Technical Report TR-22

Vancouver Fraser Port Authority Development Permit Application

Consultation Summary – Westridge Marine Terminal

Appendix N

TRANSMOUNTAIN

Vancouver CoastalHealth
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Office of the Chief
Medical Health Officer

#800 - 601 West Broadway
Vancouver, BC V5Z 4C2

October 30. 2015

Lexa Hobenshield
Manager, External Relations Kinder Morgan Canada
Stakeholder Engagement and Communications
Trans Mountain Pipeline Expansion Project

Via Email: lexa_hobenshield@kindermorgan.com

Dear Ms. Hobenshield,

RE: Trans Mountain Pipeline Expansion Project

We write to follow up on our September 30, 2015 meeting that Trans Mountain requested with Vancouver Coastal Health and Fraser Health. Thank you for the information provided by your team on the status of the project application currently before the National Energy Board (NEB), and in particular the responses given by Trans Mountain to local government information requests.
Vancouver Coastal Health is not an intervenor in the NEB review process for this project. However, Vancouver Coastal Health Medical Health Officers are assisting local governments in our region in reviewing the project pursuant to our duties under the BC Public Health Act. Our primary public health concern as Medical Health Officers with respect to this project is the potential for human health impacts arising from oil spills affecting marine and fresh waters.

We have reviewed Trans Mountain's assessment of oil spill risks, in particular Trans Mountain's response to the simulated oil spill modeling prepared by Levelton Consultants for Metro Vancouver, City of Vancouver, and the Tsleil-Waututh Nation. We leave it to Metro Vancouver, Trans Mountain, and others to debate on the technical merits of the modelling report. However, we do note with concern that while concluding the Levelton modelling is not credible, Trains Mountain has not itself publicly released any modelling of its own for potential spills in the Burrard Inlet or English Bay (Tanker Route Segments 2 and 3 in the TERMPOL analysis). We find this deeply troubling. The probability of a spill in Burrard Inlet or English Bay may be low, but the consequences of such a spill could be extremely severe, as communities on the shores of the Burrard Inlet include some of the densest neighbourhoods in British Columbia.

We understand that Trans Mountain's decision not to model a spill in the Burrard Inlet or English Bay is based on the calculated very low probability for such an event. However, given that should such an event occur the consequences could be extremely severe, we respectfully disagree with this decision. This modelling work is even more critical if in fact the National Energy Board is considering granting approval for the project. The recent fuel spill from a cargo ship (MV Marathassa) in English Bay revealed just how unprepared the current processes are to mount a timely response to a relatively miniscule spill (2700 litres or 2.7 M^3). It will require further modelling for spills in the Burrard Inlet and English Bay if we are to clearly understand the current gaps and deficiencies, so that emergency response planning is based on as much information as possible.

While a useful tool, we believe Trans Mountain is overly reliant on the probabilistic risk assessment (Monte Carlo simulations) methodology in determining where to model spills, and in particular:

1. The probability risk assessment may not be reliable for rare events (see for example http://thebulletin.org/beyond-our-imagination-fukushima-and-problem-assessing-risk-0). Moreover, there is no practical real world significance in the differences between the calculated risk frequencies for the different tanker route segments – they are all very low theoretically and not useful for informing further risk assessment priorities by themselves. Therefore the decision on which locations to pursue further oil spill modelling should be based also on the severity of the potential consequences should a spill occur.

2. The reductions in risk for segments 2 and 3 to such low theoretical calculated frequency (1 in 165,151 years for segment 2; and 1 in 231,589 years for segment 3; ref: supplemental filing A4G3U5 page 20 Table A-6 - new Case 1C with additional risk control) are predicated on the near perfect functioning of the control measures. Many of these controls are not under the direct control of Trans Mountain. We have seen from the recent fuel spill in English Bay (MV Marathassa) that responses and controls that depend on multiple agencies, overlapping mandates, and multiple jurisdictions can and do easily break down. We continue to advocate for a comprehensive systems approach to assessing and managing the spill risks from this project (for example see Leveson, Nancy G. "Engineering a safer world: systems thinking applied to safety". MIT Press, 2011. https://mitpress.mit.edu/sites/default/files/titles/free_download/9780262016629_Engineering_a_Safer_World.pdf)

In conclusion, it is the opinion of Medical Health Officers for Vancouver Coastal Health that despite the theoretical calculated very low spill risk, modeling must be undertaken for Segments 2 and 3 (Burrard Inlet and English Bay) of the tanker journey, because of the potentially high consequence should a spill occur. We view the Levelton simulation as simply a screening exercise. Furthermore we strongly believe that the Levelton report demonstrates the need for a more comprehensive analysis through additional modeling by Trans Mountain above and beyond simply critiquing the report. We note that the NEB filing requirements specifies that Trans Mountain's assessment of accidents and malfunctions include "credible worst–case scenarios **and smaller spill scenarios".** It appears that Trans Mountain carried forward for further risk analysis only scenarios that it considered to be credible worst cases. The recent fuel spill from a cargo ship in English Bay demonstrated that it is not necessary to have a worst case scenario spill to result in situations with potential human health impacts.

Once again thank you for the September 30th meeting, and the opportunity for our staff to observe the emergency planning exercise on October 29th, 2015 that simulated a spill at the Westridge Marine Terminal.

Yours sincerely,

Patricia Daly MD, FRCPC
Vice-President, Public Health and Chief Medical Health Officer
Vancouver Coastal Health

CC: Roger Quan, Director, Air Quality and Climate Change Planning, Policy and Environment Department
Victoria Lee, Chief Medical Health Officer, Fraser Health

Technical Report TR-22

Vancouver Fraser Port Authority Development Permit Application

Consultation Summary – Westridge Marine Terminal

Appendix O

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December 16, 2015

Patricia Daly MD, FRCPC
Chief Medical Health Officer
Vancouver Coastal Health Authority
Sent via email: patricia.daly@vch.ca

Victoria Lee MD, MPH MBA CCFP FRCPC
Chief Medical Health Officer
Fraser Valley Health Authority
Sent via email: victoria.lee@fraserhealth.ca

RE: Summary of filed evidence in response to concerns identified by Lower Mainland Health Authorities

Dear Dr. Daly and Dr. Lee;

I am writing to provide additional information in response to concerns identified by Vancouver Coastal and Fraser Valley Health Authorities during the meeting on September 30, 2015.

During this brief meeting, the Trans Mountain Expansion Project team indicated many of the identified concerns have been addressed either as part of our initial Facilities Application submitted to the National Energy Board (NEB) in December 2013 or in subsequent responses to Information Requests. As neither the Vancouver Coastal nor Fraser Valley Health Authority is registered as an Intervenor with the NEB, your respective organizations may not be aware of this filed evidence.

This correspondence is in response to your request for a summary of the filed evidence related to the identified concerns. In the attached documents Trans Mountain has developed a summary for each of the concerns identified as well as references for the evidence filed with the NEB. The evidence cited within the summary has been provided in PDF format for ease of reference. Additional evidence is available through the links provided. Our expectation is this information will provide you with an overview of Trans Mountain's response to identified topics of interest. Additional small group meetings or topic-specific workshops will provide an opportunity for a more detailed discussion in 2016.

The attached document provides summaries of Trans Mountain's response to the following issues of concern:

1. Emergency Planning and Response
   1.1. Systems approach to assess prevention, response and mitigation
   1.2. Health Authority notification process
   1.3. COPC monitoring and dispersion tracking
   1.4. Baseline human activity and habitat data

2. Human Health Risk Assessment
   2.1. Air dispersion modelling
   2.2. Chemicals of Potential Concern (COPCs)
   2.3. Accidents and malfunctions
      2.3.1. Products
      2.3.2. Exposure Pathways

3. Noise

4. Groundwater Protection

Trans Mountain will respond by separate cover to the correspondence received on October 30, 2015 from the Vancouver Coastal Health Authority regarding a request for large oil spill modelling in Burrard Inlet.

We would like to extend our offer for continued engagement to address these topics in more detail and to help inform Trans Mountain's enhanced emergency management plan as well as our construction, socio-economic and environmental protection plans. We will contact you early in 2016 to set up small group meetings or workshops on these topics. Please contact Lexa Hobenshield at lexa_hobenshield@kindermorgan.com or 604.809.9869 if you have any questions or would like additional information before then.

Sincerely,

Margaret Mears
Environment Lead
Trans Mountain Expansion Project

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Trans Mountain ULC
Trans Mountain Expansion Project
Response to Concerns Identified by
Vancouver Coastal and Fraser Valley Healthy Authorities

December 16, 2015

CONTENTS

NOTE TO READER

Filing IDs included in this summary refer to evidence filed with the National Energy Board by Kinder Morgan Canada.

- PDFs of specific page references cited in the Response Summaries have been attached to this correspondence and have been named by topic.
- The Filing ID hyperlink in the Response Summary provides access to the complete text of the cited evidence from which the PDF content was retrieved.
- Access to Additional References has been provided through Filing ID hyperlinks.

1.0 EMERGENCY PLANNING AND RESPONSE

1.1 SYSTEMS APPROACH TO ASSESS PREVENTION, RESPONSE AND MITIGATION

Concern Identified by Health Authority

Consideration that systems theory, oil spills risk analysis should be undertaken regarding the entire response regime. The primary interest is marine-based oil spills.

Summary of Trans Mountain Response

In the Facilities Application and subsequent regulatory documents filed with the National Energy Board (NEB) for the proposed Trans Mountain Expansion Project (TMEP), Trans Mountain has applied a systematic, risk-based approach to safety and spill preparedness for the proposed Expansion Project. Separately analyzing each component of the respective pipeline and marine transportation regimes as a stand-alone measure ignores the benefit and integrity of the combined oversight and co-ordination of each regime.

The information prepared and submitted for TMEP to the NEB was based on meeting Filing Requirements set forth in the NEB Filing Manual and the NEB's list of 12 issues to be evaluated for TMEP.

With respect to marine shipping, a risk-based approach to spill modelling and risk assessment studies for the Project was employed. The NEB released filing requirements for the evaluation of potential effect of marine shipping as a result of TMEP, assessment must include a description of:

- Measures to reduce the potential for accidents and malfunctions to occur, including an overview of relevant regulatory regimes
- Credible worst case spill scenarios and smaller spill scenarios
- The fate and behavior of any hydrocarbons that may be spilled
- Potential environmental and socio-economic effects of credible worst case spill scenarios and of smaller spill scenarios, taking into account the season-specific behavior, trajectory, and fate of hydrocarbons spilled, as well as the range of weather and marine conditions that could prevail during the spill event
- Ecological and human health risk assessments for credible worst case spill scenarios and smaller spill scenarios, including justification of the methodologies use
- Preparedness and response planning and measures, including an overview of the relevant regulatory regimes

The risk-based approach employed by Trans Mountain to assess the potential effects of accidents and malfunctions for the Westridge Marine Terminal and Project-related marine shipping activities was undertaken in consideration of this guidance. Results of the assessment for the Westridge Marine Terminal were provided in Section 8.0 of Volume 7 (Filing ID A3S4V6 PDF page 99). Results of the assessment for marine shipping activities were provided in Section 5 of Volume 8A of the Facilities Application (see Additional References).

Emergency Management Regime in Canada

As described throughout the NEB hearing process, emergency management in Canada is a shared responsibility, which relies on ongoing co-operation and communication between all levels of government. Within Canada's constitutional framework, the provincial and territorial governments and local authorities provide the first response to the vast majority of emergencies.

In January 2015, federal, provincial and territorial ministers of emergency management agreed to work together to improve and enhance the emergency response framework in order to harmonize the federal system so that it complements each provincial and territorial system. To provide a coordinated strategy in this regard, the National Emergency Response System (NERS) was developed and it incorporates the principles for emergency management (Filing ID A4S7J5 PDF page 2), which are aligned with Trans Mountain and WCMRC's approach to emergency preparedness and response.

Canada's pollution response regime is based upon polluter pays principles and is a well-recognized industry and government partnership collaboration. In that respect, industry ensures resources are in place to effectively and efficiently respond to incidents where industry has caused an oil spill. An example of this government-industry partnership collaboration is WCMRC, which is the industry-owned, Transport Canada-certified, marine oil spill Response Organization on the West Coast of Canada. WCMRC capacity has increased over the years and will further increase if the Project is approved.

Additional References

- NEB Filing Manual https://www.neb-one.gc.ca/bts/ctrg/gnnb/flngmnl/index-eng.html
- NEB's list of 12 issues to be evaluated for TMEP
- NEB. 2013. Filing Requirements Related to the Potential Environmental and Socio-Economic Effects of Increased Marine Shipping Activities. NEB Filing ID A3K9I2
- Section 5 of Volume 8A of the Application – Results of the assessment for marine shipping activities (Filing IDs A3S4Y3, A3S4Y4, A3S4Y5, A3S4Y6, A3S5Q3, A3S4Y7, A3S4Y8, A3S4Y9 and A3S4Z0)
- National Emergency Response System (NRES) Principles; referred to in Section 62, Appendix 62A – NEB Filing ID A4S7J5 https://docs.neb-one.gc.ca/ll-eng/llisapi.dll/fetch/2000/90464/90552/548311/956726/2392873/2451003/2812634/B417%2D48_%2D_Reply_Evidence%2DAppendix_62A%2DEmergency_Response_Screenshot_%2D_A4S7J5.pdf?nodeid=2811895&vernum=-2 Accessed December 12, 2015
- Tanker Safety Panel Secretariat. 2013. A review of Canada's ship-source oil spill preparedness and response regime: setting the course for the future. Tanker Safety Panel Secretariat: Ottawa, ON. 71pp https://www.tc.gc.ca/media/documents/mosprr/transport_canada_tanker_report_accessible_eng.pdf Accessed December 13, 2015
- Table 5.5.3 of Section 5 of Volume 8A of the Application: Summary of WCMRC's current and future roles, responsibilities and actions (Filing ID A3S4Y6)

1.2 HEALTH AUTHORITY NOTIFICATION PROCESS

Concern Identified by Health Authority

Inclusion of health authorities as part of spills preparedness, notification and response procedures as well as invitation to participate in emergency response exercises.

Summary of Trans Mountain Response

Kinder Morgan Canada (KMC) has an established protocol for communication with responders, regulatory agencies, municipalities and others in the unlikely event of an incident such as a spill or fire Notification of Health Authorities is described in Section 45.2.10 of the Human Health Risk Assessment (Filing ID A4S7F0 ,PDF page 115). All incidents, regardless of size/severity, are reported to the KMC Control Centre.

As discussed in Trans Mountain's response to City of Vancouver IR No. 2.04.04 (Filing ID A4H8I9 PDF page 65, item q.), in the event of a spill, the Liaison Officer will notify the health authorities of the incident, if they have not already been contacted. Additional information regarding the EMP communication and notification protocols is provided in Section 63 (Emergency Management Program).

KMC's role in working with municipal officials who have the authority to issue an evacuation or shelter-in-place order is explained in the response to City of Burnaby IR No. 2.058d.

> "...KMC's role in notification of schools, businesses and residents will primarily be to provide local emergency services agencies with air quality measurements and other relevant status information on an ongoing basis through the [Incident Command System] (ICS) Liaison Officer or other appropriate position in ICS as it becomes available to assist them in their response in the local community. The decisions made as to the best course of action and subsequent actions taken to direct residents to shelter in place or to evacuate are the responsibility of local municipal emergency services. This includes the communication of instructions for shelter in place..."

As part of the EMP engagement, KMC will consult with municipalities, Aboriginal groups and other agencies on its communication and notification protocol.

Additional References

- Section 63.10 – Communication and Notification of TMEP Reply Evidence Part 3 (NEB Filing ID A4S7J5)
- Section 63.9 – Evacuation Plans of TMEP Reply Evidence Part 3 (NEB Filing ID A4S7J5)
- Response to City of Burnaby IR No. 2.058d (Filing ID A4H8A1)

1.3 COPC MONITORING AND DISPERSION TRACKING

Concern Identified by Health Authority

Capacity of Trans Mountain and West Coast Marine Spill Response Corporation (WCMRC) to monitor specific chemical substances that might be released from the surface of a large oil spill and to track their dispersion in real-time. Specific interest in capacity to deploy air monitoring equipment within the first two hours to inform public health and safety decisions.

Summary of Trans Mountain Response

In the event of a spill, Trans Mountain's first priority is safety of the public, our employees and contractors and the environment. Trans Mountain uses the Incident Command System (ICS) to respond to emergencies which provides for seamless coordinated action with government agencies. Working with the local authority Trans Mountain would secure the area impacted by a spill and commencing air monitoring.

Trans Mountain recognizes the importance of a timely response, particularly in relation to air quality, and maintains calibrated air monitoring instruments on-site at the Sumas and Burnaby terminals as well as the Westridge Marine Terminal that can be deployed immediately to monitor the specific chemicals expected to present the greatest risk to human health in the event of a spill such as H2S, benzene and VOCs. Trans Mountain also maintains continuous ambient air monitoring stations at the fence line of the Sumas and Burnaby terminals as well as the Westridge Marine Terminal with real-time data available on a secured website. Trans Mountain will readily share all air quality data, in the event of an emergency, from both the ambient fence line monitoring stations and the air monitoring plan with local agencies, including the local health authorities, to assist with the implementation of their recommendations to protect the public. Municipal emergency services would also be provided with air quality measurements as they are gathered to assist in their response. The air quality monitoring programs that would be in place would act to ensure that vapour levels are within acceptable limits.

In addition, Trans Mountain has contractual relationships with contractors able to promptly supply additional equipment and personnel during a spill. The selected contractors would assist Trans Mountain in the execution of the air monitoring plan and they would have the capabilities to develop a timely emergency air quality dispersion model of the actual event. This would assist in the extent of air monitoring using the best available software such as SAFER Combustion Analysis ModelTM or Complex Hazardous Air Release Model. This practice has been demonstrated in emergency response exercises that simulate worse-case events.

If a marine spill occurred from a large vessel, WCMRC would be immediately notified and consultation with appropriate emergency and spill response personnel and agencies, such as the Coast Guard authorities, would occur and coordinated action would quickly be taken to contain and recover the spilled oil, as outlined in Volume 8A, Section 5.5 of the Application (Filing IDs A3S4Y6 and A3S5Q3). Environmental monitoring and surveillance programs are initiated in the event of a spill and coordinated action would be taken to determine the need for and types of measures required to protect public health.

Trans Mountain seeks ongoing dialogue and is committed to engage and inform the local health authorities and local communities of emergency and spill response programs. Feedback, concerns and other input will be gathered and considered in the development of the enhanced Emergency Management Program for the expanded TMPL system, should it proceed.

Additional References

- Section 45.2.11 Air Monitoring Plans for the Protection of Human Health of Trans Mountain Expansion Project Reply Evidence, Part 2 (Filing ID A4S7F0)
- Section 45.2.3.2 Marine Transportation, of Trans Mountain Expansion Project Reply Evidence, Part 2 (Filing ID A4S7F0)
- Section 45.2.2.2 Benzene of Trans Mountain Expansion Project Reply Evidence, Part 2 (Filing ID A4S7F0)
- Section 45.2.2.3 Carcinogens of Trans Mountain Expansion Project Reply Evidence, Part 2 (Filing ID A4S7F0)
- Section 45.2.3 Human Health Effects Associated with Multiple Pathway Exposures of Trans Mountain Expansion Project Reply Evidence, Part 2 (Filing ID A4S7F0)
- Section 63.9 Evacuation Plans of Trans Mountain Expansion Project Reply Evidence, Part 3 (Filing ID A4S7F1)
- Section 5.5 of Volume 8A of the Application (Filing IDs A3S4Y6 and A3S5Q3)
- Response to NEB IR No. 1.70b – Trans Mountain's response to previous incidents
- WCMRC Technical Manual – Safety Tactics: http://www.wcmrc.com/toolbox/wp-content/uploads/WCMRC-TM-Safety-Tactics.pdf Accessed December 12, 2015
- WCMRC Field Operations Guide: http://www.wcmrc.com/toolbox/wp-content/uploads/WCMRC-FOG-Spill-Response-Officer.pdf Accessed December 12, 2015

1.4 BASELINE HUMAN ACTIVITY AND HABITAT DATA

Concern Identified by Health Authority

Concern was expressed over "*the need for human activities and habitat baseline data to facilitate remediation decisions*." The letter specifies the baseline information of particular interest to Fraser Health and Vancouver Coastal Health. These include:

- The levels and types of First Nations and non-First Nations cultural and recreational use of Burrard Inlet beaches and water
- The recreational, commercial and First Nations fishery in the area
  The levels of COPC in soil, soil vapour, sediment, surface/ground water, drinking water and ambient/indoor air

Summary of Trans Mountain Response

Similar concern was expressed by NS NOPE with respect to the need for human activities data and by the District of North Vancouver and Shxw'ōwhámel First Nation regarding the need for baseline environmental data for the characterization of the current environmental conditions and the development of remediation targets in the event of a spill in Burrard Inlet.

Information regarding baseline First Nations and non-First Nations activities within Burrard Inlet and surrounding is available in Additional References.

Baseline environmental data for the Burrard Inlet area have been collected as part of ambient monitoring programs conducted by leading scientific and regulatory authorities such as BC Ministry of the Environment, BC Ministry of Water, Land and Air Protection and North Pacific Marine Science Organization. In addition, multimedia investigations have been completed as part of remediation programs in the Burrard Inlet. For example, sediment, groundwater/pore water, surface water, ambient air and seafood have been collected from the foreshore areas adjacent to the Chevron Refinery in the Central Harbour of Burrard Inlet (Chevron 2011a,b).

Similarly, characterization of water, sediment, mussel and crab tissue was an integral component of the remediation program for the 2007 spill at the Westridge Marine Terminal (Stantec 2012a,b, 2014).

As discussed in Trans Mountain's City of Vancouver IR No. 2.08.10 (Filing ID A4H8I9 PDF page 323), in the event of a spill, remediation of spill impacts is linked to monitoring plans agreed upon between participating entities in the spill response, including government authorities, Aboriginal groups, and scientific advisors. Monitoring of any spill-related chemical residues in different environmental media, including surface water, air, soils and/or sediment, groundwater and foodstuffs will continue as necessary to protect public health and will confirm concentrations relative to pre-defined standards or objectives. Those situation-specific remediation plans are developed after emergency actions have been completed and take into account post-emergency conditions, documented cleanup effectiveness, remaining areas affected, environmental and seasonal sensitivities, NEBA of remediation efforts and numerous other considerations. As the emergency phase concludes, the NEBA could specify the need for remediation, followed by long-term monitoring. Each spill situation is unique in this respect. For any affected shorelines, response end-points are arrived at by conducting a Shoreline Clean-up Assessment Technique (SCAT). This

standard and proven assessment methodology subscribed to by Environment Canada, guides the process of shoreline cleanup along inland rivers and lakes and marine coastlines. The SCAT process offers an objective means of data collection that is used to estimate the degree of oiling present in shoreline environments. SCAT data are then used to establish shoreline cleanup endpoints where further cleanup efforts will cease to provide environmental benefit. A NEBA systematically evaluates the advantages and disadvantages of different cleanup options and endpoints. In some cases under NEBA, natural attenuation might emerge as the best cleanup option

Additional References

Concern with respect to the need for human activities data was expressed by NS NOPE (Filing ID A4L5V1)

Concern regarding the need for baseline environmental data for the characterization of the current environmental conditions and the development of remediation targets in the event of a spill in Burrard Inlet was expressed by:

- District of North Vancouver (Filing ID A4Q0E9)
- Shxw'ōwhámel First Nation (Filing ID A4Q1A1)

Information regarding baseline First Nations and non-First Nations activities within Burrard Inlet and surrounding area:

- Evidence submitted by the Tsleil-Waututh First Nation (Filing IDs A4L5Z4, A4L5Z9, A4L6A0, A4L6A1, A4L6A2, A4L6A3, A4L6A4 and A4L6A5)
- Evidence submitted by the Squamish First Nation (Filing IDs A4L7E5, A4L7E6 and A4L7E3)
- Evidence submitted by the Musqueam Indian Band (Filing ID A4Q2F9)
- Traditional Land and Resource Use Technical Report in Volume 5D of the Application (Filing IDs A3S2G8, A3S2G9, A3S2H0 and A3S2H1)
- Marine Traditional Land and Resource Use – Marine Transportation Technical Report in Volume 8B of the Application (Filing IDs A3S4K3, A3S4K4, A3S4K5 and A3S4K6)
- Marine Commercial, Recreational and Tourism Use – Marine Transportation Technical Report presented in Volume 8B of the Application (Filing IDs A3S4K4, A3S4K5 and A3S4K6)

Trans Mountain's reply evidence:

- Section 32.0, Groundwater Quality and Quantity (Filing ID A4S7E9)
- Section 33.0, Air Quality (Filing ID A4S7E9)
- Section 45.0, Human Health Risk Assessment (Filing ID A4S7F0)
- Section 48.0, Environmental Protection Planning (Filing ID A4S7F0)
- Section 63.0, Emergency Management Program (Filing ID A4S7F1)

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2.0 HUMAN HEALTH RISK ASSESSMENT

2.1 AIR DISPERSION MODELLING

Concern Identified by Health Authority
Uncertainty about air dispersion modelling.

Summary of Trans Mountain Response

Trans Mountain agrees with the Vancouver Coastal and Fraser Valley Health Authorities that human health risk assessment (HHRA) principles should be adhered to in the air quality dispersion modelling to ensure the predicted chemicals of potential concern (COPC) results are adequate for use in the HHRA reports. The guiding HHRA principles of identifying and selecting suitable assumptions, listing the physical parameters, using established regulatory guidelines, using representative data and selecting appropriate emission scenarios for the COPCs of interest were all adhered to.

For example, the assumptions and parameters used in the dispersion modelling followed the provincial Guidelines for Air Quality Dispersion Modelling in British Columbia (BC Model Guideline) (BC MOE 2008), which is an established government and industry standard. The technical assumptions used in the marine and terrestrial air quality assessments were listed in the Detailed Model Plan (Filing ID A3S1U3, Appendix B) which was prepared by RWDI Air Inc. (RWDI), the air quality consultants, and submitted for review by Metro Vancouver and the BC MOE before any modelling work proceeded. It was signed off by these regulators on October 10, 2013. Specific technical reports included summary tables of the physical parameters used in the modelling, such as stack heights and emission rates. The same modelling approach is required by other jurisdictions such as Alberta, Ontario and in the United States. Emission scenarios examined in the dispersion model included normal operations for Project-only and cumulative effects and facility upsets.

Representative, local measurements were used to support the dispersion modelling. For example, RWDI used 10 meteorological stations across the Lower Fraser Valley that characterized conditions for the Burnaby Terminal and Westridge Marine Terminal Regional Study Area (RSA). Up to 10 years of ambient air quality monitoring records for all available COPC were summarized over all of the Metro Vancouver ambient stations in the Lower Fraser Valley. Background ambient values were calculated using the BC Model Guideline and added to all predicted concentrations to obtain a cumulative effect.

In short, the air dispersion modelling for the Project was suitable for HHRA assessments as it was completed in accordance with relevant provincial and municipal guidelines, and followed standard practice for conducting air quality assessments across Canada and the United States.

2.2 CHEMICALS OF POTENTIAL CONCERN (COPC)

Concern Identified by Health Authority

The omission of key air pollution-attributed health risk drivers identified by Metro Vancouver in the *2007 Air Toxics Emission Inventory and Health Risk Assessment – Summary Report*, such as diesel particulate matter (DPM), 1,3-butadiene and carbon tetrachloride, from the human health risk assessments (HHRAs) of the Trans Mountain Expansion Project (the Project).

Summary of Trans Mountain Response

The focus of the HHRAs was on assessing the potential human health risks associated with exposure to the chemicals that could be emitted from the Project and Project-related marine vessel traffic. Identification of the chemicals of potential concern (COPC) for the HHRAs began with the development of a comprehensive list of chemicals found in the various emissions from the Project and Project-related marine vessels. More than 90 chemicals or chemical groups, including criteria air contaminants, metals and metalloids, petroleum hydrocarbon compounds, polychlorinated biphenyls, polycyclic aromatic hydrocarbons, sulphur-containing compounds and volatile organic compounds, were identified as COPC and evaluated in the HHRAs. The complete list of COPC for the HHRAs of Westridge Marine Terminal and marine transportation can be found in Table 3.3 of the Human Health Risk Assessment of Westridge Marine Terminal Technical Report (Filing ID A3Y1F4, PDF page 23) and Table 3.3 of the Human Health Risk Assessment of Marine Transportation Technical Report (Filing ID A3Y1F7, PDF page 24), respectively.

In response to Recommendation 1.2 put forward by Vancouver Coastal Health and Fraser Health in their *Guidance to Metro Vancouver and Fraser Valley Municipalities to Assist in Reviewing the Trans Mountain Pipeline Expansion Project from a Public Health Perspective*, consideration was given to the potential for the Project and Project-related marine vessel traffic to emit DPM, 1,3-butadiene and carbon tetrachloride. As discussed in Trans Mountain's response to Fraser Valley Regional District (FVRD) IR No. 2.01a an assessment of the potential human health risks associated with exposure to DPM and 1,3-butadiene was subsequently completed. The potential human health risks associated with exposure to carbon tetrachloride were not evaluated because the Project and Project-related marine vessel traffic are not expected to emit carbon tetrachloride to air and therefore, will not contribute to existing health risks associated with carbon tetrachloride in the region.

The potential human health risks associated with exposure to DPM were presented and discussed in Trans Mountain's response to the Lower Fraser Valley Air Quality Coordinating Committee (LFVAQCC) (Filing ID A4F5C9, PDF page 24), with additional information presented in Trans Mountain's response to FVRD IR No. 2.12a (Filing ID A4H8S0, PDF page 61) and in Section 45.1.1.3 (Diesel Particulate Matter) of Trans Mountain's Reply Evidence (Filing ID A4S7F0, PDF page 46). An assessment of the potential human health risks associated with exposure to 1,3-butadiene was presented in FVRD IR No. 2.01a (Filing ID A4H8S0, PDF page 4) and summarized in Section 45.1.1.1 (1,3-Butadiene) of Trans Mountain's Reply Evidence (Filing ID A4S7F0, PDF page 46).

In addition, Trans Mountain has agreed to install a new ambient air quality monitoring station at the Westridge Marine Terminal (Trans Mountain's response to City of Burnaby IR No. 1.03.07f, Filing ID A3Y2E6, PDF page 63), which per NEB Draft Condition 19 will continuously measure the COPCs such as DPM and speciated $PM_{2.5}$ in ambient air, per NEB Draft Condition 19.

2.3 ACCIDENTS AND MALFUNCTIONS

2.3.1 PRODUCTS

Concern Identified by Health Authority

The exclusion of refined products, such as gasoline or jet fuel, that contain a greater proportion of lighter and more volatile/flammable hydrocarbon fractions when compared to Cold Lake Winter Blend (CLWB) diluted bitumen from the spill scenarios evaluated in the human health risk assessments (HHRAs) of the Trans Mountain Expansion Project.

Summary of Trans Mountain Response

Although the Trans Mountain Pipeline (TMPL) system (existing Line 1) currently transports a variety of crude oil and refined products, such as gasoline and jet fuel, the Trans Mountain Expansion Project (Line 2) has been proposed 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 off-shore markets. The expanded TMPL system will have the capability to transport a variety of crude oil products, including both light and heavy crude oil. Those crude oils often referred to as diluted bitumen will be the primary crude oil transported in Line 2 and refined products such as gasoline will continue to be transported in existing Line 1.

Further rationale for the selection of CLWB, and thereby the chemicals of potential concern (COPC) evaluated in the HHRAs, was provided in response to Recommendation 1.3 put forward by Vancouver Coastal Health and Fraser Health in their *Guidance to Metro Vancouver and Fraser Valley Municipalities to Assist in Reviewing the Trans Mountain Pipeline Expansion Project from a Public Health Perspective*. As discussed in Trans Mountain's response to Fraser Valley Regional District (FVRD) IR No. 2.01a (Filing ID A4H8S0, PDF page 10), the rationale for the selection of CLWB as the representative crude oil for the identification of the COPC in the HHRAs was:

- Diluted bitumen is expected to comprise a large percentage of the oil transported by Line 2
- CLWB is currently transported by Trans Mountain, and it will continue to represent a large percentage of the total products transported by Line 2. Accordingly, in the unlikely event of a spill occurring, there is a strong possibility that the spilled product will be CLWB.
- The diluent in CLWB is liquid condensate that is rich in light-end hydrocarbons that are volatile or semi-volatile in nature. These hydrocarbon components could potentially be released as vapours from the surface of the spilled oil, which would then disperse in a downwind direction, possibly reaching people who could inhale them.
- A sample of CLWB was tested by an accredited third-party laboratory to provide information on its physical and chemical characteristics. A full list of trace elements and organic compounds analyzed in CLWB, including the concentration of individual chemical compounds, was provided in Table 6.2 of the Qualitative Ecological Risk Assessment of Pipeline Spills Technical Report (Filing ID A3S4W9, PDF page 40). Copies of the original laboratory certificates are provided in Appendix A of the report.

- A study characterizing the emissions from the surface of the CLWB in terms of the types and amounts of chemicals present was conducted. The study was provided as BROKE IR No 1.9a – Attachment 1 – Flux Chamber Sampling Program in Support of Spill Modelling for the Trans Mountain Expansion Project Final Report (Filing ID A3Y2D4 PDF p 123).
- Additional information on the physico-chemical characteristics of CLWB was provided in *A Comparison of the Properties of Diluted Bitumen Crudes with Other Oils Technical Report* (Filing ID A3S5G7, PDF page 6).

2.3.2 EXPOSURE PATHWAYS

Concern Identified by Health Authority
The exclusion of exposure pathways other than air inhalation (i.e., inhalation of dust, food ingestion and direct dermal contact) from the spill scenarios evaluated in the human health risk assessments (HHRAs) of the Trans Mountain Expansion Project (the Project).

Summary of Trans Mountain Response

In Trans Mountain's response to Fraser Valley Regional District (FVRD) IR No. 2.01a (Filing ID A4H8S0, PDF page 11), which was intended to address Recommendation 1.4 put forward by Vancouver Coastal Health and Fraser Health in their *Guidance to Metro Vancouver and Fraser Valley Municipalities to Assist in Reviewing the Trans Mountain Pipeline Expansion Project from a Public Health Perspective*, the rationale for the inclusion or exclusion of the following pathways from the HHRAs was presented:

- Direct ingestion of spilled oil
- Direct dermal contact with spilled oil
- Inhalation of chemical vapours originating from spilled oil
- Ingestion of foods containing chemical residues originating from spilled oil
- Ingestion of drinking water containing chemical residues originating from spilled oil
- Dermal contact with soils or sediments containing chemical residues originating from spilled oil
- Inhalation of dust containing chemical residues originating from spilled oil
- Incidental ingestion of soils containing chemical residues originating from spilled oil

For ease of review, the information was summarized in Table 2.01a-5 and 2.01a-6 for the facility spill scenarios and Table 2.01a-7 and 2.01a-8 for the marine spill scenarios, with each set of tables further distinguished by receptor type, with one table devoted to the general public and the second table devoted to spill response personnel (Filing ID A4H8S0, PDF page 14). The information presented in the tables demonstrates that the single pathway by which the general public might reasonably be expected to be exposed under either the facility or marine oil spill scenarios, respectively, is through short-term (acute) inhalation exposure to the chemical vapours released from the surface of the spilled oil during the early stages of the incident, before the arrival of first responders and the implementation of emergency and spill response measures. For spill response personnel, the expectation is that they would be trained in emergency preparedness and response, would be equipped with appropriate personal protective equipment (PPE), would be aware of the chemical hazards involved and would take precautions to avoid physical contact with the spilled oil itself and any oil-tainted media as well as to limit exposure to any chemical vapours that might be present. Notwithstanding the above, if the criteria listed were not satisfied, distinct opportunity would exist for these personnel to be exposed via certain pathways, such as direct skin contact with the spilled oil itself or oil-tainted media and/or inhalation of vapours, on a short-term and longer-term basis. This points out the need for and importance of worker training and awareness of the potential hazards involved in spill response and cleanup, the proper use of PPE and precautions to take to avoid or reduce exposures.

3.0 NOISE (TERRESTRIAL)

Concern Identified by Health Authority

Noise related to construction or operations.

Summary of Trans Mountain Response

The potential effects of noise on people has been considered through the application and review process, and continues to be included in ongoing design and planning for the Project. Trans Mountain has committed to implementing construction Noise Management Plans that address the facilities and pipeline in the BC Lower Mainland, as well as to conducting noise monitoring of construction and operations. These commitments were made in multiple IRs submitted to the NEB, including City of Vancouver IR 2.12.7a (Filing ID A4H8I9), Simon Fraser University and the Township of Langley (see Additional References).

Noise from construction of the Project was initially assessed in Section 7 of Volume 5A, ESA – Biophysical of the Application for the terrestrial operations (Filing ID A3S1Q9). The commitment was made in Table 7.2.6-2 of the Application to complete a Noise Management Plan. NEB August 2015 Draft Condition 96 (Filing ID A4S1G2) and December 2015 Draft Conditions 147 and 148 (Filing ID A74635) all outline details that the management plans will address. These include: providing quantified construction noise predictions near Westridge Marine Terminal, Burnaby Terminal and HDD sites; a list of control measures to be used by contractors; monitoring during construction and shutdown requirements due to exceedances; and a method of notification and communication with the affected residents. Work on the Noise Management Plan is ongoing, so that information is available for public consultation and filing with the NEB per the requirements in August 2015 Draft Condition 96.

Noise from operations was quantified and assessed in Section 7 of Volume 5A, ESA – Biophysical of the Application for the terrestrial operations. The assessment considered criteria established by the BC Oil and Gas Commission and the Alberta Energy Regulator (Filing ID A3S1Q9, PDF page 103). A description of the criteria and how they related to human health is found in the Terrestrial Noise and Vibration Technical Report in Volume 5C, ESA (Filing ID A3S1T7). The amount of sound from operations at Westridge Marine Terminal and Burnaby Terminal is being reviewed and predictions updated as part of ongoing engineering design to ensure appropriate controls are designed into the Project. A monitoring program to verify that noise from operations meets the criteria outlined in the assessment has been committed to per NEB August 2015 Draft Condition 132 (Filing ID A4S1G2).

Additional References

- Commitments to Simon Fraser University IR 2.5.01.2 (Filing ID A4H9C9)
- Commitments to Township of Langley IR 2.17a (Filing ID A4H8T4).

4.0 GROUNDWATER

Concern Identified by Health Authority

Protection of potable water during construction.

Summary of Trans Mountain Response

Trans Mountain will incorporate reference to British Columbia's Drinking Water Protection Act SBC 2001 c. 9 in the Environmental Protection Plans (EPPs) which are to be updated and submitted to the National Energy Board (NEB) prior to construction.

In order to identify wells that may not be recorded within the provincial water well database, the field "ground-truthing" of water well locations (i.e. verification of the well's location, ownership, well depth and operating status) within 150 metres either side of the proposed pipeline centreline is currently underway and planned to be completed prior to construction (NEB Draft Condition 80, Filing ID A4S1G2, PDF page 33). The 150-metre offset distance selected for this field verification effort is considered more than adequate considering the depth of pipeline construction activities and potential hydrogeologic influences of the shallow pipeline construction.

Annual reporting on consultation with communities, municipalities and Aboriginal groups related to the protection of municipal and community water sources, per NEB Draft Condition 81 (Filing ID A4S1G2 PDF page 33), is planned. The reporting will summarize issues and concerns raised as well as a description of measures to be taken to respond to those concerns including any planned groundwater modeling or monitoring. The reporting is to be filed with the NEB 60 days prior to commencing construction and annually during construction as well as for the 5 years following the commencement of operations.

Hydrogeologic specialists will be available to monitor and support construction activities through the Fraser Valley. Section 8.0 of the Pipeline EPP (Filing ID A3S2S3,PDF page 8-22) point 29 states, "Ensure an environmental monitor with experience in contaminated sites is present to check for indications of potential groundwater contamination (i.e., sheen, adjacent soil staining) during pipeline trench excavation in areas where there is higher potential for encountering contamination (e.g., urban areas). Where groundwater contamination is suspected, the groundwater should be sampled and analyzed by an accredited laboratory." Point 48 in the same document (Filing ID A3S2S3, PDF page 8-24) states "Monitor water encountered in the trench during trenching to determine if groundwater flow is being intercepted. If spring flow has been disrupted, seek and follow the advice of the Hydrogeological or Geotechnical Resource Specialist to maintain cross drainage within the trench (e.g., installation of sub-drains, trench breakers, etc.)."

In reference to wells within 30 metres of the construction right-of-way the EPP states: "Re-establish or replace a potable water supply as required should a registered or known water well be located within 30 m of the construction installation."

Trans Mountain does not believe that the source of potential bacteria or hydrocarbon contaminants associated with pipeline construction activities are sufficient to justify a groundwater quality monitoring program for these parameters during pipeline construction activities. Historically, pipeline construction has not been a common source of groundwater contamination nor damage to wells. Discrete or select monitoring wells and a corresponding groundwater monitoring program are not typically considered to be an efficient or effective means of monitoring a linear feature such as a pipeline, and as such are not recommended for the operational pipeline.

SECTION 1.0 - EMERGENCY MANAGEMENT

2.08.10 Risk Assessment - General

Reference:

i. Human Health Risk Assessment of Marine Transportation Technical Report for the Trans Mountain Pipeline ULC, June 2014. (A3Y1F7)

ii. Human Health Risk Assessment of Marine Transportation Technical Report Intrinsik Environmental Inc. prepared for the Trans Mountain Pipeline ULC. (June 2014. (A3Y1F7)

iii. Human Health Risk Assessment of Facility and Marine Spill Scenarios Technical Report for the Trans Mountain Pipeline ULC, June 2014. Sections 5.1.1.1.2 – 5.2.2.1.2 (p5-2 – p5-9) (A3Y1E9 & A3Y1F0 & A3Y1F1 & A3Y1F2).

Preamble:

Neither the application nor the technical human health risk assessment reports speak to Trans Mountain's plans for mitigation/remediation to achieve acceptable risk levels, nor their plans for when and how to conduct risk assessments if spills occur.

Request:

a. Please advise what Trans Mountain considers to be the spill threshold volume for conducting a risk assessment.

b. Please advise at what time intervals following a spill subsequent risk assessments will be conducted to assess conditions and impact to receptors.

c. Please advise what Trans Mountain's plans are for mitigation/remediation to achieve acceptable risk levels (as defined by Provincial legislation) and what the acceptable timing would be for achieving acceptable levels.

d. Please advise what compensation and support, if any, will be made to impacted parties in the interim between a release and when acceptable risk levels are achieved.

Response:

a. The Intervenor's question cannot be answered in the manner asked, as it is unclear to Trans Mountain what is meant by "mitigation/remediation to achieve acceptable risk levels, nor their plans for when and how to conduct risk assessments if spills occur." Trans Mountain offers the following response to your question.

   There is no minimum spill threshold and no spill is acceptable. Trans Mountain maintains continuous vigilance and monitoring in order to prevent spills of any nature.

b. In the event of an oil spill, the need for and time intervals under which a site-specific human health risk assessment would be performed would be determined based on the collective opinion of Trans Mountain, the appropriate government authorities, and local, regional, provincial and/or federal public health authorities.

c. Given the many variables and uncertainties surrounding any particular incident, there is no credible way of defining specific mitigation/remediation measures that would be implemented, nor the timing for achieving acceptable levels.

It should be noted that, in the event of an oil facility or marine spill, although the overall objectives of the various emergency and spill response measures that would be taken by the different companies, organizations, government authorities and personnel would be the same (*i.e.,* to quickly contain and recover the spilled oil and to mitigate any impacts to people's health and the environment), differences principally would exist in the exact manner in which the response would proceed *vis-à-vis* timing, responsibilities, network resources involved, environmental monitoring and surveillance, public notification and engagement, and other aspects of the coordinated action taken. The differences are due, in part, to the differences between the two types of spill scenarios in terms of spill location and size, with one set of scenarios focused on spills at a manned facility equipped with a pre-deployed containment boom and access to nearby emergency and spill response resources, and the other set of scenarios centered on larger-sized spills as a result of the grounding of a laden tanker vessel in open waters. The differences are also due to differences in the parties who would bear primary responsibility for emergency and spill response and spill clean-up.

In the unlikely event of a facility spill, Trans Mountain would immediately execute its emergency response plan based on the Unified Command (UC) structure described in Volume 7 of the Application. Trans Mountain would consult with other emergency and spill response personnel, such as the Western Canada Marine Response Corporation (WCMRC) and Coast Guard authorities, and coordinated action would quickly be taken to contain and recover the spilled oil. In conjunction with these actions, Trans Mountain would quickly notify appropriate municipal, provincial and federal government authorities as well as local, regional, provincial and/or federal public health authorities of the spill, and coordinated action would be taken to determine the need for and types of measures required to protect people's health if public health and/or safety were threatened, including measures to reduce the prospect for and/or extent to which people might be exposed to the spilled oil itself and/or chemicals released from the oil, such as notifying the public of the spill, advising the public to avoid the area, securing perimeters and restricting access to the area. If public health and/or safety were threatened, people would be asked or could be ordered to evacuate the area.

In the unlikely event of an oil spill from a tanker, these same emergency and spill response measures would be taken by the vessel owner and Trans Mountain would be available for consultation.

Environmental monitoring and surveillance programs would be initiated to track the movement of the oil slick as well as monitor clean-up progress. These monitoring programs would be designed in consultation with WCMRC and other spill response network resources as well as with municipal, provincial and federal government authorities such as Fisheries and Oceans Canada and Environment Canada, and local, regional, provincial and/or federal public health authorities, with consideration given to

the location and size of the spill, the behaviour and movement of the spill, and the potential threats to health and the environment. The programs would include monitoring of the presence of the spilled oil and/or its chemical constituents in different environmental compartments, such as the water column, submerged sediments and shoreline soils. Air quality monitoring of hydrocarbon and other chemical vapours released from the surface of the oil slick also would be initiated. The information collected would be used, in part, to help guide decision-making about the need for and types of additional measures such as food advisories are required to reduce the prospect for people to be exposed to the spilled oil and/or chemicals released from the oil *via* different exposure pathways on both a short-term and longer-term basis. These controls would remain in place until the results of the monitoring program(s) indicate that public health and safety is not at risk.

