERNS IDENTIFIED THROUGH ENGAGEMENT ACTIVITIES WITH ABORIGINAL COMMUNITIES FOR THE PROJECT (continued)

| Summary of Interest or Concern | Aboriginal Community | Response Summary[1] | Where Issue is Addressed |
|---|---|---|---|
| ESA study methods, study areas, indicators and key interests, including selection of marine bird, fish and mammal species | Cowichan Tribes<br>Cowichan Nation Alliance | An environmental and socio-economic effects assessment of the Project-related increased vessel traffic was completed. The marine studies that are planned cover a wide-range of topics including: marine sediment and water quality; marine fish and fish habitat; marine air and GHG emissions; marine acoustic environment; marine birds; marine mammals; marine species at risk; traditional marine resource use; marine commercial, recreational and tourism use; human health and ecological risk assessments; accidents and malfunctions; and changes to the Project caused by the environment (*e.g.*, seismicity, climate change). See Section 4.0 for a discussion of methodology and how study areas and indicators were chosen. | Section 4.0 Marine Transportation Assessment,<br>Section 5.0 – Risk Assessment and Spill Management |
| Oil tanker adherence to environmental compliance | Cowichan Tribes<br>Cowichan Nation Alliance | Transport Canada inspects tanker vessels on their first call to Westridge and annually thereafter. Canada is a signatory to international agreements that provide inspections conducted in other ports by other countries.<br>All tankers in local waters are double hulled and have a number of compartments.<br>Tankers are the most scrutinized vessels in the shipping industry. The international tanker inspection regime includes both mandatory regulatory inspections as well as regular inspections by private customers like Trans Mountain who are all united in their efforts to ensure the safety of marine transportation of oil cargoes. Tanker construction has evolved to meet the standards of IMO, Flag State and Class Society requirements. Various modern build features include double hulling, back-up power generators, improved agility and brake horsepower capacity, high quality corrosion control, collision-avoidance radar navigational instruments. Additionally, cargo tanks are maintained in an inert condition (oxygen content less than 5% volume), which removes any danger of fire or explosion in the tank. | Section 4.0 – Marine Transportation Assessment,<br>Section 5.0 – Risk Assessment and Spill Management |
| Information on tanker traffic over 10 years | Cowichan Tribes<br>Penelakut First Nation | Kinder Morgan Canada Inc., as the operator of TMPL, is committed to transparency involving any and all spills that have occurred along its pipelines, or on vessels carrying KMC transported product. Spills are reported, and available for public knowledge.<br>Kinder Morgan Canada Inc., as the operator of TMPL, understands the safety of the BC coastline is paramount. All 900 tankers that have ever loaded and sailed from the Westridge Marine Terminal in Burnaby have done so without a single spill.<br>There is a network of safety and response organizations in the marine community as well as regulations and requirements established to ensure safe transit of oil tankers in BC waters. When it comes to marine safety, Kinder Morgan Canada Inc. also stands with BC in advocating for the necessary level of federal funding and response capabilities. | Section 5.0 – Risk Assessment and Spill Management |

## TABLE 3.3.1

## SUMMARY OF INTERESTS OR CONCERNS IDENTIFIED THROUGH ENGAGEMENT ACTIVITIES WITH ABORIGINAL COMMUNITIES FOR THE PROJECT (continued)