Once the initial emergency response is completed, response may transition to a clean-up and remediation phase whose objective is to prevent or deal with any long-term risks to public health, safety, and the environment. Spill response in Canada follows a rigorous procedure of 'Net Environmental Benefit Analysis' (NEBA). Oil is removed according to treatment recommendations that minimize any potential impacts of the oil, equipment, materials, personnel, and response strategies. Local and scientific knowledge are key inputs to these determinations that consider the nature of the receiving environment, the properties of the oil, and seasonal conditions affecting the current state of the biome.

Long-term remediation of spill impacts is linked to monitoring plans agreed upon between participating entities in the response, including government authorities, Aboriginal groups, and scientific advisors. Monitoring of any spill related chemical residues in different environmental media, including surface water, air, soils and/or sediment, groundwater, and foodstuffs will continue as necessary to protect public health and confirm concentrations relative to pre-defined standards or objectives. Those situation-specific remediation plans are developed after emergency actions have been completed and take into account post-emergency conditions, documented clean up effectiveness, remaining areas affected, environmental and seasonal sensitivities, NEBA of remediation efforts, and numerous other considerations. As the emergency phase concludes, the NEBA could specify the need for remediation, followed by long-term monitoring. Each spill situation is unique in this respect. For any affected shorelines, response end points are arrived at by conducting a Shoreline Clean-up Assessment Technique (SCAT). This standard and proven assessment methodology subscribed to by Environment Canada, guides the process of shoreline clean-up along inland rivers and lakes and marine coastlines. The SCAT process offers an objective means of data collection that is used to estimate the degree of oiling present in shoreline environments. SCAT data are then used to establish shoreline clean-up endpoints where further cleanup efforts will cease to provide environmental benefit. A NEBA systematically evaluates the advantages and disadvantages of different clean-up options and endpoints. In some cases under NEBA, natural attenuation might emerge as the best clean-up option.

d. Trans Mountain notes the nature, size, scale and scope of the release are not defined nor is the degree of potential impact to the pipeline or facilities and any resulting spills or other hazards. Kinder Morgan Canada Inc. (KMC) cannot speculate as to the different conditions under which costs may arise as a result of an emergency, but can confirm it is responsible for all of its legal liabilities.

As stated in response to McDonald K IR No. 1.3.4 (Filing ID A3X6R1), in the low likelihood event of an emergency and demonstrated damage as a result of an incident caused by Trans Mountain's facilities or operations, Trans Mountain will work with affected individuals and landowners to provide compensation as quickly and efficiently as possible. In the example of the 2007 Westridge Spill, Trans Mountain worked with impacted landowners to mitigate damages, irrespective of the ultimate responsibility associated with the insurance claims.

As described in response to Metro Vancouver IR No.1.1.2.03b (Filing ID A3Y2V0), a report of a release related to the Trans Mountain terminals or pipelines received by our control centre would result in the immediate shut down of pumps, and closure of valves. At the same time, emergency services would be contacted immediately and trained KMC technicians would be dispatched to the location to help secure the area and commence air monitoring to ensure air quality for those in the immediate vicinity.

Through Unified Command, KMC would consult with the local authorities to determine the best course of action to protect the public. A minor release may result in business as usual with ongoing air monitoring, provided there was no threat to public health or safety; while a more substantial release could result in requiring people to shelter in place until petroleum vapours dissipate or in an evacuation by local emergency services.

In the case of evacuation, KMC confirms it is responsible for all of its legal liabilities including costs associated with evacuation. KMC will work with the local authority at the evacuation centres to ensure the appropriate information regarding the claims process is disseminated to all evacuees. Trans Mountain will work with individuals affected by a pipeline/terminal incident to provide compensation as quickly and efficiently as possible.

SECTION 2.0 - 2.2 HUMAN HEALTH RISK ASSESSMENT

APPENDIX B

Date:	October 3, 2013	RWDI Reference#:	1202006

To:	Graham Veale BC Ministry of Environment	E-Mail:	J.Graham.Veale@gov.bc.ca
cc:	Glen Okrainetz BC Ministry of Environment	E-Mail:	Glen.okrainetz@gov.bc.ca
cc:	Ali Ergudenler Metro Vancouver	E-Mail:	Ali.ergudenler@metrovancouver.org
cc:	Alison Stewart Fraser Valley Regional District	E-Mail:	Astewart@fvrd.bc.ca
From:	Craig Vatcher	E-Mail:	Craig.vatcher@rwdi.com

Re: Detailed Model Plan – BC Portion of Study Area, Final (v5)
Trans Mountain Expansion Project

Please find attached the revised detailed model plan including the requested revisions to all9w sign-off by both the BC Ministry of Environment and Metro Vancouver.

RWDI acknowledges the additional questions from Metro Vancouver. These questions will be addressed in the Air Quality and Greenhouse Gas Technical Report of the ESA, which is currently in progress.

If you have any questions or comments regarding the infonnation contained in this model plan, please do not hesitate to contact Nancy Chan at (604) 730-5688 ext 2519 or the undersigned at 403-232-6771 ext 6243.

If there are no more questions or comments, please sign and date the model plan where indicated, and return a copy to RWDI for our files.

Yours very truly,

Craig Vatcher
Senior Project Manager/Associate

NWCIDSC

Attachments

Table 8.2 - Detailed Model Plan

An electronic version of this Plan template is available from the Ministry website:
www.env.gov.bc.calairlairqualitvlindex.html

General Information

Date: Oct 3, 2013

Facility Name, Company, Location (Lat, Long):

Trans Mountain Expansion Project
Kamloops Terminal (50" 39' 35" N, 120" 24' 52" W)
Sumas Terminal (49" 3' 56" N, 122" 9' 33" W)
Burnaby Terminal (49' 16' 8" N, 122" 55' 51" W)
Westridge Terminal (49' 17' 16" N, 122" 57' 16" W)

Air Quality Consultant and Contact Name:

Nancy Chan RWDI AIR Inc (604) 730-5688 x2519
David Chadder, RWDI AIR Inc. (403) 232-6771 x6228
Craig Vatcher, RWDI AIR Inc. (403) 232-6771 x6243

Ministry Contact Name:

Graham Veale

Metro Vancouver Contact Name:

Shelina Sidi

Anticipated date of ministry review completed: Oct 11, 2013

Are changes to this original plan anticipated? Y or N If yes, refer to the final table of this template.

Scope discussions are still underway and items may be added at a later date. Therefore, the final table has been included.

Does this detailed plan follow a modelling approach similar to that taken in a previous air quality assessment already reviewed and accepted by the Ministry? If so, provide the project name and ministry contact:

No.

Dispersion Model

Model Specifics

List model(s) and version to be used (see Section 2.3, 2.4). Note: follow model specific guidance in Section 9.

CALMET v6.42
CALPUFF v6.42

Note: CALPUFF v6.42 is proposed to be consistent with modelling of the Edmonton terminal which will be conducted using CALPUFF v6.42 following requirements in the draft Alberta Air Quality Model Guideline dated November 2012. This has been indicated as acceptable by the BC MOE.

Specify any non-guideline models or versions (i.e. beta-test versions) planned for use (see Section 2.1.4). Provide rationale.

CALPUFF v6.42
If modifications to any of the models are planned, provide a description and the rationale (see Section 2.1.5).

No modifications to the models are planned.

Default Switch Settings
For ISC-PRIME/S, ISC-PRIME, RTDM3.2, AERMOD identify any switch settings that could be different than the recommended defaults (see corresponding Section 9.1.3, 9.2.2, 9.3.4). Provide rationale.

N/A

For CALPUFF/CALMET identify any switch settings in CALMET Input Group 5 and CALPUFF Input Group 2 that could be subject to deviation from the "black (do not touch)" defaults as per Tables 9.8 and 9.9. Provide rationale.

No deviation from the "black (do not touch)" switch settings is planned.

CALMET Parameters

If CALMET is planned to be used, provide:
- a domain map

A separate CALMET domain will be specified for each study area shown in Figures 1 to 4.

The pipeline assessment for each terminal will be modelled using a 24 km by 24 km domain, with the Burnaby Terminal and Westridge Terminal modelled together in a single domain due to their locations less than 3 km apart. The 24 km by 24 km area is selected to include approximately 10 km distance or greater between the facility boundaries and the edge of the study area.

The marine assessment will be modelled using a 150 km by 150 km domain. To the west and south, this area extends to the end of the Strait of Juan de Fuca, and therefore, includes the entire area within which shipping lanes are relatively defined and can be reasonably represented in a dispersion model. Beyond this point, shipping lanes will diverge depending on the destination. To the east and north, this area extends approximately 15 km inland from the berths at the Westridge Terminal.

- Anticipated grid resolution: 250 m for the 24 km by 24 km domains (pipeline assessment), 1000 m for the 150 km by 150 km domain (marine assessment)

- number of grids in X andY direction: NX = NY= 96 for the 24 km by 24 km domains (pipeline assessment); NX = NY= 150 for the 150 km by 150 km domain (marine assessment)

- vertical levels (m): 0, 20, 40, 80, 160, 300,600, 1000, 1500, 2200, 3000

<u>Planned Model Output: Air Quality Assessment Needs</u>

What model output is required for decision makers and stakeholders? (i.e., what is the purpose of the assessment? – see Section 2.2). Circle as appropriate.

- Air Quality: <u>concentrations,</u> depositions, •;isibility, ro iR , isiR!J, otl1er (s eeily)

Note: Chemical transformation of S02 and NOx will be modelled using the RIVAD/ISORORIA scheme. Deposition of nitrates and sulfates will be modelled to consider secondary particulate. A more refined assessment of secondary particulate will be conducted via photochemical modelling of short-term episodes using CMAQ (not discussed in this model plan).

- Tables and Maps:
  - spatial distribution maps of air quality parameters (maxima, exceedance frequencies, annual averages)
  - tables of maximum short- and long-term average air quality parameters (locations of maximum concentrations will be provided in figures; due to causality, no one hour of meteorological conditions can be associated with maximum concentrations predicted using CALPUFF)
  - tables of concentrations predicted at select receptors of interest,
  - output spatial scale: local (<50 km), regional (>50 km)
  - special output required for odour or health risk assessments (e.g., averaging periods that are different from the BC air quality objectives)
  - other (specify):

Planned Geophysical Input

Planned Model Domlln and Receptors (check as appropriate)

_X_map of domain and receptor grid provided (see Section 6.1, 6.2)

The proposed study areas match the CALMET domains discussed above: 24 km by 24 km for the pipeline assessment, 150 km by 150 km for the marine assessment.

The standard receptor grid spacing, as per the *Guidelines for Air Quality Dispersion Modelling in British Columbia,* is proposed for the 24 km by 24 km domains (pipeline assessment), with a spacing of no more than 250m over urban areas. A single grid with 1 km spacing *is* proposed for the 150 km by 150 km domain (marine assessment).

For cumulative effects of terrestrial and marine emissions, model results over the 1 km grid (marine assessment) will be interpolated to gridded receptors within the 24 km by 24 km domain around the Burnaby Terminal and Westridge Terminal (pipeline assessment).

_X_anticipated sensitive receptors: indicate on map (if applicable) (see Section 6.4)

Planned Geophysical Data Input (check as appropriate) (see Section 8)

_X_terrain data (specify source of data):

Canadian Digital Elevation Data and USGS Shuttle Radar Topography Mission data

_X_land use (specify source of data):

BC BTM, POSTEL (US portion of Sumas study area) and USGS LULC data (US portion of marine study area)

Conversion of POSTEL land use categories are as follows:

Table 8.2- Model Detailed Plan (cont'd)

PŌSTEL Land Use Category	USGS NLCD92 Land Use Category	CALMET Land Use Category
11 – Post-flooding or irrigated cropland	82- Row crops	-20- Agricultural land- irrigated
14- Rain fed cropland	82- Row crops	20- Agricultural land – unirrigated
20- Mosaic crop and {50-70%) / Vegetation {grassland/shrub land/forest) {20-50%)	51 – Shrubland	20 -Agricultural land – unirrigated
30 – Mosaic vegetation {grassland/shrub land/forest) {50-70%) / Cropland {20-50%)	71 -Grasslands/Herbaceous	30 – Rangeland
40- Closed to open {>15%) broadleaved **evergreen or semi deciduous forest**	43- Mixed forest	43 – Mixed forest land
50- Closed (>40%) broadleaved deciduous forest (>5m)	**41 – Deciduous forest**	41 – Deciduous forest land
60- Open (15-40%) broadleaved deciduous foresUwoodland (>5m)	41 – Deciduous forest	41 – Deciduous forest land
70- Closed {>40%) needle leaved evergreen forest (>5m)	42 – Evergreen forest	42- Evergreen forest land
90- Open (15-40%) needle leaved deciduous or evergreen forest (>5m)	42- Evergreen forest	42 – Evergreen forest land
100- Closed to open (>15%) mixed broadleaved and needle leaved forest (>5m)	43 – Mixed forest	43- Mixed forest land
110- Mosaic forest or shrub land {50-70%) / Grassland {20-50%)	51 – Shrubland	40- Forest land
120- Mosaic grassland (50-70%) / Forest or shrub land (20-50%)	81 – Pasture/Hay	30- Rangeland
130- Closed to open (>15%) broadleaved or **needle leaved, evergreen or deciduous shrub** land (<5m)	81 -Pasture/Hay	30- Rangeland
140- Closed to open (>15%) herbaceous **vegetation (grassland, savanna or lichen/moss)**	81 -Pasture/Hay	30 – Rangeland
150- Sparse (<15%) vegetation	31 -Bare rock/sand/clay	70 – Barren land
160- Closed to open (>15%) broadleaved forest regularly flooded (semi-penrranently or temporarily)- Fresh or brackish water	91 -Woody wetlands	60- Wetland
170- Closed (>40%) broadleaved forest or shrub land permanently flooded – Saline or brackish water	91 -Woody wetlands	60- Wetland
180- Closed to open (>15%) grassland or **woody vegetation on regularly flooded or** waterlogged soil- Fresh, brackish or saline **water**	91 -Woody wetlands	60-Wetland
190- Artificial surfaces and associated areas (Urban areas >50%)	21 -Low intensity residential	10- Urban or built-up land
200- Bare areas	31 -Bare rock/sand/clay	70- Barren land
210- Water bodies	11 -Open water	50-Water
220- Permanent snow and ice	**12- Perennial ice/snow**	**90- Perennial snow or ice**
230- No data {burnt area, clouds, etc.)	31 – Bare rock/sand/clay	70 – Barren land

If Surface Roughness required, use Table 9.3. If this Table is not used, indicate source of data.

Table 1: Surface Roughness Heights (m)

Table B.2- Model Detailed Plan (cont'd)

Land cover characterization Category	Season 1 (Summer)	Season 2 (Autumn)	Season 3 (Winter 1)	Season4 (Winter 2)	Season 5 (Spring)
Urban	0.40	0.40	0.30	0.30	0.40
Agricultural	0.20	0.20	0.02	0.01	0.03
Rangeland	0.15	0.15	0.02	0.01	0.03
Deciduous Forest	1.30	1.30	0.60	0.50	1.00
Coniferous Forest	1.30	1.30	1.30	1.30	1.30
Mixed Forest	1.30	1.30	0.90	0.80	1.10
Water	0.001	0.001	0.001	0.002(')	0.001
Wetland[b]	0.20	0.20	0.20	0.10	0.20
Barren Land	0.05	0.05	0.05	0.05	0.05

NOTES:

Season 1: Mid summer 'Nilh lush vegetation

Season 2: Autumn with cropland that has not yet been harvested

Season 3: Winter 'Nith freezing temperatures, no snow on ground

Season 4: Winter 'Nith sub-freezing temperatures, snow cover on ground

Season 5: Transitional spring with partially green short annuals

Source: Modified from US EPA (2013)

[a] **Value borrmved from Perennial Snow or** IceH.

[b] **Values based on emergent herbaceous 'Nellands.**

If Albedo required, use Table 9.4. If this Table is not used, indicate source of data.

Table Z· Albedo

Land cover characterization Category	Season 1 (Summer)	Season 2 (Autumn)	**Season 3** (Winter **1)**	Seasol14 (Winter 2)	Season 5 (Spring)
Urban	0.16	0.16	0.18	0.45	0.16
Agricultural	0.20	0.20	0.18	0.60	0.14
Rangeland	0.20	0.20	0.18	0.60	0.14
Deciduous Forest	0.16	0.16	0.17	0.50	0.16
Coniferous Forest	0.12	0.12	0.12	0.35	0.12
Mixed Forest	0.14	0.14	0.14	0.42	0.14
Water	0.10	0.10	0.10	0.70[b])	0.10
Wetland[b]	0.14	0.14	0.14	0.30	0.14
Barren Land	0.20	0.20	0.20	0.60	0.20

NOTES:

Season 1: M!d-summenvith lush vegetation

Season 2: Autumn \vith cropland that has not yet been haiVested Season 3: Winter 'Nith freezing temperatures, no snow on ground Season 4: Winter 'Nith sub-freezing temperatures, snow cover on ground Season 5: Transitional spring with partially green short annuals

Source: Modified from US EPA (2013)

[a] **Value borrowed from "Perennial Snow or Ice".**

[b] **Values based on emergent herbaceous t.Netlands.**

If Bowen ratio required, use Table 9.5. If this Table is not used, indicate source of data.

Table 3· Bowen ratio

Land cover characterization Category	Season 1 (Summer)	Season 2 (Autumn)	Season 3 (Winter 1)	Season4 (Winter 2)	Season 5 (Spring)
Urban	0.80	1.00	1.00	0.50	0.80
Agricultural	0.50	0.70	0.70	0.50	0.30
Rangeland	0.50	0.70	0.70	0.50	0.30
Deciduous Forest	0.30	1.00	1.00	0.50	0.70
Coniferous Forest	0.30	0.80	0.80	0.50	0.70
Mixed Forest	0.30	0.90	0.90	0.50	0.70
Water	0.10	0.10	0.10	o.5o<'>	0.10
Wetland<bl	0.10	0.10	0.10	0.50	0.10
Barren Land	1.50	1.50	1.50	0.50	1.50

NOTES:

Season1: Mid-summer with lush vegetation

Season 2: Autumn with cropland that has not yet been harvested

Season 3: Winter with freezing temperatures, no snow on ground

Season 4: Winter \\lith sub-freezing temperatures, snow cover on ground

Season 5: Transitional spring with partially green short annuals

Source: Modified from US EPA(2013)

[a] **Value borrowed from "Perennial Snow or lee .**

[b] **Values based on emergent herbaceous wetlands.**

If building downwash is applicable, use BPIP-PRIME. If not BPIP-PRIME, indicate method used to specify downwash parameters.

BPIP-PRIME will be used for estimation of building downwash effects of point sources.

Planned Emission Sources and Characteristics

Emission Source Description

Table 4· Emission Source Details

Source	Type: Point (P), Area (A), Line **(L),** Voi.(V) indicate type	Contaminants (SO_2, NO_2, PM2.t•..)	Basis of Emissions (Section 5) *Underline your selection(s}, as appropriate.*
Fugitive tank emissions	P [Note 1]	H_2S, VOCs, mercaptans	proposed emission limits, manufacturer spec, emission factors, GEM, modelled emission rates stack sample other (specify): TANKS 4.09
Vapor recovery units	p	H,S, SO,NOx, CO, TSP PM_{10}, $PM_{2.5}$, VOCs, mercaptans	proposed emission limits, manufacturer sgec, emission factors, GEM, modelled emission rates stack samQie other (specify):
Line heaters and boilers	p	SO,, NOx, CO, TSP, PM_{10}, $PM_{2.5}$, VOCs	proposed emission limits, manufacturer spec, emission factors, GEM, modelled emission rates stack sample

Table B.2 -Model Detailed Plan (cont'd)

Source	Type: Point (P}, Area (A), Line (L), Voi.(V) indicate type	Contaminants (SO_2, NO,, $PM_{2.5}$' --)-	Basis of Emissions (Section 5) *Underline your se/ectlon(s), as appropriate.*
			other (specify):
Ship loading	A	H_2S, VOCs, mercaptans	proposed emissio ı limits, manufacturer spec, emission factors, GEM, modelled emission rates stack sample other (specify):
Ship exhaust	P (hotelling) orA (underway/ maneuvering)	SO,, NOx, CO, TSP, PM,o, $PM_{2.5}$. VOCs	proposed emission limits, manufacturer spec, emission factors, GEM, modelled emission rates stack sample other (specify):

NOTES:
The basis of emissions has not yet been confirmed. Slack test data and manufacturer specifications 'Nill be used in preference over emission factors but will depend on the availability of data.
All PM emissions 'Ni!l be based on total particulate (Le. filterable and condensable).
(Note 1] Tank emissions 'NiH be modelled as point sources following guidance from Ontario Ministry of Environment to allow consideration of tanks in building downwash.

Source Emission Rate Variability

Is the 25, 50, 75% emission scenario important? Y or N If yes, follow Section 5.4.1

Yes, operation of the pipeline varies with time. Modelling will be conducted for normal operation at the pipeline capacity of 300,000 bpd (Base Case) and 890,000 bpd (Project Case). Due to the variability of individual product throughput, data from the last 5 years will be reviewed as available and conservative assumptions will be made to establish the Base Case. Ship volumes will be based on the Project description and spread evenly throughout the year.

Are abnormal emission conditions important? Y or N If yes, follow Section 5.4.2

Not at this time. Spill scenarios will be modelled under separate scope.

Planned Meteorological Data Input and Processing

CALMET will be run using meteorological data for 2011. This represents the most current year with complete data.

Surface Meteorological Data

Table 5: Surface MeteoroloQical Data Stations for Pipeline Assessment at Kam oops Term1na

Surface Met Data and Location (latllong or indicate on map)	Data Source MOE, GVRD, MSC, Site Specific, other (specify) [1]	Period of Record (start/end date) [2]	%of Wind Speeds =0.0 [3]	Stability Class Method (if required) •
Afton (50.40'24" N, 120°28'54" W)	MOF	1988 to present	1.4	Not required
KamloopsA (50.42'08" N,	MSC	1953 to present	13.1	Not required

Table B.2 -Model Detailed Plan (cont'd)

Surface Met Data and Location (!at/long or indicate on map)	Data Source MOE, GVRD, MSC, Site Specific, other (specify) [1]	Period of Record (start/end date) [2]	%of Wind Spe!)dS =0.0 [3]	Stability Class Method (if required) [4]
120"26'31" WI				
Kamloops Brocklehurst (50"41'51" N, 120"23'51" W)	MOE	7/12/2009 to 6/8/2011	0.7	Not required
Kamloops Firehall (50"42'9" N, 120"24'40" W)	MOE	6/3/2011 to present	0.8	Not required

NOTES:
1. If data from a non- ministry, MV or MSC station is planned to be used, follow guidance In Section 7.2.3
2. For data completeness and data filling, follow guidance in Section 7.3.2
3. For tight wind/calm treatment, follow guidance in Section 7.5
4. For stability class, follow guidance on Section 7.6

Table 6: Surface Meteorological Data Stations for Pipeline Assessment at Sumas Terminal

Surface Met Data and Location (!at/long or indicate on map)	Data Source MOE, GVRD, MSC, Site Specific, other (specify) [1]	Period of Record (startlend date) [2]	%of Wind Speeds =0.0 [3]	Stability Class Method (if required) [4]
Abbotsford Central T33 (49'02'33'N, 122'18'35" W)	Metro Vancouver	1998 to present	0.1	Not required

NOTES:
1. If data from a non- ministry, MV or MSC station is planned to be used, follow guidance In Section 7.2.3
2. For data completeness and data filling, follow guidance in Section 7.3.2
3. For light wind/calm treatment, follow guidance in Section 7.5
4. For stability class, follow guidance on Section 7.6

Table 7: Surface Meteorological Data Stations for Pipeline Assessment at Burnaby and Westridae Terminals

Surface Met Data and Location (fat/long or indicate on map)	Data Source MOE, GVRD, MSC, Site Specific, other (specify) [1]	Period of Record (start/end date) [2]	%of Wind Speeds = 0.0 [3]	Stability Class Method (if required) [4]
Mahon Park T26 (49'19'26" N, 123'05'01'W)	Metro Vancouver	1990 to present	0.0	Not required
Second Narrows T6 (49'18'5" N, 123'01'13" W)	Metro Vancouver	1977 to present	0.0	Not required
Burnaby North T24 (49'17'15" N, 123'00'29'W)	Metro Vancouver	1999 to present	0.1	Not required
Capitol Hill T23 (49'17'16" N, 122'59'08" W)	Metro Vancouver	1995 to present	0.0	Not required
Kensington Park T4 (49'16'45" N, 122'58'15" W)	Metro Vancouver	1975 to present	0.0	Not required
Surmount T22	Metro Vancouver	1989 to present	0.0	Not required

Table B.2 - Model Detailed Plan (con!'d)

Surface Met Data and Location (!at/long or indicate on map)	Data Source MOE, GVRD, MSC, Site Specific, other (specify) [1]	Period of Record (start/end date) [2]	%of Wind Speeds =0.0•	Stability Class Method (if required) [4]
(49°16'00" N, 122°56'08" WJ				
Burnaby Mountain T14 (49°16'47" N, 122°55'20" W)	Metro Vancouver	1984 to present	0.0	Not required
Rocky Point Park T9 (49°16'51" N, 122•5o'57" W)	Metro Vancouver	1977 to present	0.3	Not required
Coquitlam T32 (49°17'18" N, 122°47'30" W)	Metro Vancouver	2000 to present	0.3	Not required
Burnaby South T18 (49°12'55" N, 122°59'09" W)	Metro Vancouver	1987 to present	0.0	Not required

NOTES:

1. If data from a non- ministry, MV or MSC station is planned to be used, follow guidance in Section 7.2.3
2. For data completeness and data Oiling, follow guidance in Section 7.3.2
3. For light wind/calm treatment, follow guidance In Section 7.5
4. For stability class. follow guidance on Section 7.6

Table 8 Surface Meteoro og1ca ID ata Stat1ons for Manne Assessment

Surface Met Data and Location (!at/long or indicate on map)	Data Source MOE, GVRD, MSC, Site Specific, other (specify) [1]	Period of Record (start/end date) [2]	%of Wind Speeds =0.0 [3]	Stability Class .Method (If required) [4]
Qualicum Beach Jones Street (49°20'18" N, 124°27'06" W)	MOE	1999 to present	0.0	Not required
Summit (48'55'39" N, 124'38'48" W)	MOF	1985 to present	15.4	Not required
Entrance Island CS (49'13'00" N, 123'48'00" W)	MSC	1994 to present	1.2	Not required
Nanaimo A (49'03'16" N, 123'52'12" W)	MSC	1954 to present	16.9	Not required
Sheringham Point (48'22'37" N, 123'55'16" W)	MSC	1994 to present	2.9	Not required
Victoria Int'l A (48'38'50" N, 123'25'33" W)	MSC	1994 to present	9.9	Not required
Saturna Capmon CS (48'46'31 N, 123'07'41" W)	MSC	2006 to present	19.7	Not required
Race Rocks CS (48'17'54" N, 123'31'54" W)	MSC	1994 to present	0.5	Not required
Sand Heads CS	MSC	1994 to present	U	Not required

Table B.2- Model Detailed Plan (cont'd)

Surface Met Data and Location (!at/long or indicate on map)	Data Source MOE, GVRD, MSC, Site Specific, other (specify) [1]	Period of Record (start/end date) [2]	%of Wind Speeds =0.0•	Stability Class Method (if required) [4]
(49"06'21" N, 123"18'12" W)				
Vancouver Int'l A (49"11'42" N, 123"10'55" Wl	MSC	1953 to present	5.6	Not required
Port Angeles (48?59" N, 123'25'59" W)	NCDC	2005 to present	3.4	Not required
Tatoosh Island (48"23'59" N, 124"43'59" W)	NCDC	1985 to present	1.3	Not required
Halibut Bank (49"20'24" N, 123"43'37" W)	EC (Buoy)	1992 to present	0.3	Not required
Cherry Point (48"51'47" N, 122"45'29" W)	NOS (Buoy)	1994 to present	0.7	Not required
Friday Harbor (48"33'49" N, 123"0'36" W)	NOS (Buoy)	1991 to present	0.5	Not required
New Dungeness (48"20'10" N, 123"9'32" W)	NDBC (Buoy)	2004 to present	0.3	Not required

NOTES:

L **If data from a nonministry, MV or MSC station Is planned to be used, follow guidance In Section 7.2.3**

> **For data completeness and data filling, follow guidance In Section 7.3.2**

3. **For Hght wind/calm treatment, follow guidance In Section 7.5**

4. **For stability class, follow guidance on Section 7.6**

Table 8.2- Model Detailed Plan (cont'd)

Mesoscale Meteorological Model Output

Table 9: Mesoscale Meteorological Model Details

Model	Agency/ Organization Providing Data	Horizontal Grid Resolution (km)	Data Peri.od (starUend date)	ForecasU Hindcast	Planned ModeiOutput Use *Underline your selection(s), as appropriate.*
WRF	RWDI	1 km	Jan 1 to Dec 31, 2011	Hindcast	CALMET "initial guess" Field CALMET "Step 1" Field CALMET as observations Pseudo ugger-air sounding Input to straight-line, Gaussian model

For testmg MM model output, see Sectton 7.1.3.

Data Processing

- Anticipated data processing utilities (see Section 7.8)

____MPRM ____PCRAMMET _X_other (specify): CALSUMIPOSTUTIUCALPOST

____unknown at this time

- Anticipated mixing height method (see Section 7.7)

_upper-air soundings _screening mixing height

_special field study _simple mixing height

_X_modelled mixing height (from MM model or CALMET)

_other (specify):

Planned Model Output

Background Concentrations

Anticipated method to define background concentrations as per Section 10.1 (check as appropriate)

_X_modelled sources (Section 10.1.3) _X_monitoring data (Section 10.1.2)

_____establish monitoring program (Section 10.1.3) _____other method- please describe

_____unknown at this time

Background concentrations for the pipeline assessment will be developed based on monitoring data as per the BC model guidelines. For the marine assessment, it would be impractical to determine a single value representing such a large area encompassing many cities as well as rural areas. Existing shipping emissions based on the Corbett inventory (or Environment Canada if available) will be modelled to represent background. These emissions will include emissions from the Westridge Terminal and would represent a "double count" but is expected to represent a minor conservatism. Cumulative effects with other sources will be considered at several discrete locations such as Vancouver Kitsilano (T2), Nanaimo Labieux Road, Duncan Cairnsmore and Victoria Topaz.

CALPUFF/CALMET Model QAJQC

If CALPUFF/CALMET is planned, follow guidance provided in Section 10.2.1.1 and Section 10.2.1.2 for QAJQC protocols.

These QA/QC protocols will be followed.

Special Topics

Indicate the condilions that are planned to be considered as part of the assessment.

Stagnation Conditions

Y or N If Yes, follow guidance in Seclion 11.2

Shore/Coastal Effects

Y or N If Yes, follow guidance in Section 11.3

Shore/Coastal effects are relevant for the marine assessment. The CALPUFF model proposed can handle this as per Section 11.3.

Horizontally Oriented Stacks and Stacks with Raincaps

Y or N If Yes, follow guidance in Section 11.6

Plume Condensation (Fogging) and Icing

Y or N If Yes follow guidance in Section 11.7

NO to NO,Conversion

Y or N If Yes, follow guidance in Section 11.4 Which method will be used?

_X_100% conversion

_X_Ambient Ratio (indicate monitoring station: see Section 11.4)

____OLM (specify background 03 concentration: see Section 11.4)

The use of the ambient ratio method will be used with data from the following monitoring stations:

24 km by 24 km (pipeline assessment) around Kamloops Terminal- Kamloops Brocklehurst, Kamloops Firehall (note Kamloops Firehall replaced Kamloops Brocklehurst in June 2011)

24 km by 24 km (pipeline assessment) around Sumas Terminal-Abbotsford Central

24 km by 24 km (pipeline assessment) around Burnaby and Westridge Terminals – Burnaby Kensington Park, Port Moody, Coquitlam, North Vancouver Mahon Park, Burnaby South

150 km by 150 km (marine assessment) - Nanaimo Labieux Road, Duncan Cairnsmore, Victoria Topaz, Tsawassen

For areas with multiple stalions identified, a single curve will be developed based on all data. Per BC model guidelines, a separate curve will first be developed for the one-hour and 24-hour averaging periods. If this results

Table B.2- Model Detailed Plan **(cont'd)**

in 24-hour NO_2 concentrations that are higher than one-hour NO,concentrations, one-hour NOx concentrations (including background) will be converted to one-hour NO_2 concentrations, and longer term averages will be calculated based on the converted one-hour NO_2 results.

____AERMOD PVRM (specify background O_3 concentration and how it was selected, and if non default equilibrium ratios and in- stack ratios are used, specify and provide rationale: see Section 11.4)

Table 10: Detailed Model Plan Submission Dates

Date	**Addition or Revision of Detailed Model Plan**
03/20/2013	Initial detailed plan submission
05/17/2013	Submission of updated detailed model plan and response to comments
06/25/2013	Submission of updated detailed model plan and response to comments
07/17/2013	Submission of updated detailed model plan and response to comments
10/03/2013	Submission of final detailed model plan with revisions to allow for sign-off by both Ministry and Metro Vancouver

Ministry Acceptance of Original Plan (Name): GRAHAM VEALE

Metro Vancouver Acceptance of Original Plan (Name): Shelina Sidi

Date: Ow 10.2013

A detailed plan can change over the course of developing the air quality assessment so acceptance of the initial submission of the plan is on the basis of the best information provided to date. Changes to the plan (additions, modifications) should be noted in the above table and agreed to with the ministry as necessary. Further guidance on this is provided in Section 4.

- expected. Exceedances were predicted for NO_2 and the respiratory irritants mixture under each of the assessment cases (*i.e.,* Base Case, Application Case, and Cumulative Case). The NO_2 exceedances were determined to be very few in number, low in frequency, and modest in magnitude. For the respiratory irritants mixture, the exceedances were determined to be very few in number, very low in frequency, and modest in magnitude within the communities; albeit, at the MPOI, the exceedances were determined to be more frequent. Further examination of the predicted exceedances indicates that the health risks are considered low, and that adverse health effects are not predicted to occur.

- In all cases, the predicted chronic health risks associated with exposure to the COPC via inhalation and the various secondary pathways of exposure (*i.e.,* inhalation of dust, food ingestion, and dermal contact) were below the benchmark (or target risk estimate) for the non-carcinogenic chemicals emitted from the Project and Project-related marine vessel traffic, indicating that adverse health effects would not be expected.

- In all cases, the predicted cancer risks associated with the Project and Project-related marine vessel traffic were predicted to be less than 1 in 100,000 (*i.e.,* less than one extra cancer case in a population of 100,000 people), indicating that the incremental cancer risks from the Project and Project-related marine vessel traffic are deemed to be "essentially negligible."

45.1.1 Human Health Effects Associated with Emissions to Air

45.1.1.1 1,3-Butadiene

Concern was expressed by BROKE (Filing ID A4L6U5), City of Burnaby (Filing ID A4L8H6), City of Vancouver (Filing IDs A4L7V8 and A4L7K9), and NS NOPE (Filing IDs A4L5V1 and A4L9R1) over the potential human health effects associated with short-term and long-term exposure to 1,3-butadiene emitted from the Project and Project-related marine vessel traffic. As part of its evidence, BROKE and NS NOPE included a report entitled "Major Human Health Impacts of the Kinder Morgan Trans Mountain Pipeline Expansion" prepared by T. Takaro *et al.*, which expressed concern over the potential health effects associated with short-term and long-term exposure to 1,3-butadiene on an individual basis and as part of a mixture, particularly as part of a leukemogens mixture with benzene. A report prepared by J. Edmonds entitled "What are the Health Effects of Pipelines and Oil Spills" also was included as part NS NOPE's evidence. Ms. Edmond's report contains a general statement regarding the potential cancer risks associated with long-term exposure to the chemicals, notably 1,3-butadiene, emitted from the Westridge Marine Terminal.

As part of its evidence, the City of Burnaby and City of Vancouver included a report prepared by Fraser Health and Vancouver Coastal Health entitled "Guidance to Metro Vancouver and Fraser Valley Municipalities to Assist in Reviewing the Trans Mountain Pipeline Project from a Public Health Perspective." The City of Vancouver expressed concern in its written evidence that 1,3-butadiene was omitted as a COPC from the HHRAs, citing a statement taken from the report prepared by Fraser Health and Vancouver Coastal Health. The Fraser Health and Vancouver Coastal Health report was submitted previously as an attachment to FVRD IR No. 2.01. A complete response to the report was presented in Trans Mountain's response to FVRD IR No. 2.01 (Filing ID A4H8R9).

The concern regarding the potential health effects associated with exposure to 1,3-butadiene emitted from the Project and Project-related marine vessel traffic on an individual basis is addressed here, while the concern over 1,3-butadiene acting as part of a leukemogenic mixture is addressed in Section **Error! Reference source not found.**.

As discussed in Trans Mountain's response to FVRD IR No. 2.01 (Filing ID A4H8R9), the association between Project and Project-related marine vessel traffic emissions and 1,3-butadiene remains uncertain. 1,3-Butadiene was not identified in the air emissions inventories for the Project or Project-related marine vessel traffic because:

- 1,3-Butadiene was not detected in either the bulk liquid analysis of CLWB (Filing ID A3S4W9), nor the vapours above CLWB (Filing ID A3Y2D4), which served as the basis for the fugitive or uncontrolled emissions inventory for the Project and Project-related marine vessel traffic; and
- 1,3-Butadiene was not listed on Environment Canada's National Marine Emissions Inventory for Canada (SNC-Lavalin Group Inc. 2012), which served as the basis of the air emissions inventory for the Project-related marine vessel engines.

Although a number of authorities such as the California Air Resources Board (CARB), the International Agency for Research on Cancer (IARC), and the U.S. EPA have associated 1,3-butadiene with diesel exhaust (CARB 2006; IARC 2014; U.S. EPA 2002a,b; U.S. EPA 2009), the association appears to relate to emissions from land-based diesel engines, and not marine diesel engines (Genesis Engineering Ltd. [Genesis] and Levelton Engineering Ltd. [Levelton] 2003).

Despite the above, the potential health risks for 1,3-butadiene were presented and described in response to FVRD IR No. 2.01 (Filing ID A4H8R9), and NS NOPE and BROKE IR No. 2.4a (Filing ID A4H8W0). For the purposes of the screening-level exercise, people were assumed to be found on both a short-term and long-term basis at the locations within Burrard Inlet corresponding to the MPOI. As previously discussed, the MPOI refers to the location at which the highest air concentration of 1,3-butadiene would be expected to occur, and at which the exposures received by the people within the Burrard Inlet would be greatest. Use of the MPOI location ensures that any potential health effects that could result from exposure to the 1,3-butadiene emissions associated with the Project-related marine vessel traffic would not be underestimated, regardless of where people might be exposed.

Reliance was placed on air dispersion modelling performed by RWDI and described in Marine Air Quality and Greenhouse Gas Technical Report – Supplemental No. 2 (Filing IDs A4F5H7, A4F5H8, A4F5H9, A4F5I0, A4F5I1, and A4F5I2). Maximum predicted 1,3-butadiene air concentrations were derived by RWDI from the maximum predicted air concentrations of total VOC using a speciation factor of 0.002 for land-based diesel engines (Genesis and Levelton 2003). Maximum predicted air concentrations were provided for different averaging periods (*i.e.,* 24-hour and annual) to allow for the assessment of both acute and chronic health risks. Consistent with the previous assessments, maximum predicted air concentrations were provided for the three assessment cases (*i.e.*, Base Case, Application Case, and Cumulative Case), as well as for the potential increase in marine vessel traffic associated with the Project (*i.e.*, Project).

On a short-term basis, peak (1st highest) predicted 24-hour air concentrations for the three assessment cases (*i.e.*, Base Case, Application Case, and Cumulative Case) were compared

with the acute (24-hour) exposure limit or Reference Concentration (RfC) of 15 µg/m³, which was developed by the U.S. EPA (2002a) for the protection of the human population (including sensitive individuals) against the potential reproductive and developmental effects associated with short-term inhalation of 1,3-butadiene.[1] Chronic health risks were assessed by comparing the maximum predicted annual air concentrations for the three assessment cases (*i.e.*, Base Case, Application Case, and Cumulative Case) to the U.S. EPA's chronic RfC of 2 µg/m³ for the potential reproductive and developmental effects associated with long-term inhalation of 1,3-butadiene (U.S. EPA 2002a). The potential cancer risks, specifically the risk of developing leukemia, also were assessed. The incremental lifetime cancer risks for 1,3-butadiene were determined by comparing the maximum incremental increase in predicted annual average air concentrations associated with the Project-related marine vessel traffic against the U.S. EPA's Risk-specific Concentration (RsC) of 0.3 µg/m³.[2] Complete details surrounding the manner by which the assessment was performed, the results that emerged, and the conclusions that were reached were presented in the response to FVRD IR No. 2.01 (Filing ID A4H8R9) and NS NOPE and BROKE IR No. 2.4a (Filing ID A4H8W0).

Overall, the weight-of-evidence indicates a low risk of adverse health effects associated with short-term and long-term exposure to 1,3-butadiene in the Burrard Inlet area. The weight-of-evidence includes:

- In all cases, the maximum predicted short-term and long-term exposures to 1,3-butadiene were below the corresponding exposure limits, indicating that adverse health effects would not be anticipated.
- In all instances, cancer risks for 1,3-butadiene were predicted to be less than 1 in 100,000 (*i.e.,* less than one extra cancer case in a population of 100,000 people), indicating that the incremental cancer risks from the Project-related increase in marine vessel traffic are deemed to be "essentially negligible."

Moreover, the contribution from the Project-related marine vessel traffic to the cumulative 1,3-butadiene exposures was negligible. In all instances, the potential health risks remained unchanged between the Base Case and Application Case, signifying that the Project-related marine vessel traffic will have very little, if any, effect on the Base Case health risks associated with 1,3-butadiene exposure.

45.1.1.2 Benzene

As discussed earlier, BROKE (Filing ID A4L6U5) and NS NOPE (Filing ID A4L9R1) submitted a report prepared by T. Takaro *et al*. Consistent with the 1,3-butadiene-related concern addressed above, the report expressed concern over the potential human health effects associated with short-term and long-term exposure to benzene on an individual basis and as part of a mixture, particularly as part of a leukemogens mixture with 1,3-butadiene. The report prepared by J. Edmonds for NS NOPE (Filing ID A4L5V1) also contained a general statement regarding the potential cancer risks associated with long-term exposure to the chemicals, notably benzene,

1.

[1] RfC refers to level of an airborne chemical at which adverse health effects would not be expected. It is expressed as a concentration of the chemical in air (i.e., µg/m³) and applies only to threshold chemicals.

[2] RsC refers to the level of an airborne carcinogen that results in a regulatory acceptable incremental increase in cancer (typically 1 in 100,000). It is expressed as a concentration of the chemical in air (*i.e.*, µg/m³) and applies only to carcinogens.

Sensory disturbance, Section 8.4.7:

- Employ all measures in the Environmental Protection Plans related to management of noise, air emissions, dust, odours, lighting, and litter/waste.
- Notify potentially affected residents of any major construction activities that will occur at night.

Community way-of-life, Section 8.4.11:

- Continue communication and engagement with stakeholders as the Project progresses.
- Develop and implement an issues tracking process to monitor and respond to Project-related socio-economic issues and opportunities that emerge during construction and reclamation.
- Establish a process by which community members can raise complaints or concerns related to Project activities or workers. Ensure this process includes protocols for timely follow-up by Trans Mountain and/or its Contractors and transparent issue resolution, and communicate this process to communities.

Alongside these commitments, the responses to NEB IR No. 1.16a and 1.17d discuss the development of a Community Readiness Engagement Program and a Worker Code of Conduct, respectively. Both of these commitments aim to reduce stress and anxiety about the Project.

f) An Automated Monitoring System (SAM[1]) unit is installed in the northwest corner of the Burnaby terminal as shown on Figure 1 of the response to NEB IR No.1.35a (NEB IR No.1.35a – Attachment 1). The SAM unit collects sulphur dioxide (SO_2), hydrogen sulphide (H_2S) and total volatile organic compounds (VOCs), wind speed and wind direction data based on 1-minute averages. Odours will therefore be monitored indirectly, though the monitoring of the above contaminants. A new ambient monitoring station will be installed at the Westridge Marine Terminal in 2015. This new unit will meet the nine requirements of NEB Draft Condition No. 21 – Air Emissions Management Plan for the Westridge Marine Terminal. This Condition requires methods and schedule for ambient monitoring of contaminants of potential concern in air including particulate matter, carbon monoxide, nitrogen dioxide, sulphur dioxide, hydrogen sulphide and volatile organic compounds.

In addition to the SAM unit installed directly at the Burnaby terminal, there are also Metro Vancouver (MV) and National Air Pollution Surveillance (NAPS) stations in the proximity of the Burnaby and Westridge Marine terminals. These stations monitor SO_2, total reduced sulphur (TRS) and VOCs (refer to the Application, Section 3.4.1.2 of Technical Report 5C-4 in Volume 5C, Air Quality and Greenhouse Gas Technical Report [RWDI December 2013]). Summaries from the MV and NAPS stations, which monitor SO_2, TRS

[1] Système Automatisé de Monitoring

and VOCs and corresponding methods and schedules are shown in Table 1.03.07F-1. The distances to the Burnaby and Westridge Marine Terminals are also included.

TABLE 1.03.07F-1

METRO VANCOUVER (MV) AND NATIONAL AIR POLLUTION SURVEILLANCE (NAPS) AIR QUALITY MONITORING STATIONS NEAR BURNABY AND WESTRIDGE MARINE TERMINALS

Station ID	Station Name / Data Source	Longitude, Latitude, Location Relative to the Terminal Centre	Contaminants Monitored[1]	Schedule	Methods
26a	Burmount / NAPS (ID 100133)	-122.936, 49.267 500 m southwest of the Burnaby Terminal and 2.7 km southeast of the Westridge Marine Terminal	Volatile organic compounds including benzene, toluene, ethyl benzene and xylene	Intermittent basis (every sixth day)	Canister
26b	Burnaby-Burmount / MV (ID T22)	-122.936, 49.267 500 m southwest of the Burnaby Terminal and 2.7 km southeast of the Westridge Marine Terminal	TRS	Continuous	Instrumental
27	Burnaby-Capitol Hill / MV (ID T23)	-122.986, 49.288 4.5 km northwest of the Burnaby Terminal and 2.2 km west of the Westridge Marine Terminal	SO_2, TRS	Continuous	Instrumental
28	Burnaby North Eton	-123.008, 49.288 5.5 km west-northwest of the Burnaby Terminal and 3.7 km west of the Westridge Marine Terminal	SO_2	Continuous	Instrumental
29	Burnaby Kensington Park / MV (ID T04)	-122.971, 49.279 3 km northwest of the Burnaby Terminal and 1.4 km southwest of the Westridge Marine Terminal	SO_2, TRS	Continuous	Instrumental
30	Port Moody / MV (ID T09)	-122.849, 49.281 6 km northeast of the Burnaby Terminal and 7.6 km east-southeast of the Westridge Marine Terminal	SO_2	Continuous	Instrumental
33	Second Narrows / MV (ID T06)	-123.020, 49.302 7 km northwest of the Burnaby Terminal and 4.9 km west-northwest of the Westridge Marine Terminal	SO_2	Continuous	Instrumental
34	Burnaby South / MV (ID T18)	-122.986, 49.215 7 km southwest of the Burnaby Terminal and 8.4 km south-southwest of the Westridge Marine Terminal	SO_2	Continuous	Instrumental

Notes: 1. SO_2 = sulphur dioxide; TRS = total reduced sulphur (only SO_2, TRS and volatile organic compounds are shown)

45.1.1.3 Diesel Particulate Matter

The City of Burnaby (Filing ID A4L8H6), City of Vancouver (Filing IDs A4L7V8 and A4L7K9), FVRD (Filing ID A4L8W6), Metro Vancouver (Filing ID A4L7Y3) and Miller B (Filing ID A4L8L6) expressed concern regarding the potential health risks associated with exposure to DPM emitted from the Westridge Marine Terminal and Project-related marine vessel traffic. Particular concern was expressed by FVRD, Metro Vancouver and B. Miller regarding the potential cancer risks.

As part of its evidence, the City of Burnaby and the City of Vancouver included a report prepared by Fraser Health and Vancouver Coastal Health entitled "Guidance to Metro Vancouver and Fraser Valley Municipalities to Assist in Reviewing the Trans Mountain Pipeline Project from a Public Health Perspective." The City of Vancouver expressed concern in its written evidence that DPM was omitted as a COPC from the HHRAs, citing a statement taken from the report prepared by Fraser Health and Vancouver Coastal Health. The Fraser Health and Vancouver Coastal Health report was submitted previously as an attachment to FVRD IR No. 2.01. A complete response to the report was presented in Trans Mountain's response to FVRD IR No. 2.01 (Filing ID A4H8R9).

In its written evidence (Filing ID A4L7Y3), Metro Vancouver stated the following with respect to the risks associated with DPM:

> *"*Metro Vancouver requests that the NEB reject Trans Mountain's flawed analysis and conclusions regarding DPM cancer risk presented in both the Responses to Lower Fraser Valley Air Quality Coordinating Committee Informal Information Requests and Response to Fraser Valley Regional District IR No. 2. The only way to credibly assess cancer risks associated with Project-related DPM is to use maximum over-land DPM concentrations from Marine Air Quality dispersion modeling, together with the OEHHA cancer unit risk for DPM. As demonstrated above, DPM cancer risks associated with the Project exceed Health Canada screening thresholds, so it is vital that further dispersion modeling and associated human health risk assessment be performed to clarify the validity of the assumptions underpinning the existing analyses*."* [Section 3.10.2, page 48, 1st paragraph]

Metro Vancouver supports its position by suggesting that:

1. Based on the results of two toxic air pollutant risk assessments prepared for the Lower Fraser Valley (*i.e.*, Exhibits 17 and 18 in the Metro Vancouver submission [Filing IDs A4L8A3 and A4L8A4, respectively]), Trans Mountain inaccurately characterized the "*evidence supporting DPM cancer risks, and the relative level of DPM health risks posed by the Project*" [Section 3.10, page 44, 3rd paragraph];

2. In its assessment of the DPM-related health risks, Trans Mountain "dismissed" the California Office of Environmental Health Hazard Assessment (OEHHA) cancer unit risk value for DPM;

3. An appropriate way to assess the DPM-related health risks would be to adopt a conservative risk assessment approach by applying the OEHHA unit risk value for lung cancer;

4. Trans Mountain inappropriately characterized the cancer risks by using DPM concentrations averaged over the air quality local study area to present a "*population-level risk*";

5. Existing background DPM levels in the areas surrounding Burrard Inlet result in background DPM cancer risks that are well in excess of Health Canada's 1 in 100,000 (equivalent to 10 per million) screening level (*i.e.*, 372 per million) [Section 3.10.1, page 47]; and,

6. The incremental emissions associated with the Application Case result in maximum DPM concentrations and associated cancer risks that exceed the 10 per million screening level by a considerable margin.

In their submission, FVRD states that:

> *"The information provided by Trans Mountain suggests that under the project case, excess cancer cases due to diesel particulate matter could be 630 per 1,000,000 people over a lifetime of exposure, which is more the [sic] sixty times higher the [sic] Health Canada threshold. It is acknowledged that this value includes previous base case or background levels, which would be above the 10 in 1,000,000 threshold as well. However, the situation underscores that the existing risk posed by diesel emissions in the Lower Fraser Valley is unacceptably high, and that any increase in diesel emissions, including from the proposed TMEP, must be mitigated to avoid increasing the health risk for developing cancer."* [Section 23 of Rebecca Abernathy Affidavit]

This statement is similar to the argument made by Metro Vancouver with respect to the calculated DPM-related excess cancer risks (see point 5 above).

Each of the concerns raised by Metro Vancouver and FVRD is addressed in Trans Mountain's response below. In doing so, Trans Mountain will provide evidence that its assessment of the potential health risks associated with DPM in the area remains appropriate and that the conclusions with respect to the Project-related cancer risks remain valid.

Trans Mountain provided a comprehensive assessment of the potential carcinogenicity of DPM in its response to FVRD IR No. 2.12 (Filing ID A4H8S0). This response described how the weight-of-evidence currently does not support the use of a cancer-based exposure limit for assessing the health risks associated with DPM. However, in order to explicitly address FVRD's concern, the response to FVRD IR No. 2.12 presented the cancer risks using the same OEHHA unit risk value that was used to characterize the DPM cancer risks in Exhibits 17 and 18 of the Metro Vancouver submission (Filing ID A4L8A3 and Filing ID A4L8A4, respectively).

Trans Mountain fully recognizes that there is general consensus among regulatory agencies that diesel exhaust, including DPM, is carcinogenic (IARC 2014, National Toxicology Program 2014, OEHHA 2001). However, considerable uncertainty exists with respect to the actual dose-response relationship of DPM, thereby limiting regulators' ability to develop a proper cancer-based exposure limit (U.S. EPA 2009). In light of this uncertainty, neither Health Canada nor the U.S. EPA has developed a cancer-based exposure limit (or unit risk value) for DPM. In Section 3.10.1 of its evidence (Filing ID A4L7Y3), Metro Vancouver contends that "*an appropriately conservative risk assessment approach would be to use the OEHHA's cancer unit risk in the*

Trans Mountain assessment, while acknowledging the inherent uncertainty raised by the US EPA and others." The fact is that Trans Mountain used the OEHHA cancer unit risk in its assessment of DPM and in doing so described in detail the "*inherent uncertainty raised by the US EPA*" in its response to FVRD IR No. 2.12. Trans Mountain maintains that the low confidence of the OEHHA cancer unit risk essentially limits its usefulness when attempting to assess the potential risks to health associated with DPM exposure.

The basis of the OEHHA cancer unit risk is a retrospective case-control investigation published in a series of papers from a research team that evaluated diesel particulate exposure and lung cancer mortality in railway workers during the 1980s (Garshick *et al*. 1987, 1988; Woskie *et al*. 1988a,b). However, the U.S. EPA argues that use of a cancer-based exposure limit is not supported by the current state of science. The key factors that substantiate the U.S. EPA conclusion were described in detail in Trans Mountain's response to FVRD IR No. 2.12.

The U.S. EPA's (2009) Integrated Science Assessment document for PM includes a comprehensive review of the epidemiological literature on DPM that was available at the time of their assessment. The U.S. EPA (2009) acknowledged that there is considerable evidence from human and animal studies that strongly supports classification of DPM as a carcinogen, but concluded that a confident dose-response relationship (and corresponding cancer-based exposure limit) could not be established due to the existing data gaps and uncertainties. The sources of uncertainty highlighted by the U.S. EPA also were described in Trans Mountain's response to FVRD IR No. 2.12. For ease of reference, the sources of uncertainty identified by the U.S. EPA are restated here:

- absence of DPM exposure data for workers in the available occupational studies;
- absence of DPM exposure data for controls in the available occupational studies owing to the presence of diesel engine exhaust in ambient air for controls in a non-occupational setting;
- possible confounders such as smoking or asbestos exposure that could contribute to cancer risks observed in the occupational studies;
- the representativeness of occupational workers for the general population, including sensitive subpopulations;
- use of supporting animal data from rats with lung tumor responses to direct inhalation exposure given that the mode of action in high exposure rat responses is not suitable for human dose response analysis at environmental levels of exposure; and,
- use of health effects data that were derived from engine technologies and fuels that existed in the past and may no longer be representative of health effects from DPM emissions of modern engines and fuel.

Contrary to Metro Vancouver's assertion, Trans Mountain did not inaccurately characterize the evidence supporting DPM cancer risks. In fact, Trans Mountain's position with respect to the use of a cancer-based exposure limit is well supported by the U.S. EPA. Further support of this position can be found in Health Canada's letter of comment (Filing ID A4S0Z6), which states

that "*there is much uncertainty about the unit risk factor for DPM, therefore, the calculated ILCR should be interpreted with much caution*." Metro Vancouver further suggested that Trans Mountain "dismissed" the OEHHA cancer unit risk value for DPM. However, the fact is that Trans Mountain carefully reviewed and weighed the basis of the OEHHA value. Coupled with the rationale provided in the U.S. EPA assessment of DPM, Trans Mountain determined that there was greater certainty in assessing the potential health risks for DPM using the U.S. EPA chronic non-cancer exposure limit. As such, its initial assessment of DPM was based on the U.S. EPA non-cancer inhalation exposure limit of 5 $\mu g/m^3$ (Filing ID A4F5C9). Trans Mountain's interpretation of the DPM exposure limits appears to be supported by the 2015 Sonoma Technology "Toxic Air Pollutants Risk Assessment" for Metro Vancouver (Filing ID A4L8A4), which indicated that the dose-response certainty for lifetime excess cancer risk for DPM is low (see Figure 2-2 in Filing ID A4L8A4). The same report further classifies the dose-response certainty for non-cancer risk for DPM as high (see Figure 2-3 in Filing ID A4L8A4).

Metro Vancouver argues that Trans Mountain inappropriately characterized cancer risks when it used DPM air concentrations averaged over the air quality LSAs in its response to FVRD IR No. 2.12. Metro Vancouver suggests that Trans Mountain's approach underestimates the risks at certain over-land locations and is "out of step" with the approach used for the rest of the HHRAs. As described in the response to FVRD IR No. 2.12, Trans Mountain elected to use predicted DPM air concentrations averaged over a 5 km radius centred on the Westridge Marine Terminal in order to remain consistent with the approach presented in the Levelton 2007 "Air Toxics Emission Inventory and Health Risk Assessment" (Filing IDs A4L8A3 and A4L8X8). Like the 2015 Sonoma Technology assessment (Filing IDs A4L8A4), the Levelton 2007 report presented single DPM air concentrations and carcinogenic risk estimates for the entire GVRD and FVRD region. As opposed to presenting risks at discrete receptor locations, this allows for a more reasonable estimate of population-level risks.

Health Canada and the BC MOE assume that any level of long-term exposure to carcinogenic chemicals is associated with some hypothetical risk of cancer. On this basis, Health Canada and BC MOE have specified an incremental or excess (*i.e.*, over and above background) lifetime cancer risk of 1 in 100,000, which these regulatory health authorities consider acceptable, tolerable or essentially negligible (BC MOE 2009, Health Canada 2010). The 1 in 100,000 excess cancer risk level is equivalent to the 10 in 1,000,000 screening level that Metro Vancouver and FVRD refer to in their submissions. Because the assumed acceptable cancer risk level of 1 in 100,000 was specifically developed to address cancer risks over and above background cancer incidence, background exposures typically are not included in the assessment of potential health risks for non-threshold compounds like DPM. In its response to FVRD IR No. 2.12, Trans Mountain calculated an incremental lifetime cancer risk (ILCR) for DPM by comparing the predicted incremental level of exposure associated with the Project-related marine vessel traffic to the OEHHA unit risk value. The calculated ILCR for the Project-related marine vessel traffic was then compared to the acceptable cancer risk level of 1 in 100,000. As shown in Table 2.12A-3, in the response to FVRD IR No. 2.12, the predicted Project-related excess cancer risks for the DPM concentrations averaged over the air quality LSA were less than 1 in 100,000 (*i.e.*, 0.8 in 100,000).

Trans Mountain does acknowledge that, when using the OEHHA unit risk value for DPM, the calculated excess cancer risks will exceed 1 in 100,000 at certain locations along the shores of the Burrard Inlet. The predicted DPM concentrations for the Project-related marine vessel traffic are shown as a series of contours in Figure 45.1.1. The DPM concentrations are presented for

the following concentration ranges (or contours): 0.033 µg/m³ to 0.066 µg/m³; 0.066 µg/m³ to 0.132 µg/m³; and, 0.132 µg/m³ to 0.18 µg/m³. The last concentration range "ends" at 0.18 µg/m³ because this equates to the maximum DPM concentration predicted for the Project-related marine vessel traffic. The concentrations in Figure 45.1.1 are based on the assumptions that all emitted $PM_{2.5}$ is in the form of DPM and that marine vessels at berth include boilers.

The OEHHA provides an inhalation unit risk of 0.0003 per µg/m³ (OEHHA 2001). Based on this, 1 µg/m³ of DPM theoretically equates to an excess lung cancer risk of 30 in 100,000. Another way to put this is that a DPM air concentration of 0.033 µg/m³ equates to a lung cancer risk of 1 in 100,000, which is the incremental or excess cancer risk level considered negligible by Health Canada and BC MOE. Therefore, the concentration ranges presented in Figure 45.1.1 would equate to Project-related cancer (lung) risk levels of: 1.0 in 100,000 to 2.0 in 100,000; 2.0 in 100,000 to 4.0 in 100,000; and, 4.0 in 100,000 to 5.4 in 100,000.

These risk estimates should be interpreted with some degree of caution. This is perhaps best illustrated by exploring the estimates of cancer risk presented in the 2007 Levelton and 2015 Sonoma Technology reports (*i.e.*, Filing IDs A4L8X8, A4L8A3 and A4L8A3), all of which are based on the OEHHA unit risk value for lung cancer (*i.e.,* 0.0003 per µg/m^3). In their submissions to the NEB, both FVRD and Metro Vancouver relied heavily on the Levelton (2007) and Sonoma Technology (2015) reports. In its "Air Toxics Emission Inventory and Health Risk Assessment," Levelton (2007) estimated a single lung cancer risk of 35 in 100,000 (or 350 in 1,000,000) for the Greater Vancouver Regional District and the FVRD (page 6, Filing IDs A4L8X8 and A4L8A3). In a more recent analysis, Sonoma Technology (2015) calculated a single lung cancer risk of 22.4 in 100,000 (or 224 in 1,000,000) for the entire LFV (page 2-10, Filing ID A4L8A3). In presenting this risk, Sonoma Technology (2015) acknowledges that the "*diesel PM risk estimate should be considered highly uncertain as a quantitative value*." These calculated risk estimates suggest that existing DPM concentrations in Metro Vancouver and FVRD may be responsible for 22.4 to 35.0 cases of lung cancer per 100,000 people.

However, the cancer risk estimates presented in the Levelton and Sonoma reports are not borne out by the actual number of cases of lung cancer in the LFV. In fact, the lung cancer risk estimates presented by Metro Vancouver and FVRD appear to significantly overstate the actual risk of DPM-related lung cancer in the region.

Figure 45.1.1 Predicted Annual Diesel Particulate Matter Concentrations, Including All Marine Transportation, Project Only Case (in µg/m³)

In their BC 2011 Regional Cancer Report, the BC Cancer Agency presents the following age-standardized incidence rates of lung cancer per 100,000 for the Fraser Health and Vancouver Coastal Health regions[1]:

- Fraser Health = 46.82 per 100,000
- Vancouver Coastal Health = 41.64 per 100,000

According to the Canadian Cancer Society[2], the primary risk factors for lung cancer, listed in order from most significant to least significant, are:

- smoking tobacco;
- second-hand smoke;
- radon;
- asbestos;
- outdoor air pollution;
- occupational exposure to chemical carcinogens;
- personal or family history of lung cancer;
- arsenic;
- previous lung disease;
- exposure to radiation;
- indoor burning of coal;
- weakened immune system; and
- lupus.

The risk factor that appears to overwhelm all others is exposure to tobacco smoke. In fact, the BC Lung Association indicates that more than 90% of lung cancers in men and at least 70% in women are directly caused by cigarette smoking[3]. This is supported by the BC Cancer Agency[4], which suggests that "about 85-90% of lung cancer patients are smokers, former smokers or people exposed long-term to second-hand smoke." Similarly, the Canadian Cancer Society suggests that smoking is related to more than 85% of lung cancer cases in Canada, while the

1 http://www.bccancer.bc.ca/statistics-and-reports-site/Documents/Section8IncidenceMortalitySurvivalandPrevalencePar%20(2).pdf
2 http://www.cancer.ca/en/cancer-information/cancer-type/lung/risks/?region=on
3 http://www.lung.ca/lung-health/lung-disease/lung-cancer/causes
4 http://www.bccancer.bc.ca/health-info/types-of-cancer/lung/lung

Centers for Disease Control and Prevention[5] links smoking to about 90% of lung cancers in the United States.

Using the Fraser Health statistic as an example, between 39.8 and 42.1 cases of lung cancer per 100,000 are likely due to smoking (*i.e.*, between 85% and 90% of the overall rate of 46.8 per 100,000). This suggests that the other risk factors may be responsible for approximately 4.7 to 7.0 cases of lung cancer per 100,000 (*i.e.*, 10-15% of the overall rate in the Fraser Health region). However, these numbers are in stark contrast to the cancer risks presented in the Levelton and Sonoma reports. For example, in the Sonoma Technology (2015) report, the risk for lung cancer associated with DPM was presented as 22.4 per 100,000. In its submission, Metro Vancouver uses the OEHHA unit risk value to suggest that existing ("background") DPM levels in the areas surrounding Burrard Inlet could result in DPM cancer risks that are even higher (*i.e.*, 37.2 per 100,000, see Section 3.10.1, page 47]. When based on the OEHHA unit risk value, the calculated risk estimates would suggest that DPM is the dominant risk factor for lung cancer in the region (*i.e.*, it would erroneously exceed the risks associated with tobacco smoking). In all likelihood, use of the OEHHA unit risk value results in an exaggeration of the actual risks to the DPM-related cancer risks in the region.

In response to the concerns raised by FVRD and Metro Vancouver with respect to DPM, Trans Mountain offers that:

- It used a scientifically defensible approach for assessing the potential health risks for DPM in both the responses to the LFVAQCC and to FVRD IR No. 2.12.
- There is low confidence in the OEHHA unit risk value that FVRD and Metro Vancouver used to characterize the potential carcinogenic risks associated with DPM.
- The incremental emissions associated with the Project-related marine vessel traffic will not exceed the 1 in 100,000 screening level by a considerable margin.
- The excess lung cancer risks presented in the FVRD and Metro Vancouver submissions are unrealistic estimates of what the actual DPM-related risks are for lung cancer in the region.

Finally, Trans Mountain stands by its original conclusion that the Project-related marine vessel traffic is not expected to adversely affect health in the region.

45.1.1.4 Lead

In its written evidence, the City of Vancouver (Filing ID A4L7V8) suggests that the potential health effects of long-term inhalation exposure to lead be assessed using information presented in BC Ministry of Environment's "Technical Guidance on Contaminated Sites: Supplemental Guidance for Risk Assessment" (Filing ID A4L7K7), notably the OEHHA's inhalation unit risk estimate of 0.000012 per µg/m³ (which equates to an air concentration of 0.8 µg/m³ based on a 1 in 100,000 cancer risk level) (Filing ID A4L7K8). This cancer-based exposure limit is based on an oral rat study, where significant incidences of kidney tumors were observed in test animals exposed to lead acetate in their diet. The OEHHA limit was not used in the HHRAs as the weight-of-evidence suggests that other toxicological endpoints such as neurological impairment are more relevant when characterizing the potential health effects for lead. Further details

[5] http://www.cdc.gov/cancer/lung/basic_info/risk_factors.htm

45.1.1.3 Diesel Particulate Matter

The City of Burnaby (Filing ID A4L8H6), City of Vancouver (Filing IDs A4L7V8 and A4L7K9), FVRD (Filing ID A4L8W6), Metro Vancouver (Filing ID A4L7Y3) and Miller B (Filing ID A4L8L6) expressed concern regarding the potential health risks associated with exposure to DPM emitted from the Westridge Marine Terminal and Project-related marine vessel traffic. Particular concern was expressed by FVRD, Metro Vancouver and B. Miller regarding the potential cancer risks.

As part of its evidence, the City of Burnaby and the City of Vancouver included a report prepared by Fraser Health and Vancouver Coastal Health entitled "Guidance to Metro Vancouver and Fraser Valley Municipalities to Assist in Reviewing the Trans Mountain Pipeline Project from a Public Health Perspective." The City of Vancouver expressed concern in its written evidence that DPM was omitted as a COPC from the HHRAs, citing a statement taken from the report prepared by Fraser Health and Vancouver Coastal Health. The Fraser Health and Vancouver Coastal Health report was submitted previously as an attachment to FVRD IR No. 2.01. A complete response to the report was presented in Trans Mountain's response to FVRD IR No. 2.01 (Filing ID A4H8R9).

In its written evidence (Filing ID A4L7Y3), Metro Vancouver stated the following with respect to the risks associated with DPM:

> *"*Metro Vancouver requests that the NEB reject Trans Mountain's flawed analysis and conclusions regarding DPM cancer risk presented in both the Responses to Lower Fraser Valley Air Quality Coordinating Committee Informal Information Requests and Response to Fraser Valley Regional District IR No. 2. The only way to credibly assess cancer risks associated with Project-related DPM is to use maximum over-land DPM concentrations from Marine Air Quality dispersion modeling, together with the OEHHA cancer unit risk for DPM. As demonstrated above, DPM cancer risks associated with the Project exceed Health Canada screening thresholds, so it is vital that further dispersion modeling and associated human health risk assessment be performed to clarify the validity of the assumptions underpinning the existing analyses*."* [Section 3.10.2, page 48, 1st paragraph]

Metro Vancouver supports its position by suggesting that:

1. Based on the results of two toxic air pollutant risk assessments prepared for the Lower Fraser Valley (*i.e.*, Exhibits 17 and 18 in the Metro Vancouver submission [Filing IDs A4L8A3 and A4L8A4, respectively]), Trans Mountain inaccurately characterized the "*evidence supporting DPM cancer risks, and the relative level of DPM health risks posed by the Project*" [Section 3.10, page 44, 3rd paragraph];

2. In its assessment of the DPM-related health risks, Trans Mountain "dismissed" the California Office of Environmental Health Hazard Assessment (OEHHA) cancer unit risk value for DPM;

3. An appropriate way to assess the DPM-related health risks would be to adopt a conservative risk assessment approach by applying the OEHHA unit risk value for lung cancer;

4. Trans Mountain inappropriately characterized the cancer risks by using DPM concentrations averaged over the air quality local study area to present a "*population-level risk*";

5. Existing background DPM levels in the areas surrounding Burrard Inlet result in background DPM cancer risks that are well in excess of Health Canada's 1 in 100,000 (equivalent to 10 per million) screening level (*i.e.*, 372 per million) [Section 3.10.1, page 47]; and,

6. The incremental emissions associated with the Application Case result in maximum DPM concentrations and associated cancer risks that exceed the 10 per million screening level by a considerable margin.

In their submission, FVRD states that:

> *"The information provided by Trans Mountain suggests that under the project case, excess cancer cases due to diesel particulate matter could be 630 per 1,000,000 people over a lifetime of exposure, which is more the [sic] sixty times higher the [sic] Health Canada threshold. It is acknowledged that this value includes previous base case or background levels, which would be above the 10 in 1,000,000 threshold as well. However, the situation underscores that the existing risk posed by diesel emissions in the Lower Fraser Valley is unacceptably high, and that any increase in diesel emissions, including from the proposed TMEP, must be mitigated to avoid increasing the health risk for developing cancer."* [Section 23 of Rebecca Abernathy Affidavit]

This statement is similar to the argument made by Metro Vancouver with respect to the calculated DPM-related excess cancer risks (see point 5 above).

Each of the concerns raised by Metro Vancouver and FVRD is addressed in Trans Mountain's response below. In doing so, Trans Mountain will provide evidence that its assessment of the potential health risks associated with DPM in the area remains appropriate and that the conclusions with respect to the Project-related cancer risks remain valid.

Trans Mountain provided a comprehensive assessment of the potential carcinogenicity of DPM in its response to FVRD IR No. 2.12 (Filing ID A4H8S0). This response described how the weight-of-evidence currently does not support the use of a cancer-based exposure limit for assessing the health risks associated with DPM. However, in order to explicitly address FVRD's concern, the response to FVRD IR No. 2.12 presented the cancer risks using the same OEHHA unit risk value that was used to characterize the DPM cancer risks in Exhibits 17 and 18 of the Metro Vancouver submission (Filing ID A4L8A3 and Filing ID A4L8A4, respectively).

Trans Mountain fully recognizes that there is general consensus among regulatory agencies that diesel exhaust, including DPM, is carcinogenic (IARC 2014, National Toxicology Program 2014, OEHHA 2001). However, considerable uncertainty exists with respect to the actual dose-response relationship of DPM, thereby limiting regulators' ability to develop a proper cancer-based exposure limit (U.S. EPA 2009). In light of this uncertainty, neither Health Canada nor the U.S. EPA has developed a cancer-based exposure limit (or unit risk value) for DPM. In Section 3.10.1 of its evidence (Filing ID A4L7Y3), Metro Vancouver contends that "*an appropriately conservative risk assessment approach would be to use the OEHHA's cancer unit risk in the*

Trans Mountain assessment, while acknowledging the inherent uncertainty raised by the US EPA and others." The fact is that Trans Mountain used the OEHHA cancer unit risk in its assessment of DPM and in doing so described in detail the "*inherent uncertainty raised by the US EPA*" in its response to FVRD IR No. 2.12. Trans Mountain maintains that the low confidence of the OEHHA cancer unit risk essentially limits its usefulness when attempting to assess the potential risks to health associated with DPM exposure.

The basis of the OEHHA cancer unit risk is a retrospective case-control investigation published in a series of papers from a research team that evaluated diesel particulate exposure and lung cancer mortality in railway workers during the 1980s (Garshick *et al*. 1987, 1988; Woskie *et al*. 1988a,b). However, the U.S. EPA argues that use of a cancer-based exposure limit is not supported by the current state of science. The key factors that substantiate the U.S. EPA conclusion were described in detail in Trans Mountain's response to FVRD IR No. 2.12.

The U.S. EPA's (2009) Integrated Science Assessment document for PM includes a comprehensive review of the epidemiological literature on DPM that was available at the time of their assessment. The U.S. EPA (2009) acknowledged that there is considerable evidence from human and animal studies that strongly supports classification of DPM as a carcinogen, but concluded that a confident dose-response relationship (and corresponding cancer-based exposure limit) could not be established due to the existing data gaps and uncertainties. The sources of uncertainty highlighted by the U.S. EPA also were described in Trans Mountain's response to FVRD IR No. 2.12. For ease of reference, the sources of uncertainty identified by the U.S. EPA are restated here:

- absence of DPM exposure data for workers in the available occupational studies;
- absence of DPM exposure data for controls in the available occupational studies owing to the presence of diesel engine exhaust in ambient air for controls in a non-occupational setting;
- possible confounders such as smoking or asbestos exposure that could contribute to cancer risks observed in the occupational studies;
- the representativeness of occupational workers for the general population, including sensitive subpopulations;
- use of supporting animal data from rats with lung tumor responses to direct inhalation exposure given that the mode of action in high exposure rat responses is not suitable for human dose response analysis at environmental levels of exposure; and,
- use of health effects data that were derived from engine technologies and fuels that existed in the past and may no longer be representative of health effects from DPM emissions of modern engines and fuel.

Contrary to Metro Vancouver's assertion, Trans Mountain did not inaccurately characterize the evidence supporting DPM cancer risks. In fact, Trans Mountain's position with respect to the use of a cancer-based exposure limit is well supported by the U.S. EPA. Further support of this position can be found in Health Canada's letter of comment (Filing ID A4S0Z6), which states

that "*there is much uncertainty about the unit risk factor for DPM, therefore, the calculated ILCR should be interpreted with much caution*." Metro Vancouver further suggested that Trans Mountain "dismissed" the OEHHA cancer unit risk value for DPM. However, the fact is that Trans Mountain carefully reviewed and weighed the basis of the OEHHA value. Coupled with the rationale provided in the U.S. EPA assessment of DPM, Trans Mountain determined that there was greater certainty in assessing the potential health risks for DPM using the U.S. EPA chronic non-cancer exposure limit. As such, its initial assessment of DPM was based on the U.S. EPA non-cancer inhalation exposure limit of 5 $\mu g/m^3$ (Filing ID A4F5C9). Trans Mountain's interpretation of the DPM exposure limits appears to be supported by the 2015 Sonoma Technology "Toxic Air Pollutants Risk Assessment" for Metro Vancouver (Filing ID A4L8A4), which indicated that the dose-response certainty for lifetime excess cancer risk for DPM is low (see Figure 2-2 in Filing ID A4L8A4). The same report further classifies the dose-response certainty for non-cancer risk for DPM as high (see Figure 2-3 in Filing ID A4L8A4).

Metro Vancouver argues that Trans Mountain inappropriately characterized cancer risks when it used DPM air concentrations averaged over the air quality LSAs in its response to FVRD IR No. 2.12. Metro Vancouver suggests that Trans Mountain's approach underestimates the risks at certain over-land locations and is "out of step" with the approach used for the rest of the HHRAs. As described in the response to FVRD IR No. 2.12, Trans Mountain elected to use predicted DPM air concentrations averaged over a 5 km radius centred on the Westridge Marine Terminal in order to remain consistent with the approach presented in the Levelton 2007 "Air Toxics Emission Inventory and Health Risk Assessment" (Filing IDs A4L8A3 and A4L8X8). Like the 2015 Sonoma Technology assessment (Filing IDs A4L8A4), the Levelton 2007 report presented single DPM air concentrations and carcinogenic risk estimates for the entire GVRD and FVRD region. As opposed to presenting risks at discrete receptor locations, this allows for a more reasonable estimate of population-level risks.

Health Canada and the BC MOE assume that any level of long-term exposure to carcinogenic chemicals is associated with some hypothetical risk of cancer. On this basis, Health Canada and BC MOE have specified an incremental or excess (*i.e.*, over and above background) lifetime cancer risk of 1 in 100,000, which these regulatory health authorities consider acceptable, tolerable or essentially negligible (BC MOE 2009, Health Canada 2010). The 1 in 100,000 excess cancer risk level is equivalent to the 10 in 1,000,000 screening level that Metro Vancouver and FVRD refer to in their submissions. Because the assumed acceptable cancer risk level of 1 in 100,000 was specifically developed to address cancer risks over and above background cancer incidence, background exposures typically are not included in the assessment of potential health risks for non-threshold compounds like DPM. In its response to FVRD IR No. 2.12, Trans Mountain calculated an incremental lifetime cancer risk (ILCR) for DPM by comparing the predicted incremental level of exposure associated with the Project-related marine vessel traffic to the OEHHA unit risk value. The calculated ILCR for the Project-related marine vessel traffic was then compared to the acceptable cancer risk level of 1 in 100,000. As shown in Table 2.12A-3, in the response to FVRD IR No. 2.12, the predicted Project-related excess cancer risks for the DPM concentrations averaged over the air quality LSA were less than 1 in 100,000 (*i.e.*, 0.8 in 100,000).

Trans Mountain does acknowledge that, when using the OEHHA unit risk value for DPM, the calculated excess cancer risks will exceed 1 in 100,000 at certain locations along the shores of the Burrard Inlet. The predicted DPM concentrations for the Project-related marine vessel traffic are shown as a series of contours in Figure 45.1.1. The DPM concentrations are presented for

the following concentration ranges (or contours): 0.033 µg/m³ to 0.066 µg/m³; 0.066 µg/m³ to 0.132 µg/m³; and, 0.132 µg/m³ to 0.18 µg/m³. The last concentration range "ends" at 0.18 µg/m³ because this equates to the maximum DPM concentration predicted for the Project-related marine vessel traffic. The concentrations in Figure 45.1.1 are based on the assumptions that all emitted $PM_{2.5}$ is in the form of DPM and that marine vessels at berth include boilers.

The OEHHA provides an inhalation unit risk of 0.0003 per µg/m³ (OEHHA 2001). Based on this, 1 µg/m³ of DPM theoretically equates to an excess lung cancer risk of 30 in 100,000. Another way to put this is that a DPM air concentration of 0.033 µg/m³ equates to a lung cancer risk of 1 in 100,000, which is the incremental or excess cancer risk level considered negligible by Health Canada and BC MOE. Therefore, the concentration ranges presented in Figure 45.1.1 would equate to Project-related cancer (lung) risk levels of: 1.0 in 100,000 to 2.0 in 100,000; 2.0 in 100,000 to 4.0 in 100,000; and, 4.0 in 100,000 to 5.4 in 100,000.

These risk estimates should be interpreted with some degree of caution. This is perhaps best illustrated by exploring the estimates of cancer risk presented in the 2007 Levelton and 2015 Sonoma Technology reports (*i.e.*, Filing IDs A4L8X8, A4L8A3 and A4L8A3), all of which are based on the OEHHA unit risk value for lung cancer (*i.e.,* 0.0003 per µg/m^3). In their submissions to the NEB, both FVRD and Metro Vancouver relied heavily on the Levelton (2007) and Sonoma Technology (2015) reports. In its "Air Toxics Emission Inventory and Health Risk Assessment," Levelton (2007) estimated a single lung cancer risk of 35 in 100,000 (or 350 in 1,000,000) for the Greater Vancouver Regional District and the FVRD (page 6, Filing IDs A4L8X8 and A4L8A3). In a more recent analysis, Sonoma Technology (2015) calculated a single lung cancer risk of 22.4 in 100,000 (or 224 in 1,000,000) for the entire LFV (page 2-10, Filing ID A4L8A3). In presenting this risk, Sonoma Technology (2015) acknowledges that the "*diesel PM risk estimate should be considered highly uncertain as a quantitative value*." These calculated risk estimates suggest that existing DPM concentrations in Metro Vancouver and FVRD may be responsible for 22.4 to 35.0 cases of lung cancer per 100,000 people.

However, the cancer risk estimates presented in the Levelton and Sonoma reports are not borne out by the actual number of cases of lung cancer in the LFV. In fact, the lung cancer risk estimates presented by Metro Vancouver and FVRD appear to significantly overstate the actual risk of DPM-related lung cancer in the region.

Figure 45.1.1 Predicted Annual Diesel Particulate Matter Concentrations, Including All Marine Transportation, Project Only Case (in µg/m³)

In their BC 2011 Regional Cancer Report, the BC Cancer Agency presents the following age-standardized incidence rates of lung cancer per 100,000 for the Fraser Health and Vancouver Coastal Health regions[1]:

- Fraser Health = 46.82 per 100,000
- Vancouver Coastal Health = 41.64 per 100,000

According to the Canadian Cancer Society[2], the primary risk factors for lung cancer, listed in order from most significant to least significant, are:

- smoking tobacco;
- second-hand smoke;
- radon;
- asbestos;
- outdoor air pollution;
- occupational exposure to chemical carcinogens;
- personal or family history of lung cancer;
- arsenic;
- previous lung disease;
- exposure to radiation;
- indoor burning of coal;
- weakened immune system; and
- lupus.

The risk factor that appears to overwhelm all others is exposure to tobacco smoke. In fact, the BC Lung Association indicates that more than 90% of lung cancers in men and at least 70% in women are directly caused by cigarette smoking[3]. This is supported by the BC Cancer Agency[4], which suggests that "about 85-90% of lung cancer patients are smokers, former smokers or people exposed long-term to second-hand smoke." Similarly, the Canadian Cancer Society suggests that smoking is related to more than 85% of lung cancer cases in Canada, while the

1 http://www.bccancer.bc.ca/statistics-and-reports-site/Documents/Section8IncidenceMortalitySurvivalandPrevalencePar%20(2).pdf
2 http://www.cancer.ca/en/cancer-information/cancer-type/lung/risks/?region=on
3 http://www.lung.ca/lung-health/lung-disease/lung-cancer/causes
4 http://www.bccancer.bc.ca/health-info/types-of-cancer/lung/lung

Centers for Disease Control and Prevention[5] links smoking to about 90% of lung cancers in the United States.

Using the Fraser Health statistic as an example, between 39.8 and 42.1 cases of lung cancer per 100,000 are likely due to smoking (*i.e.*, between 85% and 90% of the overall rate of 46.8 per 100,000). This suggests that the other risk factors may be responsible for approximately 4.7 to 7.0 cases of lung cancer per 100,000 (*i.e.*, 10-15% of the overall rate in the Fraser Health region). However, these numbers are in stark contrast to the cancer risks presented in the Levelton and Sonoma reports. For example, in the Sonoma Technology (2015) report, the risk for lung cancer associated with DPM was presented as 22.4 per 100,000. In its submission, Metro Vancouver uses the OEHHA unit risk value to suggest that existing ("background") DPM levels in the areas surrounding Burrard Inlet could result in DPM cancer risks that are even higher (*i.e.*, 37.2 per 100,000, see Section 3.10.1, page 47]. When based on the OEHHA unit risk value, the calculated risk estimates would suggest that DPM is the dominant risk factor for lung cancer in the region (*i.e.*, it would erroneously exceed the risks associated with tobacco smoking). In all likelihood, use of the OEHHA unit risk value results in an exaggeration of the actual risks to the DPM-related cancer risks in the region.

In response to the concerns raised by FVRD and Metro Vancouver with respect to DPM, Trans Mountain offers that:

- It used a scientifically defensible approach for assessing the potential health risks for DPM in both the responses to the LFVAQCC and to FVRD IR No. 2.12.
- There is low confidence in the OEHHA unit risk value that FVRD and Metro Vancouver used to characterize the potential carcinogenic risks associated with DPM.
- The incremental emissions associated with the Project-related marine vessel traffic will not exceed the 1 in 100,000 screening level by a considerable margin.
- The excess lung cancer risks presented in the FVRD and Metro Vancouver submissions are unrealistic estimates of what the actual DPM-related risks are for lung cancer in the region.

Finally, Trans Mountain stands by its original conclusion that the Project-related marine vessel traffic is not expected to adversely affect health in the region.

45.1.1.4 Lead

In its written evidence, the City of Vancouver (Filing ID A4L7V8) suggests that the potential health effects of long-term inhalation exposure to lead be assessed using information presented in BC Ministry of Environment's "Technical Guidance on Contaminated Sites: Supplemental Guidance for Risk Assessment" (Filing ID A4L7K7), notably the OEHHA's inhalation unit risk estimate of 0.000012 per µg/m³ (which equates to an air concentration of 0.8 µg/m³ based on a 1 in 100,000 cancer risk level) (Filing ID A4L7K8). This cancer-based exposure limit is based on an oral rat study, where significant incidences of kidney tumors were observed in test animals exposed to lead acetate in their diet. The OEHHA limit was not used in the HHRAs as the weight-of-evidence suggests that other toxicological endpoints such as neurological impairment are more relevant when characterizing the potential health effects for lead. Further details

[5] http://www.cdc.gov/cancer/lung/basic_info/risk_factors.htm

RWDI used local monitoring stations to establish background ambient conditions, based on 10 meteorological stations across the Lower Fraser Valley that represent conditions for the Burnaby Terminal and Westridge Marine Terminal Regional Study Area (RSA). For the Marine RSA, 16 meteorological stations were used to represent existing conditions. Emissions from non-Project marine vessels used Environment Canada's National Marine Emissions Inventory for Canada (SNC-Lavalin Environment [SNC-Lavalin] 2012), which is based on actual vessel movements. Up to 10 years of ambient air quality monitoring records for all available COPC were summarized over all of the Metro Vancouver ambient stations in the Lower Fraser Valley. Three years of data (based on 2009 to 2011) and five years of data (based on 2007 to 2011) were selected from these stations that were deemed to be representative of the RSA and added to the predicted concentrations for criteria air contaminants (CACs) and volatile organic compounds (VOCs), respectively.

In short, the air dispersion modelling that was completed for the Project was, and is, in accordance with relevant provincial guidelines, and followed standard practice for conducting air quality assessments. Likewise, the Application reflects national and international standards for conducting HHRAs.

CONCERN 2: THE OMISSION OF IDENTIFIED KEY AIR POLLUTANTS IN THE METRO VANCOUVER/FRASER VALLEY REGIONS IN THE AIR DISPERSION MODELS.

This concern is associated with the following recommendation:

> ***Recommendation 1.2:*** *The key air pollution-attributed health risk drivers identified by Metro Vancouver in the 2007 Air Toxics Emission Inventory and Health Risk Assessment – Summary Report, such as diesel particulate matter, 1,3-butadiene and carbon tetrachloride, should be included in a revised detailed HHRA. The results of the 2002 UBC HHRA report on Air Emissions from the Chevron North Burnaby Refinery can be considered in establishing a list of COPC and the baseline conditions for a regional study area.*

In accordance with BC MOE (2008), the screening level human health risk assessment (SLHHRA) and HHRA focused on assessing the potential short-term and long-term health risks to people associated with exposure to the chemicals that could be emitted from the Project. The Air Toxics Emission Inventory and Health Risk Assessment (Levelton Consultants Ltd. [Levelton] 2007a) and the Human Health Impact Assessment of Air Emissions from the Chevron North Burnaby Refinery (Kennedy *et al.* 2002) included a number of chemicals that were not assessed in the SLHHRA or the HHRA, as these chemicals are not expected to be emitted by the Trans Mountain Project. For this reason, the Project will not contribute to or influence the health risks associated with those chemicals identified in the Levelton (2007a) and Kennedy *et al.* (2002) assessments.

Identification of the COPC for the HHRAs began with the development of a comprehensive list of chemicals found in the various emissions associated with the

Project. For example, the chemical emissions inventory for the Project-related marine vessel traffic was developed by RWDI based on the combustion-type emissions from the boilers and engines as well as the fugitive emissions from the outbound laden tanker holds of the Project-related marine vessels. Environment Canada's National Marine Emissions Inventory for Canada (SNC-Lavalin 2012) served as the basis of the air emissions inventory for the Project-related marine vessel engines. The fugitive emissions were characterized based on the chemicals detected in a bulk liquid analysis of Cold Lake Winter Blend (CLWB) provided in Appendix A of the Qualitative Ecological Risk Assessment of Pipeline Spills Technical Report (Stantec Consulting Ltd. [Stantec] December 2013) (Filing ID A3S4W9), and an analysis of the vapours above the surface of CLWB provided in Flux Chamber Sampling Program in Support of Spill Modelling for the Trans Mountain Expansion Project (RWDI June 2014) (Filing ID A3Y2D4).

The chemical emissions inventory for the Project consisted of more than 90 individual chemicals and chemical groups, including CACs, metals and metalloids, petroleum hydrocarbon compounds, polycyclic aromatic hydrocarbons, sulphur-containing compounds, and VOCs. As such, a comprehensive list of COPC was assessed as part of the SLHHRA and HHRA of the Project.

An assessment of the potential human health risks associated with diesel particulate matter (DPM) emitted from the diesel engines of the marine vessel traffic (*i.e.,* non-spill-related sources, but combustion sources) was completed and presented in response to concerns expressed by the Lower Fraser Valley Air Quality Coordinating Committee. The response was filed with the National Energy Board (NEB) in December 2014 (Filing IDs A4F5C8 and A4F5C9). Additional information regarding the potential health risks associated with DPM is presented in the response to FVRD IR No. 2.12a.