| Summary of Interest or Concern | Aboriginal Community | Response Summary[1] | Where Issue is Addressed |
|---|---|---|---|
| Tanker spills | Ermineskin Cree Nation<br><br>Canim Lake Band<br><br>Nooaitch Indian Band<br><br>Chawathil First Nation<br><br>Shxw'ow'hamel First Nation<br><br>Semiahmoo First Nation<br><br>Ts'elxweyeqw Tribe Management Limited<br><br>Cowichan Nation Alliance Métis Nation of BC | If an oil spill occurs in the marine environment, multiple organizations quickly take co-ordinated action to mitigate public and environmental impacts.<br><br>Trans Mountain is supportive of BC's 5 Conditions and the work of the Federal Tanker Safety Expert Panel that is assessing Canada's oil spill response regime.<br><br>Kinder Morgan Canada Inc. has an existing spill response plan for the Westridge Marine Terminal that is exercised regularly. With respect to the Project, Trans Mountain believes it compares well against other terminal response plans available in Canada and other jurisdictions globally. The plan will be expanded in keeping with the terminal expansion and increased Project-related marine vessel traffic to the Westridge Marine Terminal.<br><br>WCMRC is a federally certified oil spill response organization and is responsible for providing spill response to all marine commercial vessels and oil handling facilities along the BC Coast. WCMRC is undertaking a benchmarking exercise against other global spill response organizations as well as assessing any increased need for spill response as a result of TMEP. If more resources are required either as a result of WCMRC's recommendations or from the Federal Tanker Safety Expert Panel, they will be made available well in advance of the operation of the Project. If an oil spill occurs in the marine environment, multiple organizations quickly take co-ordinated action to mitigate public and environmental impacts. | Section 5.0 – Risk Assessment and Spill Management |
| Increased marine traffic in Burrard Inlet | Cheam First Nation<br><br>Halalt First Nation<br><br>Chemainus First Nation<br><br>Semiahmoo First Nation<br><br>Penelakut First Nation<br><br>Cowichan Nation Alliance<br><br>Ts'elxweyeqw Tribe Management Limited<br><br>Métis Nation of BC | The existing shipping lanes are used by marine vessel traffic for recreational, commercial, tourism and passenger transit on a daily basis. The expected increased Project-related marine vessel traffic is not anticipated to pose a capacity problem for the internationally regulated shipping lanes.<br><br>Every month, PMV currently handles 250 vessels of all types. At present, the Westridge Marine Terminal handles approximately eight vessels per month (five of which are tankers) — representing less than three per cent of the total traffic in PMV. Should the proposed expansion be approved, the number of vessels, including tankers and barges, being loaded at the Westridge Marine Terminal could increase to approximately 37 per month (34 of which could be tankers) in 2017, or about 14% of today's total PMV vessel traffic. | Section 4.0 – Marine Transportation Assessment |

## TABLE 3.3.1

## SUMMARY OF INTERESTS OR CONCERNS IDENTIFIED THROUGH ENGAGEMENT ACTIVITIES WITH ABORIGINAL COMMUNITIES FOR THE PROJECT (continued)

| Summary of Interest or Concern | Aboriginal Community | Response Summary[1] | Where Issue is Addressed |
|---|---|---|---|
| Tanker procedures and safety measures | Métis Nation of BC<br><br>Cowichan Nation Alliance | PMV has worked closely with PPA and the marine industry and government stakeholders over the past five years to develop new ways to further strengthen existing safety procedures when escorting all vessels through the Second Narrows.<br><br>The review included comprehensive simulation exercises and live trials with an Aframax vessel. This led to a number of modifications to the procedures in place, and a higher standard of safety. The new procedures involve new tug escort requirements, installation of new aids to navigation, and development of an enhanced training program for tug captains and ship pilots.<br><br>These procedures and additional aids to navigation are now in place. The new, innovative procedures further strengthen navigational safety within PMV controlled waters. Information on procedures through the Second Narrows can be found through PMV (2013).<br><br>Although Trans Mountain is not directly responsible for the operation of marine traffic, Trans Mountain is committed to working with the marine industry to ensure the safe movement of vessels that travel in BC waters and call on the Westridge Marine Terminal in Burnaby. Tug escorts are used in Burrard Inlet and through Haro Strait, as required by the CCG. Trans Mountain will require that all Project-related tankers calling at the Westridge Marine Terminal have mandatory tug escort for the entire route between the Westridge Marine Terminal and the Pacific Ocean.<br><br>Two qualified Canadian pilots are on board all tankers leaving the Westridge Marine Terminal. | Section 5.0 – Risk Assessment and Spill Management |
| Bitumen transportation | Métis Nation of BC<br><br>Cowichan Nation Alliance | With a maximum density of 0.94, diluted bitumen transported on the Trans Moutnain pipeline is lighter than fresh water (density 1.00) and seawater (density 1.02).<br><br>Research is taking place to quantify how the diluted bitumen reacts over time in water, with wave action, with fast-moving currents, with different sediment levels and with various other factors. Trans Mountain has commissioned its own study of this issue, the results of which are summarized in Section 5.0, Volume 8A. Other studies have recently been conducted or are underway, including the SL Ross study (Meso-scale Weathering of Cold Lake Bitumen/Condensate Blend) that was prepared for a Joint Review Panel submission by Enbridge Northern Gateway Project and the anticipated Natural Resources Canada look into the weathering effects of diluted bitumen on water.<br><br>In the case of any spill, response time is critical. A rapid response means that the spilled product has less time to disperse and to weather, ultimately making the cleanup process more efficient and more predictable. WCMRC has examined its emergency response capacity in light of the Project-related increase in tankers and Trans Mountain is working with WCMRC to ensure this capacity would be in place prior to the operation of the Project. | Section 5.0 – Risk Assessment and Spill Management |