Although a number of authorities such as the California Air Resources Board (CARB), the International Agency for Research on Cancer (IARC) and the United States Environmental Protection Agency (US EPA) have associated 1,3-butadiene with DPM (CARB 2006; IARC 2014; US EPA 2002a,b; US EPA 2009), 1,3-butadiene was not identified in the emissions inventory for the Project-related marine vessel traffic, and therefore was not assessed as a COPC for the characterization of the potential health risks in the SLHHRA of Marine Transportation Technical Report (Intrinsik Environmental Sciences Inc. [Intrinsik] December 2013) (Filing ID A3S4R1) or the supplemental HHRA of Marine Transportation Technical Report (Intrinsik June 2014) (Filing IDs A3Y1F7 and A3Y1F8). Moreover, the association between 1,3-butadiene and DPM appears to relate to emissions from land-based diesel engines, and not marine diesel engines (Genesis Engineering Ltd. [Genesis] and Levelton Engineering Ltd. [Levelton] 2003). However, in an attempt to further address this concern, the potential health risks associated with 1,3-butadiene are discussed below.

For the purpose of the response, people were assumed to be found on both a short-term and long-term basis at the locations within Burrard Inlet corresponding to the maximum points of impingement (MPOI) over land and water. The MPOI refers to the location at which the highest air concentration of 1,3-butadiene would be expected to occur, and at

which the exposures received by the people within the Burrard Inlet would be greatest. Use of the MPOI locations in this response ensures that any potential health effects that could result from exposure to the chemical emissions associated with the Project-related marine vessel traffic would not be underestimated, regardless of where people might be exposed.

Reliance was placed on air dispersion modelling performed by RWDI and described in Supplemental Marine Air Quality and Greenhouse Gas Marine Transportation Technical Report No. 2 (RWDI December 2014) (Filing IDs A4F5H7, A4F5H8, A4F5H9, A4F5I0, A4F5I1 and A4F5I2). Maximum predicted ground-level air concentrations of 1,3-butadiene were derived from the maximum predicted ground-level total VOC concentrations using a speciation factor of 0.002 for land-based diesel engines (Genesis and Levelton 2003). Maximum predicted air concentrations were provided for different averaging periods (*i.e.,* 24-hour and annual) to allow for the assessment of both short-term and long-term inhalation health risks. On a short-term basis, maximum (1st highest) 24-hour air concentrations were used to evaluate the potential acute health risks associated with 1,3-butadiene (to match the averaging time of the acute exposure limit). Long-term health risks were assessed using the maximum annual air concentrations.

Consistent with the previous assessments, maximum predicted air concentrations were provided for the three assessment cases (*i.e.,* Base, Application and Cumulative Cases), as well as for the potential increase in marine vessel traffic associated with the Project (*i.e.,* Project). The assessment cases are described as:

- Base Case: includes existing conditions in the Air Quality RSA, including the chemical emissions from existing marine vessel traffic in Burrard Inlet.
- Application Case: includes Base Case plus the chemical emissions associated with the increase in marine vessel traffic associated with the Project in Burrard Inlet.
- Cumulative Case: includes Application Case plus the chemical emissions associated with the reasonably foreseeable increase in all other marine vessel traffic in Burrard Inlet.

Measured ambient air concentrations of 1,3-butadiene were obtained from the Burnaby Burmount National Air Pollution Surveillance station between 2007 and 2011, and were added to the predicted air concentrations over land under the Base, Application and Cumulative cases in order to determine the background contribution from land-based emission sources. The 98th percentile of 24-hour ambient air concentrations of 1,3-butadiene (*i.e.,* 0.16 µg/m³) was used to represent the short-term background air concentrations within the Burrard Inlet. Annual background air concentrations were based on the 50th percentile of 24-hour measured ambient air concentrations of 1,3-butadiene (*i.e.,* 0.037 µg/m³). Conversely, measured ambient air concentrations were not added over water as marine vessel traffic was assumed to be the principal emission source and the contribution from land-based sources was assumed to be negligible (see Section 3.4.3.4 in Marine Air Quality and Greenhouse Gas Marine Transportation Technical Report [RWDI December 2013] [Filing ID A3S4J7]).

Maximum predicted 24-hour and annual air concentrations of 1,3-butadiene over land and water are provided in Table 2.01a-1.

TABLE 2.01A-1

MAXIMUM PREDICTED AIR CONCENTRATIONS OF 1,3-BUTADIENE AT THE MAXIMUM POINTS OF IMPINGEMENT

Location	Averaging Time	Maximum Predicted Air Concentration (µg/m³)			
		Base Case	Application Case	Cumulative Case	Project[1]
MPOI over land	24-hour	0.20	0.20	0.20	0.0032
	Annual	0.041	0.041	0.041	0.00072
MPOI over water	24-hour	0.041	0.042	0.050	0.0013
	Annual	0.0046	0.0047	0.0056	0.00026

Note:
1 The maximum predicted air concentrations for the Project are based on the chemicals emissions associated with the Project-related increase in marine vessel traffic.

The short-term (or acute) and long-term (or chronic) inhalation exposure limits selected for 1,3-butadiene are presented in Table 2.01a-2. A chronic oral exposure limit was not required for 1,3-butadiene as the physico-chemical properties (*i.e.,* molecular weight, Henry's Law Constant, vapour pressure, and octanol-water partitioning coefficient) and fugacity modelling for 1,3-butadiene suggest that if emitted to the air, the potential for 1,3-butadiene to deposit and persist or accumulate in the environment is negligible, and only limited opportunity exists for exposure *via* secondary pathways. Accordingly, the response focused on the potential health risks associated with exposure to 1,3-butadiene *via* inhalation, and not secondary pathways.

TABLE 2.01A-2

SUMMARY OF INHALATION EXPOSURE LIMITS FOR 1,3-BUTADIENE

Duration	Averaging Time	Type[1]	Value (µg/m³)	Critical Health Endpoint	Reference
Acute	24-hour	RfC	15	Reproductive and developmental effects	US EPA 2002b
Chronic	Annual	RfC	2	Reproductive and developmental effects	US EPA 2002b
		RsC	0.3	Leukemia	US EPA 2002b

Note:
1 Reference Concentration (RfC) refers to level of an airborne chemical at which adverse health effects would not be expected. It is expressed as a concentration of the chemical in air (*i.e.,* µg/m³) and applies only to threshold chemicals. Risk-Specific Concentration (RsC) refers to the level of an airborne carcinogen that results in a regulatory acceptable incremental increase in cancer (typically 1 in 100,000). It is expressed as a concentration of the chemical in air (*i.e.,* µg/m³) and applies only to carcinogens.

Quantifying or otherwise estimating the potential health risks that could be presented to people as a result of exposure to the Project-related 1,3-butadiene emissions involved the comparison of the maximum predicted air concentrations against the corresponding exposure limits. The risk estimates are expressed as risk quotients (RQs) for the non-carcinogenic assessment of 1,3-butadiene and as incremental lifetime cancer risks (ILCRs) for the carcinogenic assessment. Details surrounding the calculation and

interpretation of both types of risk estimates were provide in the Section 3.2.4 of the HHRA (Intrinsik June 2014) (Filing ID A3Y1F7).

The potential non-carcinogenic health risks (expressed as RQs) that could be presented to people from the inhalation of 1,3-butadiene on both a short-term and long-term basis are shown in Table 2.01a-3. Examination of the findings revealed that the maximum predicted air concentrations of 1,3-butadiene are lower than the corresponding exposure limits (*i.e.,* RQ ≤ 1.0).

TABLE 2.01A-3

ACUTE AND CHRONIC INHALATION RISK QUOTIENTS FOR 1,3-BUTADIENE AT THE MAXIMUM POINTS OF IMPINGEMENT

Location	Averaging Time	Risk Quotients[1]			
		Base Case	Application Case	Cumulative Case	Project[2]
MPOI over land	24-hour	0.013	0.013	0.014	0.00021
	Annual	0.020	0.020	0.021	0.00036
MPOI over water	24-hour	0.0028	0.0028	0.0034	0.000087
	Annual	0.0023	0.0023	0.0028	0.00013

Notes:
1 An RQ that is less than 1.0 indicates that the maximum predicted air concentration is less than the exposure limit.
2 The Project RQs are based on the chemical emissions associated with the Project-related increase in marine vessel traffic.

The potential carcinogenic risks (expressed as ILCRs) that could be presented to people from the inhalation of 1,3-butadiene on a long-term basis are shown in Table 2.01a-4. The potential carcinogenic risks were calculated on an incremental basis for the Project-related increase in marine vessel traffic in isolation (*i.e.,* Project), and in combination with the anticipated increase in all other marine vessel traffic (*i.e.,* Future). Examination of the findings revealed that the maximum predicted incremental change associated with the potential increase in Project-related marine vessels and all other marine vessels within the Burrard Inlet were less than the corresponding exposure limit, signalling that the ILCRs associated with 1,3-butadiene are lower than the acceptable benchmark risk of one in 100,000 (*i.e.,* one extra cancer case in a population of one hundred thousand people).

TABLE 2.01A-4

CHRONIC INHALATION INCREMENTAL LIFETIME CANCER RISKS FOR 1,3-BUTADIENE AT THE MAXIMUM POINTS OF IMPINGEMENT

Location	Averaging Time	Incremental Lifetime Cancer Risks (per 100,000)[1]	
		Project[2]	Future
MPOI over land	Annual	0.0024	0.0024
MPOI over water	Annual	0.00086	0.0017

Notes:
1 An ILCR that is less than 1.0 indicates that the maximum predicted air concentration is less than the exposure limit, and signifies that the ILCR is below the benchmark of one in 100,000 (*i.e.,* within the generally accepted limit deemed to be protective of public health).
2 The Project ILCRs are based on the chemical emissions associated with the Project-related increase in marine vessel traffic.

Overall, the findings and conclusion of the 1,3-butadiene assessment remain consistent with earlier assessments. These are:

- The contribution from the Project-related marine vessel traffic to the cumulative 1,3-butadiene exposures was negligible. In all instances, the potential health risks remained unchanged between the Base Case and Application Case, signifying that the Project-related marine vessel traffic will have very little, if any, effect on the Base Case health risks.

- In all cases, acute and chronic non-carcinogenic inhalation risks for 1,3-butadiene were predicted to be below the benchmark of 1.0, indicating that estimated short-term and long-term inhalation exposures were less than the corresponding exposure limits. Risk estimates less than or equal to 1.0 are associated with a negligible or low health risk, and therefore adverse health effects would not be expected.

- In all instances, carcinogenic risks for 1,3-butadiene were predicted to be less than one in 100,000 (*i.e.,* one extra cancer case in a population of 100,000 people), indicating that the incremental cancer risks from the Project-related increase in marine vessel traffic and anticipated marine vessel traffic are deemed to be "essentially negligible".

- The findings are consistent with those of the earlier assessments in that they continued to show a low potential for adverse health effects as a result of the potential increase in marine vessel traffic associated with the Project.

Carbon tetrachloride is not expected to be emitted from any of the sources related to the Project, including any of the described spill scenarios. Therefore, carbon tetrachloride was not included as a COPC in either the SLHHRA of Marine Transportation Technical Report (Intrinsik December 2013) (Filing ID A3S4R1) or the supplemental HHRA of Marine Transportation Technical Report (Intrinsik June 2014) (Filing IDs A3Y1F7 and A3Y1F8).

Carbon tetrachloride was identified as a priority air toxic for the Greater Vancouver Regional District (GVRD) in the 2007 Air Toxics Emission Inventory and Health Risk Assessment (Levelton 2007a). The technical appendix of that same study states that carbon tetrachloride emissions in the GVRD are related primarily to point sources (80%) and much less so to area sources (20%). The point sources described by Levelton (2007b) include wood combustion in the wood products and paper and allied products sectors. The area sources are described as being municipal and industrial landfills, prescribed burning, forest fires, and industrial and architectural surface coatings. Levelton (2007a,b) does not identify marine traffic or any sources related to the Project as possible sources of carbon tetrachloride. For this reason, the HHRA was not updated to include carbon tetrachloride as a COPC.

2.12 Human Health Risk Assessment - Diesel Particulate Matter

Reference:

i. B291-28 Technical Update #4 Part 12 Responses AQ HHRA Follow up LFVAQCC A4F5C9, December 1, 2014, section 2.0, item 1, PDF p. 24.

ii. Air Toxics Emission Inventory and Health Risk Assessment. Levelton Consultants Ltd. 2007. [PDF Attachment #4]

Preamble:

Diesel particulate matter was found to be leading cause of cancer from assessed toxic air pollutants in Reference (i), by a large margin in the Lower Fraser Valley. It is very important to the FVRD that the impact of the TMEP on diesel particulate matter emissions and human health risk be quantified.

Request:

a) In the absence of a better inhalation unit risk for diesel particulate matter, please complete the calculation for carcinogenic outcomes in the Lower Fraser Valley using the Office of Environmental Health Hazard Assessment estimate provided in Reference (i). Commentary regarding its potential overestimation of the risk may accompany. This would be consistent with the Air Toxics Human Health Risk Assessment and Emission Inventory conducted in the Lower Fraser Valley in Reference (ii).

Response:

a) The composition of diesel particulate matter (DPM) varies depending on the engines and type of diesel fuel involved, but generally consists of elemental carbon with adsorbed compounds such as organic compounds (*e.g.,* polycyclic aromatic hydrocarbons [PAHs] and aliphatic hydrocarbons), sulphate, nitrate, metals and other trace elements (California Air Resources Board 2001). DPM thus represents a mixture of compounds, many of which were evaluated individually or in groups (*e.g.,* particulate matter, PAHs, aliphatic hydrocarbons and metals) in the Human Health Risk Assessments (HHRAs of Westridge Marine Terminal [Filing IDs A3Y1F4 and A3Y1F5] and Marine Transportation [Filing IDs A3Y1F7 and A3Y1F8]).

The December 2014 response to concerns expressed by the Lower Fraser Valley Air Quality Coordinating Committee (LFVAQCC) described how the weight-of-evidence currently does not support the use of a cancer-based exposure limit for assessing the health risks associated with DPM. Instead, DPM-related health risks were characterized by comparing the maximum predicted DPM air concentrations against the United States Environmental Protection Agency's (US EPA's) non-cancer exposure limit. The comparisons indicated that none of the maximum DPM air concentrations exceeded the exposure limit. The reason for using the US EPA's non-cancer exposure limit was based on:

1. The quality and relevance of the available cancer exposure limit from the California Office of Environmental Health Hazard Assessment (OEHHA).
2. The evaluation of diesel PM components within the HHRAs of Westridge Marine Terminal (Filing IDs A3Y1F4 and A3Y1F5) and Marine Transportation (Filing IDs A3Y1F7 and A3Y1F8).

Although there is general consensus among regulatory agencies that diesel exhaust, including DPM, exhibits some carcinogenic potential in humans (International Agency for Research on Cancer 2014, National Toxicology Program 2014, OEHHA 2001), considerable uncertainty exists with respect to the actual dose-response relationship of DPM and the available corresponding cancer-based exposure limit (US EPA 2009).

The California OEHHA considers DPM to be carcinogenic and has established an inhalation unit risk of 0.0003 per µg/m³, which corresponds to a cancer-based exposure limit of 0.03 µg/m³ when tied to a one in 100,000 incremental lifetime cancer risk (OEHHA 2001). The basis of the OEHHA cancer inhalation unit risk is a retrospective case-control investigation published in a series of papers from a research team that evaluated diesel particulate exposure and lung cancer mortality in railway workers during the 1980s (Garshick *et al.* 1987, 1988; Woskie *et al.* 1988a,b). However, the US EPA (2009) concluded that use of a cancer-based exposure limit was not supported by the current state of science. The key factors that substantiate this conclusion are:

- low reliability of how DPM exposure was characterized in the studies, and challenges in extrapolating these exposures to the general population;
- poorly characterized exposure to PM *via* other sources such as wood burning stoves or wildfires exposures, and ambient PM from other traffic sources;
- lack of characterization and control of confounding variables such as cigarette smoking, exposure to second hand smoke, and historical asbestos exposures;
- lack of information regarding the composition of the DPM from the various railroad-equipment sources and descriptions of potential variability between regions within the United States;
- questionable relevance of the predominantly male worker population to the general population (*e.g.,* men, women and children of all ages), and the limited information provided regarding potentially sensitive individuals within the worker population;
- lack of information regarding industrial hygiene practices by the rail workers; and
- lack of a clear dose-response relationship between DPM exposure and lung cancer.

The US EPA's (2009) Integrated Science Assessment document for PM includes a comprehensive review of the epidemiological literature on DPM that was available at the time of their assessment. The US EPA (2009) acknowledged that there is considerable evidence from human and animal studies that strongly supports classification of DPM as a carcinogen, but concluded that a confident dose-response relationship (and corresponding cancer-based exposure limit) could not be established due to the existing data gaps and uncertainties. The sources of uncertainty highlighted by the US EPA are:

- absence of DPM exposure data for workers in the available occupational studies;
- absence of DPM exposure data for controls in the available occupational studies owing to the presence of diesel engine exhaust in ambient air for controls in a non-occupational setting;
- possible confounders such as smoking or asbestos exposure that could contribute to cancer risks observed in the occupational studies;
- the representativeness of occupational workers for the general population, including sensitive subpopulations;
- use of supporting animal data from rats with lung tumor responses to direct inhalation exposure given that the mode-of-action in high exposure rat responses is not suitable for human dose response analysis at environmental levels of exposure; and
- use of health effects data that were derived from engine technologies and fuels that existed in the past and may no longer be representative of health effects from DPM emissions of modern engines and fuel.

The current guidance regarding the assessment of mixtures of chemicals (such as DPM) from Europe and various agencies within the US notes that whole mixtures may be evaluated for potential health risks when compared with toxicity data for 'sufficiently similar' mixtures (Agency for Toxic Substances and Disease Registry [ATSDR] 2014, European Food Safety Authority [EFSA] 2013, US EPA 2000). The European Commission (2012) notes that "A major limitation of the whole-mixture approach is that its applicability is restricted to mixtures that do not significantly change in their composition; the Working Group therefore does not recommend using this as a general approach".

DPM can vary in composition and particles sizes between engine types, operating conditions, and fuel formulation (Wichmann 2007). Diesel exhaust composition can vary with speed, load, age, fuel composition and consumption, ambient air temperature and humidity (Watson *et al.* 2013). Different fuels result in different composition of soot emissions (Fiebig *et al.* 2014). Diesel engines in passenger cars and commercial vehicles have undergone significant development in the last 30 years, and have improved in efficiency and environmental impact through reduced emissions. There are differences in diesel fuel composition (*e.g.,* sulphur content), improved injection systems, combustion systems, engine controls and exhaust after-treatment.

The most relevant sources of diesel emissions to the general population are on-road vehicles (*i.e.,* passenger vehicles, light-duty and heavy-duty vehicles). Other sources such as rail, marine vessels, and industrial equipment may contribute to exposure, particularly for exposed workers (Wichmann 2007). As such, the source of the diesel mixture upon which the cancer limit is based may not be applicable to general population exposures in the region.

This variance could be the result of the demonstrated differences in the composition in diesel emissions as a result of various physical factors (*e.g.*, fuel, emission source type, temperature, activity, *etc.*), as well as changes in the components of DPM as a function of improved diesel engine technologies over time. The latter is demonstrated in a study by the Southwest Research Institute and the Desert Research Institute (Khalek *et al.* 2012) which compared the emissions from diesel engines that were in compliance with 2007 US EPA engine requirements with diesel engines from 1994-2004. The observed reductions in the emissions between the newer (2007) technology engines and older engines (1994-2004) for several chemicals of relevance to the HHRAs of Westridge Marine Terminal (Filing IDs A3Y1F4 and A3Y1F5) and Marine Transportation (Filing IDs A3Y1F7 and A3Y1F8) are presented in Table 2.12a-1. Reductions ranging from 80% to more than 99% were observed by Khalek *et al.* (2012) for these volatile organics, metals, and polycyclic aromatic hydrocarbons (PAHs). In addition, Khalek *et al.* (2012) reported that the proportion of organic carbon and elemental carbon particles within the exhaust were reduced by 96 and 99%, respectively. Khalek *et al.* (2012) notes that the particulate matter composition from the newer engines differs from the older engines due to a large reduction in soot emissions (reductions of 10-90%, depending on engine operating conditions). However, nitrogen dioxide emissions were found to increase between the older and newer engines (Khalek *et al.* 2012).

TABLE 2.12A-1

SUMMARY OF CHANGES IN THE EMISSIONS OF SOME DIESEL EXHAUST COMPONENTS BETWEEN 2007 ENGINES AND 1994-2000 ENGINES

Compound	2007 Technology Engines (mg/bhp-hr)	1994-2000 Technology Engines (mg/bhp-hr)	Percent Reduction in Emission Between 1994-2000 and 2007
Acetaldehyde	0.61 ± 0.27	10.3	93%
Acrolein	<0.01	2.7	>99%
Benzene	<0.01	1.82	>99%
Biphenyl	0.0138 ± 0.002	-	-
Ethylbenzene	0.05 ± 0.04	0.49	90%
Formaldehyde	1.90 ± 1.01	25.9	94%
Hexane	<0.01	0.14	> 93%
Propionaldehyde	0.01	1.8	>99%
Styrene	<0.01	0.73	>99%
Toluene	0.26 ± 0.28	0.64	59%
Xylenes	0.35 ± 0.10	2.2	85%
Lead	0.0784 ± 0.0731	1.83	>96%
Nickel	0.0002 ± 0.0001	0.01	98%
Copper	0.0004 ± 0.0002	0.78	>99%
Zinc	0.0027 ± 0.002	1.16	>99%
Sulphur	0.291 ± 0.129	2.89	>99%
Naphthalene	0.0982± 0.0423	0.4829	80%
Acenaphthene	0.0005 ± 0.0005	0.0524	98%
Acenaphthylene	0.0004 ±0.0001	0.0215	98%
Fluorene	0.00150 ± 0.0009	0.0425	96%
Phenanthrene	0.0077 ± 0.0025	0.05	85%
Anthracene	0.0003 ± 0.0001	0.0121	97%
Fluoranthene	0.0006 ± 0.0006	0.0041	85%
Pyrene	0.0005 ± 0.0004	0.0101	95%

TABLE 2.12A-1

SUMMARY OF CHANGES IN THE EMISSIONS OF SOME DIESEL EXHAUST COMPONENTS BETWEEN 2007 ENGINES AND 1994-2000 ENGINES (continued)

Compound	2007 Technology Engines (mg/bhp-hr)	1994-2000 Technology Engines (mg/bhp-hr)	Percent Reduction in Emission Between 1994-2000 and 2007
Benzo(a)anthracene	< 0.0000001	0.0004	>99%
Benzo(a)pyrene	< 0.0000001	<0.0003	>99%
Chrysene	< 0.0000001	0.0004	>99%

As a result, the OEHHA DPM cancer limit from the 1980s railroad worker data is probably not directly applicable to the proposed emissions from the Project-related marine vessels on the basis that this limit and the toxicity data upon which it is based does not meet the requirement of being sufficiently similar in its DPM composition to complete such an analysis, as specified by several regulatory authorities (ATSDR 2004, EC 2012, EFSA 2013, US EPA 2000). There are no alternative cancer-based limits for evaluating DPM as a mixture at this time. Recent literature reviews have also acknowledged this issue, and recommend that the carcinogenic assessment of DPM from newer engines be evaluated separately from older, traditional diesel engines (Hesterberg *et al.* 2006, 2012; McClellan *et al.* 2012).

DPM is a mixture of compounds, many of which were evaluated individually or in groups (including PM, PAHs, aliphatic hydrocarbons and metals) in the HHRAs of the Westridge Marine Terminal (Filing IDs A3Y1F4 and A3Y1F5) and Marine Transportation (Filing IDs A3Y1F7 and A3Y1F8). Those components or constituents of DPM with defensible cancer-based exposure limits were assessed according to their carcinogenic potency in the HHRAs. The list of carcinogenic chemicals of potential concern (COPC) included a number of metals, PAHs and other organic compounds. Examples of organic compounds include benzene and formaldehyde, both of which have been noted by IARC (2014) as being present in both diesel and gasoline emissions. The data upon which the benzene and formaldehyde cancer limits are based include high-level exposures of either humans or animals, rather than exposure to a mixture of multiple compounds, of which either benzene or formaldehyde are a small part (as would be the case for evaluating a DPM mixture). The use of substance-specific toxicity limits permits the evaluation of the unique toxicological hazards associated with each substance on their own. Thus, the use of individual limits based on sole-source exposures combined with the evaluation of predicted air quality emissions of the COPC on their own (instead of being evaluated as a DPM mixture) ensures that the results of the HHRAs of Westridge Marine Terminal (Filing IDs A3Y1F4 and A3Y1F5) and Marine Transportation (Filing IDs A3Y1F7 and A3Y1F8) with respect to these carcinogens are more specific and meaningful.

In its air toxics emissions inventory and health risk assessment of the Greater Vancouver Regional District (GVRD) and Fraser Valley Regional District (FVRD), Levelton (2007a,b) chose to use the OEHHA inhalation unit risk factor to characterize the carcinogenic risks for DPM. According to Levelton (2007a,b), the existing population-

level cancer risk associated with the estimated concentrations of DPM in the GVRD and FVRD is 35 in 100,000.

In light of the concerns raised by FVRD and a number of other interveners related to DPM, the potential carcinogenic risks associated with the Project are presented below by using the OEHHA unit risk factor for DPM (*i.e.*, 0.0003 per µg/m^3), despite the recognized uncertainty that surrounds the quantification of DPM-related cancer risks.

The average predicted annual DPM air concentrations for the Local Study Area (LSA) for Westridge Marine Terminal, with a 5 km radius centred on the terminal, are presented in Table 2.12a-2. To remain consistent with the Levelton (2007a,b) study, which presented single air concentrations and carcinogenic risk estimates for the entire GVRD and FVRD region, the assessment focused on air concentrations averaged over the LSA. As opposed to presenting risks at discrete receptor locations, this allows for a more reasonable estimate of population-level risks. The average annual DPM air concentrations are predicted for the three assessment cases:

- Base Case, which includes DPM emissions from all existing vessel marine traffic.
- Application Case, which includes DPM emissions from all Base Case sources and the Project-related marine vessel traffic.
- Cumulative Case, which includes DPM emissions from all existing marine vessel traffic, the Project-related marine vessel traffic and all other marine vessel traffic in the reasonably foreseeable future.

TABLE 2.12A-2

AVERAGE PREDICTED ANNUAL AIR CONCENTRATIONS OF DIESEL PARTICULATE MATTER IN THE WESTRIDGE MARINE TERMINAL AIR QUALITY LOCAL STUDY AREA

Description	Predicted Annual Air Concentration (µg/m^3)			
	Base Case	Application Case	Cumulative Case	Project[1]
LSA over land (without background)	0.42	0.44	0.15	0.027

Notes:
1 Project refers to the chemicals emissions associated with the Project-related increase in marine vessel traffic combined.

The predicted decrease in Cumulative Case DMP air concentrations is the result of more stringent fuel sulphur regulations in the reasonably foreseeable future. The maximum sulphur content in fuel oils within emission control areas will decrease to 0.1% as of January 2015. Also, in the case of non-large vessels (less than or equal to 30,000 cc), the maximum sulphur content in fuel oils within emission control areas was set to 0.0015% as of June 1, 2012.

Regulatory health authorities such as Health Canada and British Columbia Ministry of Environment (BC MOE) assume that any level of long-term exposure to carcinogenic chemicals is associated with some hypothetical cancer risk. On this basis, Health Canada and BC MOE have specified an incremental (*i.e.,* over and above background) lifetime cancer risk of one in 100,000, which these regulatory health authorities consider acceptable, tolerable or essentially negligible (BC MOE 2009, Health Canada 2010).

Because the assumed acceptable cancer risk level of one in 100,000 was specifically developed to address cancer risks over and above background cancer incidence, there is no clear regulatory benchmark for background or baseline cancer risks and therefore, background exposures typically are not included in the assessment of potential health risks for non-threshold compounds like DPM.

For the current assessment, an incremental lifetime cancer risk (ILCR) was calculated for DPM by comparing the predicted incremental level of exposure associated with the Project-related marine vessel traffic to the OEHHA unit risk factor. The ILCR for the Project-related marine vessel traffic can then be compared to the acceptable cancer risk level of one in 100,000. The predicted cancer risks associated with the Project-related increase in marine vessel traffic (*i.e.*, Project) and the reasonably foreseeable increase in all marine vessel traffic (*i.e.*, Future) are presented in Table 2.12a-3. As shown in the table, the DPM ILCR for the Project-related marine vessel traffic is less than one in 100,000, indicating that the Project-related DPM emissions are associated with a negligible risk of cancer in the LSA.

TABLE 2.12A-3

PREDICTED CANCER RISKS ASSOCIATED WITH DIESEL PARTICULATE MATTER IN THE WESTRIDGE MARINE TERMINAL AIR QUALITY LOCAL STUDY AREA

Location	Incremental Lifetime Cancer Risk (per 100,000)[1]	
	Project[2]	Future[3]
LSA over land (without background)	0.8	0.8

Notes:

1 An ILCR that is less than 1.0 indicates that the maximum predicted air concentration is less than the exposure limit, and signifies that the ILCR is below the benchmark of one in 100,000 (i.e., within the generally accepted limit deemed to be protective of public health).

2 The Project ILCRs are based on the chemicals emissions associated with the Project-related increase in marine vessel traffic.

3 With the Cumulative Case DPM air concentrations expected to decrease, the ILCR for "Future" is assumed to be the same as the ILCR for the Project.

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Chemicals for which sufficient toxicological information could not be identified in the form of a defensible exposure limit or a representative surrogate chemical could not be evaluated in the HHRA, were not carried forward as COPC. These include: alkylphenols C10-C11, benzothiazole, dibenzothiophene, dimethylbenzylalcohol, dimethyloctyne diol, dimethyl sulphide, methyl ethyl sulphide, octanol, tetramethylpentanone, tetramethylthiourea, trimethylcyclohexanol and trimethylcyclopentanone. Many of these sulphur-containing compounds would be considered odourous. The potential odours associated with these compounds were addressed in the Marine Air Quality and Greenhouse Gas Marine Transportation Technical Report (see Technical Report 5C-4 in Volume 5C of the Application).

TABLE 3.3

CHEMICALS OF POTENTIAL CONCERN FOR THE HUMAN HEALTH RISK ASSESSMENT OF MARINE TRANSPORTATION

Criteria Air Contaminants	Metals and Metalloids	Petroleum Hydrocarbon Fractions	Polycyclic Aromatic Hydrocarbons[1]	Sulphur-Containing Compounds	Volatile Organic Compounds	Other
Carbon monoxide (CO)	Arsenic	Aliphatics C_1-C_4 [2]	Acenaphthene	Ethanethiol group [3]	Acetaldehyde	PCBs
Nitrogen dioxide (NO_2)	Barium	Aliphatics C_5-C_8	Anthracene		Acrolein	
Particulate matter ($PM_{2.5}$ and PM_{10})	Beryllium	Aliphatics C_9-C_{16}	Benzo(a)pyrene[4] (and equivalents)		Benzene	
Sulphur dioxide (SO_2)	Cadmium	Aromatics C_9-C_{16}	Biphenyl		Chlorobenzene	
	Chromium III	Aromatics C_{17}-C_{34}	Fluoranthene		Cyclohexane	
	Chromium VI		Fluorene		Ethylbenzene	
	Cobalt		Naphthalene		Formaldehyde	
	Copper		Pyrene		Hexachlorobenzene	
	Lead				n-Hexane	
	Manganese				Propionaldehyde	
	Methyl mercury[5]				Styrene	
	Mercury				Toluene	
	Molybdenum				Trimethylbenzenes	
	Nickel				Xylenes	
	Selenium					
	Strontium					
	Titanium					
	Vanadium					
	Zinc					

Notes:
1 Acenaphthylene is assessed in the aromatics C_9-C_{16}.
2 Aliphatics C1-C4 includes acetylene, iso-butane, n-butane, ethane, ethylene, methane, propane and propylene.
3 Ethanethiol group includes n-butanethiol, sec-butanethiol, ethanethiol, n-hexanethiol, iso-propanethiol and thiophene.
4 Benzo(a)pyrene (and equivalents) includes all the carcinogenic PAHs for which a potency equivalency factors (PEF) has been assigned by Health Canada (2010a). This includes benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, chrysene, fluoranthene, indeno(1,2,3-cd)pyrene, and phenanthrene.
5 Although marine vessel traffic relating to the Project will not emit methyl mercury directly to the environment, the inorganic mercury emitted to air might deposit to local surface water bodies and bio-transform to methyl mercury. On this basis, methyl mercury, in addition to inorganic mercury, was identified as a COPC in the multiple pathway assessment of the SLHHRA, and subsequently the HHRA.

3.2.1.3 People Potentially at Risk

The people potentially at risk represent those people whose health might be adversely affected as a result of exposure to the chemical emissions associated with Project-related marine vessel traffic. In this regard, consideration was given to:

- The need to assess the potential effects of the chemical emissions on the health of both people living in the area (referred to as residents), and people who might visit or frequent the area for recreation or other purposes and theoretically could be found anywhere within the Burrard Inlet LSA at any given time (referred to as area users).

were not carried forward as COPC in the current assessment. These include: alkylphenols C_{10}-C_{11}, benzothiazole, dibenzothiophene, dimethylbenzylalcohol, dimethyloctyne diol, dimethyl sulphide, methyl ethyl sulphide, octanol, tetramethylpentanone, tetramethylthiourea, trimethylcyclohexanol and trimethylcyclopentanone. Many of these compounds contain sulphur, and therefore would be considered odourous. The potential odours associated with these sulphur-containing compounds were addressed in the Air Quality and Greenhouse Gas Technical Report (see Technical Report 5C-4 in Volume 5C of the Application).

TABLE 3.3

CHEMICALS OF POTENTIAL CONCERN FOR THE HUMAN HEALTH RISK ASSESSMENT OF WESTRIDGE MARINE TERMINAL EXPANSION

Criteria Air Contaminants	Metals and Metalloids	Petroleum Hydrocarbon Fractions	Polycyclic Aromatic Hydrocarbons[1]	Sulphur-Containing Compounds	Volatile Organic Compounds	Other
Carbon monoxide (CO)	Arsenic	Aliphatics C_1-C_4 [2]	Acenaphthene	Ethanethiol group [3]	Acetaldehyde	PCBs
Nitrogen dioxide (NO_2)	Barium	Aliphatics C_5-C_8	Anthracene		Acrolein	
Particulate matter ($PM_{2.5}$ and PM_{10})	Beryllium	Aliphatics C_9-C_{16}	Benzo(a)pyrene[4] (and equivalents)		Benzene	
Sulphur dioxide (SO_2)	Cadmium	Aromatics C_9-C_{16}	Biphenyl		Chlorobenzene	
	Chromium III	Aromatics C_{17}-C_{34}	Fluoranthene		Cyclohexane	
	Chromium VI		Fluorene		Ethylbenzene	
	Cobalt		Naphthalene		Formaldehyde	
	Copper		Pyrene		Hexachlorobenzene	
	Lead				n-Hexane	
	Manganese				Propionaldehyde	
	Methyl mercury[5]				Styrene	
	Mercury				Toluene	
	Molybdenum				Trimethylbenzenes	
	Nickel				Xylenes	
	Selenium					
	Strontium					
	Titanium					
	Vanadium					
	Zinc					

Notes:
1 Acenaphthylene is assessed in the Aromatics C_9-C_{16}.
2 Aliphatics C_1-C_4 includes acetylene, iso-butane, n-butane, ethane, ethylene, methane, propane and propylene.
3 Ethanethiol group includes n-butanethiol, sec-butanethiol, ethanethiol, n-hexanethiol, iso-propanethiol and thiophene.
4 Benzo(a)pyrene (and equivalents) includes all the carcinogenic PAHs for which a potency equivalency factors (PEF) has been assigned by Health Canada (2010a). This includes benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, chrysene, fluoranthene, indeno(1,2,3-cd)pyrene, and phenanthrene.
5 Although the Westridge Marine Terminal will not emit methyl mercury directly to the environment, the inorganic mercury emitted to air might deposit to local surface water bodies and bio-transform to methyl mercury. On this basis, methyl mercury, in addition to inorganic mercury, was identified as a COPC in the multiple pathway assessment of the SLHHRA (Technical Report 5D-7 in Volume 5D of the Application), and subsequently the HHRA.

3.2.1.3 People Potentially at Risk

The people potentially at risk represent those people whose health might be adversely affected as a result of exposure to the chemical emissions from the Westridge Marine Terminal expansion. In this regard, consideration was given to:

- The need to assess the potential effects of the chemical emissions on the health of both people living in the area (referred to as residents), and people who might visit or frequent the area for recreation or other purposes and theoretically could be found anywhere within the LSA at any given time (referred to as area users).

SECTION 2.3 ACCIDENTS AND MALFUNCTIONS REFERENCES

- ID A3S4W9). Copies of the original laboratory certificates are provided in Appendix A of the report (Stantec December 2013) (Filing ID A3S4W9).
- A study characterizing the emissions from the surface of the CLWB in terms of the types and amounts of chemicals present was conducted. The study is provided in Appendix I of A Study of Fate and Behaviour of Diluted Bitumen Oil on Marine Waters (Witt O'Brien's, Polaris Applied Sciences, and Western Canada Marine Response Corporation [WCMRC] December 2013) (Filing ID A3S5G5).

Additional information on the physical and chemical characteristics of CLWB are provided in A Comparison of the Properties of Diluted Bitumen Crudes with other Oils (Polaris Applied Sciences December 2013) (Filing ID A3S5G7). Based on the above, an assessment of potential human health effects associated with other products carried in Line 2 was not considered as the HHRA is based on the most representative product (*i.e.,* CLWB) and the associated COPC.

CONCERN 4: THE EXCLUSION FROM SPILL SCENARIOS OF EXPOSURE PATHWAYS OTHER THAN AIR INHALATION.

This concern is associated with the following recommendation:

> ***Recommendation 1.4****: The HHRA reports for different spill scenarios appear to be focused primarily on the inhalation of vapours as the most significant exposure pathway. Other plausible pathways of potential exposure (i.e., inhalation of dust, food ingestion and direct dermal contact) should be included in health risk assessments for the scenario(s) following a spill and post-remediation to determine the effectiveness of a clean-up. Such an assessment would require a series of assumptions for a spill scenario and the results/effectiveness of a hypothetical clean-up in estimating potential exposure to residual COPC from air, soil, sediment and surface/ground water. The authors of the TMP HHRA reports should identify how they intend to assess potential post-spill health risks and other plausible exposures to the public and to individuals involved in spill clean-up.*

The HHRA of Facility and Marine Spill Scenarios Technical Report (Intrinsik June 2014) (Filing IDs A3Y1E9, A3Y1F0, A3Y1F1 and A3Y1F2) focused on the potential health effects that could occur among people found in the area at the time of the spill from inhalation exposure to the hydrocarbon and other chemical vapours released from the surface of the spilled oil, with a specific focus on exposures that could be received on a short-term basis during the early stages of the incident. Detailed assessment of exposure pathways other than the acute inhalation pathway was, and still is, considered to be unwarranted since the prospect for people to be exposed as well as the extent to which they might be exposed *via* these other pathways is considered to be low to very low depending on the pathway involved, and adverse health effects would not be anticipated. Opportunity for exposure of the general public by these other pathways would be limited, in part, because of the emergency and spill response measures outlined in Volumes 7 and 8A of the Application that would be taken by Trans Mountain,

the Western Canada Marine Response Corporation (WCMRC), Coast Guard authorities and other spill response agencies and personnel to quickly contain and recover the spilled oil. In addition, notification of and consultation with appropriate municipal, provincial and federal government authorities as well as local, regional, provincial and/or federal public health authorities would quickly occur as part of a coordinated response directed, in part, at determining the need for and type of actions required to protect people if public health and/or safety were threatened. These timely, coordinated spill response actions would serve to reduce the prospect for and/or extent to which people to be exposed to the spilled oil itself and/or chemicals released from the oil *via* all exposure pathways on both a short-term and longer-term basis.

Explanation and discussion of the reasoning behind the choice of exposure pathways examined in the HHRA was provided in Sections 4.1.5 "Identification of Exposure Pathways" and 6.0 "Discussion" of the HHRA (Intrinsik June 2014) (Filing ID A3Y1E9). The rationale surrounding the selection of exposure pathways is outlined further below. Since it is not entirely clear from the VCH and FHA recommendation whether interest rests principally with the manner and extent to which people might be exposed to the spilled oil and/or chemicals originating from the spilled oil under the simulated oil spill scenarios involving a loading accident at the Westridge Marine Terminal (*i.e.,* facility spill scenarios) and/or the oil spill scenarios involving the grounding of a laden tanker on Arachne Reef (*i.e.,* marine spill scenarios), the discussion extends to both types of spill scenarios. For ease of review, the information is summarized in Table 2.01a-5 and 2.01a-6 for the facility spill scenarios and Table 2.01a-7 and 2.01a-8 for the marine spill scenarios, with each set of tables further distinguished by receptor type, with one table devoted to the general public and the second table devoted to spill response personnel. Distinction also is made between response measures common to all exposure pathways and measures that are more specific to individual pathways. For completeness, the list of pathways has been expanded beyond those specifically mentioned and used as examples in the HHRA. Coverage extends to both pathways involving direct exposure to the spilled oil itself and pathways involving exposure to the hydrocarbons and other chemicals that could originate from the spilled oil and potentially end up in various environmental compartments that people might encounter.

The information presented in the tables is focused on the various emergency and spill response measures that would be taken by different companies, organizations, government authorities and personnel as described in Volumes 7 and 8A of the Application as part of a coordinated action to mitigate any impacts on public health and the environment that might occur in the unlikely event of a spill, with emphasis on those measures that would act to reduce any exposures that might be received by people *via* the pathways. It should be noted that although the overall objectives of the various emergency and spill response measures that would be taken under each type of spill scenario would be the same; that is, to quickly contain and recover the spilled oil and to mitigate any impacts to people's health and the environment, the descriptions of the measures provided in the tables are similar for both types of spill scenarios. Differences principally would exist in the exact manner in which the response would proceed vis-à-vis timing, responsibilities, network resources involved, environmental monitoring and

surveillance, public notification and engagement, and other aspects of the coordinated action taken. The differences are due, in part, to the differences between the two types of spill scenarios in terms of spill location and size, with one set of scenarios focused on spills at a manned facility equipped with a pre-deployed containment boom and access to nearby emergency and spill response resources, and the other set of scenarios centered on larger-sized spills as a result of the grounding of a laden tanker vessel in open waters. The differences are also due to differences in the parties who would bear primary responsibility for emergency and spill response and spill clean-up. These differences should be respected since they account, in part, for the subtle differences in the potential for people to be exposed to the spilled oil and/or chemicals originating from the spilled oil under each type of scenario.

The information presented in the tables demonstrates that the single pathway by which the general public might reasonably be expected to be exposed under either the facility or marine oil spill scenarios to either the spilled oil itself and/or chemicals originating from the oil and for which exposure is such that assessment of the potential health effects that people might experience is warranted is through acute inhalation exposure to the chemical vapours released from the surface of the spilled oil during the early stages of the incident, before the arrival of first responders and the implementation of emergency and spill response measures. The information shows the prospect for and extent to which the general public might be exposed to either the spilled oil itself and/or chemicals originating from the spilled oil through other exposure pathways on either a short-term or long-term basis to be low to very low, and adverse health effects would not be anticipated. For this reason, these other pathways were not examined in detail in the HHRA.

The information also shows that the prospect for and extent to which spill response personnel might be exposed to the spilled oil itself and/or chemicals released from the oil in a manner that would allow direct entry of the chemicals into the body (*i.e.*, direct ingestion by mouth, direct skin contact and/or direct inhalation) to be low across all of the potential exposure pathways. The expectation is that these personnel would be trained in emergency preparedness and response, would be equipped with appropriate personal protective equipment (PPE), would be aware of the chemical hazards involved, and would take precautions to avoid physical contact with the spilled oil itself and any oil-tainted media as well as to limit exposure to any chemical vapours that might be present. Notwithstanding the above, if the criteria listed were not satisfied, distinct opportunity would exist for these personnel to be exposed *via* certain pathways, such as direct skin contact with the spilled oil itself or oil-tainted media and/or inhalation of vapours, on a short-term and longer-term basis, thus introducing some prospect for health effects to occur such as headache, dizziness, nausea, and eye, skin, nose and throat irritation, with the likelihood and severity of effects becoming more pronounced with increasing exposure. This points out the need for and importance of worker training and awareness of the potential hazards involved in spill response and clean-up, the proper use of PPE, and precautions to take to avoid or reduce exposures.

TABLE 2.01A-5

EXPOSURE PATHWAY SELECTION FOR THE WESTRIDGE MARINE TERMINAL SIMULATED OIL SPILL SCENARIOS FOR THE GENERAL PUBLIC[1]

Exposure Pathway	Measures to Reduce Exposure		Rationale for Inclusion/Exclusion
	Common	Specific	
Direct ingestion of the spilled oil	In the unlikely event of a spill, Trans Mountain would immediately execute its emergency response plan based on the Unified Command (UC) structure described in Volume 7 of the Application. Trans Mountain would consult with other emergency and spill response personnel, such as the WCMRC and Coast Guard authorities, and coordinated action would quickly be taken to contain and recover the spilled oil. In conjunction with these actions, Trans Mountain would quickly notify appropriate municipal, provincial and federal government authorities as well as local, regional, provincial and/or federal public health authorities of the spill, and coordinated action would be taken to determine the need for and types of measures required to protect people's health if public health and/or safety were threatened, including measures to reduce the prospect for and/or extent to which people might be exposed to the spilled oil itself and/or chemicals released from the oil, such as notifying the public of the spill, advising the public to avoid the area, securing perimeters and restricting access to the area. If public health and/or safety were threatened, people would be asked or could be ordered to evacuate the area. Additionally, environmental monitoring and surveillance programs would be initiated to track the movement of the oil slick as well as monitor clean-up progress. These monitoring programs would be designed by Trans Mountain, the WCMRC and other spill response agencies in consultation with municipal, provincial and federal government authorities such as Fisheries and Oceans Canada (DFO) and Environment Canada, local, regional, provincial and/or federal public health authorities and other network resources as described in Volume 7 of the Application, with consideration given to the location and size of the spill, the behaviour and movement of the spill, and the potential threats to health and the environment. The programs would	If warranted, notification of the public of the spill would include notice to avoid contact with the spilled oil, with examples provided of precautions to take to prevent both direct and incidental exposure, including avoiding hand-to-mouth behavior that could lead to ingestion of the oil and washing the hands with soap and water if they become soiled with oil.	The emergency and spill response measures that would be taken to contain and recover the spilled oil as well as to limit public access to the area would act to reduce any opportunity for people to be exposed to the spilled oil itself, including the very unlikely case of exposure from ingesting the oil directly as well as exposure through hand-to-mouth behavior, on both a short-term and long-term basis. Additionally, even in the very unlikely case that a person was to accidentally ingest the oil, the oil-salt water mixture would be very unpalatable, and would quickly be spit out. The likelihood and extent to which the general public might be exposed *via* this pathway on a short-term and longer-term basis was considered to be very low, and adverse health effects would not be anticipated. For these reasons, this pathway was excluded from further analysis.
Direct dermal contact with the spilled oil		The information collected as part of the environmental monitoring and surveillance programs (see Common Measures to Reduce Exposure) would be used to help guide decision-making with respect to public access to and use of nearby public waterways, beaches and/or shorelines. If conditions were such that people might be exposed to the oil through direct skin contact (for example, if beach or shoreline oiling was to occur), Trans Mountain would consult with the appropriate authorities on measures to be taken beyond oil recovery and clean-up, such as notifying the public of the potential hazard and/or posting of warnings, until such time that environmental monitoring and surveillance revealed conditions to be safe for the public. Closure of public waterways, beaches and/or shorelines could be ordered by the appropriate authorities if public health and/or safety were threatened. As indicated above for the direct ingestion pathway, notification of the public of the spill would include notice to avoid contact with the spilled oil as well as the recommendation to wash the hands	The emergency and spill response measures that would be taken to contain and recover the spilled oil as well as the measures that would be taken to limit or restrict access to public waters, beaches and/or shorelines if public health and safety was threatened would act to reduce any opportunity for exposure to the spilled oil *via* direct skin contact in both the short-term and long-term. In the case of the smaller-sized spill, in which the spilled oil remained inside the containment boom, access would be limited by the presence of the boom, thereby precluding any reasonable opportunity for the public to be exposed to the spilled oil by direct skin contact. Additionally, because public notices would advise people to avoid contact with the spilled oil and to wash any areas of the body that might become soiled with the oil with soap and water, if a person swimming, wading or strolling in the area was to encounter the spilled oil and get it on their skin, it is reasonable to expect that they would take measures to wash it off, thereby reducing and/or interrupting any exposure. Given the measures that would be taken to limit any direct exposure to the spilled oil *via* skin contact, the likelihood and extent to which the general public would be exposed by the pathway was considered to be very low and adverse health effects would not be anticipated. Based on the above, this pathway was excluded from further analysis.

Exposure Pathway	Measures to Reduce Exposure		Rationale for Inclusion/Exclusion
	Common	Specific	
	include monitoring of the presence of the spilled oil and/or its chemical constituents in different environmental compartments, such as the water column, submerged sediments and shoreline soils, with specifics surrounding the nature and extent of the monitoring again decided by Trans Mountain in consultation with the above agencies as part of a timely, coordinated approach. Air quality monitoring of hydrocarbon and other chemical vapours released from the surface of the oil slick also would be initiated. The information collected would be used, in part, to help guide decision-making opposite the need for and types of additional measures required to reduce any impacts on health and/or the environment, including measures to reduce the prospect for and/or extent to which people might be exposed to the spilled oil and/or chemicals released from the oil *via* different exposure pathways on both a short-term and longer-term basis. It is also important to note that the Westridge Marine Terminal is a manned facility, with equipment on-site that will be deployed during tanker loading, such as the containment boom, or which would immediately be deployed in the unlikely event of a spill such that the spilled oil would quickly be contained and recovery quickly initiated. Facility personnel would immediately take action, including alerting people in the immediate vicinity and instructing and assisting them, as needed, to move upwind and away from the spill; securing the perimeter of the facility; and restricting any further access of the public to the facility and surrounding property. Additional spill response network personnel and resources would arrive on-scene within one hour to lend assistance. Notification of and consultation with appropriate government agencies and other spill response personnel would quickly occur to determine the need for and type of emergency and spill response measures required for the protection of public health and safety. The net result would be a coordinated action to quickly reduce any potential for harm to people and the environment through use of personnel, equipment and other spill response resources located either on-site or nearby.	and/or other parts of the body with soap and water if they become soiled with oil.	
Inhalation of chemical vapours originating from the spilled oil		As part of the overall emergency and spill response and environmental monitoring programs (see Common Measures to Reduce Exposure) air quality monitoring surveys would be initiated to measure hydrocarbon and other chemical vapour levels in the air, and the information used, in part, to help guide decision-making with respect to public health and safety, including the need for continued environmental surveillance and management of public access to the area. Access would only be allowed if public health and safety was not threatened; otherwise, access would be restricted until monitoring revealed vapour levels to be within acceptable limits based on comparison against baseline and/or other appropriate reference levels and/or air quality objectives/guidelines developed for the protection of public health. Shelter-in-place advisories would be issued as an interim measure, if warranted, to reduce exposure to the chemical vapours in the short-term. If vapour levels were such that public health and/or safety were threatened, evacuation of the area could be ordered by the appropriate authorities.	Some possibility would exist for people in the area to be exposed to hydrocarbon and other chemical vapours released from the surface of the spilled oil during the early stages of the incident, before the arrival of first responders and the implementation of emergency and spill response measures. Depending on conditions, these vapours could first appear and be released from the surface of the oil slick and disperse into the area soon after the spill, before people are made aware of the incident. Accordingly, the acute inhalation pathway was examined in the HHRA. The prospect for and/or extent to which people might be exposed to the vapours would quickly decline as the emergency and spill response measures are put into place. Additionally, the rate and extent to which hydrocarbon and other chemical vapours would be released from the surface of the spilled oil would diminish over time with weathering, which, combined with the recovery and removal of the oil, would reduce opportunity for long-term exposure to the vapours. The air quality monitoring programs that would be in place would act to ensure that vapour levels are within acceptable limits, further reducing any prospect for the general public to experience long-term exposure to the vapours at elevated levels, such that adverse health effects would not be anticipated. For these reasons, long-term exposure to the chemicals contained in the spilled oil *via* the inhalation pathway was not examined in the HHRA.
Ingestion of foods containing chemical residues originating from the spilled oil		As already indicated (see Common Measures to Reduce Exposure), environmental monitoring and surveillance programs would be initiated, in part, to determine the partitioning of the spilled oil into different environmental media, including the water column, submerged sediment, and shoreline soils, and extending to local foodstuffs, if warranted. In this regard, once a spill has occurred, DFO would be notified. DFO along with other government authorities, such as Environment Canada and the Canadian Food Inspection Agency (CFIA), working in consultation with other appropriate network resources would assess the spill and, based on its location, size and the potential opportunities for people to be exposed to the spilled oil through different exposure pathways, would determine if additional spill response measures may be needed to protect public health. This determination would	Due to the various emergency and spill response measures that would be taken in the unlikely event of a spill at the facility, including measures, if warranted, aimed at ensuring the safety of the public food supply, the prospect for and/or extent to which people might be exposed to the spilled oil and/or chemicals originating from the oil on a short-term or long-term basis was considered to be very low. The public would be quickly notified of the spill, and if there was reason to suspect that the safety of the food supply was threatened, the public would be informed and cautioned to avoid foods that might be tainted. By avoiding these foods, exposure to the chemicals *via* the food consumption pathway would be prevented. Based on the above, the likelihood and extent to which the general public would be exposed by the pathway was considered to be very low and adverse health effects would not be anticipated. For these reasons, this pathway was excluded from further analysis.

Exposure Pathway	Measures to Reduce Exposure		Rationale for Inclusion/Exclusion
	Common	Specific	
		extend to measures required to ensure the safety of the public food supply, and if warranted, could include controls such as the closure of commercial and recreational fisheries and the issuance of fish, shellfish and/or other seafood consumption advisories. (Note that any such controls would be in addition to the already long-standing bivalve closure in effect for the Burrard Inlet, Indian Arm and Vancouver Harbour for sanitary reasons).	
Ingestion of drinking water containing chemical residues originating from the spilled oil		Notification of the public of the spill would include notice to avoid contact with the spilled oil, with examples provided of precautions to take to prevent both direct and incidental exposure. Since exposure to the spilled oil itself and/or chemicals contained therein *via* the drinking water pathway would not be anticipated since people living in the communities located near the Westridge Marine Terminal and along the shores of the Burrard Inlet, including the FVRD, rely on municipal water supplies as their source of drinking water, notification of the public in this regard would more likely be in the form of assurances that the drinking water was safe to consume.	No obvious opportunity exists for people to be exposed to the spilled oil itself and/or to chemicals originating from the spilled oil through the drinking water pathway. Firstly, salt water would not be used as a source of drinking water by people, even on an incidental basis. Additionally, people living in the communities located near the Westridge Marine Terminal and along the shores of the Burrard Inlet, including the FVRD, rely on municipal water supplies as their source of drinking water. These water supplies would not be affected by an oil spill at the facility under the simulated oil spill scenarios that were assessed in the HHRA. Based on the above, the drinking water consumption pathway was excluded from further analysis.
Dermal contact with soils or sediments containing chemical residues originating from the spilled oil		As indicated above, if warranted, the environmental monitoring and surveillance programs would extend to soils and submerged sediments, including soils and sediments in areas that could be frequented by the public such as public beaches and shorelines. If surveillance revealed shoreline or beach oiling (see Specific Measures to Reduce Exposure for direct dermal contact with spilled oil) and/or if monitoring showed chemicals originating from the spilled oil to be present in the soils and/or submerged sediments at elevated levels that could pose a threat to public health and/or safety, Trans Mountain would consult with the appropriate authorities on measures to be taken beyond oil recovery and clean-up, such as notifying the public of the potential hazard and/or posting of warnings, until such time that monitoring and surveillance revealed conditions to be safe for the public. Closure of public beaches and/or shorelines could be ordered by the appropriate authorities, with restrictions remaining in place until clean-up is completed and monitoring results show the levels	The emergency and spill response measures that would be quickly taken to contain and recover the spilled oil as well as the measures that would be taken to limit or restrict access to public waters, beaches and/or shorelines if public health and safety was threatened would act to reduce any opportunity for exposure to the spilled oil itself and/or chemicals released from the oil *via* skin contact in both the short-term and long-term. Based on the above, the likelihood and extent to which the general public would be exposed by the pathway was considered to be very low, with health effects not being anticipated. As a result, this pathway was excluded from further analysis.

Exposure Pathway	Measures to Reduce Exposure		Rationale for Inclusion/Exclusion
	Common	Specific	
		of the chemicals to be within acceptable limits based on comparison against baseline and/or other reference levels and/or soil quality criteria developed for the protection of human health. The public notices and/or warnings would advise the public to avoid contact with any oil-stained soils, and to wash any affected areas of skin with soap and water if contact was to occur.	
Inhalation of dust containing chemical residues originating from the spilled oil		The only reasonable source of such dust would be wind-blown soil particles contaminated by the spilled oil that might become suspended in air if the liquid oil was allowed to spread and dry on the soil surface over time. The source itself would be limited insofar as the emergency and spill response measures that would be quickly taken in the unlikely event of a spill at the Westridge Marine Terminal would include the containment and recovery of the spilled oil and the clean-up of affected shoreline, beaches, *etc*. If warranted, the air quality surveys performed as part of the environmental monitoring program (see above) could include the measurement of suspended dust as well as chemical vapours, with the information used to help guide decision-making with respect to the need for continued surveillance and management of public access to any areas affected by dust. Access would only be allowed if public health and safety was not threatened.	Exposure of the general public to soil-borne dust containing chemical residues originating from the spilled oil would not be expected to occur in the short-term given the nature of the media involved (*i.e.,* a liquid product spilled into a liquid medium) and the need for time to elapse to allow any oil that reaches the shoreline to dry on the soil surface. Due to the various emergency and spill response measures that would be taken in the unlikely event of a spill at the facility, including the surveillance and monitoring of soils in the area, the prospect for and/or extent to which people might be exposed to soil-borne dust containing chemical residues originating from the spilled oil on a long-term basis would be very low, and adverse health effects would not be anticipated. For these reasons, this pathway was excluded from further analysis.
Incidental ingestion of soils containing chemical residues originating from the spilled oil		As indicated above as part of overall emergency and spill response, notification of the public of the spill would include notice to avoid contact with the spilled oil, with examples provided of precautions to take to prevent both direct and incidental exposure, including avoiding hand-to-mouth behavior, such as if a child was to inadvertently (or deliberately as part of pica-like behavior) place soil into his/her mouth. Also as indicated above, if warranted, environmental monitoring and surveillance programs would extend to soils, including soils in areas that could be frequented by the public such as public beaches and shorelines. If surveillance revealed shoreline or beach oiling (see Specific Measures to Reduce Exposure for direct dermal contact with spilled oil) and/or if monitoring showed chemicals originating from the spilled oil to be present in the soils at elevated	Direct or incidental exposure of the public to the spilled oil itself and/or chemicals originating from the spilled oil through the ingestion of soils in the area is considered to be very remote. First, if accidently ingested, the oil-salt water-soil mix would be highly unpalatable, and would quickly be spit out. Second, deliberate ingestion of soils is unlikely even in the case of pica-like behavior since this condition is rare and isolated. Third, if warranted, a number of emergency and spill response measures would be taken to manage and/or restrict public access to areas where environmental surveillance and/or monitoring show the presence of oil and/or chemicals originating from the oil in soils at elevated levels that could threaten public health. For these reasons, this pathway was excluded from further analysis.

Exposure Pathway	Measures to Reduce Exposure		Rationale for Inclusion/Exclusion
	Common	Specific	
		levels that could pose a threat to public health and/or safety, Trans Mountain would consult with the appropriate authorities on measures to be taken beyond recovery and clean-up, such as notifying the public of the potential hazard and/or posting of warnings, until such time that environmental monitoring and surveillance revealed conditions to be safe for the public. Closure of public beaches and/or shorelines could be ordered by the appropriate authorities, with restrictions remaining in place until clean-up is completed and monitoring results show the levels of the chemicals to be within acceptable limits based on comparison against baseline and/or other reference levels and/or soil quality criteria developed for the protection of human health.	

Notes:

1 Includes residents, area users, bystanders and other members of the general public who might be frequenting the area at the time of the oil spill.

TABLE 2.01A-6

EXPOSURE PATHWAY SELECTION FOR THE WESTRIDGE MARINE TERMINAL SIMULATED OIL SPILL SCENARIOS FOR SPILL RESPONSE PERSONNEL[1]

Exposure Pathway	Measures to Reduce Exposure		Rationale for Inclusion/Exclusion
	Common	Specific	
Direct ingestion of the spilled oil	The expectation is that spill response personnel would be: • Trained in emergency preparedness and response; • Equipped with appropriate PPE; and • Aware of the need to 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. Training will extend to awareness of the hazardous properties of the chemicals involved, including awareness of the potential health effects that can result from exposure to the chemicals, as well as first-aid measures to be taken in the event of over-exposure to the chemicals, with the relevant information drawn from Safety Data Sheets and other reference sources and guides. As discussed in Table 2.01a-5 for the general public, environmental monitoring and surveillance programs would be performed, in part, to track the movement of the spilled oil as well as to assess spill clean-up progress. The monitoring also would be used to determine the presence of the oil and any chemicals originating from the oil in different environmental media, such as air, soils and submerged sediments that first responders and spill response personnel may come into contact with. Air quality monitoring of hydrocarbon and other chemical vapours released from the surface of the oil slick also would be initiated. If warranted, monitoring would be extended to the use of personal monitors. The exact scope and nature of the monitoring programs would be decided by Trans Mountain in consultation with the WCMRC and other spill response agencies as well as local, provincial and federal health and government authorities as	Awareness of the need to avoid exposure to the spilled oil (see Common Measures to Reduce Exposure) would include an understanding and appreciation of the need for proper industrial hygiene practices to be followed, including the need to avoid hand-to-mouth and other behaviors that could lead to direct or incidental ingestion of the oil.	Training and awareness of spill response personnel of the need to avoid exposure to the spilled oil would extend to the need to avoid behaviours that could lead to direct or incidental ingestion of the oil. Due to this training and awareness, the prospect for and/extent to which these individuals might be exposed to the oil by this pathway on either a short-term or longer-term basis would be negligible. For this reason, the pathway was excluded from further analysis.
Direct dermal contact with the spilled oil		Awareness of the need to avoid exposure to the spilled oil (see Common Measures to Reduce Exposure) would include understanding and appreciation of the need for proper industrial hygiene practices to be followed, including the need to avoid direct or incidental skin contact with the oil. Personnel will be equipped and properly fitted with appropriate PPE, such as chemical-resistant gloves, protective eyewear and/or full face shields, coveralls and boots, to minimize dermal contact with the oil. Care will be taken to ensure that PPE is clean and in good working condition.	Training and awareness of spill response personnel of the need to avoid exposure to the spilled oil would extend to the need to avoid dermal contact with the oil. Due to this training and awareness, as well as the use of PPE, the prospect for and/or extent to which these individuals might be exposed to the oil by this pathway on either a short-term or longer-term basis would be low. For this reason, the pathway was excluded from further analysis.
Inhalation of chemical vapours originating from the spilled oil		Training and awareness of personnel would extend to the need to avoid exposure to the chemical vapours that could be released from the surface of the spilled oil. Personnel will be equipped and properly fitted with appropriate PPE, as required, to limit inhalation exposure to vapours. Care will be taken to ensure that PPE is clean and in good working order. Air quality monitoring will be performed in the area to alert personnel to the presence of any vapours and the need to take appropriate precautions to avoid exposure. Personnel would be fitted with personal monitors, if warranted.	Training and awareness of spill response personnel of the need to avoid exposure to the spilled oil would extend to the need to avoid inhalation of the hydrocarbon and other chemical vapours released from the surface of the oil. Due to this training and awareness, as well as the use of PPE, the prospect for and/or extent to which these individuals might be exposed to the oil by this pathway on either a short-term or longer-term basis would be low. For this reason, the pathway was excluded from further analysis.
Ingestion of foods containing chemical residues originating from		The specific measures discussed in Table 2.01a-5 that would be taken to limit exposure of the general public to any chemical residues originating from the spilled oil that might occur in foods also	Because of the emergency and spill response measures that would be taken to ensure that the safety of the food supply is not compromised, exposure of spill response personnel *via* this pathway would be very low. The pathway was excluded

Exposure Pathway	Measures to Reduce Exposure		Rationale for Inclusion/Exclusion
	Common	Specific	
the spilled oil	part of the UC described in Volume 7 of the Application. The monitoring results would be used to alert response personnel of the presence of the oil and/or chemicals such that appropriate precautions could be taken to avoid exposure. Access to areas would be controlled based on the monitoring results, with access allowed only if worker health and safety was not threatened. The above measures would act to limit any chemical exposures that might be experienced by first responders and other spill response personnel. That said, if the above measures were not taken, distinct opportunity could exist for spill response personnel to be exposed to the spilled oil and/chemicals originating from the spilled *via* certain pathways on a short-term and/or longer-term basis at levels that could cause health effects such as headache, nausea, dizziness and/or eye, nose, throat and/or skin irritation, with the likelihood of occurrence and severity of effects becoming more pronounced with increasing exposure.	would apply to spill response personnel.	from further analysis.
Ingestion of drinking water containing chemical residues originating from the spilled oil		Since exposure to the spilled oil itself and/or chemicals contained therein *via* the drinking water pathway would not be anticipated, personnel would receive assurances that the drinking water remains safe to consume, as needed to ease any concern.	This pathway was excluded from further analysis for the same reasons stated for the general public in Table 2.01a-5.
Dermal contact with soils or sediments containing chemical residues originating from the spilled oil		Awareness of the need to avoid exposure to the spilled oil (see Common Measures to Reduce Exposure) would include understanding and appreciation of the need for proper industrial hygiene practices to be followed, including the need to avoid direct or incidental skin contact with the spilled oil itself as well as soils or sediments that might contain chemical residues originating from the oil. Personnel will be equipped and properly fitted with appropriate PPE, such as gloves, protective eyewear and/or full face shields, coveralls and boots, to minimize dermal contact with the oil itself and any environmental media, including soils or sediments that might contain chemical residues originating from the spilled oil. Care will be taken to ensure that PPE is clean and in good working condition. As discussed for the general public in Table 2.01a-5, environmental monitoring of soils and sediments for the presence of chemical residues would be performed, and spill response personnel would be alerted of the need to avoid exposure to contaminated soils and sediments.	Training and awareness of spill response personnel of the need to avoid exposure to the spilled oil would extend to the need to avoid dermal contact with the spilled oil itself as well as any oil-tainted soils and sediments. Due to this training and awareness, as well as the use of PPE, the prospect for and/or extent to which these individuals might be exposed to the oil by this pathway on either a short-term or longer-term basis would be low. For this reason, the pathway was excluded from further analysis.
Inhalation of dust containing chemical residues originating from the spilled oil		Training and awareness of personnel would extend to the need to avoid exposure to dusts that may contain chemical residues originating from the spilled oil. Personnel will be equipped and properly fitted with appropriate PPE, as required, to limit inhalation exposure to dusts. Care will be taken to ensure that PPE is clean and in good working order. Air quality monitoring will be performed in the area to alert personnel of the presence of any suspended dusts and the need to take appropriate precautions to avoid exposure.	Training and awareness of spill response personnel of the need to avoid exposure to the spilled oil would extend to the need to avoid inhalation of suspended dust that could contain chemicals originating from the spilled oil. Due to this training and awareness, as well as the use of PPE, the prospect for and/or extent to which these individuals might be exposed to the oil by this pathway on either a short-term or longer-term basis would be low. For this reason, the pathway was excluded from further analysis.

Notes:

1 Includes Trans Mountain, WCMRC and other spill response agency personnel who would be engaged in the coordinated action to quickly contain and recover the spilled oil and to mitigate any public health and environmental impacts as part of the UC structure described in Volume 7 of the Application. These personnel would not include volunteers since Trans Mountain does not rely on volunteers for emergency response.

TABLE 2.01A-7

EXPOSURE PATHWAY SELECTION FOR THE MARINE SIMULATED OIL SPILL SCENARIOS FOR THE GENERAL PUBLIC[1]

Exposure Pathway	Measures to Reduce Exposure		Rationale for Inclusion/Exclusion
	Common	Specific	
Direct ingestion of the spilled oil	In the unlikely event of a spill, the vessel owner would immediately notify the WCMRC, and consultation with appropriate emergency and spill response personnel and agencies, such as the Coast Guard authorities, would occur and coordinated action would quickly be taken to contain and recover the spilled oil, as outlined in Volume 8A of the Application. Trans Mountain would be available for consultation and to provide assistance. In conjunction with these actions, appropriate municipal, provincial and federal government authorities as well as local, regional, provincial and/or federal public health authorities would be notified of the spill, and coordinated action would be taken to determine the need for and types of measures required to protect people's health if public health and/or safety were threatened, including measures to reduce the prospect for and/or extent to which people might be exposed to the spilled oil itself and/or chemicals released from the oil, such as notifying the public of the spill, advising the public to avoid the area, and restricting access to the area. If public health and/or safety were threatened, people would be asked or could be ordered to evacuate the area. Additionally, environmental monitoring and surveillance programs would be initiated to track the movement of the oil slick as well as monitor clean-up progress. These monitoring programs would be designed in consultation with Trans Mountain, and other spill response network resources as well as with municipal, provincial and federal government authorities such as DFO and Environment Canada, and local, regional, provincial and/or federal public health authorities, with consideration given to the location and size of the spill, the behaviour and movement of the spill, and the potential threats to health and the environment. The programs would include monitoring of the presence of the spilled oil and/or its chemical constituents in different	If warranted, notification of the public of the spill would include notice to avoid contact with the spilled oil, with examples provided of precautions to take to prevent both direct and incidental exposure, including avoiding hand-to-mouth behavior that could lead to ingestion of the oil and washing the hands with soap and water if they become soiled with oil.	The emergency and spill response measures that would be taken to contain and recover the spilled oil as well as to limit public access to the area will act to reduce any opportunity for people to be exposed to the spilled oil itself, including the very unlikely case of exposure from ingesting the oil directly as well as exposure through hand-to-mouth behavior, on both a short-term and long-term basis. Additionally, even in the very unlikely case that a person was to accidentally ingest the oil, the oil-salt water mixture would be very unpalatable, and would quickly be spit out. The likelihood and extent to which the general public might be exposed *via* this pathway on either a short-term or longer-term basis was considered to be very low, and health effects would not be anticipated. For these reasons, this pathway was excluded from further analysis.
Direct dermal contact with the spilled oil		The information collected as part of the environmental monitoring and surveillance programs (see Common Measures to Reduce Exposure) would be used to help guide decision-making with respect to public access to and use of nearby public waterways, beaches and/or shorelines. If conditions were such that people might be exposed to the oil through direct skin contact (for example, if beach or shoreline oiling was to occur), consultation with the appropriate network resources and public health authorities would be undertaken on measures to be implemented beyond recovery and clean-up, such as notifying the public of the potential hazard and/or posting of warnings, until such time that environmental monitoring and surveillance revealed conditions to be safe for the public. Closure of public waterways, beaches and/or shorelines could be ordered by the appropriate authorities if public health and/or safety were threatened. As indicated above for the direct ingestion pathway, notification of the public of the spill would include notice to avoid contact with the spilled oil as well as the recommendation to wash the hands	The emergency and spill response measures that would be taken to contain and recover the spilled oil as well as the measures that would be taken to limit or restrict access to public waters, beaches and/or shorelines if public health and safety were threatened would act to reduce any opportunity for exposure to the spilled oil *via* direct skin contact in both the short-term and long-term. Additionally, because public notices would advise people to avoid contact with the spilled oil and to wash any areas of the body that might become soiled with the oil with soap and water, if a person swimming or wading or strolling in the area was to encounter the spilled oil and get it on their skin, it is reasonable to expect that they would take measures to wash it off, thereby reducing and/or interrupting any exposure. Given the measures that would be taken to limit any direct exposure to the spilled oil *via* skin contact, the likelihood and extent to which the general public would be exposed by the pathway was considered to be low to very low. Based on the above, this pathway was excluded from further analysis.

Exposure Pathway	Measures to Reduce Exposure		Rationale for Inclusion/Exclusion
	Common	Specific	
	environmental compartments, such as the water column, submerged sediments and shoreline soils. Air quality monitoring of hydrocarbon and other chemical vapours released from the surface of the oil slick also would be initiated. The information collected would be used, in part, to help guide decision-making opposite the need for and types of additional measures required to reduce any impacts on health and/or the environment, including measures to reduce the prospect for and/or extent to which people might be exposed to the spilled oil and/or chemicals released from the oil *via* different exposure pathways on both a short-term and longer-term basis.	and/or other parts of the body with soap and water if they become soiled with oil.	
Inhalation of chemical vapours originating from the spilled oil		As part of the overall emergency and spill response and environmental monitoring programs (see Common Measures to Reduce Exposure) air quality monitoring surveys would be initiated to measure hydrocarbon and other chemical vapour levels in the air, and the information used, in part, to help guide decision-making with respect to public health and safety, including the need for continued environmental surveillance and management of public access to the area. Access would only be allowed if public health and safety was not threatened; otherwise, access would be restricted until monitoring revealed vapour levels to be within acceptable limits based on comparison against baseline and/or other appropriate reference levels and/or air quality objectives/guidelines developed for the protection of public health. If vapour levels in the area were such that public health and/or safety were threatened, evacuation of the area could be ordered by the appropriate authorities.	Some possibility would exist for people in the area, for example people on nearby recreational or commercial watercraft, to be exposed to hydrocarbon and other chemical vapours released from the surface of the spilled oil during the early stages of the incident, before the arrival of first responders and the implementation of emergency and spill response measures. Depending on conditions, these vapours could first appear and be released from the surface of the oil slick and disperse into the area soon after the spill, before people are made aware of the incident. Accordingly, the acute inhalation pathway was examined in the HHRA. The prospect for and/or extent to which people might be exposed to the vapours would quickly decline as the emergency and spill response measures are put into place. Additionally, the rate and extent to which hydrocarbon and other chemical vapours would be released from the surface of the spilled oil would diminish over time with weathering, which, combined with the recovery and removal of the oil, would reduce opportunity for long-term exposure to the vapours. The air quality monitoring programs that would be in place would act to ensure that vapour levels are within acceptable limits, further reducing any prospect for the general public to experience long-term exposure to the vapours at elevated levels, such that health effects would not be anticipated. For these reasons, long-term exposure to the chemicals contained in the spilled oil *via* the inhalation pathway was not examined in detail in the HHRA.
Ingestion of foods containing chemical residues originating from the spilled oil		As already indicated (see Common Measures to Reduce Exposure), environmental monitoring and surveillance programs would be initiated, in part, to determine the partitioning of the spilled oil into different environmental media, including the water column, submerged sediment, and shoreline soils, and extending to local foodstuffs, if warranted. In this regard, once a spill has occurred, DFO would be notified. DFO along with other government authorities, such as Environment Canada and the CFIA, working in consultation with other appropriate network resources would assess the spill and, based on its location, size and the potential opportunities for people to be exposed to the spilled oil through different exposure pathways, would determine if additional spill response measures may be needed to protect public health.	Due to the various emergency and spill response measures that would be taken in the unlikely event of a marine spill, including measures, if warranted, aimed at ensuring the safety of the public food supply, the prospect for and/or extent to which people might be exposed to the spilled oil and/or chemicals originating from the oil via this pathway on a short-term or long-term basis was considered to be very low. The public would be quickly notified of the spill, and if there was reason to suspect that the safety of the food supply could be compromised, the public would be informed and cautioned to avoid foods that might be tainted. By avoiding these foods, exposure to the chemicals *via* the food consumption pathway would be prevented. Based on the above, the likelihood and extent to which the general public would be exposed by the pathway was considered to be low to very low, and health effects would not be anticipated. For these reasons, this pathway was excluded from further

Exposure Pathway	Measures to Reduce Exposure		Rationale for Inclusion/Exclusion
	Common	Specific	
		This determination would extend to measures required to ensure the safety of the public food supply, and if warranted, could include controls such as the closure of commercial and recreational fisheries and the issuance of fish, shellfish and/or other seafood consumption advisories.	analysis.
Ingestion of drinking water containing chemical residues originating from the spilled oil		Notification of the public of the spill would include notice to avoid contact with the spilled oil, with examples provided of precautions to take to prevent both direct and incidental exposure. Since exposure to the spilled oil itself and/or chemicals contained therein *via* the drinking water pathway would not be anticipated since people along the marine transport route would not obtain their drinking water from salt-water sources, notification of the public in this regard would more likely be in the form of assurances that the drinking water was safe to consume.	No obvious opportunity exists for people to be exposed to the spilled oil itself and/or to chemicals originating from the spilled oil through the drinking water pathway. Salt water would not be used as a source of drinking water by people, even on an incidental basis. Based on the above, the drinking water consumption pathway was excluded from further analysis.
Dermal contact with soils or sediments containing chemical residues originating from the spilled oil		As indicated above, if warranted, the environmental monitoring and surveillance programs would extend to soils and submerged sediments, including soils and sediments in areas that could be frequented by the public such as public beaches and shorelines. If surveillance revealed shoreline or beach oiling (see Specific Measures to Reduce Exposure for direct dermal contact with spilled oil) and/or if monitoring showed chemicals originating from the spilled oil to be present in the soils and/or submerged sediments at elevated levels that could pose a threat to public health and/or safety, consultation with the appropriate authorities would be undertaken on measures to be implemented beyond recovery and clean-up, such as notifying the public of the potential hazard and/or posting of warnings, until such time that environmental monitoring and surveillance revealed conditions to be safe for the public. Closure of public beaches and/or shorelines could be ordered by the appropriate authorities, with restrictions remaining in place until clean-up is completed and environmental monitoring results show the levels of the chemicals to be within acceptable limits based on comparison against baseline and/or other reference levels and/or soil quality criteria developed for the protection of human health. The public notices	The emergency and spill response measures that would be quickly taken to contain and recover the spilled oil as well as the measures that would be taken to limit or restrict access to public waters, beaches and/or shorelines if public health and safety was threatened would act to reduce any opportunity for exposure to the spilled oil itself and/or chemicals released from the oil *via* skin contact in both the short-term and long-term. Based on the above, the likelihood and extent to which the general public would be exposed by the pathway was considered to be low to very low, and as a result, this pathway was excluded from further analysis.

Exposure Pathway	Measures to Reduce Exposure		Rationale for Inclusion/Exclusion
	Common	Specific	
		and/or warnings would advise the public to avoid contact with any oil-stained soils, and to wash any affected areas of skin with soap and water if contact was to occur.	
Inhalation of dust containing chemical residues originating from the spilled oil		The only reasonable source of such dust would be wind-blown soil particles contaminated by the spilled oil that might become suspended in air if the liquid oil was allowed to spread and dry on the soil surface over time. If warranted, the air quality surveys performed as part of the environmental monitoring program (see above) could include the measurement of suspended dust as well as chemical vapours, with the information used to help guide decision-making with respect to the need for continued surveillance and management of public access to any areas affected by dust. Access would only be allowed if public health and safety was not threatened.	Exposure of the general public to soil-borne dust containing chemical residues originating from the spilled oil would not be expected to occur in the short-term given the nature of the media involved (*i.e.,* a liquid product spilled into a liquid medium) and the need for time to elapse to allow any oil that reaches the shoreline to dry on the soil surface. Due to the surveillance and monitoring of affected soils, the prospect for and/or extent to which people might be exposed to soil-borne dust containing chemical residues originating from the spilled oil on a long-term basis would be very low, and health effects would not be anticipated. For these reasons, this pathway was excluded from further analysis.
Incidental ingestion of soils containing chemical residues originating from the spilled oil		As indicated above as part of overall emergency and spill response, notification of the public of the spill would include notice to avoid contact with the spilled oil, with examples provided of precautions to take to prevent both direct and incidental exposure, including avoiding hand-to-mouth behavior, such as if a child was to inadvertently (or deliberately as part of pica-like behavior) place soil into his/her mouth. Also as indicated above, if warranted, environmental monitoring and surveillance programs would extend to soils, including soils in areas that could be frequented by the public such as public beaches and shorelines. If surveillance revealed shoreline or beach oiling (see Specific Measures to Reduce Exposure for direct dermal contact with spilled oil) and/or if monitoring showed chemicals originating from the spilled oil to be present in the soils at elevated levels that could pose a threat to public health and/or safety, consultation with the appropriate authorities would be undertaken on measures to be implemented beyond recovery clean-up, such as notifying the public of the potential hazard and/or posting of warnings, until such time that environmental monitoring and surveillance revealed conditions to be safe for the public. Closure of public beaches and/or shorelines could be ordered by the appropriate authorities, with	Direct or incidental exposure of the public to the spilled oil itself and/or chemicals originating from the spilled oil through the ingestion of oil-tainted soils in the area is considered to be remote. First, if accidently ingested, the oil-salt water-soil mix would be highly unpalatable, and would quickly be spit out. Second, deliberate ingestion of soils is unlikely even in the case of pica-like behavior since this condition is rare and isolated. Third, if warranted, a number of emergency and spill response measures would be taken to manage and/or restrict public access to areas where environmental surveillance and/or monitoring show the presence of oil and/or chemicals originating from the oil in soils at elevated levels that could threaten public health. For these reasons, this pathway was excluded from further analysis.

Exposure Pathway	Measures to Reduce Exposure		Rationale for Inclusion/Exclusion
	Common	Specific	
		restrictions remaining in place until clean-up is completed and environmental monitoring results show the levels of the chemicals to be within acceptable limits based on comparison against baseline and/or other reference levels and/or soil quality criteria developed for the protection of human health.	

Note:

1 Includes people who could be on the water in the area for work, recreation or other reasons, such as fishermen, and people in pleasure or commercial watercraft.

TABLE 2.01A-8

EXPOSURE PATHWAY SELECTION FOR THE MARINE SIMULATED OIL SPILL SCENARIOS FOR SPILL RESPONSE PERSONNEL[1]

Exposure Pathway	Measures to Reduce Exposure		Rationale for Inclusion/Exclusion
	Common	Specific	
Direct ingestion of the spilled oil	The expectation is that spill response personnel will be: • Trained in emergency preparedness and response; • Equipped with appropriate PPE; and • Aware of the need to 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. Training will extend to awareness of the hazardous properties of the chemicals involved, including awareness of the potential health effects that can result from exposure to the chemicals, as well as first-aid measures to be taken in the event of over-exposure to the chemicals, with the relevant information drawn from Safety Data Sheets and other reference sources and guides. As discussed in Table 2.01a-7 for the general public, environmental monitoring and surveillance programs will be performed, in part, to track the movement of the spilled oil as well as to assess spill clean-up progress. The monitoring also will be used to determine the presence of the oil and any chemicals originating from the oil in different environmental media, such as air, soils and submerged sediments that first responders and spill response personnel may come into contact with. Air quality monitoring of hydrocarbon and other chemical vapours released from the surface of the oil slick also would be initiated. If warranted, monitoring could include measurement of oil-salt water aerosol levels. Also if warranted, monitoring would be extended to the use of personal monitors. The exact scope and nature of the monitoring programs would be decided in consultation with Trans Mountain, the WCMRC and other spill response agencies as well as local, provincial and federal health and government authorities. The environmental monitoring results would be used to alert response personnel of the presence of the oil	Awareness of the need to avoid exposure to the spilled oil (see Common Measures to Reduce Exposure) would include an understanding and appreciation of the need for proper industrial hygiene practices to be followed, including the need to avoid hand-to-mouth and other behaviors that could lead to direct or incidental ingestion of the oil.	Training and awareness of spill response personnel of the need to avoid exposure to the spilled oil would extend to the need to avoid behaviours that could lead to direct or incidental ingestion of the oil. Due to this training and awareness, the prospect for and/or extent to which these individuals might be exposed to the oil by this pathway on either a short-term or longer-term basis would be negligible. For this reason, the pathway was excluded from further analysis.
Direct dermal contact with the spilled oil		Awareness of the need to avoid exposure to the spilled oil (see Common Measures to Reduce Exposure) would include understanding and appreciation of the need for proper industrial hygiene practices to be followed, including the need to avoid direct or incidental skin contact with the oil. Personnel will be equipped and properly fitted with appropriate PPE, such as chemical-resistant gloves, protective eyewear and/or full face shield, coveralls and boots, to minimize dermal contact with the oil. Care will be taken to ensure that PPE is clean and in good working condition.	Training and awareness of spill response personnel of the need to avoid exposure to the spilled oil would extend to the need to avoid dermal contact with the oil. Due to this training and awareness, as well as the use of PPE, the prospect for and/or extent to which these individuals might be exposed to the oil by this pathway on either a short-term or longer-term basis would be low. For this reason, the pathway was excluded from further analysis.
Inhalation of chemical vapours originating from the spilled oil		Training and awareness of personnel would extend to the need to avoid exposure to the chemical vapours that could be released from the surface of the spilled oil. Personnel would be equipped and properly fitted with appropriate PPE, as required, to limit inhalation exposure to vapours. Care would be taken to ensure that PPE is clean and in good working order. Air quality monitoring would be performed in the area to alert personnel to the presence of any vapours and the need to take appropriate precautions to avoid exposure. Personnel would be fitted with personal monitors, if warranted.	Training and awareness of spill response personnel of the need to avoid exposure to the spilled oil would extend to the need to avoid inhalation of the hydrocarbon and other chemical vapours released from the surface of the oil. Due to this training and awareness, as well as the use of PPE, the prospect for and/or extent to which these individuals might be exposed to the oil by this pathway on either a short-term or longer-term basis would be low. For this reason, the pathway was excluded from further analysis.
Ingestion of foods containing chemical residues originating from the spilled oil		The specific measures discussed in Table 2.01a-7 that would be taken to limit exposure of the general public to any chemical residues originating from the spilled oil that might occur in foods also would apply to spill response personnel.	Due to the emergency and spill response measures that would be taken to ensure that the safety of the food supply is not compromised, exposure of spill response personnel *via* this pathway would be very low. The pathway was excluded from further analysis.
Ingestion of drinking water		Since exposure to the spilled oil itself and/or chemicals contained therein *via* the drinking water	This pathway was excluded from further analysis for the same reasons stated for the general public in Table 2.01a-7.

Exposure Pathway	Measures to Reduce Exposure		Rationale for Inclusion/Exclusion
	Common	Specific	
containing chemical residues originating from the spilled oil	and/or chemicals such that appropriate precautions could be taken to avoid exposure. Access to areas would be controlled based on the environmental monitoring results, with access allowed only if worker health and safety was not threatened. If warranted and in consultation with appropriate health authorities, medical surveillance of spill response personnel could be initiated in the form of routine physical exams, lung function testing, biomonitoring and/or other tests to establish fitness for work, evidence of exposure to contaminants and/or effectiveness of PPE, with outcomes used to assess clean-up work practices and the need for stricter exposure reduction/avoidance measures The above measures would act to limit any chemical exposures that might be experienced by first responders and other spill response personnel. That said, if the above measures were not taken, distinct opportunity could exist for spill response personnel to be exposed to the spilled oil and/chemicals originating from the spilled *via* certain pathways on a short-term and/or longer-term basis at levels that could cause health effects such as headache, nausea, dizziness and/or eye, nose, throat and/or skin irritation, with the likelihood of occurrence and severity of effects becoming more pronounced with increasing exposure.	pathway would not be anticipated, personnel would receive assurances that the drinking water remains safe to consume, as needed to ease any concern.	
Dermal contact with soils or sediments containing chemical residues originating from the spilled oil		Awareness of the need to avoid exposure to the spilled oil (see Common Measures to Reduce Exposure) would include understanding and appreciation of the need for proper industrial hygiene practices to be followed, including the need to avoid direct or incidental skin contact with the spilled oil itself as well as soils or sediments that might contain chemical residues originating from the oil. Personnel will be equipped and properly fitted with appropriate PPE, such as chemical-resistant gloves, protective eyewear and/or full face shields, and coveralls and boots, to minimize dermal contact with the oil itself and any environmental media, including soils or sediments that might contain chemical residues originating from the spilled oil. Care will be taken to ensure that PPE is clean and in good working condition. As discussed for the general public in Table 2.01a-7, environmental monitoring of soils and sediments for the presence of chemical residues would be performed, and spill response personnel would be alerted of the need to avoid exposure to oil-tainted soils and sediments.	Training and awareness of spill response personnel of the need to avoid exposure to the spilled oil would extend to the need to avoid dermal contact with the oil as well as any oil-tainted soils and sediments. Due to this training and awareness, as well as the use of PPE, the prospect for and/or extent to which these individuals might be exposed to the oil by this pathway on either a short-term or longer-term basis would be low. For this reason, the pathway was excluded from further analysis.
Inhalation of dust containing chemical residues originating from the spilled oil		Training and awareness of personnel would extend to the need to avoid exposure to dusts that may contain chemical residues originating from the spilled oil. Personnel would be equipped and properly fitted with appropriate PPE, as required, to limit inhalation exposure to dusts. Care will be taken to ensure that PPE is clean and in good working order. Air quality monitoring would be performed in the area to alert personnel of the presence of any suspended dusts and the need to take appropriate precautions to avoid exposure.	Training and awareness of spill response personnel of the need to avoid exposure to the spilled oil would extend to the need to avoid inhalation of suspended dust that could contain chemicals originating from the spilled oil. Due to this training and awareness, as well as the use of PPE, the prospect for and/or extent to which these individuals might be exposed to the oil by this pathway on either a short-term or longer-term basis would be low. For this reason, the pathway was excluded from further analysis.

Notes:

1 Includes vessel personnel, the WCMRC, Coast Guard authorities and other spill response agency personnel who would be engaged in spill containment, recovery and/or clean-up as described in Volume 8A of the Application

Table 3 Ranges of physical properties for example Alberta crude oil blends and ANS crude

Properties	Mixed Sweet Blend (MSW)	Husky Synthetic Blend (HSB)	Premium Albian Synthetic (PAS)	Lloyd Kerrobert (LLK)	Wabasca Heavy (WH)	Western Canadian Blend (WCB)	Access Western Blend (AWB)	Cold Lake (CL)	Western Canadian Select (WCS)	Albian Heavy Synthetic (AHS)	ANS Crude[2]
Type crude	Light sweet	Light synthetic		Heavy sour conventional			Dilbit			Dilsynbit	Medium
Density[1] (kg/m^3)	827.2 ± 3.3	863.8 ± 3.8	860.4 ± 5.4	929.8 ± 4.6	932.2 ± 4.8	929.5 ± 4.7	922.2 ± 5.4	928.0 ± 5.1	929.3 ± 4.9	938.8 ± 2.4	866 - 894
Gravity[1] (°API)	39.4 ± 0.7	32.2 ± 0.7	32.8 ± 1.0	20.6 ± 0.7	20.2 ± 0.8	20.6 ± 0.8	21.8 ± 0.9	20.9 ± 0.8	20.6 ± 0.8	19.1 ± 0.4	31.8 – 26.6
10% Mass Recovered[1]	87.4 ± 9.26	175.1 ± 11.07	174.1 ± 5.90	141.8 ± 44.55	142.6 ± 20.54	162.9 ± 28.69	83.0 ± 17.27	105.3 ± 25.76	127.8 ± 34.17	106.4 ± 25.45	99 - 127
20% Mass Recovered[1]	130.9 ± 8.50	240.1 ± 9.60	212.8 ± 7.08	271.1 ± 19.59	249.6 ± 15.61	265.8 ± 13.40	234.3 ± 44.40	255.3 ± 20.62	261.4 ± 19.36	256.8 ± 47.21	159 - 197
30% Mass Recovered[1]	183.6 ± 10.86	277.4 ± 9.50	240.7 ± 8.70	343.0 ± 15.07	324.1 ± 13.11	331.6 ± 11.67	348.7 ± 21.50	340.2 ± 13.90	336.9 ± 13.29	377.0 ± 17.89	216 - 262
40% Mass Recovered[1]	240.1 ± 12.26	307.0 ± 8.78	265.0 ± 9.79	408.6 ± 13.54	394.9 ± 12.57	394.2 ± 12.01	424.1 ± 17.81	411.4 ± 13.30	403.6 ± 13.12	433.8 ± 12.07	236 - 316

Notes: 1) from CrudeMonitor (2013) - 5-yr average and range; 2) Range obtained from ETC Oil Database

CONCERN 3: THE EXCLUSION FROM SPILL SCENARIOS OF PRODUCTS OTHER THAN COLD LAKE WINTER BLEND DILUTED BITUMEN THAT WOULD ALSO BE CARRIED BY THE EXPANDED PIPELINE SYSTEM (REFINED PRODUCTS SUCH A GASOLINE, JET FUEL).