## TABLE 3.3.1

## SUMMARY OF INTERESTS OR CONCERNS IDENTIFIED THROUGH ENGAGEMENT ACTIVITIES WITH ABORIGINAL COMMUNITIES FOR THE PROJECT (continued)

| Summary of Interest or Concern | Aboriginal Community | Response Summary[1] | Where Issue is Addressed |
|---|---|---|---|
| Harbour and water details | Nooaitch Indian Band | An environmental and socio-economic effects assessment of the Project-related increased vessel traffic was completed. The marine studies that are planned cover a wide-range of topics including: marine sediment and water quality; marine fish and fish habitat; marine air and GHG emissions; marine acoustic environment; marine birds; marine mammals; marine species at risk; traditional marine resource use; marine commercial, recreational and tourism use; human health and ecological risk assessments; accidents and malfunctions; and changes to the Project caused by the environment (*e.g.*, seismicity, climate change). | Section 4.0 - Marine Transportation Assessment,<br>Section 5.0 – Risk Assessment and Spill Management |
| Increased marine traffic at Delta Port | Penelakut First Nation | The existing shipping lanes are used by marine vessel traffic for recreational, commercial, tourism and passenger transit on a daily basis. The expected increased Project-related marine vessel traffic is not anticipated to pose a capacity problem for the internationally regulated shipping lanes.<br>The cumulative effects assessment (Section 4.4) considers the Project's contribution to cumulative effects from reasonably foreseeable increased vessel traffic in the Salish Sea. | Section 4.0 - Marine Transportation Assessment |
| Freighters mooring in the area | Halalt First Nation<br>Chemainus First Nation<br>Cowichan Nation Alliance<br>Penelakut First Nation | The marine transportation acoustic environment assessment (Section 4.3.5) considers increased frequency of noise events like ship anchors being raised and lowered and vessel horns. The types of noise events are not expected to change from existing vessel operations; however, the frequency may increase. | Section 4.0 – Marine Transportation Assessment |
| Marine and beach pollution | Tseycum First Nation<br>Cowichan Nation Alliance<br>Semiahmoo First Nation | In support of the ESA for the Project, Trans Mountain has commissioned a HHRA, the principal aim of which is to identify and understand the potential short-term and long-term health risks, including carcinogenic risks, to people exposed to the chemicals that could be released to the environment from normal tanker operations or a marine spill. | Section 4.0 – Marine Transportation Assessment<br>Section 5.0 – Risk Assessment and Spill Management (Human Health Risk Assessment)<br>Screening Level Human Health Risk Assessment of Marine Transportation, Volume 8B |

**TABLE 3.3.1**

**SUMMARY OF INTERESTS OR CONCERNS IDENTIFIED THROUGH ENGAGEMENT ACTIVITIES WITH ABORIGINAL COMMUNITIES FOR THE PROJECT (continued)**