This concern is associated with the following recommendation:

> ***Recommendation 1.3:*** *Considering that refined products contain a greater proportion of lighter and more volatile/flammable hydrocarbon fractions when compared to Cold Lake Winter Blend (CLWB) diluted bitumen, transportation and possible large spills of gasoline, jet fuel or other refined products should be included in a revised HHRA under a credible worst-case scenario.*

Although the Trans Mountain Pipeline (TMPL) system (existing Line 1) currently transports a variety of crude oil and refined products such as gasoline or jet fuel, the expansion (Line 2) has been proposed 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. The expanded TMPL system will have the capability to transport a variety of crude oil products, including both light and heavy crude oil. Those crude oils often referred to as diluted bitumen will be the primary crude oil transported in Line 2, and refined products such as gasoline and jet fuel will continue to be transported in existing Line 1. Assessment of products carried in existing Line 1 is outside the scope of the Application.

As such, the HHRA of Marine Transportation Technical Report (Intrinsik 2014) (Filing IDs A3Y1F7 and A3Y1F8) focused on assessing the potential health risk associated with the transport of CLWB diluted bitumen (or dilbit) as the representative product *via* Line 2, and subsequently *via* marine vessels. The rationale for the selection of CLWB is:

- Diluted bitumen is expected to comprise a large percentage of the oil transported by Line 2 (see Section 5.1.1.1 in Volume 7) (Filing A3S4V5).
- CLWB is currently transported by Trans Mountain, and it will continue to represent a large percentage of the total products transported by Line 2.
- The diluent in CLWB is liquid condensate that is rich in light-end hydrocarbons that are volatile or semi-volatile in nature. These hydrocarbon components could potentially be released as vapours from the surface of the laden tanker holds, which would then disperse in a downwind direction, possibly reaching humans who could inhale them.
- A sample of CLWB was tested by an accredited third-party laboratory to provide information on its physical and chemical characteristics. A full list of trace elements and organic compounds analyzed in CLWB, including the concentration of individual chemical compounds, is provided in Table 6.2 of Qualitative Ecological Risk

Assessment of Pipeline Spills Technical Report (Stantec December 2013) (Filing ID A3S4W9). Copies of the original laboratory certificates are provided in Appendix A of the report (Stantec December 2013) (Filing ID A3S4W9).

- A study characterizing the emissions from the surface of the CLWB in terms of the types and amounts of chemicals present was conducted. The study is provided in Appendix I of A Study of Fate and Behaviour of Diluted Bitumen Oil on Marine Waters (Witt O'Brien's, Polaris Applied Sciences, and Western Canada Marine Response Corporation [WCMRC] December 2013) (Filing ID A3S5G5).

Additional information on the physical and chemical characteristics of CLWB are provided in A Comparison of the Properties of Diluted Bitumen Crudes with other Oils (Polaris Applied Sciences December 2013) (Filing ID A3S5G7). Based on the above, an assessment of potential human health effects associated with other products carried in Line 2 was not considered as the HHRA is based on the most representative product (*i.e.,* CLWB) and the associated COPC.

TABLE 6.1 PHYSICAL PROPERTIES FOR COLD LAKE WINTER BLEND DILUTED BITUMEN

Physical Property	Units	Cold Lake Winter Blend Diluted Bitumen
Interfacial Tension	dyne/cm	42
Absolute Density @ 15°C	kg/m^3	926
Measured Relative Density @ 15°C	N/A	0.9268
American Petroleum Institute (API) Gravity @ 15°C	N/A	21.2
Closed Cup Flash Point	°C	<-35
Pour Point	°C	-33
Viscosity @ 5°C – kinematic	cSt	542.1
Viscosity @ 10°C – kinematic	cSt	371.2
Viscosity @ 15°C – kinematic	cSt	261.6
Viscosity @ 30°C – kinematic	cSt	105.9
Viscosity @ 40°C – kinematic	cSt	64.09
Viscosity @ 60°C – kinematic	cSt	28.63
Gas Equivalency Factor	m^3 gas / m^3 liquid	86.6

Source: Analysis performed by Maxxam Analytics, with the exception of viscosity at 5, 10, and 15°C, which were calculated from the measured values at higher temperature following ASTM D-341 by C. Brown (pers. comm. 2013).

6.1.1.2. Chemical Properties of Representative Cold Lake Winter Blend

The majority of the chemical analysis carried out on the sample of CLWB was done by Maxxam Analytics, with confirmatory analysis for selected test groups carried out by Research and Productivity Council (Fredericton, New Brunswick). The following analytical packages were included:

- Trace elements
- Petroleum hydrocarbons
- Polycyclic aromatic hydrocarbons (PAH)
- Alkylated PAH
- Pentachlorophenol and phenol
- Volatile organic compounds (VOC)
- Alkylated mono aromatic hydrocarbons (MAH).

Table 6.2 provides a full list of trace elements and organic compounds analyzed in the CLWB. Copies of the original laboratory certificates are provided in Appendix A of this report.

TABLE 6.2 CHEMICAL CONSTITUENTS OF COLD LAKE WINTER BLEND DILUTED BITUMEN

Analyte	Concentration (mg/kg)	Analyte	Concentration (mg/kg)
Metals			
Aluminum	<1	Mercury	0.021
Barium	<1	Molybdenum	5
Beryllium	<1	Nickel	46.8
Boron	1	Phosphorus	0.8
Cadmium	<1	Potassium	1
Calcium	2	Silicon	2
Chromium	<1	Silver	<1
Cobalt	<1	Sodium	12
Copper	<1	Strontium	<1
Iron	3	Sulphur	37,100
Lead	<1	Tin	<1
Lithium	<1	Titanium	1
Magnesium	<1	Vanadium	135
Manganese	<1	Zinc	<1
Sulfur Compounds			
Hydrogen Sulphide (H_2S)	<0.5	n-Propanethiol	<0.5
Carbonyl Sulphide	<0.5	Thiophene/sec-Butanethiol	2.9
Methanethiol	<0.5	Diethyl Sulphide	<0.5
Ethanethiol	1.1	Iso-Butanethiol	<0.5
Dimethyl Sulphide	1.7	n-Butanethiol	0.5
Carbon Disulphide	<0.5	Dimethyl Disulphide	<0.5

TABLE 6.2 CHEMICAL CONSTITUENTS OF COLD LAKE WINTER BLEND DILUTED BITUMEN

Analyte	Concentration (mg/kg)	Analyte	Concentration (mg/kg)
Iso-Propanethiol	2.5	n-Pentanethiol	<0.5
t-Butanethiol	<0.5	n-Hexanethiol	0.5
Methyl Ethyl Sulphide	0.9	n-Heptanethiol	<0.5
SAPA (Saturates, Aromatics, Polars, Asphaltenes)			
Saturates	318,000	Polars	398,000
Aromatics	203,000	Asphaltenes	80,000
Summary Composition			
Methane	<100	n-Butane	5,100
Ethane	<100	Iso-Pentane	31,600
Propane	400	n-Pentane	34,200
Iso-Butane	1,000		
BTEX (Benzene, Toluene, Ethylbenzene, Xylenes)			
Benzene	1,800	Ethylbenzene	470
Toluene	3,900	Xylenes	3,500
PHCs (Petroleum Hydrocarbons)			
F1 (C_6-C_{10}) - BTEX	110,000	Aliphatics >C_{21}-C_{34}	60,000
F2 (C_{10}-C_{16})	82,000	Aliphatics >C_{34}-C_{50}	23,000
F3 (C_{16}-C_{34})	260,000	Aromatics >C_8-C_{10}	<6,000
F4 (C_{34}-C_{50})	110,000	Aromatics >C_{10}-C_{12}	4,100
Aliphatics C_6-C_8	55,000	Aromatics >C_{12}-C_{16}	22,000
Aliphatics >C_8-C_{10}	20,000	Aromatics >C_{16}-C_{21}	47,000
Aliphatics >C_{10}-C_{12}	16,000	Aromatics >C_{21}-C_{34}	120,000
Aliphatics >C_{12}-C_{16}	40,000	Aromatics >C_{34}-C_{50}	77,000
Aliphatics >C_{16}-C_{21}	46,000		
SVOCs – PAHs (Semi Volatile Organic Compounds – PAHs)			
Acenaphthene	12	Fluoranthene	7.3
C1-Acenaphthene	<4.5	C1-fluoranthene/pyrene	75
Acenaphthylene	<4.5	C2-fluoranthene/pyrene	200
Acridine	39	C3-fluoranthene/pyrene	340
Anthracene	6.6	C4-fluoranthene/pyrene	170
Benzo(a)anthracene	5.6	Fluorene	21
C1-benzo(a)anthracene/chrysene	59	C1-Fluorene	150
C2-benzo(a)anthracene/chrysene	230	C2-Fluorene	300
C3-benzo(a)anthracene/chrysene	110	C3-Fluorene	770
C4-benzo(a)anthracene/chrysene	37	Indeno(1,2,3-cd)pyrene	<4.5
Benzo(b&j)fluoranthene	6.7	2-Methylnaphthalene	80
Benzo(k)fluoranthene	<4.5	Naphthalene	34
C1-benzo(b,j,k)fluoranthene/benzo(a)pyrene	21	C1-Naphthalene	160
C2-benzo(b,j,k)fluoranthene/benzo(a)pyrene	37	C2-Naphthalene	600
Benzo(g,h,i)perylene	4.8	C3-Naphthalene	780
Benzo(c)phenanthrene	<4.5	C4-Naphthalene	810
Benzo(a)pyrene	5.8	Phenanthrene	63
Benzo(e)pyrene	5.1	C1-phenanthrene/anthracene	310
Biphenyl	7.3	C2-phenanthrene/anthracene	550
C1-biphenyl	50	C3-phenanthrene/anthracene	660
C2-biphenyl	84	C4-phenanthrene/anthracene	230
Chrysene	8.6	Perylene	9
Dibenz(a,h)anthracene	<4.5	Pyrene	<13
Dibenzothiophene	44	Quinoline	<8.9
C1-dibenzothiophene	330	Retene	43
C2-dibenzothiophene	910		
C3-dibenzothiophene	700		
C4-dibenzothiophene	440		
SVOCs – Phenols (Semi Volatile Organic Compounds – Phenols)			
Cresols	<16	2,4-dinitrophenol	<43
Phenol	<8.1	2,6-dichlorophenol	<8.5
3 & 4-chlorophenol	<21	2-chlorophenol	<4.3
2,3,5,6-tetrachlorophenol	<4.3	2-methylphenol	<8.7
2,3,4,6-tetrachlorophenol	<4.3	2-nitrophenol	<43
2,4,5-trichlorophenol	<4.3	3 & 4-methylphenol	16

TABLE 6.2 CHEMICAL CONSTITUENTS OF COLD LAKE WINTER BLEND DILUTED BITUMEN

Analyte	Concentration (mg/kg)	Analyte	Concentration (mg/kg)
2,4,6-trichlorophenol	<4.3	4,6-dinitro-2-methylphenol	<43
2,3,5-trichlorophenol	<4.3	4-chloro-3-methylphenol	<4.3
2,3,4-trichlorophenol	<4.3	4-nitrophenol	<43
2,4-dichlorophenol	<6.3	Pentachlorophenol	<4.3
2,4-dimethylphenol	29		
VOCs (Volatile Organic Compounds)			
Bromodichloromethane	<150	Methyl methacrylate	<200
Bromoform	<250	Methyl-tert-butylether (MTBE)	<150
Bromomethane	<100	Styrene	<100
Carbon tetrachloride	<100	1,1,1,2-tetrachloroethane	<500
Chlorobenzene	<100	1,1,2,2-tetrachloroethane	<250
Chlorodibromomethane	<100	Tetrachloroethene	<100
Chloroethane	<100	1,2,3-trichlorobenzene	<200
Chloroform	<100	1,2,4-trichlorobenzene	<200
Chloromethane	<150	1,3,5-trichlorobenzene	<200
1,2-dibromoethane	<100	1,1,1-trichloroethane	<100
1,2-dichlorobenzene	<100	1,1,2-trichloroethane	<100
1,3-dichlorobenzene	<100	Trichloroethene	<50
1,4-dichlorobenzene	<100	Trichlorofluoromethane	<100
1,1-dichloroethane	<100	1,2,4-trimethylbenzene	300
1,2-dichloroethane	<100	1,3,5-trimethylbenzene	<2,500
1,1-dichloroethene	<100	Vinyl chloride	<50
cis-1,2-dichloroethene	<100	neo-Hexane	<100
trans-1,2-dichloroethene	<100	Methylcyclopentane	8,000
Dichloromethane	<150	Cyclohexane	10,000
1,2-dichloropropane	<100	Methylcyclohexane	10,500
cis-1,3-dichloropropene	<100		
trans-1,3-dichloropropene	<100		

Source: Analysis performed by Maxxam Analytics.

Non-petroleum compounds in crude oils, such as metals, are seldom of environmental concern as primary pollutants. For example, after the discharge of an estimated 160 to 340 million gallons of crude oil during the 1991 Gulf War, trace metal concentrations in oiled intertidal and sub-tidal sediments remained below background levels (Fowler *et al.* 1993 in Hugenin *et al.* 1996). Similarly, the USEPA (2011a) concluded in response to a crude oil spill into the Yellowstone River in Montana that metal concentrations in the spilled oil were present only at very low levels, and as such were unlikely to pose any threat to human life or the environment. Likewise, Anderson (2006) concluded that there was no post-spill evidence of an increase in water or sediment metal concentrations at Wabamun Lake, Alberta, following a spill of bunker "C" fuel oil and pole treating oil in 2005.

As indicated in Table 6.2, the measured concentrations of trace metals in CLWB are generally very low (<1 mg/kg), with the exception of nickel (46.8 mg/kg) and vanadium (135 mg/kg). However, it is believed that these trace metals are likely to remain largely associated with the diluted bitumen following a spill. Therefore, the ERA focuses on the environmental effects of hydrocarbons (*i.e.,* crude oil and its hydrocarbon constituents) released into the freshwater environment.

6.1.2. Identification of Representative Hypothetical Spill Scenarios

Four locations were selected as representative locations for hypothetical spill scenarios. The selection was guided by consideration of the following engineering and environmental/socio-economic risk factors:

Environmental and socio-economic considerations (where available):

- Spill locations should be reflective of areas of expressed concern for spills by Aboriginal peoples or the general public.

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APPENDIX D

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D1. LIGHT HYDROCARBONS SUMMARY RESULTS

Table D1a: Summary of Light Hydrocarbons Results (May 13, 2013 to May 15, 2013)

Sampling Date	2013-05-15	2013-05-13	2013-05-13	2013-05-14	2013-05-14	2013-05-14	2013-05-14	2013-05-15	2013-05-15	2013-05-15
Sampling Time	14:22	14:55	20:54	2:54	9:02	13:22	21:37	3:54	9:58	15:31
Nitrogen Flow (L/min)	- Blank	5.85	6.01	5.81	5.88	6.12	6.14	5.88	5.94	6.03
Sample ID	C1	D01-H00	D01-H06	D01-H12	D01-H18	D01-H24	D02-H06	D02-H12	D02-H18	D02-H24
Parameter	**Conc (µg/m³)**	**Flux (µg/s/m²)**	**Flux (µg/s/m²)**	**Flux (µg/s/m²)**	**Flux (µg/s/m²)**	**Flux (µg/s/m²)**	**Flux (µg/s/m²)**	**Flux (µg/s/m²)**	**Flux (µg/s/m²)**	**Flux (µg/s/m²)**
Acetylene	< 149	< 0.09460	< 0.09710	< 0.08720	< 0.09500	< 0.10600	< 0.09920	< 0.09500	< 0.09600	< 0.09750
Ethane	< 172	27.300	5.370	2.4800	1.8800	1.7100	0.7450	0.5720	0.7210	0.5790
Ethylene	< 161	< 0.10200	< 0.10500	< 0.09390	< 0.10200	< 0.11400	< 0.10700	< 0.10200	< 0.10300	< 0.10500
Methane	1970	31.200	6.410	2.6400	3.7600	2.4800	3.6700	2.8900	2.4100	2.2300
n-Butane	13500	7240	650.0	284.00	242.00	268.00	109.00	83.30	127.00	110.00
n-Pentane	1180	29900	3270.0	1360.0	1600.0	1490.0	589.0	470.0	722.0	617.0
Propane	< 252	252.00	57.60	28.400	23.000	25.100	9.720	7.470	10.900	9.080
Propene	< 241	1.0000	0.21300	< 0.14100	< 0.15400	< 0.17100	< 0.16000	< 0.15400	< 0.15500	< 0.15700
Propyne	< 458	< 0.30100	< 0.29900	< 0.27900	< 0.29200	< 0.31500	< 0.30500	< 0.29200	< 0.29500	< 0.30000

Notes:

All data corrected to 101.3 kPa and 25 °C

'<' indicates that laboratory results were below the detection limit. The detection limit was used to calculate the concentration and flux rate.

All data is expressed up to 3 significant figures

Table D1b: Summary of Light Hydrocarbons Results (May 16, 2013 to May 18, 2013)

Parameter	Flux (µg/s/m²)	Conc (µg/m³)	Flux (µg/s/m²)	Flux (µg/s/m²)	Flux (µg/s/m²)	Flux (µg/s/m²)	Flux (µg/s/m²)	Flux (µg/s/m²)	Flux (µg/s/m²)	Flux (µg/s/m²)
Acetylene	< 0.09500	< 192	< 0.09700	< 0.13200	< 0.13300	< 0.12400	< 0.13100	< 0.13400	< 0.12900	< 0.13200
Ethane	0.34500	307	0.40800	0.40000	0.34000	0.4310	0.37300	0.36700	0.33700	0.38600
Ethylene	< 0.10200	< 206	< 0.10400	< 0.14200	< 0.14400	< 0.13400	< 0.14100	< 0.14500	< 0.13900	< 0.14200
Methane	4.1800	4460	4.270	3.6300	4.0200	5.950	4.650	4.790	5.020	5.570
n-Butane	39.400	< 831	55.70	52.60	17.200	18.500	35.300	7.250	8.790	10.700
n-Pentane	245.00	< 531	326.00	365.00	233.00	113.00	228.00	48.90	58.30	73.30
Propane	3.2200	< 324	4.460	3.9900	1.3100	1.4000	2.5600	0.5380	0.6440	0.7900
Propene	< 0.15400	< 310	< 0.15700	< 0.21300	< 0.21600	< 0.20100	< 0.21100	< 0.21700	< 0.20800	< 0.21400
Propyne	< 0.29200	< 573	< 0.30900	< 0.40500	< 0.41000	< 0.38200	< 0.40200	< 0.41300	< 0.39700	< 0.40700

Notes:

All data corrected to 101.3 kPa and 25 °C

'<' indicates that laboratory results were below the detection limit. The detection limit was used to calculate the concentration and flux rate.

All data is expressed up to 3 significant figures

Table D1c: Summary of Light Hydrocarbons Results (May 19, 2013 to May 22, 2013)

Sampling Date	2013-05-19	2013-05-19	2013-05-19	2013-05-20	2013-05-20	2013-05-21	2013-05-21	2013-05-22
Sampling Time	0:37	8:49	21:38	9:07	21:34	9:14	21:54	8:38
Nitrogen Flow (L/min)	5.92	5.84	6.10	6.00	5.84	5.96	5.87	5.98
Sample ID	D06-H00	D06-H08	D06-H21	D07-H09	D07-H21	D08-H09	D08-H21	D09-H08
Parameter	**Flux (µg/s/m²)**	**Flux (µg/s/m²)**	**Flux (µg/s/m²)**	**Flux (µg/s/m²)**	**Flux (µg/s/m²)**	**Flux (µg/s/m²)**	**Flux (µg/s/m²)**	**Flux (µg/s/m²)**
Acetylene	< 0.13700	< 0.12800	< 0.13400	< 0.13200	< 0.12800	< 0.13100	< 0.12900	< 0.13100
Ethane	0.5520	0.27300	0.39800	0.28800	< 0.14800	< 0.15100	0.19600	< 0.15100
Ethylene	< 0.14700	< 0.13800	< 0.14400	< 0.14200	< 0.13800	< 0.14100	< 0.13900	< 0.14100
Methane	7.580	3.7800	5.640	3.8400	1.7000	< 1.6100	2.4200	2.2100
n-Butane	9.760	6.470	4.560	5.410	3.3100	4.760	3.0300	2.6200
n-Pentane	70.10	44.80	31.200	38.400	24.300	34.300	20.700	18.700
Propane	0.6940	0.4680	0.39400	0.39900	0.24000	0.30300	0.23000	< 0.22200
Propene	< 0.22100	< 0.20700	< 0.21600	< 0.21300	< 0.20700	< 0.21100	< 0.20800	< 0.21200
Propyne	< 0.42100	< 0.39400	< 0.41200	< 0.40500	< 0.39400	< 0.40200	< 0.39600	< 0.40400

Notes:

All data corrected to 101.3 kPa and 25 °C

'<' indicates that laboratory results were below the detection limit. The detection limit was used to calculate the concentration and flux rate.

All data is expressed up to 3 significant figures

D2. VOLATILE ORGANIC COMPOUNDS SUMMARY RESULTS

Table D2a: Summary of Volatile Organic Compounds Results (May 13, 2013 to May 14, 2013)

Parameter	Flux (µg/s/m²)	Flux (µg/s/m²)	Flux (µg/s/m²)	Flux (µg/s/m²)	Flux (µg/s/m²)	Flux (µg/s/m²)
Dichlorodifluoromethane (FREON 12)	< 14.1	< 3.5400	< 1.3100	< 1.4200	< 1.4800	< 0.6910
1,2-Dichlorotetrafluoroethane	< 16.8	< 4.3300	< 1.5400	< 1.6900	< 1.7600	< 0.8380
Chloromethane	< 8.77	< 2.2900	< 0.8060	< 0.8820	< 0.9320	< 0.4400
Vinyl Chloride	< 6.48	< 1.6700	< 0.5960	< 0.6520	< 0.6950	< 0.32300
Chloroethane	< 11.2	< 2.9200	< 1.0300	< 1.1300	< 1.1900	< 0.5620
1,3-Butadiene	< 15.4	< 4.0400	< 1.3900	< 1.5500	< 1.6100	< 0.7800
Trichlorofluoromethane (FREON 11)	< 16	< 4.0300	< 1.4900	< 1.6100	< 1.6800	< 0.7850
Ethanol (ethyl alcohol)	< 155	< 41.700	< 16.600	< 16.800	< 18.800	< 8.900
Trichlorotrifluoroethane	< 16.500	< 4.1900	< 1.5000	< 1.6600	< 1.7300	< 0.8160
2-propanol	< 104	< 27.200	< 9.600	< 10.500	< 11.100	< 5.240
2-Propanone	< 27.100	< 6.960	< 2.5400	< 2.7300	< 2.8400	< 1.3300
Methyl Ethyl Ketone (2-Butanone)	< 125	< 32.700	< 11.500	< 12.600	< 13.300	< 6.280
Methyl Isobutyl Ketone	< 187	< 48.10	< 17.300	< 18.800	< 19.600	< 9.270
Methyl Butyl Ketone (2-Hexanone)	< 117	< 29.400	< 10.800	< 11.800	< 12.200	< 5.730
Methyl t-butyl ether (MTBE)	< 10.3	< 2.5800	< 0.9540	< 1.0300	< 1.0800	< 0.5040
Ethyl Acetate	< 112	< 28.200	< 10.400	< 11.300	< 12.000	< 5.520
1,1-Dichloroethylene	< 14.1	< 3.6200	< 1.3000	< 1.4200	< 1.4700	< 0.6860
cis-1,2-Dichloroethylene	< 10.8	< 2.8400	< 0.9990	< 1.0900	< 1.1300	< 0.5280
trans-1,2-Dichloroethylene	< 11.3	< 2.8400	< 1.0500	< 1.1400	< 1.1800	< 0.5540
Methylene Chloride(Dichloromethane)	< 397	< 97.30	< 37.200	< 44.30	< 46.10	< 20.800

Sampling Date	2013-05-13	2013-05-13	2013-05-14	2013-05-14	2013-05-14	2013-05-14
Sampling Time	14:55	20:54	2:54	9:02	13:22	21:37
Nitrogen Flow (L/min)	5.85	6.01	5.81	5.88	6.12	6.14
Sample ID	D01-H00	D01-H06	D01-H12	D01-H18	D01-H24	D02-H06
Parameter	**Flux (µg/s/m²)**	**Flux (µg/s/m²)**	**Flux (µg/s/m²)**	**Flux (µg/s/m²)**	**Flux (µg/s/m²)**	**Flux (µg/s/m²)**
Chloroform	< 10.5	< 2.6700	< 0.9530	< 1.0600	< 1.100	< 0.5200
Carbon Tetrachloride	< 26.7	< 6.970	< 2.4600	< 2.6900	< 2.8400	< 1.3400
1,1-Dichloroethane	< 11.6	< 2.9000	< 1.0700	< 1.1600	< 1.2100	< 0.5660
1,2-Dichloroethane	< 11.6	< 2.9000	< 1.0700	< 1.1600	< 1.2100	< 0.5660
Ethylene Dibromide	< 18.5	< 4.760	< 1.6900	< 1.8600	< 1.9400	< 0.9210
1,1,1-Trichloroethane	< 23.2	< 6.040	< 2.1300	< 2.3300	< 2.4600	< 1.1600
1,1,2-Trichloroethane	< 11.8	< 2.9900	< 1.0700	< 1.1800	< 1.2300	< 0.5810
1,1,2,2-Tetrachloroethane	< 19.6	< 4.920	< 1.8200	< 1.9700	< 2.0500	< 0.9600
cis-1,3-Dichloropropene	< 11.5	< 2.9600	< 1.0600	< 1.1600	< 1.2300	< 0.5740
trans-1,3-Dichloropropene	< 10.9	< 2.8100	< 1.0000	< 1.1000	< 1.1400	< 0.5440
1,2-Dichloropropane	< 26.4	< 6.620	< 2.4200	< 2.6500	< 2.7600	< 1.2900
Bromomethane	< 9.85	< 2.5300	< 0.9050	< 0.9900	< 1.0600	< 0.4910
Bromoform	< 29.5	< 7.410	< 2.7300	< 2.9600	< 3.0900	< 1.4400
Bromodichloromethane	< 19.1	< 4.800	< 1.7700	< 1.9200	< 2.0000	< 0.9360
Dibromochloromethane	< 24.3	< 6.100	< 2.2500	< 2.4400	< 2.5400	< 1.1900
Trichloroethylene	< 22.8	< 5.950	< 2.1000	< 2.2900	< 2.4200	< 1.1400
Tetrachloroethylene	< 19.4	< 4.860	< 1.7900	< 1.9500	< 2.0200	< 0.9480
Benzene	1030	223.00	104.00	111.00	127.00	53.80
Toluene	856	307.00	163.00	169.00	226.00	108.00
Ethylbenzene	33.6	16.400	10.500	10.800	17.800	8.790
p+m-Xylene	129	63.10	41.600	42.90	75.50	37.000
o-Xylene	35	16.800	10.600	11.100	20.300	10.100
Styrene	< 12.2	< 3.0500	< 1.1300	< 1.2200	< 1.2700	< 0.6240
4-ethyltoluene	< 153	< 38.400	< 14.200	< 15.400	< 16.300	< 7.530
1,3,5-Trimethylbenzene	< 34.3	< 8.970	< 3.1000	< 3.4500	3.6500	1.8500

Sampling Date	2013-05-13	2013-05-13	2013-05-14	2013-05-14	2013-05-14	2013-05-14
Sampling Time	14:55	20:54	2:54	9:02	13:22	21:37
Nitrogen Flow (L/min)	5.85	6.01	5.81	5.88	6.12	6.14
Sample ID	D01-H00	D01-H06	D01-H12	D01-H18	D01-H24	D02-H06
Parameter	**Flux (µg/s/m²)**	**Flux (µg/s/m²)**	**Flux (µg/s/m²)**	**Flux (µg/s/m²)**	**Flux (µg/s/m²)**	**Flux (µg/s/m²)**
1,2,4-Trimethylbenzene	< 34.3	< 8.970	3.2200	< 3.4500	5.670	3.0300
Chlorobenzene	< 13.100	< 3.3000	< 1.2200	< 1.3200	< 1.3700	< 0.6430
Benzyl chloride	< 72.2	< 18.900	< 6.850	< 7.260	< 7.900	< 3.7900
1,3-Dichlorobenzene	< 34.300	< 8.620	< 3.1400	< 3.4500	< 3.5900	< 1.6800
1,4-Dichlorobenzene	< 34.300	< 8.620	< 3.1400	< 3.4500	< 3.5900	< 1.6800
1,2-Dichlorobenzene	< 34.300	< 8.620	< 3.1400	< 3.4500	< 3.5900	< 1.6800
1,2,4-Trichlorobenzene	< 212.00	< 53.20	< 19.600	< 21.300	< 22.200	< 10.400
Hexachlorobutadiene	< 453	< 118.00	< 41.600	< 45.50	< 48.10	< 22.700
Hexane	9370	1880.0	815.0	901.0	987.0	404.00
Heptane	2280	652.0	320.00	342.00	424.0	187.00
Cyclohexane	2250	505.0	223.00	257.00	324.00	134.00
Tetrahydrofuran	< 16.8	< 4.2300	< 1.5400	< 1.6900	< 1.7600	< 0.8240
1,4-Dioxane	< 103	< 25.800	< 9.530	< 10.300	< 10.800	< 5.040
Xylene (Total)	164	79.80	52.20	54.00	95.60	47.10
Vinyl Bromide	< 12.5	< 3.1300	< 1.1600	< 1.2500	< 1.3100	< 0.6110
Propene	< 196	< 16.800	< 6.610	< 7.130	< 6.850	< 2.7500
2,2,4-Trimethylpentane	< 13.3	< 3.3500	< 1.2400	< 1.3400	< 1.3900	< 0.6530
Carbon Disulfide	< 21.7	< 5.680	< 1.9600	< 2.1800	< 2.2700	< 1.1000
Vinyl Acetate	< 10	< 2.5200	< 0.9310	< 1.0100	< 1.0500	< 0.4920

Notes:

All data corrected to 101.3 kPa and 25 °C

'<' indicates that laboratory results were below the detection limit. The detection limit was used to calculate the concentration and flux rate.

All flux rates are presented up to 3 significant figures

Table D2b: Summary of Volatile Organic Compounds Results (May 15, 2013 to May 16, 2013)

Parameter	Conc (µg/m³)	Flux (µg/s/m²)	Flux (µg/s/m²)	Flux (µg/s/m²)	Flux (µg/s/m²)	Conc (µg/m³)	Flux (µg/s/m²)	Flux (µg/s/m²)
Dichlorodifluoromethane (FREON 12)	< 1.38	< 0.883	< 0.892	< 0.905	< 0.883	< 0.988	< 0.868	< 0.611
1,2-Dichlorotetrafluoroethane	< 1.68	< 1.07	< 1.08	< 1.1	< 1.07	< 0.84	< 1.05	< 0.727
Chloromethane	< 0.867	< 0.553	< 0.558	< 0.567	< 0.553	< 1.48	< 0.537	< 0.39
Vinyl Chloride	< 0.639	< 0.407	< 0.411	< 0.418	< 0.407	< 0.89	< 0.399	< 0.283
Chloroethane	< 1.11	< 0.706	< 0.714	< 0.724	< 0.706	< 1.48	< 0.686	< 0.498
1,3-Butadiene	< 1.55	< 0.987	< 0.997	< 1.01	< 0.987	< 2.47	< 0.964	< 0.691
Trichlorofluoromethane (FREON 11)	< 1.57	< 1	< 1.01	< 1.03	< 1	< 0.988	< 0.987	< 0.694
Ethanol (ethyl alcohol)	< 6.03	< 20.4	< 20.6	< 22.2	< 22.8	< 11.4	< 20.8	< 10.2
Trichlorotrifluoroethane	< 1.61	< 1.03	< 1.04	< 1.05	< 1.03	< 0.741	< 0.997	< 0.698
2-propanol	< 10.3	< 6.58	< 6.65	< 6.75	< 6.58	< 14.8	< 6.4	< 4.64
2-Propanone	< 2.61	< 1.67	< 1.68	< 1.71	< 1.67	< 3.95	< 1.7	< 1.17
Methyl Ethyl Ketone (2-Butanone)	< 12.4	< 7.9	< 7.98	< 8.1	< 7.9	< 14.8	< 7.67	< 5.56
Methyl Isobutyl Ketone	< 18.4	< 11.8	< 11.9	< 12.1	< 11.8	< 15.8	< 11.5	< 8
Methyl Butyl Ketone (2-Hexanone)	< 11.5	< 7.31	< 7.39	< 7.5	< 7.31	< 9.88	< 7.19	< 5.06
Methyl t-butyl ether (MTBE)	< 1.01	< 0.643	< 0.65	< 0.66	< 0.643	< 0.988	< 0.633	< 0.446
Ethyl Acetate	< 11.2	< 7.12	< 7.19	< 7.3	< 7.12	< 10.9	< 6.8	< 4.92

Parameter	Conc (µg/m³)	Flux (µg/s/m²)	Flux (µg/s/m²)	Flux (µg/s/m²)	Flux (µg/s/m²)	Conc (µg/m³)	Flux (µg/s/m²)	Flux (µg/s/m²)
1,1-Dichloroethylene	< 1.39	< 0.885	< 0.894	< 0.907	< 0.885	< 1.24	< 0.851	< 0.619
cis-1,2-Dichloroethylene	< 1.07	< 0.682	< 0.689	< 0.7	< 0.682	< 0.939	< 0.645	< 0.464
trans-1,2-Dichloroethylene	< 1.11	< 0.708	< 0.715	< 0.726	< 0.708	< 0.988	< 0.696	< 0.49
Methylene Chloride(Dichloromethane)	< 3.82	58	94.2	109	98.1	< 3.95	55.6	57.2
Chloroform	< 1.02	< 0.654	< 0.66	< 0.67	< 0.654	< 0.741	< 0.635	< 0.445
Carbon Tetrachloride	< 2.64	< 1.68	< 1.7	< 1.73	< 1.68	< 1.48	< 1.64	< 1.19
1,1-Dichloroethane	< 1.13	< 0.722	< 0.73	< 0.741	< 0.722	< 0.988	< 0.711	< 0.5
1,2-Dichloroethane	< 1.13	< 0.722	< 0.73	< 0.741	< 0.722	< 0.988	< 0.711	< 0.5
Ethylene Dibromide	< 1.84	< 1.18	< 1.19	< 1.21	< 1.18	< 0.84	< 1.15	< 0.8
1,1,1-Trichloroethane	< 2.29	< 1.46	< 1.48	< 1.5	< 1.46	< 1.48	< 1.42	< 1.03
1,1,2-Trichloroethane	< 1.14	< 0.73	< 0.738	< 0.749	< 0.73	< 0.741	< 0.71	< 0.497
1,1,2,2-Tetrachloroethane	< 1.92	< 1.23	< 1.24	< 1.26	< 1.23	< 0.988	< 1.21	< 0.848
cis-1,3-Dichloropropene	< 1.13	< 0.723	< 0.731	< 0.742	< 0.723	< 0.89	< 0.708	< 0.502
trans-1,3-Dichloropropene	< 1.09	< 0.694	< 0.701	< 0.712	< 0.694	< 0.84	< 0.679	< 0.472
1,2-Dichloropropane	< 2.59	< 1.65	< 1.67	< 1.69	< 1.65	< 1.98	< 1.59	< 1.14
Bromomethane	< 0.97	< 0.619	< 0.625	< 0.635	< 0.619	< 0.89	< 0.606	< 0.429
Bromoform	< 2.89	< 1.84	< 1.86	< 1.89	< 1.84	< 0.988	< 1.82	< 1.28
Bromodichloromethane	< 1.87	< 1.2	< 1.21	< 1.23	< 1.2	< 0.988	< 1.18	< 0.828

Parameter	Conc (µg/m³)	Flux (µg/s/m²)	Flux (µg/s/m²)	Flux (µg/s/m²)	Flux (µg/s/m²)	Conc (µg/m³)	Flux (µg/s/m²)	Flux (µg/s/m²)
Dibromochloromethane	< 2.38	< 1.52	< 1.54	< 1.56	< 1.52	< 0.988	< 1.5	< 1.05
Trichloroethylene	< 2.26	< 1.44	< 1.45	< 1.48	< 1.44	< 1.48	< 1.4	< 1.01
Tetrachloroethylene	< 1.9	< 1.21	< 1.22	< 1.24	< 1.21	< 0.988	< 1.19	< 0.838
Benzene	1.28	37.1	57.4	47.2	24	< 0.89	24.5	29.9
Toluene	3.13	86	115	108	90.3	1.73	74.5	82.8
Ethylbenzene	< 1.22	6.14	7.61	8.06	5.37	< 0.988	4.8	7.09
p+m-Xylene	2.52	24.5	30.2	32.4	25.4	< 1.83	19.2	30.2
o-Xylene	< 1.21	6.7	8.05	9	8.33	< 0.988	5.54	8.92
Styrene	< 1.19	0.763	< 1.1	< 0.863	< 1.44	< 0.988	< 1.03	0.579
4-ethyltoluene	< 15.2	< 9.71	< 9.81	< 9.96	< 9.71	< 10.9	< 9.27	< 6.71
1,3,5-Trimethylbenzene	< 3.44	< 2.19	< 2.22	< 2.25	2.37	< 2.47	< 2.14	1.9
1,2,4-Trimethylbenzene	< 3.44	2.2	2.35	2.63	3.16	< 2.47	< 2.14	2.95
Chlorobenzene	< 1.29	< 0.822	< 0.83	< 0.843	< 0.822	< 0.988	< 0.808	< 0.569
Benzyl chloride	< 7.24	< 4.62	< 4.67	< 4.74	< 4.62	< 4.94	< 4.38	< 3.2
1,3-Dichlorobenzene	< 3.36	< 2.15	< 2.17	< 2.2	< 2.15	< 1.98	< 2.07	< 1.49
1,4-Dichlorobenzene	< 3.36	< 2.15	< 2.17	< 2.2	< 2.15	< 1.98	< 2.07	< 1.49
1,2-Dichlorobenzene	< 3.36	< 2.15	< 2.17	< 2.2	< 2.15	< 1.98	< 2.07	< 1.49
1,2,4-Trichlorobenzene	< 20.8	< 13.2	< 13.4	< 13.6	< 13.2	< 9.88	< 13	< 9.17

Parameter	Conc (µg/m³)	Flux (µg/s/m²)	Flux (µg/s/m²)	Flux (µg/s/m²)	Flux (µg/s/m²)	Conc (µg/m³)	Flux (µg/s/m²)	Flux (µg/s/m²)
Hexachlorobutadiene	< 44.8	< 28.6	< 28.8	< 29.3	< 28.6	< 14.8	< 27.7	< 20.1
Hexane	6.59	288	456	369	182	1.63	194	220
Heptane	2.74	136	202	178	95.4	< 1.48	97	119
Cyclohexane	1.62	96.3	161	137	74.4	< 0.988	79	95.6
Tetrahydrofuran	< 1.65	< 1.05	< 1.06	< 1.08	< 1.05	< 1.98	< 1.02	< 0.729
1,4-Dioxane	< 10100	< 6.43	< 6.5	< 6.6	< 6.43	< 9.88	< 6.33	< 4.45
Xylene (Total)	< 3640	31.3	38.3	41.4	33.8	< 2.97	24.8	39.3
Vinyl Bromide	< 1220	< 0.781	< 0.789	< 0.801	< 0.781	< 0.988	< 0.768	< 0.541
Propene	< 2240	< 2.52	< 3.44	< 2.92	< 1.86	3.66	< 1.79	< 1.68
2,2,4-Trimethylpentane	< 1310	< 0.834	< 0.842	< 0.855	< 0.834	< 0.988	< 0.82	< 0.577
Carbon Disulfide	< 2180	< 1.39	< 1.4	< 1.42	< 1.39	< 2.47	< 1.36	< 0.972
Vinyl Acetate	< 985	< 0.628	< 0.635	< 0.644	< 0.628	< 0.988	< 0.618	< 0.435

Notes:

All data corrected to 101.3 kPa and 25 °C

'<' indicates that laboratory results were below the detection limit. The detection limit was used to calculate the concentration and flux rate.

All flux rates are presented up to 3 significant figures

Table D2c: Summary of Volatile Organic Compounds Results (May 17, 2013 to May 18, 2013)

Parameter	Flux (µg/s/m²)		Flux (µg/s/m²)		Flux (µg/s/m²)		Flux (µg/s/m²)		Flux (µg/s/m²)		Flux (µg/s/m²)	
Dichlorodifluoromethane (FREON 12)	<	0.31	<	0.289	<	0.478	<	0.249	<	0.24	<	0.246
1,2-Dichlorotetrafluoroethane	<	0.373	<	0.349	<	0.586	<	0.301	<	0.29	<	0.297
Chloromethane	<	0.191	<	0.187	<	0.306	<	0.151	<	0.145	<	0.148
Vinyl Chloride	<	0.145	<	0.134	<	0.231	<	0.115	<	0.111	<	0.114
Chloroethane	<	0.243	<	0.239	<	0.391	<	0.193	<	0.185	<	0.19
1,3-Butadiene	<	0.35	<	0.33	<	0.542	<	0.279	<	0.268	<	0.275
Trichlorofluoromethane (FREON 11)	<	0.352	<	0.328	<	0.544	<	0.283	<	0.272	<	0.279
Ethanol (ethyl alcohol)	<	3.48	<	5.01	<	9.48	<	5.13	<	5.28	<	5.67
Trichlorotrifluoroethane	<	0.359	<	0.338	<	0.544	<	0.29	<	0.278	<	0.286
2-propanol	<	2.27	<	2.23	<	3.65	<	1.79	<	1.72	<	1.77
2-Propanone	<	0.595	<	0.554	<	0.935	<	69.3	<	92.4	<	106
Methyl Ethyl Ketone (2-Butanone)	<	2.72	<	2.68	<	4.38	<	2.15	<	2.07	<	2.12
Methyl Isobutyl Ketone	<	4.05	<	3.72	<	6.34	<	3.26	<	3.13	<	3.21
Methyl Butyl Ketone (2-Hexanone)	<	2.56	<	2.39	<	3.96	<	2.07	<	1.98	<	2.04
Methyl t-butyl ether (MTBE)	<	0.226	<	0.21	<	0.349	<	0.182	<	0.175	<	0.179
Ethyl Acetate	<	2.38	<	2.31	<	3.95	<	2.01	<	1.93	<	1.98

Parameter	Flux (µg/s/m²)		Flux (µg/s/m²)		Flux (µg/s/m²)		Flux (µg/s/m²)		Flux (µg/s/m²)		Flux (µg/s/m²)	
1,1-Dichloroethylene	<	0.314	<	0.283	<	0.486	<	0.25	<	0.24	<	0.246
cis-1,2-Dichloroethylene	<	0.235	<	0.221	<	0.358	<	0.189	<	0.182	<	0.187
trans-1,2-Dichloroethylene	<	0.248	<	0.231	<	0.384	<	0.2	<	0.192	<	0.197
Methylene Chloride(Dichloromethane)	<	8.7	<	11.7		51.8	<	8.3	<	7.97	<	8.86
Chloroform	<	0.228	<	0.215	<	0.346	<	0.185	<	0.177	<	0.182
Carbon Tetrachloride	<	0.58	<	0.571	<	0.933	<	0.459	<	0.441	<	0.452
1,1-Dichloroethane	<	0.253	<	0.236	<	0.392	<	0.204	<	0.196	<	0.201
1,2-Dichloroethane	<	0.253	<	0.236	<	0.392	<	0.204	<	0.196	<	0.201
Ethylene Dibromide	<	0.41	<	0.384	<	0.644	<	0.331	<	0.318	<	0.326
1,1,1-Trichloroethane	<	0.503	<	0.495	<	0.809	<	0.398	<	0.383	<	0.392
1,1,2-Trichloroethane	<	0.255	<	0.241	<	0.387	<	0.206	<	0.198	<	0.203
1,1,2,2-Tetrachloroethane	<	0.43	<	0.401	<	0.664	<	0.346	<	0.333	<	0.341
cis-1,3-Dichloropropene	<	0.257	<	0.238	<	0.41	<	0.205	<	0.197	<	0.202
trans-1,3-Dichloropropene	<	0.242	<	0.227	<	0.381	<	0.196	<	0.188	<	0.193
1,2-Dichloropropane	<	0.579	<	0.539	<	0.894	<	0.46	<	0.442	<	0.453
Bromomethane	<	0.22	<	0.204	<	0.351	<	0.175	<	0.168	<	0.173
Bromoform	<	0.647	<	0.603	<	1	<	0.521	<	0.501	<	0.514
Bromodichloromethane	<	0.419	<	0.391	<	0.648	<	0.338	<	0.325	<	0.333

Parameter	**Flux (µg/s/m²)**		**Flux (µg/s/m²)**		**Flux (µg/s/m²)**		**Flux (µg/s/m²)**		**Flux (µg/s/m²)**		**Flux (µg/s/m²)**	
Dibromochloromethane	<	0.533	<	0.497	<	0.824	<	0.43	<	0.413	<	0.423
Trichloroethylene	<	0.496	<	0.488	<	0.797	<	0.392	<	0.377	<	0.386
Tetrachloroethylene	<	0.425	<	0.396	<	0.656	<	0.342	<	0.328	<	0.337
Benzene		9.03		9.65		17.6		4.79		6.5		7.5
Toluene		26.1		29.8		50.6		14.3		17.7		21.2
Ethylbenzene		2.41		2.57		5.07		1.67		2.05		2.87
p+m-Xylene		10.5		11.3		22.4		7.69		9.35		13.7
o-Xylene		3.09		3.41		6.89		2.55		3.1		4.71
Styrene	<	0.267		0.282		0.618	<	0.215	<	0.206	<	0.212
4-ethyltoluene	<	3.24	<	3.15	<	5.39	<	2.74	<	2.63	<	2.7
1,3,5-Trimethylbenzene	<	0.778		0.8		1.87		0.678		0.702		1.41
1,2,4-Trimethylbenzene		1.05		1.22		2.78		1.19		1.18		2.59
Chlorobenzene	<	0.288	<	0.269	<	0.445	<	0.232	<	0.223	<	0.229
Benzyl chloride	<	1.64	<	1.51	<	2.54	<	1.31	<	1.25	<	1.29
1,3-Dichlorobenzene	<	0.753	<	0.701	<	1.16	<	0.598	<	0.575	<	0.589
1,4-Dichlorobenzene	<	0.753	<	0.701	<	1.16	<	0.598	<	0.575	<	0.589
1,2-Dichlorobenzene	<	0.753	<	0.701	<	1.16	<	0.598	<	0.575	<	0.589
1,2,4-Trichlorobenzene	<	4.65	<	4.33	<	7.18	<	3.74	<	3.6	<	3.69

Parameter	Flux (µg/s/m²)		Flux (µg/s/m²)		Flux (µg/s/m²)		Flux (µg/s/m²)		Flux (µg/s/m²)		Flux (µg/s/m²)	
Hexachlorobutadiene	<	9.84	<	9.68	<	15.8	<	7.78	<	7.48	<	7.67
Hexane		65		70.6		131		40.5		54.8		62
Heptane		36.5		39.6		73.8		27.2		37.1		43.4
Cyclohexane		28.6		32.6		63.5		24.4		34.7		39.8
Tetrahydrofuran	<	0.369	<	0.344	<	0.571	<	0.293	<	0.282	<	0.289
1,4-Dioxane	<	2.26	<	2.1	<	3.49	<	1.82	<	1.75	<	1.79
Xylene (Total)		13.6		14.7		29.4		10.3		12.5		18.4
Vinyl Bromide	<	0.274	<	0.255	<	0.423	<	0.221	<	0.212	<	0.217
Propene	<	0.635	<	0.58	<	1.04	<	0.126	<	0.121	<	0.124
2,2,4-Trimethylpentane	<	0.293	<	0.273	<	0.452	<	0.236	<	0.226	<	0.232
Carbon Disulfide	<	0.493	<	0.464	<	0.763	<	0.393	<	0.377	<	0.387
Vinyl Acetate	<	0.22	<	0.205	<	0.341	<	4.67	<	6.06	<	6.9

Notes:

All data corrected to 101.3 kPa and 25 °C

'<' indicates that laboratory results were below the detection limit. The detection limit was used to calculate the concentration and flux rate.

All flux rates are presented up to 3 significant figures

Table D2d: Summary of Volatile Organic Compounds Results (May 19, 2013 to May 22, 2013)

Sampling Date	2013-05-19	2013-05-19	2013-05-19	2013-05-20	2013-05-20	2013-05-21	2013-05-21	2013-05-22
Sampling Time	0:37	8:49	21:38	9:07	21:34	9:14	21:54	8:38
Nitrogen Flow (L/min)	5.92	5.84	6.1	6	5.84	5.96	5.87	5.98
Sample ID	D06-H00	D06-H08	D06-H21	D07-H09	D07-H21	D08-H09	D08-H21	D09-H08
Parameter	**Flux (µg/s/m²)**	**Flux (µg/s/m²)**	**Flux (µg/s/m²)**	**Flux (µg/s/m²)**	**Flux (µg/s/m²)**	**Flux (µg/s/m²)**	**Flux (µg/s/m²)**	**Flux (µg/s/m²)**
Dichlorodifluoromethane (FREON 12)	< 0.254	< 0.238	< 0.249	< 0.244	< 0.0595	< 0.121	< 0.0598	< 0.0609
1,2-Dichlorotetrafluoroethane	< 0.305	< 0.288	< 0.3	< 0.296	< 0.0708	< 0.145	< 0.0712	< 0.0725
Chloromethane	< 0.159	< 0.144	< 0.15	< 0.148	< 0.0379	< 0.076	< 0.0381	< 0.0388
Vinyl Chloride	< 0.118	< 0.11	< 0.115	< 0.113	< 0.0275	< 0.0562	< 0.0277	< 0.0282
Chloroethane	< 0.203	< 0.184	< 0.192	< 0.189	< 0.0484	< 0.0972	< 0.0487	< 0.0496
1,3-Butadiene	< 0.284	< 0.266	< 0.278	< 0.273	< 0.0672	< 0.136	< 0.0676	< 0.0688
Trichlorofluoromethane (FREON 11)	< 0.288	< 0.27	< 0.282	< 0.278	< 0.0676	< 0.138	< 0.0679	< 0.0692
Ethanol (ethyl alcohol)	< 5.8	< 4.17	< 5.98	< 5.39	< 0.716	< 0.828	< 1.8	< 0.867
Trichlorotrifluoroethane	< 0.295	< 0.277	< 0.289	< 0.284	< 0.0679	< 0.144	< 0.0683	< 0.0696
2-propanol	< 1.89	< 1.71	< 1.79	< 1.76	< 0.451	< 0.905	< 0.454	< 0.462
2-Propanone	< 104	< 67.7	< 45.6	< 55.6	< 0.114	< 0.23	< 0.115	< 0.117
Methyl Ethyl Ketone (2-Butanone)	< 2.27	< 2.05	< 2.15	< 2.11	< 0.541	< 1.09	< 0.544	< 0.554
Methyl Isobutyl Ketone	< 3.42	< 3.11	< 3.25	< 3.2	< 0.778	< 1.62	< 0.782	< 0.797
Methyl Butyl Ketone (2-Hexanone)	< 2.1	< 1.97	< 2.06	< 2.02	< 0.493	< 1.01	< 0.495	< 0.505
Methyl t-butyl ether (MTBE)	< 0.185	< 0.173	< 0.181	< 0.178	< 0.0434	< 0.0885	< 0.0436	< 0.0444
Ethyl Acetate	< 2.04	< 1.92	< 2	< 1.97	< 0.479	< 0.978	< 0.482	< 0.491

Sampling Date	2013-05-19	2013-05-19	2013-05-19	2013-05-20	2013-05-20	2013-05-21	2013-05-21	2013-05-22
Sampling Time	0:37	8:49	21:38	9:07	21:34	9:14	21:54	8:38
Nitrogen Flow (L/min)	5.92	5.84	6.1	6	5.84	5.96	5.87	5.98
Sample ID	D06-H00	D06-H08	D06-H21	D07-H09	D07-H21	D08-H09	D08-H21	D09-H08
1,1-Dichloroethylene	< 0.254	< 0.238	< 0.249	< 0.245	< 0.0602	< 0.123	< 0.0605	< 0.0617
cis-1,2-Dichloroethylene	< 0.193	< 0.181	< 0.189	< 0.186	< 0.0452	< 0.0922	< 0.0454	< 0.0463
trans-1,2-Dichloroethylene	< 0.204	< 0.191	< 0.199	< 0.196	< 0.0477	< 0.0973	< 0.0479	< 0.0488
Methylene Chloride(Dichloromethane)	< 9.36	< 8.36	< 10.6	< 10.4	< 2.42	< 3.59	< 5.53	< 2.93
Chloroform	< 0.188	< 0.176	< 0.184	< 0.181	< 0.0433	< 0.0915	< 0.0435	< 0.0443
Carbon Tetrachloride	< 0.484	< 0.438	< 0.458	< 0.45	< 0.115	< 0.232	< 0.116	< 0.118
1,1-Dichloroethane	< 0.208	< 0.195	< 0.203	< 0.2	< 0.0487	< 0.0994	< 0.0489	< 0.0499
1,2-Dichloroethane	< 0.208	< 0.195	< 0.203	< 0.2	< 0.0487	< 0.0994	< 0.0489	< 0.0499
Ethylene Dibromide	< 0.335	< 0.316	< 0.33	< 0.325	< 0.0778	< 0.159	< 0.0782	< 0.0797
1,1,1-Trichloroethane	< 0.42	< 0.38	< 0.397	< 0.39	< 0.1	< 0.201	< 0.101	< 0.103
1,1,2-Trichloroethane	< 0.21	< 0.197	< 0.206	< 0.202	< 0.0484	< 0.102	< 0.0486	< 0.0495
1,1,2,2-Tetrachloroethane	< 0.352	< 0.33	< 0.345	< 0.339	< 0.0826	< 0.169	< 0.083	< 0.0846
cis-1,3-Dichloropropene	< 0.21	< 0.195	< 0.204	< 0.201	< 0.0488	< 0.0997	< 0.0491	< 0.05
trans-1,3-Dichloropropene	< 0.198	< 0.187	< 0.195	< 0.192	< 0.046	< 0.0938	< 0.0462	< 0.0471
1,2-Dichloropropane	< 0.475	< 0.439	< 0.458	< 0.451	< 0.111	< 0.227	< 0.112	< 0.114
Bromomethane	< 0.179	< 0.167	< 0.175	< 0.172	< 0.0418	< 0.0853	< 0.042	< 0.0428
Bromoform	< 0.531	< 0.497	< 0.519	< 0.511	< 0.124	< 0.254	< 0.125	< 0.127
Bromodichloromethane	< 0.344	< 0.322	< 0.337	< 0.331	< 0.0806	< 0.164	< 0.081	< 0.0825
Dibromochloromethane	< 0.437	< 0.41	< 0.428	< 0.421	< 0.102	< 0.209	< 0.103	< 0.105
Trichloroethylene	< 0.414	< 0.374	< 0.391	< 0.384	< 0.0987	< 0.198	< 0.0992	< 0.101

Sampling Date	2013-05-19	2013-05-19	2013-05-19	2013-05-20	2013-05-20	2013-05-21	2013-05-21	2013-05-22
Sampling Time	0:37	8:49	21:38	9:07	21:34	9:14	21:54	8:38
Nitrogen Flow (L/min)	5.92	5.84	6.1	6	5.84	5.96	5.87	5.98
Sample ID	D06-H00	D06-H08	D06-H21	D07-H09	D07-H21	D08-H09	D08-H21	D09-H08
Tetrachloroethylene	< 0.348	< 0.326	< 0.341	< 0.335	< 0.0816	< 0.166	< 0.082	< 0.0835
Benzene	7.22	4.87	3.19	3.89	2.71	3.51	2.32	2.38
Toluene	19.4	21.5	12	14.2	7.11	10.1	7.43	6.4
Ethylbenzene	2.39	1.83	1.36	1.38	1.03	1.35	0.898	0.889
p+m-Xylene	10.9	8.16	6.23	6.21	4.98	6.28	4.14	4.19
o-Xylene	3.65	2.8	2.16	2.19	1.72	2.17	1.54	1.55
Styrene	< 0.219	0.294	< 0.214	< 0.211	< 0.0512	< 0.105	0.0759	< 0.0525
4-ethyltoluene	< 2.78	< 2.61	< 2.73	< 2.69	< 0.654	< 1.33	< 0.657	< 0.669
1,3,5-Trimethylbenzene	0.921	0.797	0.66	0.623	0.473	0.607	0.438	0.427
1,2,4-Trimethylbenzene	1.64	1.43	1.18	1.09	0.924	1.13	0.763	0.771
Chlorobenzene	< 0.236	< 0.221	< 0.231	< 0.228	< 0.0554	< 0.113	< 0.0557	< 0.0567
Benzyl chloride	< 1.33	< 1.25	< 1.3	< 1.28	< 0.311	< 0.636	< 0.313	< 0.319
1,3-Dichlorobenzene	< 0.617	< 0.571	< 0.596	< 0.587	< 0.145	< 0.295	< 0.145	< 0.148
1,4-Dichlorobenzene	< 0.617	< 0.571	< 0.596	< 0.587	< 0.145	< 0.295	< 0.145	< 0.148
1,2-Dichlorobenzene	< 0.617	< 0.571	< 0.596	< 0.587	< 0.145	< 0.295	< 0.145	< 0.148
1,2,4-Trichlorobenzene	< 3.81	< 3.57	< 3.73	< 3.67	< 0.893	< 1.82	< 0.897	< 0.914
Hexachlorobutadiene	< 8.21	< 7.43	< 7.76	< 7.63	< 1.96	< 3.93	< 1.97	< 2
Hexane	61.8	40.2	26.1	32.6	21.1	24.6	17.6	19
Heptane	42.6	28	18.7	22.5	14.7	15.6	11.8	13.6
Cyclohexane	41.7	27.9	18	24	14.8	17.8	14.5	16.4

Sampling Date	2013-05-19		2013-05-19		2013-05-19		2013-05-20		2013-05-20		2013-05-21		2013-05-21		2013-05-22	
Sampling Time	0:37		8:49		21:38		9:07		21:34		9:14		21:54		8:38	
Nitrogen Flow (L/min)	5.92		5.84		6.1		6		5.84		5.96		5.87		5.98	
Sample ID	D06-H00		D06-H08		D06-H21		D07-H09		D07-H21		D08-H09		D08-H21		D09-H08	
Tetrahydrofuran	<	0.303	<	0.28	<	0.293	<	0.288		4.71	<	0.145	<	0.0713		4.95
1,4-Dioxane	<	1.85	<	1.73	<	1.81	<	1.78	<	0.433	<	0.885	<	0.436	<	0.444
Xylene (Total)		14.5		11		8.38		8.42		6.68		8.47		5.66		5.74
Vinyl Bromide	<	0.225	<	0.21	<	0.22	<	0.216	<	0.0526	<	0.107	<	0.0529	<	0.0539
Propene	<	0.133	<	0.12	<	0.125	<	0.123	<	0.0316	<	0.2	<	0.0318	<	0.0324
2,2,4-Trimethylpentane	<	0.24	<	0.225	<	0.235	<	0.231	<	0.0562	<	0.115	<	0.0565	<	0.0575
Carbon Disulfide	<	0.4	<	0.375	<	0.391	<	0.385	<	0.0946	<	0.191	<	0.0951	<	0.0969
Vinyl Acetate	<	7.23	<	4.68	<	3.03	<	3.89	<	0.0424	<	0.0864	<	0.0426	<	0.0434

Notes:

All data corrected to 101.3 kPa and 25 °C

'<' indicates that laboratory results were below the detection limit. The detection limit was used to calculate the concentration and flux rate.

All flux rates are presented up to 3 significant figures

D3. VOLATILE ORGANIC HYDROCARBONS SUMMARY RESULTS

Table D3a: Summary of Volatile Organic Hydrocarbons Results (May 13, 2013 to 14, 2013)

Parameter	Flux (µg/s/m²)	Flux (µg/s/m²)	Flux (µg/s/m²)	Flux (µg/s/m²)	Flux (µg/s/m²)	Flux (µg/s/m²)
Benzene	1020	222.00	105.00	111.00	127.00	53.70
Toluene	857	306.00	163.00	169.00	226.00	107.00
Ethylbenzene	33.3	16.300	10.500	10.800	17.800	8.790
Total Xylenes	164	79.50	52.10	53.90	95.60	47.00
Aliphatic >C_5-C_6	17900	2990.0	1270.0	1430.0	1580.0	649.0
Aliphatic >C_6-C_8	5370	1540.0	750.0	816.0	1080.0	474.0
Aliphatic >C_8-C_{10}	337	216.00	146.00	150.00	270.00	141.00
Aliphatic >C_{10}-C_{12}	< 69.8	< 18.300	< 6.300	< 7.020	< 7.300	< 3.5300
Aliphatic >C_{12}-C_{16}	< 69.80	< 18.300	< 6.300	< 7.020	< 7.300	< 3.5300
Aromatic >C_7-C_8 (TEX Excluded)	< 69.8	< 18.300	< 6.300	< 7.020	< 7.300	< 3.5300
Aromatic >C_8-C_{10}	< 69.80	31.300	20.200	21.300	37.700	19.400
Aromatic >C_{10}-C_{12}	< 69.8	< 18.300	< 6.300	< 7.020	< 7.300	< 3.5300
Aromatic >C_{12}-C_{16}	< 69.8	< 18.300	< 6.300	< 7.020	< 7.300	< 3.5300

Notes:

All data corrected to 101.3 kPa and 25 °C

'<' indicates that laboratory results were below the detection limit. The detection limit was used to calculate the concentration and flux rate.

All flux rates are presented up to 3 significant figures

Table D3b: Summary of Volatile Organic Hydrocarbons Results (May 15, 2013 to 16, 2013)

Parameter	Conc (µg/m³)		Flux (µg/s/m²)		Flux (µg/s/m²)		Flux (µg/s/m²)		Flux (µg/s/m²)		Conc (µg/m³)		Flux (µg/s/m²)		Flux (µg/s/m²)	
Benzene	<	1.7		37.1		57.3		47.2		23.9	<	1.2		24.5		29.9
Toluene		3.2		86.1		115		108		89.9	<	1.6		74.8		82.7
Ethylbenzene	<	2.2		6.12		7.6		8.05		5.34	<	1.6		4.76		7.09
Total Xylenes		3.4		31.2		38.1		41.3		33.7	<	2.2		24.7		39.1
Aliphatic >C_5-C_6		8.1		311		515		412		196	<	5		225		240
Aliphatic >C_6-C_8		32.6		624		967		824		432	<	5		453		506
Aliphatic >C_8-C_{10}		20.8		150		180		213		110	<	5		128		171
Aliphatic >C_{10}-C_{12}		12	<	4.46	<	4.51	<	4.58		18.1	<	5	<	4.36		16.9
Aliphatic >C_{12}-C_{16}		54.6	<	4.46	<	4.51	<	4.58	<	4.46		23.8	<	4.36	<	3.12
Aromatic >C_7-C_8 (TEX Excluded)	<	7	<	4.46	<	4.51	<	4.58	<	4.46	<	5	<	4.36	<	3.12
Aromatic >C_8-C_{10}	<	7		17.3		20.2		22.2		18.8	<	5		14		20.7
Aromatic >C_{10}-C_{12}	<	7	<	4.46	<	4.51	<	4.58	<	4.46	<	5	<	4.36		4.91
Aromatic >C_{12}-C_{16}	<	7	<	4.46	<	4.51	<	4.58	<	4.46	<	5	<	4.36	<	3.12

Notes:
All data corrected to 101.3 kPa and 25 °C
'<' indicates that laboratory results were below the detection limit. The detection limit was used to calculate the concentration and flux rate.
All flux rates are presented up to 3 significant figures

Table D3c: Summary of Volatile Organic Hydrocarbons Results (May 17, 2013 to 18, 2013)

Sampling Date	2013-05-17		2013-05-17		2013-05-17		2013-05-18		2013-05-18		2013-05-18	
Sampling Time	0:36		8:46		15:54		0:39		8:52		16:26	
Nitrogen Flow (L/min)	6.08		5.98		5.95		6.12		5.88		6.03	
Sample ID	D04-H00		D04-H08		D04-H16		D05-H00		D05-H08		D05-H16	
Parameter	**Flux (µg/s/m²)**		**Flux (µg/s/m²)**		**Flux (µg/s/m²)**		**Flux (µg/s/m²)**		**Flux (µg/s/m²)**		**Flux (µg/s/m²)**	
Benzene		9.04		9.67		17.6		4.78		6.51		7.52
Toluene		26		29.8		50.5		14.3		17.7		21.1
Ethylbenzene		2.4		2.57		5.06		1.66		2.05		2.88
Total Xylenes		13.6		14.7		29.2		10.2		12.4		18.4
Aliphatic >C_5-C_6		70.6		77.8		148		42		56.9		64.5
Aliphatic >C_6-C_8		154		167		319		90.9		124		143
Aliphatic >C_8-C_{10}		55.8		63		132		45.3		59.8		83.1
Aliphatic >C_{10}-C_{12}		6.35		6.94		16.8		4.72		5.98		12.2
Aliphatic >C_{12}-C_{16}	<	1.58	<	1.49	<	2.45	<	1.26	<	1.21	<	1.24
Aromatic >C_7-C_8 (TEX Excluded)	<	1.58	<	1.49	<	2.45	<	1.26	<	1.21	<	1.24
Aromatic >C_8-C_{10}		7.25		7.98		16.3		6.49		7.34		12.6
Aromatic >C_{10}-C_{12}		2.12		2.74		4.88		3.45		3.18		7.39
Aromatic >C_{12}-C_{16}	<	1.58	<	1.49	<	2.45	<	1.26	<	1.21	<	1.24

Notes:
All data corrected to 101.3 kPa and 25 °C
'<' indicates that laboratory results were below the detection limit. The detection limit was used to calculate the concentration and flux rate.
All flux rates are presented up to 3 significant figures

Table D3d: Summary of Volatile Organic Hydrocarbons Results (May 19, 2013 to 22, 2013)

Sampling Date	2013-05-19	2013-05-19	2013-05-19	2013-05-20	2013-05-20	2013-05-21	2013-05-21	2013-05-22
Sampling Time	0:37	8:49	21:38	9:07	21:34	9:14	21:54	8:38
Nitrogen Flow (L/min)	5.92	5.84	6.1	6	5.84	5.96	5.87	5.98
Sample ID	D06-H00	D06-H08	D06-H21	D07-H09	D07-H21	D08-H09	D08-H21	D09-H08
Parameter	**Flux (µg/s/m²)**	**Flux (µg/s/m²)**	**Flux (µg/s/m²)**	**Flux (µg/s/m²)**	**Flux (µg/s/m²)**	**Flux (µg/s/m²)**	**Flux (µg/s/m²)**	**Flux (µg/s/m²)**
Benzene	7.19	4.87	3.2	3.88	2.71	3.51	2.31	2.37
Toluene	19.5	21.5	12	14.2	7.1	10.1	7.45	6.4
Ethylbenzene	2.38	1.82	1.35	1.38	1.03	1.35	0.898	0.889
Total Xylenes	14.5	11	8.34	8.4	6.72	8.47	5.67	5.74
Aliphatic >C_5-C_6	66.1	43	27.6	36	25	33	22	24.6
Aliphatic >C_6-C_8	144	95	63	78.8	55.2	73.7	49.3	54.7
Aliphatic >C_8-C_{10}	71.9	49.2	38.4	41	32.1	39.6	30.9	31.7
Aliphatic >C_{10}-C_{12}	8.16	5.99	5.45	4.84	4.45	4.25	4.23	4.11
Aliphatic >C^{12}-C_{16}	< 1.28	< 1.2	< 1.26	< 1.24	< 0.304	< 0.614	< 0.306	< 0.311
Aromatic >C_7-C_8 (TEX Excluded)	< 1.28	< 1.2	< 1.26	< 1.24	< 0.304	< 0.614	< 0.306	< 0.311
Aromatic >C_8-C_{10}	9.05	7.03	5.68	5.47	5.08	5.2	3.9	4.35
Aromatic >C_{10}-C_{12}	4.76	4.28	3.88	3.64	3.03	2.45	2.38	2.59
Aromatic >C_{12}-C_{16}	< 1.28	< 1.2	< 1.26	< 1.24	< 0.304	< 0.614	< 0.306	< 0.311

Notes:

All data corrected to 101.3 kPa and 25 °C

'<' indicates that laboratory results were below the detection limit. The detection limit was used to calculate the concentration and flux rate.

All flux rates are presented up to 3 significant figures

D4. TOTAL REDUCED SULPHURS SUMMARY RESULTS

Table D4a: Summary of Total Reduced Sulphurs Results (May 13, 2013 to May 14, 2013)

Parameter	Flux (µg/s/m²)	Flux (µg/s/m²)	Flux (µg/s/m²)	Flux (µg/s/m²)	Flux (µg/s/m²)	Flux (µg/s/m²)
Dimethyl Disulphide	1.0500	< 0.7030	< 0.6550	< 0.6880	< 0.7410	< 0.7180
Dimethyl Sulphide	8.860	1.4100	0.6400	< 0.4540	0.4890	< 0.4740
Hydrogen Sulphide	0.6360	< 0.5180	< 0.4650	< 0.4980	< 0.5360	< 0.5100
Methyl Mercaptan	2.3700	< 0.35900	< 0.33500	< 0.35100	< 0.37900	< 0.36700

Notes:
All data corrected to 101.3 kPa and 25 °C
'<' indicates that laboratory results were below the detection limit. The detection limit was used to calculate the concentration and flux rate.
All data is expressed up to 3 significant figures

Table D4b: Summary of Total Reduced Sulphurs Results (May 15, 2013 to May 16, 2013)

Sampling Date	2013-05-15		2013-05-15		2013-05-15		2013-05-15		2013-05-16		2013-05-16	
Sampling Time	14:22		3:54		9:58		15:31		0:34		8:53	
Nitrogen Flow (L/min)	- Blank		5.88		5.94		6.03		5.88		6	
Sample ID	C1		D02-H12		D02-H18		D02-H24		D03-H00		D03-H08	
Parameter	**Conc (µg/m³)**		**Flux (µg/s/m²)**		**Flux (µg/s/m²)**		**Flux (µg/s/m²)**		**Flux (µg/s/m²)**		**Flux (µg/s/m²)**	
Dimethyl Disulphide	<	1080	<	0.688	<	0.695	<	0.705	<	0.688	<	0.727
Dimethyl Sulphide	<	711		0.454	<	0.458	<	0.465	<	0.454	<	0.479
Hydrogen Sulphide	<	780	<	0.506	<	0.503	<	0.519	<	0.498	<	0.526
Methyl Mercaptan	<	551	<	0.351	<	0.355	<	0.36	<	0.351	<	0.371

Notes:

All data corrected to 101.3 kPa and 25 °C

'<' indicates that laboratory results were below the detection limit. The detection limit was used to calculate the concentration and flux rate.

All data is expressed up to 3 significant figures

D5. TOTAL HYDROCARBONS (DETECTED) SUMMARY RESULTS

Table D5a: Summary of Total Hydrocarbons (Detected) Results (May 13, 2013 to May 14, 2013)

Parameter	Flux (µg/s/m²)	Flux (µg/s/m²)	Flux (µg/s/m²)	Flux (µg/s/m²)	Flux (µg/s/m²)	Flux (µg/s/m²)
Total Hydrocarbon[1] (as methane)	77100	12400	5550	6130	6970	2940

Notes:
[1] Aliphatic and Aromatic mixtures were assumed to have an average molecular mass
All data corrected to 101.3 kPa and 25 °C
'<' indicates that laboratory results were below the detection limit. The detection limit was used to calculate the concentration and flux rate.
All flux rates are presented up to 3 significant figures

Table D5b: Summary of Total Hydrocarbons (Detected) Results (May 15, 2013 to May 16, 2013)

Parameter	Flux (µg/s/m²)	Flux (µg/s/m²)	Flux (µg/s/m²)	Flux (µg/s/m²)	Flux (µg/s/m²)	Flux (µg/s/m²)
Total Hydrocarbon[1] (as methane)	2350	3580	3100	1580	1710	1980

Notes:
[1] Aliphatic and Aromatic mixtures were assumed to have an average molecular mass
All data corrected to 101.3 kPa and 25 °C
'<' indicates that laboratory results were below the detection limit. The detection limit was used to calculate the concentration and flux rate.
All flux rates are presented up to 3 significant figures

Table D5c: Summary of Total Hydrocarbons (Detected) Results (May 17, 2013 to May 18, 2013)

Parameter	**Flux (µg/s/m²)**	**Flux (µg/s/m²)**	**Flux (µg/s/m²)**	**Flux (µg/s/m²)**	**Flux (µg/s/m²)**	**Flux (µg/s/m²)**
Total Hydrocarbon[1] (as methane)	735	666	1290	380	498	612

Notes:
[1] Aliphatic and Aromatic mixtures were assumed to have an average molecular mass
All data corrected to 101.3 kPa and 25 °C
'<' indicates that laboratory results were below the detection limit. The detection limit was used to calculate the concentration and flux rate.
All flux rates are presented up to 3 significant figures

Table D5d: Summary of Total Hydrocarbons (Detected) Results (May 19, 2013 to May 22, 2013)

Sampling Date	2013-05-19	2013-05-19	2013-05-19	2013-05-20	2013-05-20	2013-05-20	2013-05-21	2013-05-22
Sampling Time	0:37	8:49	21:38	9:07	21:34	9:14	21:54	8:38
Nitrogen Flow (L/min)	5.92	5.84	6.1	6	5.84	5.96	5.87	5.98
Sample ID	D06-H00	D06-H08	D06-H21	D07-H09	D07-H21	D08-H09	D08-H21	D09-H08
Parameter	**Flux (µg/s/m²)**	**Flux (µg/s/m²)**	**Flux (µg/s/m²)**	**Flux (µg/s/m²)**	**Flux (µg/s/m²)**	**Flux (µg/s/m²)**	**Flux (µg/s/m²)**	**Flux (µg/s/m²)**
Total Hydrocarbon[1] (as methane)	585	398	276	327	224	281	201	211

Notes:
[1] Aliphatic and Aromatic mixtures were assumed to have an average molecular mass
All data corrected to 101.3 kPa and 25 °C
'<' indicates that laboratory results were below the detection limit. The detection limit was used to calculate the concentration and flux rate.
All flux rates are presented up to 3 significant figures

D6. TOTAL VOLATILE ORGANIC COMPOUNDS (DETECTED) SUMMARY RESULTS

Table D6a: Summary of Total Volatile Organic Compounds (Detected) Results (May 13, 2013 to May 14, 2013)

Parameter	Flux (µg/s/m²)	Flux (µg/s/m²)	Flux (µg/s/m²)	Flux (µg/s/m²)	Flux (µg/s/m²)	Flux (µg/s/m²)
TVOC[1] (as ethylbenzene)	16000	3700	1710	1870	2250	966

Notes:
[1] Aliphatic and Aromatic mixtures were assumed to have an average molecular mass
All data corrected to 101.3 kPa and 25 °C
'<' indicates that laboratory results were below the detection limit. The detection limit was used to calculate the concentration and flux rate.
All flux rates are presented up to 3 significant figures

Table D6b: Summary of Total Volatile Organic Compounds (Detected) Results (May 15, 2013 to May 16, 2013)

Sampling Date	2013-05-15	2013-05-15	2013-05-15	2013-05-16	2013-05-16	2013-05-16
Sampling Time	3:54	9:58	15:31	0:34	8:53	15:55
Nitrogen Flow (L/min)	5.88	5.94	6.03	5.88	6	6
Sample ID	D02-H12	D02-H18	D02-H24	D03-H00	D03-H08	D03-H16
Parameter	**Flux (µg/s/m²)**	**Flux (µg/s/m²)**	**Flux (µg/s/m²)**	**Flux (µg/s/m²)**	**Flux (µg/s/m²)**	**Flux (µg/s/m²)**
TVOC[1] (as ethylbenzene)	700	1060	914	530	513	624

Notes:
[1] Aliphatic and Aromatic mixtures were assumed to have an average molecular mass
All data corrected to 101.3 kPa and 25 °C
'<' indicates that laboratory results were below the detection limit. The detection limit was used to calculate the concentration and flux rate.
All flux rates are presented up to 3 significant figures

Table D6c: Summary of Total Volatile Organic Compounds (Detected) Results (May 17, 2013 to May 18, 2013)

Sampling Date	2013-05-17	2013-05-17	2013-05-17	2013-05-18	2013-05-18	2013-05-18
Sampling Time	0:36	8:46	15:54	0:39	8:52	16:26
Nitrogen Flow (L/min)	6.08	5.98	5.95	6.12	5.88	6.03
Sample ID	D04-H00	D04-H08	D04-H16	D05-H00	D05-H08	D05-H16
Parameter	**Flux (µg/s/m²)**	**Flux (µg/s/m²)**	**Flux (µg/s/m²)**	**Flux (µg/s/m²)**	**Flux (µg/s/m²)**	**Flux (µg/s/m²)**
TVOC[1] (as ethylbenzene)	192	212	397	135	178	219

Notes:
[1] Aliphatic and Aromatic mixtures were assumed to have an average molecular mass
All data corrected to 101.3 kPa and 25 °C
'<' indicates that laboratory results were below the detection limit. The detection limit was used to calculate the concentration and flux rate.
All flux rates are presented up to 3 significant figures

Table D6d: Summary of Total Volatile Organic Compounds (Detected) Results (May 19, 2013 to May 22, 2013)

Sampling Date	2013-05-19	2013-05-19	2013-05-19	2013-05-20	2013-05-20	2013-05-21	2013-05-21	2013-05-22
Sampling Time	0:37	8:49	21:38	9:07	21:34	9:14	21:54	8:38
Nitrogen Flow (L/min)	5.92	5.84	6.1	6	5.84	5.96	5.87	5.98
Sample ID	D06-H00	D06-H08	D06-H21	D07-H09	D07-H21	D08-H09	D08-H21	D09-H08
Parameter	**Flux (µg/s/m²)**	**Flux (µg/s/m²)**	**Flux (µg/s/m²)**	**Flux (µg/s/m²)**	**Flux (µg/s/m²)**	**Flux (µg/s/m²)**	**Flux (µg/s/m²)**	**Flux (µg/s/m²)**
TVOC[1] (as ethylbenzene)	206	149	99	118	78	91	68	73

Notes:
[1] Aliphatic and Aromatic mixtures were assumed to have an average molecular mass
All data corrected to 101.3 kPa and 25 °C
'<' indicates that laboratory results were below the detection limit. The detection limit was used to calculate the concentration and flux rate.
All flux rates are presented up to 3 significant figures

5. TOTAL VOLATILE ORGANIC COMPUNDS (DETECTED) SUMMARY RESULTS

SECTION 3 NOISE REFERENCES

Appendix A Draft conditions for comment

In these draft conditions, the following terms are defined as:

Trans Mountain	Trans Mountain Pipeline ULC
NEB	National Energy Board
the Project	The proposed Trans Mountain Expansion Project, in all its applied-for components.
for approval	When a condition requires a filing for NEB approval, Trans Mountain must not commence the indicated activity until the NEB issues its written approval of that filing.
including	Use of this term, or any variant of it, is not intended to limit the elements to just those listed. Rather, it implies minimum requirements with the potential for augmentation, as appropriate.

Overarching conditions	
1	**Condition compliance** Trans Mountain must comply with all of the [certificate/order] conditions, unless the NEB otherwise directs.
2	**Compliance with commitments** Unless the NEB otherwise directs, Trans Mountain must implement all of the commitments it made in its Project application, or as otherwise agreed to in the evidence it filed during the OH-001-2014 proceeding, or in its related submissions.
3	**Environmental protection** Trans Mountain must implement or cause to be implemented, at a minimum, all of the policies, practices, programs, mitigation measures, recommendations, and procedures for the protection of the environment included in or referred to in its Project application, its subsequent filings, the evidence it provided during the OH-001-2014 proceeding, or as otherwise committed to during questioning or in its related submissions.
4	**Engineering and safety** Trans Mountain must cause the Project facilities to be designed, located, constructed, installed, and operated in accordance with, at a minimum, the specifications, standards, policies, mitigation measures, procedures, and other information included or referred to in its Project application or as otherwise committed to during the OH-001-2014 proceeding.
5	**Certificate expiration (sunset clause)** Unless the NEB otherwise directs **prior to 30 June 2019,** this [certificate/order] will expire on **30 June 2019**, unless construction of the Project has commenced by that date.
6	**Project completion** Trans Mountain must file with the NEB, **within 30 days after commencing operations**, confirmation, signed by an officer of the company, that the Project was completed and constructed in compliance with all applicable [certificate/order] conditions. If compliance with any of the conditions cannot be confirmed, the officer of the company must include the reason(s) for this and the proposed course of action to achieve compliance. This filing must include a statement confirming that the signatory to the filing is an officer of the company.

Conditions with initial filings due prior to commencing construction	
7	**Landowner complaint records** Trans Mountain must create and maintain records, **for the life of the Project (from pre-construction to the end of operations)**, that chronologically track landowner complaints related to the Project. These records must include: a) a description of each complaint; b) how each complaint was received (e.g., telephone, letter, email); c) the date each complaint was received; d) subsequent dates of all contact or correspondence with each complainant; e) records of any site visits, monitoring, or inspections; f) contact information for all parties involved in each complaint; g) the date of each complaint's resolution; and h) if a complaint remains unresolved, a description of any further actions to be taken or an explanation for why no further action is required. Trans Mountain must maintain these records for audit purposes and make them available to the NEB **upon request.** Trans Mountain must make available to a landowner, **upon request**, the records related to the complaint(s) that landowner made to Trans Mountain, including any investigations, reports, or surveys conducted in relation to the complaint.
8	**Commitments tracking table** Trans Mountain must implement the commitments contained within its commitments tracking table and must: a) file with the NEB, at the following times, an updated commitments tracking table: i) **within 90 days after the [certificate/order] date**; and ii) **at least 30 days prior to commencing construction**; b) update the status of the commitments and file those updates with the NEB **on a monthly basis until commencing operations, and quarterly during operations until all conditions are satisfied (except those that involve filings for the Project's operational life)**; c) post on its company website the same information required by a) and b), **using the same indicated timeframes**; and d) maintain at each of its construction offices: i) the relevant environmental portion of the commitments tracking table listing all of Trans Mountain's regulatory commitments, including those from the Project application and subsequent filings, and conditions from received permits, authorizations, and approvals; ii) copies of any permits, authorizations, and approvals for the Project issued by federal, provincial, or other permitting authorities that include environmental conditions or site-specific mitigation or monitoring measures; and iii) any subsequent variances to any permits, authorizations, and approvals in d)ii).

9	**Route re-alignments** As applicable, Trans Mountain must file with the NEB for approval, **concurrent with its filing of the Plan, Profile and Book of Reference pursuant to section 33 of the *National Energy Board Act***, an environmental and socio-economic assessment for each proposed detailed route re-alignment that extends beyond the applied-for right-of-way width of Trans Mountain's preferred route in proximity to: • Ohamil Indian Reserve 1; • Tzeachten Indian Reserve 13; and • Surrey Bend Regional Park. Any assessment must include: a) environmental alignment sheets at an appropriate scale, clearly depicting the proposed route re-alignments; b) results of any pre-construction surveys within the areas that were not previously subject to such surveys, and an indication of potential residual effects; c) all associated mitigation measures that are beyond those identified during the OH-001-2014 proceeding; d) analysis supporting the use of the measures in c), including any supplementary reports; e) confirmation that Trans Mountain will update the relevant Environmental Protection Plans to include any relevant information based on any supplemental surveys completed; f) details of consultation activities undertaken with appropriate government authorities and potentially affected stakeholders in respect of the proposed route re-alignment, including: i) the name of parties consulted; ii) the methods, dates, and locations of all meetings or consultations; iii) a summary of all issues or concerns raised; and iv) a description of the measures taken, or that will be taken, to address or respond to concerns raised, or an explanation why no further action is required to address or respond to issues or concerns. Trans Mountain must provide a copy of any filing to each party consulted about that filing (and identified in f)) at the same time that it is filed with the NEB.
10	**Design temperatures – above-ground facilities** Trans Mountain must file with the NEB, **at least 90 days prior to ordering pipe for above-ground facilities**, confirmation, with rationale, that: a) the selected maximum and minimum design temperatures for all above-ground facilities are in accordance with CSA Z662-15, Clause 5.2.1; b) the selected design temperatures are based on historical, location-specific extreme daily maximum and minimum temperatures, as opposed to average temperatures; and c) the extent of the historical weather data used is commensurate with the expected operational life of the Project.

11	**Quality Management Plan** Trans Mountain must file with the NEB, **at least 6 months prior to manufacturing any pipe and major components for the Project,** a Project-specific Quality Management Plan that includes: a) material/vendor qualification requirements; b) quality control and assurance of pipe, fittings, and components that ensure all materials meet Trans Mountain's specifications (i.e., processes, procedures, specifications, random testing, inspection, and test reports); c) mandatory documentation of process conditions during manufacture and verification of the conformance of manufacturer material test reports with Trans Mountain's requirements; d) mandatory inspection requirements, inspector competency training, and qualifications; e) non-conformance reporting and correction procedures; f) change management process; g) commissioning requirements; and h) material handling requirements during transportation.
12	**Joining Program** Trans Mountain must develop a Joining Program and file it with the NEB **at least 30 days prior to conducting welding procedure qualification tests** for: a) field circumferential production, tie-in, and repair pipeline welds, including the tie-in welds between existing segments and Line 2; and b) welding of Project facilities. The Joining Program must include: i) welder qualification requirements; ii) requirements for welding inspector qualifications and duties; iii) welding procedure specifications; iv) non-destructive examination (NDE) specifications; v) procedure qualification records for welding procedure specifications and NDE specifications; vi) a quality assurance program for field welds and welding procedures; and vii) any additional information that supports the Joining Program.
13	**Training and Education Monitoring Plan** a) Trans Mountain must file with the NEB for approval, **at least 1 year prior to commencing construction**, a plan for monitoring the implementation and outcomes of Aboriginal, local, and regional training and education measures and opportunities for the Project. The plan must include: i) a description of, and rationale for selecting, the indicators that will be monitored to track the implementation of training and education measures and opportunities; ii) the monitoring methods and schedule, including information and data sources for the indicators being monitored; and iii) plans for consulting and reporting on the implementation and outcomes of training and education measures and opportunities with relevant Aboriginal, local, and regional communities; business; industry; community; and education and training organizations.

	b) Trans Mountain must file with the NEB, **at least 90 days prior to commencing construction**, any updates to the elements of the Training and Education Monitoring Plan described in a)i) through iii) above.
14	**Aboriginal, local, and regional skills and business capacity inventory** a) Trans Mountain must file with the NEB, **at least 1 year prior to commencing construction**, an Aboriginal, local, and regional skills and business capacity inventory for the Project. The skills and capacity inventory must include: i) a description of the information and data sources; ii) a summary of Aboriginal, local, and regional skills and business capacity; iii) an analysis of the Aboriginal, local and regional capacity for employment and business opportunities for the Project; iv) plans for communicating employment and business opportunities to Aboriginal, local, and regional communities; v) a description of identified or potential skills and business capacity gaps, and any proposed measures to address them or to support or increase skills or capacity; and vi) plans for communicating identified gaps regarding skills and business capacity with Aboriginal, local, and regional communities and businesses, and any proposed measures to support or increase skills or capacity. b) Trans Mountain must file with the NEB, **at least 90 days prior to commencing construction**, any updates to the elements of the inventory described in a)i) through vi).
15	**Phased filings** Due to the Project's large spatial extent, Trans Mountain may wish to commence Project construction activities at specific locations at different times (i.e., using a phased approach). This may entail doing so on the basis of pipeline spreads of defined lengths, or by regions, or work areas of Trans Mountain's choosing. If Trans Mountain intends to use a phased approach for Project construction, it must undertake the following: a) Trans Mountain must file with the NEB, **at least 7 months prior to commencing construction**, a complete list of construction spreads, regions, or work areas that, for the duration of Project construction, will serve as the basis by which Trans Mountain may submit condition filings in a phased approach. Each spread, region, or work area must be clearly delineated (e.g., by kilometre posts). b) As part of its filing for a), to aid the NEB in anticipating future submissions, Trans Mountain must indicate the specific conditions where it expects to apply this phased approach. Trans Mountain must file updates to this estimate **as they are available**. c) When submitting a filing for any condition using this phased approach, Trans Mountain must clearly indicate which spread(s), region(s), or work area(s) that filing applies to. d) Construction of a particular spread, region, or work area must not proceed until all pre-construction conditions using this phased approach have been satisfied for that spread, region, or work area. Prior to commencing construction of the initial spread, region, or work area, all applicable conditions with more general pre-construction timing elements must also be satisfied.