| Summary of Interest or Concern | Aboriginal Community | Response Summary[1] | Where Issue is Addressed |
|---|---|---|---|
| Current tanker loading operations | Tsleil-Waututh Nation | An environmental and socio-economic effects assessment of the Project-related increased vessel traffic was completed. The marine studies that are planned cover a wide-range of topics including: marine sediment and water quality; marine fish and fish habitat; marine air and GHG emissions; marine acoustic environment; marine birds; marine mammals; marine species at risk; traditional marine resource use; marine commercial, recreational and tourism use; human health and ecological risk assessments; accidents and malfunctions; and changes to the Project caused by the environment (*e.g.*, seismicity, climate change).<br><br>The application does not consider potential effects from existing tanker traffic associated with the operation of the Westridge Marine Terminal as current operations are considered to form part of the existing environment. The application considers potential effects related to the increased Project-related marine vessel traffic. | Section 4.0 - Marine Transportation Assessment,<br><br>Section 5.0 – Risk Assessment and Spill Management |
| Environmental effects of increased ships on traditional harvesting areas | Penelakut First Nation<br>Semiahmoo First Nation<br><br>Cowichan Nation Alliance<br><br>Hwlitsum First Nation<br><br>Esquimalt First Nation | The existing shipping lanes are used by marine vessel traffic for recreational, commercial, tourism and passenger transit on a daily basis. The expected increased Project-related marine vessel traffic is not anticipated to pose a capacity problem for the internationally regulated shipping lanes.<br><br>Trans Mountain will continue to provide information about Project-related shipping to other marine users. Specifically:<br><br>• provide regular updated information on Project-related marine vessel traffic to fishing industry organizations, Aboriginal communities, and other affected stakeholders, where possible through the Chamber of Shipping of BC (COSBC); and<br><br>• initiate a public outreach program prior to Project operations phase. Communicate any applicable information on Project-related timing and scheduling with fishing industry organisations, Aboriginal communities and other affected stakeholders.<br><br>Transport Canada requires all vessels, including tankers, to comply with the *International Regulations for Preventing Collisions at Sea* (with Canadian Modifications) and other major international maritime conventions.<br><br>Transport Canada requires compliance by all vessels with the *Canada Shipping Act,* 2001*, Collision Regulations,* the *Navigation Safety Regulations* pursuant to the Act and other applicable regulations and standards, except Government or Military vessels.<br><br>The CCG ensures that all large vessels, including Project-related tankers, register with MCTS for communications with port authorities and CCG, and employ Automatic Identification Systems (AIS).<br><br>The CCG requires compliance with the CCG fishing vessel advisory notice for commercial ships and fishing vessels using the inside passage waters of British Columbia during the commercial fishing season. This notice refers to all inside marine waters of BC. | Section 4.0 - Marine Transportation Assessment,<br><br>Section 5.0 – Risk Assessment and Spill Management |

**TABLE 3.3.1**

**SUMMARY OF INTERESTS OR CONCERNS IDENTIFIED THROUGH ENGAGEMENT ACTIVITIES WITH ABORIGINAL COMMUNITIES FOR THE PROJECT (continued)**

| Summary of Interest or Concern | Aboriginal Community | Response Summary[1] | Where Issue is Addressed |
|---|---|---|---|
| | | The PPA requires compliance with the PPA Compulsory Pilotage Areas (PPA 2013). Pilots of the BCCP ensure compliance.<br><br>PMV ensures compliance with PMV's MRA regulations, including "Clear Narrows" regulations (PMV 2010).<br><br>To enhance preventive measures currently in place through applicable legislation and regulations, implement May 2013 recommendations of Canadian Marine Pilot's Association Submission to the Tanker Safety Expert Panel.<br><br>Trans Mountain will ensure an untethered tug accompanies the Project-related tankers through the Strait of Georgia and between Race Rocks and the 12 nautical mile limit in addition to tug requirements to assist with navigation. The tug can be tethered for extra navigational assistance if needed. | |

# Appendix F Recommended Approach to Aboriginal Engagement in TERMPOL Review Process

# Recommended Approach to Aboriginal Engagement in a TERMPOL Review Process (TRP)

*Why Engage*

Aboriginal groups residing along shipping routes on the West Coast have expressed an interest in participating in TRPs being conducted in their areas. TRPs are usually associated with projects that involve new or expanded activities (e.g., the transport of a new cargo). Outside of a TRP, Aboriginal groups may be consulted on the project for which the TRP is being conducted.

As such, it makes sense for proponents to engage Aboriginal groups (along with other local waterway users) early in the process, in the *surveys and studies stage* of a TRP. TRP surveys and studies may deal with subject matters of interest to Aboriginal groups who may have local and traditional knowledge that could enhance the technical assessment of marine safety.

*How to Engage*

Transport Canada recommends that the proponent:

- Provide sufficient information about the project to enable participants' understanding of the project;
- Listen to concerns raised by Aboriginal groups and, where possible, address these concerns;
- Provide Aboriginal groups an opportunity to review and comment on the draft surveys and studies of interest, and consider Aboriginal groups' comments;
- Document its efforts to engage Aboriginal groups, including: a written communication log, a summary of issues raised, how the proponent has addressed concerns (as applicable), and a description of outstanding issues;
- Provide Aboriginal groups an opportunity to review and validate the summary of issues raised; and,
- Provide Transport Canada with a copy of the documentation above.

For more information please contact Katherine Beavis, Sr. Consultant, Aboriginal Relations at 604-666-5845 or by email at katherine.beavis@tc.gc.ca.

Transport Canada can assist proponents by:

- Helping to identify potentially interested Aboriginal groups; and,
- Providing information to Aboriginal groups about the TRP.