16	**Training and education monitoring reports** a) Trans Mountain must file with the NEB, **at least 6 months prior to commencing construction**, **and every 6 months thereafter until completing construction**, monitoring reports for the implementation and outcomes of Aboriginal, local, and regional training and education measures and opportunities for the Project. The reports must include the following: i) A description of each training and education measure and opportunity indicator that was monitored, including duration, participant groups, education and training organization, and intended outcomes. ii) A summary and analysis of the progress made toward achieving intended outcomes of each training and education measure and opportunity, including an explanation for why any intended outcomes were not achieve. iii) A description of identified or potential training or education gaps, and any proposed measures to address them or to support or increase training and education measures and opportunities. iv) A summary of Trans Mountain's consultation with relevant Aboriginal, local, and regional communities; business; industry; community; and education and training organizations regarding the implementation and outcomes of training and education measures and opportunities for the reporting period. This summary must include any issues or concerns raised regarding these measures and opportunities and how Trans Mountain has addressed or responded to them. b) Trans Mountain must file with the NEB, **within 6 months after completing construction**, a final report.
17	**Socio-Economic Effects Monitoring Plan** Trans Mountain must file with the NEB for approval, **at least 6 months prior to commencing construction**, a plan for monitoring potential adverse socio-economic effects of the Project during construction. The plan must include the following: a) The factors or indicators to be monitored. b) The methods and rationale for selecting the factors or indicators. c) A description of the baseline, pre-construction socio-economic conditions. d) The monitoring methods and schedule, including third party data source identification. e) Data recording, assessment, and reporting details. f) A discussion of how measures will be implemented to address any identified adverse effects, including: i) the criteria or thresholds that will require measures to be implemented; ii) how monitoring methods and measures implementation to address adverse effects, as necessary, are incorporated into Construction Execution Plans; and iii) a description of the roles and responsibilities of construction prime contractors, sub-contractors, and community relations staff in monitoring socio-economic effects and implementing measures to address adverse effects. g) A summary of Trans Mountain's consultation with potentially affected communities, Aboriginal groups, local and regional authorities, and service providers regarding the Socio-Economic Effects Monitoring Plan. This summary must include: i) a description of any developed agreements or protocols;

	ii) any issues or concerns raised regarding the plan, and how Trans Mountain has addressed or responded to them; and iii) a list of, and explanation for, outstanding issues or concerns, and the steps that Trans Mountain will take to address or respond to them. h) Plans for regular consultation and reporting on effects during construction with potentially affected communities, Aboriginal groups, local and regional authorities, and service providers.
18	**Worker accommodation strategy** Trans Mountain must file with the NEB for approval, **at least 6 months prior to commencing construction**, a worker accommodation strategy, developed in consultation with appropriate municipal or provincial authorities. The strategy must include: a) a final summary of all proposed accommodations, including the location of any temporary camp(s); b) the number of workers that will be housed; and c) a description of how the strategy addresses any concerns or requests raised in consultation with municipal or provincial authorities. In the event that temporary camp(s) are to be used, the strategy must also include: i) a description of how the potential environmental and socio-economic impacts have been assessed, and a description of all associated mitigation measures; ii) copies of, or reference to, any mitigation or operational plans that will be required or implemented for the camp(s), including a description of how Trans Mountain has incorporated any additional mitigation measures into its Pipeline Environmental Protection Plan (required by Condition No. 63); iii) copies of all appropriate municipal or provincial permits for any camp(s); iv) copies or excerpts of all policies relating to the rules of conduct for workers housed at the camp(s); v) confirmation that all policies relating to the camp(s) will be provided to workers; vi) confirmation that all policies relating to the camp(s) were made available to all local communities and other relevant service providers in proximity to any camp(s) that will be used for the Project; and vii) a description of consultations with potentially affected residents and landowners where any camp(s) will be located: 1) a description of the information provided to local residents and landowners; and 2) a summary of all issues and concerns raised and the steps Trans Mountain has taken or will take to address the issues and concerns.
19	**Air Emissions Management Plan for the Westridge Marine Terminal** Trans Mountain must file with the NEB for approval, **at least 6 months prior to commencing construction**, an Air Emissions Management Plan for the Westridge Marine Terminal that includes: a) a description of the baseline, pre-construction conditions informed by relevant modelling results and recent existing monitoring data; b) locations of air monitoring sites (on a map or diagram), including the rationale for the locations selected; c) the timing for installing air monitoring stations;

	d) the methods and schedule for ambient monitoring of contaminants of potential concern in air (e.g., particulate matter [including diesel particulate matter and speciation of $PM_{2.5}$], carbon monoxide, nitrogen oxide, sulphur dioxide, hydrogen sulphide, and volatile organic compounds); e) procedures for monitoring station data recording, assessment, and reporting details; f) a particulate matter management plan; g) a description of the public and Aboriginal communication and complaint response processes; h) the criteria or thresholds that, if triggered or exceeded, would require implementing additional mitigation measures; i) a description of additional mitigation measures that could be implemented as a result of the monitoring data or ongoing concerns; and j) a summary of consultation with appropriate government authorities and any potentially affected landowners and Aboriginal groups, including any issues or concerns raised with respect to the Air Emissions Management Plan and how Trans Mountain has addressed or responded to them.
20	**Pre-construction caribou habitat assessment** Trans Mountain must file with the NEB for approval, **at least 6 months prior to commencing construction**, a detailed caribou habitat assessment for each caribou range. The framework of the habitat assessment must use the components of critical habitat outlined in the proposed *Recovery Strategy for the Woodland Caribou, Southern Mountain Population in Canada (2014)*. The habitat assessment must include: a) map(s) indicating the location of the habitat; b) a description of the amount of habitat and the existing habitat alteration, in hectares; c) a description of how Trans Mountain has incorporated available and applicable Aboriginal traditional ecological knowledge studies into the assessment; and d) a description of the type of habitat characterized by the biophysical attributes of critical habitat, as defined in the applicable Recovery Strategy.
21	**Caribou Habitat Restoration Plan (CHRP)** Trans Mountain must file with the NEB for approval, in accordance with the timelines below, preliminary and final versions of a CHRP for each caribou range potentially affected by the Project. a) Preliminary CHRP – to be filed **at least 6 months prior to commencing construction of any project component potentially affecting each caribou range**. This version of the CHRP must include the following: i) The CHRP's goals and measureable objectives for each caribou range. ii) A list of criteria used to identify potential caribou habitat restoration sites. iii) Conceptual decision-making tree(s) or decision framework(s) that will be used to identify and prioritize restoration sites, and mitigative actions to be used at different types of sites, including consideration of typical site factors that may constrain implementation. iv) A literature review upon which the decision-making tree(s) or decision framework(s) are based, including: 1) an identification of applicable temporal and spatial caribou habitat restoration methodologies; 2) an assessment of the relative effectiveness of the identified methodologies; and

	3) a detailed methodology of how the literature review was conducted. v) The quantifiable targets and performance measures that will be used to evaluate the extent of predicted residual effects, CHRP effectiveness, the extent to which the goals and objectives have been met, and the need for further measures to offset unavoidable and residual effects on habitat. vi) A schedule indicating when mitigation measures will be initiated and their estimated completion dates. vii) A description of how Trans Mountain has taken available and applicable Aboriginal traditional ecological knowledge studies into consideration in identifying potential caribou habitat restoration sites. viii) A summary of Trans Mountain's consultation with appropriate government authorities and any potentially affected Aboriginal groups regarding the preliminary CHRP. This summary must include any issues or concerns raised regarding the preliminary CHRP and how Trans Mountain has addressed or responded to them. b) Final CHRP – to be filed **on or before 1 November after the first complete growing season after commencing operations**. This version of the CHRP must include the following: i) The preliminary CHRP, with any updates identified in a revision log that includes the rationale for any changes. ii) A detailed decision-making tree(s) or process that will be used to identify and prioritize restoration actions among selected habitat restoration sites. iii) A complete tabular list of caribou habitat restoration sites, including locations, spatial areas, habitat quality descriptions, site-specific restoration activities, and challenges. iv) Maps or updated Environmental Alignment Sheets showing the site locations. v) Specification drawings for the implementation of each restoration method. vi) A quantitative and qualitative assessment of the total area of direct and indirect disturbance to caribou habitat that will be restored, the duration of spatial disturbance, and the area-based extent of the resulting unavoidable and residual effects to be offset. vii) A summary of Trans Mountain's consultation with appropriate government authorities and any potentially affected Aboriginal groups regarding the final CHRP. This summary must include any issues or concerns raised regarding the final CHRP and how Trans Mountain has addressed or responded to them.
22	**Sowaqua Spotted Owl Mitigation Plan** Trans Mountain must file with the NEB for approval, **at least 6 months prior to commencing construction of any Project component within the Sowaqua spotted owl wildlife habitat area**, a Sowaqua Spotted Owl Mitigation Plan that includes: a) a summary of results from supplemental surveys conducted in the Sowaqua spotted owl wildlife habitat area; b) the area of habitat potentially directly and indirectly affected by the Project; c) a description of how an avoidance, mitigation, and offset hierarchy was considered in the plan; d) mitigation measures to be implemented, including all relevant measures committed to throughout the OH-001-2014 proceeding, any new mitigation measures resulting from supplementary surveys, detailed criteria using clear and unambiguous language that describes the circumstances under which each measure will be applied, and measurable goals for evaluating mitigation success;

	e) an evaluation of offset options within or outside of the Sowaqua spotted owl wildlife habitat area, an indication of the selected option, and the rationale for the selected option; f) details on post-construction monitoring of mitigation measures and offset measures, including survey methods, corrective measures, detailed criteria using clear and unambiguous language that describes the circumstances under which each measure will be applied, any adjustments to the offset measures, and a proposed reporting schedule; g) a commitment to include results of the monitoring in the post-construction environmental monitoring reports filed under Condition No. 140; h) a description of how Trans Mountain has taken available and applicable Aboriginal traditional land use and traditional ecological knowledge into consideration in developing the mitigation plan; i) a summary of Trans Mountain's consultation concerning a) to f) with appropriate government authorities, species experts, and any potentially affected Aboriginal groups, including any issues or concerns raised and how Trans Mountain has addressed or responded to them; and j) confirmation that Trans Mountain will update the relevant Environmental Protection Plans to include any relevant information from the mitigation plan.
23	**Air Emissions Management Plan for the Edmonton, Sumas, and Burnaby Terminals** Trans Mountain must file with the NEB for approval, **at least 6 months prior to commencing construction at each of the Edmonton, Sumas, and Burnaby terminals**, an Air Emissions Management Plan for each of those terminals that includes: a) a description of the baseline, pre-construction conditions informed by relevant modelling results and recent existing monitoring data; b) descriptions of the locations of air monitoring sites (on a map or diagram), including the rationale for the locations selected; c) the timing for installing air monitoring stations; d) the methods and schedule for monitoring ambient ground-level concentrations of potential concern (e.g., volatile organic compounds, ozone, hydrogen sulphide, mercaptans, criteria air contaminants, secondary ozone and particulate matter, and reduced visibility) and emissions source tracking; e) procedures for monitoring station data recording, assessment, and reporting details; f) a description of the public and Aboriginal communication and complaint response process; g) the criteria or thresholds that, if triggered or exceeded, will require implementing additional emissions reduction measures; h) possible measures that will be implemented as a result of the monitoring data or ongoing concerns; and i) a summary of consultation with appropriate government authorities, any potentially affected landowners and Aboriginal groups, including any issues or concerns raised with respect to the Air Emissions Management Plan and how Trans Mountain has addressed or responded to them.
24	**Power system protection for pump stations and terminals** Trans Mountain must file with the NEB, **at least 6 months prior to commencing construction**, the following details of its electrical power system design for its pump stations and terminals: a) Descriptions of the overcurrent and ground fault protection schemes including: i) a summary of coordination studies between the upstream and downstream protective devices;

	ii) relay settings and time-current curves; iii) the specification of neutral grounding resistors; iv) specifications of contactors, fuses, and circuit breakers; and v) a description of other electrical protections, relay settings, and trip characteristics. b) Consistent with the NEB's Safety Advisory SA-2015-03, dated 4 May 2015, confirmation that Trans Mountain has performed the ground fault and arcing fault protection designs for each pump station and terminal, including: i) a means to clear ground faults without intentional time delay if the fault currents exceed the design limit set by the neutral grounding resistance; and ii) a means to block the stored energy from other running motors from feeding an electrical fault in another motor running from the same bus. This filing must include a description of the ground fault and arcing fault protection designs including the above measures. c) The electrical configuration of all stations and terminals for which Trans Mountain determined during detailed design that arcing fault could exceed the safe operating limits. This filing must include a list of these stations and terminals, and the additional equipment and devices that will be used to mitigate the adverse effects of such arcing faults. d) Single-line diagrams of the electrical power systems for each pump station and terminal.
25	**Sumas Terminal Geotechnical Report** Trans Mountain must file with the NEB, **at least 6 months prior to commencing construction,** a geotechnical report that provides feasibility-level geotechnical design recommendations for the proposed new tank and related facilities at the Sumas Terminal.
26	**Westridge Marine Terminal Onshore Geotechnical Report** Trans Mountain must file with the NEB, **at least 6 months prior to commencing construction**, a geotechnical report that provides feasibility-level geotechnical design recommendations for the proposed new onshore facilities at the Westridge Marine Terminal**.**
27	**Westridge Marine Terminal Offshore Geotechnical Report** Trans Mountain must file with the NEB**, at least 6 months prior to commencing construction**, the final Preliminary Geotechnical Report on the offshore portion of the Westridge Marine Terminal, based on the selected pile design option.
28	**Existing NPS 24 delivery pipeline location** Trans Mountain must file with the NEB, **at least 6 months prior to commencing construction,** its decision on whether it intends to "relocate" the existing NPS 24 delivery pipeline to the Burnaby Mountain tunnel (i.e., replace it with a new third pipeline in the Burnaby Mountain tunnel) and, if so, provide: a) details of any required changes to the design, construction, and operation of the proposed Burnaby Mountain tunnel; b) a discussion of the factors Trans Mountain considered in deciding to replace/relocate the existing NPS 24 delivery pipeline; and

	c) an indication of when Trans Mountain expects to apply for NEB approval to relocate/replace the existing NPS 24 delivery pipeline.
29	**Updated terminal risk assessments** Trans Mountain must file with the NEB for approval, **at least 6 months prior to commencing construction**, updated risk assessments for the Edmonton Terminal West Tank Area, the Sumas Terminal, and the Burnaby Terminal. The updated risk assessments must quantify and/or include the following: a) the effect of the revised spill burn rates; b) the potential consequences of a boil-over; c) the potential consequences of flash fires and vapour cloud explosions; d) the cumulative risk based on the total number of tanks in the terminal, considering all potential events (pool fire, boil-over, flash fire, vapour cloud explosion); e) the domino (knock-on) effect caused by a release of the contents of one tank on other tanks within the terminal's common impoundment area(s), or other tanks in adjacent impoundment areas; and f) risk mitigation measures, including ignition source control methods. For those risks that cannot be eliminated, Trans Mountain must demonstrate in each risk assessment that mitigation measures will reduce the risks to levels that are As Low As Reasonably Practicable (ALARP) while complying with the Major Industrial Accidents Council of Canada (MIACC) criteria for risk acceptability. The quantitative risk analysis must be based on recognized methodology, models, and software. Product release frequencies and event probabilities must be based on recent, documented data sources. The effect of mitigation measures on the risk results must be justified and documented.
30	**Secondary containment – Edmonton Terminal** Trans Mountain must file with the NEB for approval, **at least 6 months prior to commencing construction**, the final design of the Edmonton Terminal West Tank Area, including a report demonstrating the following: a) The drainage system's capability to rapidly and safely channel a significant release from any tank in the West Tank Area Common Impoundment to the Remote Impoundment Annex and Remote Impoundment at the same time that a design precipitation event is occurring, without overtopping the diked areas. b) The adequacy of the design in mitigating the following consequences of an accidental release and/or ignition of hydrocarbons, both within and beyond the Edmonton Terminal property boundary: • Harm to personnel and the public. • Environmental damage. • Damage to facilities. c) The ability of the Common Impoundment, Remote Impoundment Annex, and Remote Impoundment to contain a release of hydrocarbons from a rupture of the largest tank within the West Tank Area concurrent with a 1-in-100 year, 24-hour storm event. The scenario must include an allowance for water generated from potential firefighting activities and the maximum potential amount of standing water in all areas of the secondary containment system.

31	**Secondary containment – Burnaby Terminal** Trans Mountain must file with the NEB for approval, **at least 6 months prior to commencing construction**, the final design of the Burnaby Terminal, including a report demonstrating the following: a) The drainage system's capability to rapidly and safely channel a significant release from either Tank 96, 97, or 98 to the Partial Remote Impoundment at the same time that a design precipitation event is occurring, without overtopping the diked areas. b) The adequacy of the proposed design in mitigating the following consequences of an accidental release and/or ignition of hydrocarbons, both within and beyond the Burnaby Terminal property boundary: • Harm to personnel and the public. • Environmental damage. • Damage to facilities. c) The ability of the individual containment areas, Common Impoundment areas, Intermediate Stormwater Retention, Partial Remote Impoundment, and Tertiary Containment to contain a release of hydrocarbons from a multiple-tank rupture scenario concurrent with a 1-in-100 year, 24-hour storm event. The scenario must include an allowance for water generated from potential firefighting activities and the maximum potential amount of standing water in all areas of the secondary containment system.
32	**Secondary containment – Sumas Terminal** Trans Mountain must file with the NEB for approval, **at least 6 months prior to commencing construction**, the final design of the Sumas Terminal, including a report demonstrating the following: a) The adequacy of the proposed design in preventing the following consequences of an accidental release and/or ignition of hydrocarbons, both within and beyond the Sumas Terminal property boundary: • Harm to personnel and the public. • Environmental damage. • Damage to facilities. b) The ability of the secondary containment system to contain a release of hydrocarbons from a multiple-tank rupture scenario concurrent with a 1-in-100 year, 24-hour storm event. The scenario must include an allowance for water generated from potential firefighting activities and the maximum potential amount of standing water in all areas of the secondary containment system.
33	**Transient hydraulic analysis on the existing delivery pipeline** Trans Mountain must file with the NEB, a**t least 6 months prior to commencing construction**, the conclusions of the transient hydraulic analysis undertaken on the existing NPS 24 delivery pipeline from the Burnaby Terminal to the Westridge Marine Terminal. The filed conclusions must: a) demonstrate that the analysis considered the occurrences of maximum surge pressure in the existing NPS 24 delivery pipeline; and b) support Trans Mountain's decision to either retain or eliminate the proposed relief tank at the Westridge Marine Terminal.

34	**Valve locations on Line 2**[1] Trans Mountain must file with the NEB for approval, **at least 6 months prior to commencing construction**, its final valve location assessment for Line 2. This assessment must include: a) A table showing each valve's location, function, and description (the description must include valve type, valve closure time, and whether the valve can be remotely controlled by the control center); b) confirmation that the valve closure times provided in a) will not cause unsafe transient pressures according to the final transient analysis, along with a summary of the analysis; c) calculated volume release and elevation plots in a format similar to that provided by Trans Mountain in its Oil Spill Outflow Model Results for Line 2 for May 2014 Route (Filing A3Z8G6); d) clarification of how the Outflow Volume Score for Non-Watercourse Intersects ($S_{v,Nonwatercourse}$) is considered in identifying and prioritizing pipeline segments for valve optimization; e) for each 5-kilometre-long section of Line 2, information demonstrating that the risks within that section are managed to levels that are As Low As Reasonably Practicable (ALARP), based on the valve locations provided in a); f) an outflow volume versus chainage graph illustrating the effectiveness of the valve locations provided in a) showing the outflow limit in a format similar to that provided in Figure 4 of Attachment 2 to Trans Mountain's response to NEB Information Request No. 3.050b) (Filing A4H2D7); g) mitigation measures for the locations shown to exceed the outflow limit in the graph provided in f); and h) full-bore release and spill extent mapping that identifies and plots all geohazards identified by Trans Mountain at the time of its submission, in a format and scale similar to the maps provided by Trans Mountain in Filing A3Z8G7.
35	**Valve locations and upgrades – Line 1**[2] Trans Mountain must file with the NEB for approval, **at least 6 months prior to commencing construction**, its final valve location assessment for Line 1. This assessment must include: a) a plan for upgrading existing manual block valves to automated valves, remotely operable valves, or new valves in order to control consequences, including initiation and completion dates for the required activities; b) a table showing each valve's location, function, and description (the description must include valve type, valve closure time, and whether the valve can be remotely controlled by the control center); c) confirmation that the valve closure times provided in a) will not cause unsafe transient pressures according to the final transient analysis, along with a summary of the analysis; d) calculated volume release and elevation plots in a format similar to that provided by Trans Mountain in its Oil Spill Outflow Model Results for Line 2 for May 2014 Route (Filing A3Z8G6); e) for each 5-kilometre-long section, information demonstrating that the risks within that section are managed to levels that are As Low As Reasonably Practicable (ALARP), based on the valve locations provided in a);

[1] In these conditions, "Line 2" refers to, combined, the new pipeline segments and the two currently operating Trans Mountain Pipeline System segments transferring to Line 2 service.

[2] In these conditions, "Line 1" refers to, combined, the pipeline segments to be reactivated and the currently operating Trans Mountain Pipeline System segments.

	f) an outflow volume versus chainage graph illustrating the effectiveness of the valve locations provided in a), in a format similar to that provided in Figure 4 of Attachment 2 to Trans Mountain's response to NEB Information Request No. 3.050b) (Filing A4H2D7); and g) full-bore release and spill extent mapping that identifies and plots all geohazards identified by Trans Mountain at the time of its submission, in a format and scale similar to the maps provided by Trans Mountain in Filing A3Z8G7.
36	**Burnaby Mountain tunnel option – design, construction, and operation** Trans Mountain must file with the NEB, **at least 6 months prior to commencing construction**, the following details for the tunnel between the Burnaby Terminal and the Westridge Marine Terminal and related delivery pipelines: a) for NEB approval: i) A description of the selected tunnel lining method with rationale for its selection. ii) Tunnel confined space entry procedures during construction and, if applicable, following construction. b) for NEB review: i) The results of any geotechnical or geophysical feasibility surveys completed since the evidence filed in the OH-001-2014 hearing. ii) A description of the tunnel portals and permanent road access, if applicable. iii) A description of the selected tunnel excavation method with rationale for its selection. iv) A description of the tunnel backfilling method with rationale for its selection. v) A description of the methods to be used for pipe handling and welding. vi) A discussion on the adequacy of the pipe support methods for the new delivery pipelines during construction and commissioning, including hydrostatic testing and operation, if applicable. vii) A discussion on the adequacy of the selected leak detection methods. viii) Information demonstrating how the precautionary design of the new delivery pipelines would mitigate issues related to limited accessibility for future maintenance and repairs. ix) The final tunnel cross-sectional design drawings.
37	**Burnaby Mountain tunnel option – backfilling** Trans Mountain must file with the NEB, **at least 6 months prior to commencing construction**, the following information on backfilling the tunnel between the Burnaby Terminal and the Westridge Marine Terminal: a) A discussion of the adequacy of the measures to be taken during tunnel backfilling to eliminate or mitigate potential damage to the delivery pipelines. b) The method(s) that will be used to confirm the consistency and continuity of the tunnel backfill (i.e., backfilling is completed without any spatial gaps). c) The method(s) that will be used to confirm holiday detection and coating repair methodology prior to backfilling. d) The methods that will be used to confirm the integrity of the delivery pipelines in the tunnel, both prior to and after backfilling, but prior to commissioning.

	e) The methods that will be used for monitoring, maintaining, and repairing backfill during operations, considering conditions such as fill deterioration and a potential increase in permeability.
38	**Burnaby Mountain tunnel option – cathodic protection** Trans Mountain must file with the NEB, a**t least 6 months prior to commencing construction**, the following information on the cathodic protection system for the delivery pipelines in the tunnel between the Burnaby Terminal and the Westridge Marine Terminal: a) A description of the cathodic protection system design. b) Risk mitigation measures for all potential cathodic protection performance issues, such as shielding from the backfill material. c) A method for verifying the effectiveness of the cathodic protection system during operations.
39	**Burnaby Mountain tunnel option – rock mass** Trans Mountain must file with the NEB for approval, **at least 6 months prior to commencing construction,** the following details on rock mass quality expected to be encountered during construction of the tunnel between the Burnaby Terminal and the Westridge Marine Terminal: a) The characterization of the rock mass quality. b) Waste rock managing methods during construction and operations, if applicable. c) Proposed acid rock mitigation measures, such as the treatment or disposal of acid rock, if encountered. d) The locations, sizes, and designs of all confirmed waste rock disposal areas. e) Plans for disposing any waste rock that is not expected to be stored in the confirmed waste rock disposal areas.
40	**Pipeline segment reactivation (Hinton to Hargreaves; Darfield to Black Pines)[3] – engineering assessment and certificate** Trans Mountain must file with the NEB for approval, **at least 6 months prior to commencing construction**: a) an engineering assessment for the above two pipeline segments, in accordance with Canadian Standards Association (CSA) Z662-15, Clauses 3.3 and 10.15.2; and b) a certificate with a supporting report issued by an independent certification body,[4] stating unconditionally that the above two pipeline segments: i) are fit for service for the specified operating conditions;[5]

[3] Hinton, Alberta, to Hargreaves, British Columbia: 150 kilometres long; 609.6 millimetres (NPS 24) in outside diameter; built in 1953; deactivated in 2008.

Darfield to Black Pines, British Columbia: 43 kilometres long; 609.6 millimetres (NPS 24) in outside diameter, built in 1953; deactivated in 2004.

[4] In these conditions, an" independent certification body" is an internationally recognized company or organization, such as Lloyd's Register or Det Norske Veritas, which is able to certify compliance to statutory requirements. The independent certification body must have expertise in pipeline integrity. The NEB reserves the right to accept or reject the certificate. In addition, the NEB's decision is not contingent on the results of the certificate.

	ii) meet all applicable requirements of CSA Z662-15; and iii) will meet the hydrostatic test requirements outlined in CSA Z662-15, Clause 8, at any time during the certified period. The certificate must be valid for at least 5 years and be validated on an annual basis during the certified period. The supporting report must include the qualifications of the independent certification body, the justification used to grant the certificate, and the expiry date of the certificate.
41	**Pipeline segment reactivation (Hinton to Hargreaves; Darfield to Black Pines) – new certificate and certificate validation** Trans Mountain must file with the NEB**, before expiry of the previous certificate identified in Condition No. 40**, a new certificate with a supporting report issued by an independent certification body for the two pipeline segments identified in Condition No. 40. The certificate and report must demonstrate that the two pipeline segments: a) are fit for service for the specified operating conditions; b) meet all applicable requirements of CSA Z662-15; and c) will meet the hydrostatic test requirements outlined in CSA Z662-15, Clause 8, at any time during the certified period. The certificate must be valid for at least 5 years and be validated on an annual basis during the certified period. The supporting report must include the qualifications of the independent certification body, the justification used to grant the certificate, and the expiry date of the certificate.
42	**Changing pipeline segment operating conditions (Hinton to Hargreaves; Darfield to Black Pines)**[6] Trans Mountain must file with the NEB for approval, **at least 6 months prior to commencing construction**, the following: a) An engineering assessment in accordance with CSA Z662-15, Clauses 3.3 and 10.1, for the above two pipeline segments for which Trans Mountain proposes to change from operating on the existing Line 1 to the proposed Line 2. The engineering assessment must demonstrate that the two pipeline segments are fit for their intended service under the operating conditions of Line 2, and that they meet all relevant requirements of CSA Z662-15. The engineering assessment must include a schedule of planned integrity monitoring activities. b) A certificate with a supporting report issued by an independent certification body, stating unconditionally that the 43-kilometre-long, 762 millimetre outside diameter (NPS 30) pipeline segment from Darfield to Black Pines, British Columbia is fit for its intended service under the operating conditions of Line 2.

[5] In these conditions, "operating conditions" must include the Project-specific operating conditions, possible transient flow conditions, slack flow conditions, and effects on operating pressure due to temperature changes.

[6] Hinton, Alberta, to Hargreaves, British Columbia: 151 kilometres long; 914 millimetres (NPS 36) in outside diameter; built in 2008.

Darfield to Black Pines, British Columbia: 43 kilometres long; 762 millimetres (NPS 30) in outside diameter; built in 1957.

	The supporting report must include the qualifications of the independent certification body and the justification used to grant the certificate.
43	**Reactivation of the Niton Pump Station** Trans Mountain must file with the NEB for approval, **at least 6 months prior to commencing construction,** an engineering assessment for the Niton Pump Station, in accordance with CSA Z662-15, Clauses 3.3 and 10.15.2. The engineering assessment must demonstrate that the pump station is fit for its intended service, and meets all applicable requirements of CSA Z662-15.
44	**Wildlife Species at Risk Mitigation and Habitat Restoration Plans** Trans Mountain must file with the NEB for approval, **at least 4 months prior to commencing construction**, Wildlife Species at Risk Mitigation Plans for each species whose draft, candidate, proposed, or final critical habitat is directly or indirectly affected by the Project. Each plan must include a) a summary of supplementary pre-construction survey results, including surveys for biophysical attributes of critical habitat; b) the area and type of critical habitat, including biophysical attributes, potentially directly and indirectly affected by the Project footprint; c) mitigation and habitat restoration measures to be implemented, including all relevant measures committed to throughout the OH-001-2014 proceeding, any new mitigation measures resulting from supplementary surveys, detailed criteria using clear and unambiguous language that describes the circumstances under which each measure will be applied, and measurable goals for evaluating mitigation success; d) details on post-construction monitoring of mitigation measures and habitat restoration measures, including survey methods, corrective measures, detailed criteria using clear and unambiguous language that describes the circumstances under which each measure will be applied, and a proposed reporting schedule; e) a commitment to include the results of the monitoring in the post-construction environmental monitoring reports filed under Condition No. 140; f) a description of how Trans Mountain has taken available and applicable Aboriginal traditional land use and traditional ecological knowledge into consideration in developing the plans; g) a summary of Trans Mountain's consultation concerning a) to f) with appropriate government authorities, species experts, and any potentially affected Aboriginal groups, including any issues or concerns raised and how Trans Mountain has addressed or responded to them; and h) confirmation that Trans Mountain will update the relevant Environmental Protection Plans to include any relevant information from the Wildlife Species at Risk Mitigation and Habitat Restoration Plans.
45	**Grizzly Bear Mitigation Plan** Trans Mountain must file with the NEB for approval, **at least 4 months prior to commencing construction**, a Grizzly Bear Mitigation Plan that includes: a) a summary of results from any supplemental surveys conducted; b) potential direct and indirect effects of Project activities on vulnerable grizzly bear population units;

	c) mitigation measures to be implemented, including all relevant measures committed to throughout the OH-001-2014 proceeding, any new mitigation measures resulting from supplementary surveys, detailed criteria using clear and unambiguous language that describes the circumstances under which each measure will be applied, and measurable goals for evaluating mitigation success; d) details on post-construction monitoring of mitigation measures, including survey methods, corrective measures, detailed criteria using clear and unambiguous language that describes the circumstances under which each measure will be applied, and a proposed reporting schedule; e) a commitment to include results of the monitoring in the post-construction environmental monitoring reports filed under Condition No. 140; f) a description of how Trans Mountain has taken available and applicable Aboriginal traditional land use and traditional ecological knowledge into consideration in developing the plan; g) a summary of Trans Mountain's consultation concerning a) to d) with appropriate government authorities, species experts, and any potentially affected Aboriginal groups, including any issues or concerns raised and how Trans Mountain has addressed or responded to them; and h) confirmation that Trans Mountain will update the relevant Environmental Protection Plans to include any relevant information from the Grizzly Bear Mitigation Plan, including confirmation that the mitigation, monitoring, and corrective measures in this plan will be implemented in the case of discovery via their inclusion in Trans Mountain's Wildlife Species of Concern Discovery Contingency Plan.
46	**Navigation and navigation safety** Trans Mountain must file with the NEB, **at least 4 months prior to commencing construction**: a) an updated list of navigable waterways that may be affected by the Project (including the pipeline, power lines, marine terminal, temporary or permanent bridge crossings, or other ancillary works that are physically or operationally connected to the Project); b) an updated assessment of Project effects on navigation and navigation safety for each of the identified waterways identified in a); c) proposed mitigation measures to address Project effects on navigation and navigation safety for each of the identified waterways, including adherence to codes and standards (such as the Canadian Standards Association); d) any issues or concerns raised by waterway users and any potentially affected Aboriginal groups regarding their navigational use of each of the identified waterways and how Trans Mountain has addressed or responded to those issues or concerns; and e) an assessment of the potential effects of proposed fish habitat offsets (those included in the offsetting plan required by Condition No. 98) on navigation and navigation safety and any mitigation measures proposed to reduce or avoid those effects.
47	**Fugitive Emissions Management Plan for Edmonton, Sumas, and Burnaby Terminals** Trans Mountain must file with the NEB for approval, **at least 4 months prior to commencing construction**, a Fugitive Emissions Management Plan for the Edmonton, Sumas, and Burnaby Terminals. This plan must include: a) a description of the fugitive emission sources within the terminals during construction and operations; b) a description of the emission and odour controls that will be employed to reduce fugitive emissions from the tanks, and any other sources identified in a);

	c) procedures for verifying the capture and destruction efficiency of tank vapour activation units or any other emission or odour control units at the terminals; d) quantification of fugitive emissions during operations, including the methods used; e) any additional mitigation measures that will be employed to further reduce the fugitive emissions; f) a description of Trans Mountain's program for addressing complaints with respect to fugitive emissions, including a public and Aboriginal communication and complaint response process; and g) a summary of consultation with appropriate government authorities and any potentially affected landowners and Aboriginal groups, including any issues or concerns raised with respect to the Fugitive Emissions Management Plan and how Trans Mountain has addressed or responded to them.
48	**Fugitive Emissions Management Plan for pump stations** Trans Mountain must file with the NEB for approval, **at least 4 months prior to commencing construction**, a Fugitive Emissions Management Plan for the pump stations associated with the Project that includes: a) a description of the procedures implemented for leak detection and the criteria used in selecting target leaking components; b) quantification methods considered and the rationale for the selected method(s); c) monitoring frequency for each target leaking component and the parameters that will be measured; d) a decision framework that will be implemented to repair or replace leaking components; e) a description of record-keeping procedures; and f) a discussion of additional mitigation measures that will be employed to minimize fugitive emissions.
49	**Contamination Identification and Assessment Plan** Trans Mountain must file with the NEB for approval, **at least 4 months prior to commencing construction**, a Contamination Identification and Assessment Plan that includes: a) a description of the procedures that have been implemented to-date, and that will be implemented prior to or during construction, to identify and assess pre-existing contamination that could be disturbed by, or affect, the Project, including whether site investigations have been or will be undertaken; b) a demonstration of the adequacy of the procedures in a) with reference to relevant standards, guidelines, and best practices, including how historical land use has been taken into account and a discussion of the potential for chemicals of concern to not be detectable by smell or by sight; c) the information that has been or will be reported by Trans Mountain, including to whom and when, concerning pre-existing contamination; d) a summary of Trans Mountain's consultation concerning a) to c) with appropriate government authorities, landowners, and any potentially affected Aboriginal groups, including any issues or concerns raised and how Trans Mountain has addressed or responded to them; and e) confirmation that the relevant Environmental Protection Plans will be updated to include any relevant information from the Contamination Identification and Assessment Plan.

50 **Rare Ecological Community and Rare Plant Population Management Plan**

Trans Mountain must file with the NEB for approval, **at least 4 months prior to commencing construction**, an updated Rare Ecological Community and Rare Plant Population Management Plan that includes ecological communities of concern; rare plants and lichens; and draft, candidate, proposed, or final critical habitat for plant and lichen species under the *Species at Risk Act* that are potentially affected by the Project during construction or operations. The plan must include the following:

a) A summary of supplementary survey results.

b) Mitigation measures to be implemented, including all relevant measures committed to throughout the OH-001-2014 proceeding, any new mitigation measures resulting from supplementary surveys, detailed criteria using clear and unambiguous language that describes the circumstances under which each measure will be applied, and measurable goals for evaluating mitigation success.

c) A description of how the avoidance, mitigation, and offset hierarchy was considered in developing the plan.

d) Details on post-construction monitoring, including survey methods, corrective measures, and detailed criteria using clear and unambiguous language that describes the circumstances under which each measure will be applied.

e) A Preliminary Rare Ecological Community and Rare Plant Population Offset Plan for ecological communities and rare plant and lichen species that have an at-risk status of S1 or S1S2 or that are listed under federal or provincial legislation for protection and that, after five years of operations, have not achieved reclamation success. This preliminary plan must include the following:

   i) A discussion of whether the community, species, or critical habitat can be avoided by a sufficient distance to avoid both direct and indirect residual effects.

   ii) If avoidance by a sufficient distance is not feasible:

      1) the expected residual effects on that community, species, or critical habitat, taking into account the success on past projects of the proposed mitigation and corrective measures in b) and d) above;

      2) an explanation of how the need for offset measures will be determined and quantified, including offset ratios;

      3) the potential offset measures, the process for selecting which will be implemented, and an evaluation of the probability of their success; and

      4) a discussion of how the effectiveness of offsets measures will be monitored, assessed, and reported on.

f) A description of how Trans Mountain has taken available and applicable Aboriginal traditional land use and traditional ecological knowledge into consideration in developing the plan;

g) A summary of Trans Mountain's consultation concerning a) to f) with appropriate government authorities, species experts, and any potentially affected Aboriginal groups, including any issues or concerns raised and how Trans Mountain has addressed or responded to them.

h) Confirmation that the relevant Environmental Protection Plans will be updated to include any relevant information from the Rare Ecological Community and Rare Plant Population Management Plan, including confirmation that the mitigation, monitoring, corrective, and offset measures in the Rare Ecological Community and Rare Plant Population Management Plan will be implemented in the case of discovery via their inclusion in the Rare Ecological Communities or Rare Plant Species Discovery Contingency Plan.

51	**Old Growth Management Areas Mitigation and Replacement Plan** Trans Mountain must file with the NEB for approval, **at least 4 months prior to commencing construction**, an Old Growth Management Areas Mitigation and Replacement Plan that includes: a) a description (including quantification) of all old growth management areas intersected by the final Project footprint; b) mitigation to be implemented to avoid and reduce the effects on old growth management areas; c) replacement or other offset measures that will be implemented to compensate for unavoidable residual effects; d) a summary of Trans Mountain's consultation concerning a) to c) with appropriate government authorities, and any potentially affected Aboriginal groups, including any issues or concerns raised and how Trans Mountain has addressed or responded to them; and e) confirmation that the relevant Environmental Protection Plans will be updated to include any relevant information from the Old Growth Management Areas Mitigation and Replacement Plan.
52	**Wetland Survey and Mitigation Plan** Trans Mountain must file with the NEB for approval, **at least 4 months prior to commencing construction**, a pre-construction Wetland Survey and Mitigation Plan that includes: a) A summary of supplementary survey results for wetlands potentially affected by the Project. b) A description of any wetlands for which ground-based surveys were not possible, an explanation as to why not, attempts made to obtain access, and what further information on each wetland will be collected immediately prior to or during construction. c) A description of the functional condition of each wetland for comparison during post-construction monitoring, including individual functional conditions (e.g., habitat, hydrology and biogeochemistry) and a description of the methods used to determine functional conditions. d) A description of the crossing methods, mitigation measures, and reclamation measures to be implemented for potentially affected wetlands, including clear and unambiguous criteria, and rationales for such criteria, explaining under what circumstances such methods and measures will be applied. e) Measurable goals for evaluating wetland mitigation and reclamation success. f) A description of how the avoidance, mitigation, and offset hierarchy, and the goal of no net loss of each individual wetland function, were considered in developing the plan. g) Details of the monitoring plan for wetlands for the first five years of operations, including corrective actions that might be necessary and the circumstances under which each such action would be taken. h) A Preliminary Wetland Offset Plan for those wetlands that will have a temporary loss in any individual functional condition and for those wetlands that, after five years of operations, have not achieved reclamation success. This plan must include: i) an explanation of how the need for offset measures will be determined and quantified, including offset ratios; ii) the potential offset measures, the process for selecting which will be implemented, and an evaluation of the probability of their success; iii) a discussion of how the effectiveness of offsets measures will be monitored, assessed, and reported on; and

	iv) the offset measures that will be implemented during the first five years of operations to compensate for expected temporary losses to individual functional conditions, including a timeline for their implementation and monitoring. i) A description of how Trans Mountain has taken available and applicable Aboriginal traditional land use and traditional ecological knowledge into consideration in developing the plan. j) A summary of Trans Mountain's consultation concerning a) to i) with appropriate government authorities, and any potentially affected Aboriginal groups, including any issues or concerns raised and how Trans Mountain has addressed or responded to them.
53	**Weed and Vegetation Management Plan** Trans Mountain must file with the NEB for approval, **at least 4 months prior to commencing construction**, an updated Weed and Vegetation Management Plan for the Project that includes: a) a summary of supplementary survey results, including pre-construction weed surveys, and a justification of the adequacy of such surveys; b) measurable goals; c) criteria describing when and where problem vegetation will be managed for each project phase, including pre-construction, construction, post-construction, and operations; d) management procedures and a decision-making framework for selecting the appropriate treatment measures, including how stakeholder concerns and potential adverse effects of treatment measures will be considered; e) short- and long-term vegetation monitoring; f) a summary of Trans Mountain's consultation concerning a) to e) with appropriate government authorities, landowners, invasive plant councils or committees, and any potentially affected Aboriginal groups, including any issues or concerns raised and how Trans Mountain has addressed or responded to them; and g) confirmation that the relevant Environmental Protection Plans will be updated to include any relevant information from the Weed and Vegetation Management Plan.
54	**Fugitive Emissions Management Plan for the Westridge Marine Terminal** Trans Mountain must file with the NEB for approval, **at least 4 months prior to commencing construction**, a Fugitive Emissions Management Plan for the Westridge Marine Terminal that includes: a) a description of the sources of the fugitive emissions that will be generated from the Westridge Marine Terminal during construction and operations; b) a description of the emission and odour controls that will be employed to reduce fugitive emissions during tanker loading and other sources identified in a); c) procedures for verifying, tracking, and reporting on: i) volatile organic compound collection efficiency; ii) the vapour recovery unit's hydrogen sulphide and mercaptan removal efficiency, as well as its BTEX reduction efficiency; and iii) the vapour combustion unit's hydrogen sulphide and mercaptan removal efficiency, as well as its combustion efficiency; d) procedures for identifying any leaks or equipment malfunctions during operation of the vapour recovery and vapour combustion units;

	e) methods for quantifying emissions (with vapour recovery and vapour combustion units in operation); f) any additional mitigation measures that will be employed to further reduce fugitive emissions; g) a description of Trans Mountain's program for addressing complaints with respect to fugitive emissions, including a communication and notification plan; and h) a summary of consultation with appropriate regulatory or government authorities and any potentially affected landowners and Aboriginal groups, including any issues or concerns raised with respect to the Fugitive Emissions Management Plan and how Trans Mountain has addressed or responded to them.
55	**Access Management Plan(s)** Trans Mountain must file with the NEB for approval, **at least 4 months prior to commencing construction**, an Access Management Plan(s) to be included within the updated Facilities Environmental Protection Plan and Pipeline Environmental Protection Plan (required by Condition Nos. 62 and 63, respectively). Each plan must address issues related to soil, vegetation, fish and fish habitat, and wildlife and wildlife habitat. Each plan must also describe access control measures proposed to control both human and predator access during construction and operations, and include: a) objectives of the plan; b) measurable goals for evaluating the plan's success in achieving its objectives; c) a summary of any related baseline information that has been or will be collected to aid in evaluating the plan's success, and justification of the adequacy of this baseline information, or a rationale if no baseline information has or will be collected; d) a list of sites where access control measures will be implemented for construction and those that will remain in place throughout operations, the control measure(s) proposed at those sites, and the rationale for selecting those sites and measures; e) the methods for monitoring the effectiveness of access control measures implemented during construction and operations, and justification of the adequacy of such monitoring; f) a description of available adaptive management measures and of the criteria Trans Mountain will use to determine if and when adaptive management measures are warranted based on monitoring results; g) a commitment to report, as part of Trans Mountain's post-construction environmental monitoring reports (required by Condition No. 140), on the control measures implemented, monitoring undertaken, and the success of control measures in meeting Access Management Plan goals and objectives, as well as a schedule, with rationale, for reporting throughout operations; h) a description of how Trans Mountain has taken available and applicable Aboriginal traditional land use and traditional ecological knowledge studies into consideration; and i) a summary of Trans Mountain's consultation with appropriate government authorities and any potentially affected Aboriginal groups and stakeholders, including any issues or concerns raised and how Trans Mountain has addressed or responded to them.
56	**High-voltage alternating current (AC) interference** Trans Mountain must file with the NEB, **at least 4 months prior to commencing construction**, a report confirming that Trans Mountain has achieved an engineered solution to mitigate the induced voltages on pipeline segments resulting from the steady state and transient conditions of BC Hydro's unshielded power lines that are located less than 10 metres from those segments. The report must also include: a) a summary of the above-mentioned engineered solution;

	b) a list of the pipeline segments where mitigation will be applied; and c) an explanation of how Trans Mountain reached an agreement with BC Hydro towards implementing the engineered solution. Trans Mountain must provide a copy of the report to BC Hydro at the same time that it is filed with the NEB.
57	**List of infrastructure sites** Trans Mountain must file with the NEB, **at least 90 days prior to commencing construction**, and any **updates as they are available**, a complete list of all infrastructure sites to be constructed for the Project. This list must include information on each site's location, structures to be installed, the anticipated date for commencing construction, and activities involved in its construction. The initial list and updates must also include the condition numbers (those under the "prior to commencing construction" phase heading) that are applicable to each site and an indication of whether each of those conditions has been or remains to be satisfied.
58	**Construction schedule** Trans Mountain must file with the NEB, **at least 90 days prior to commencing construction**, a construction schedule identifying the major construction activities expected and, **on a monthly basis from the start of any clearing until commencing operations**, updated detailed construction schedules.
59	**Security Programs** Trans Mountain must confirm with the NEB in writing, in accordance with the timelines below, that it has developed Security Programs for the construction and operations phases of the Project, pursuant to the *National Energy Board Onshore Pipeline Regulations* (as amended from time to time) and CSA Z246.1: a) **at least 90 days prior to commencing construction** for the construction phase Security Program; and b) **at least 90 days prior to commencing operations** for the operations phase Security Program.
60	**Safety manuals** Trans Mountain must file with the NEB, **at least 90 days prior to commencing construction**: a) the Health and Safety Management Plan for the Project; and b) Construction Safety Manuals (Project-Specific Safety Plans) for the applicable Project components. These must include separate Construction Safety Manuals for pipeline construction, facilities construction, Burnaby Mountain tunnel construction, and Westridge Marine Terminal construction. These manuals must address routine construction activities, as well as blasting, tunneling, avalanche safety, and special access procedures that may be required in areas subject to activities other than Project construction.
61	**Traffic Control Plans for public roadways** Trans Mountain must file with the NEB, **at least 90 days prior to commencing construction**, traffic control plans for the use of public roadways for the Project. The plans must include: a) information regarding the timing and location of key construction activities (including equipment mobilization and staging, pipe stockpiling, pipeline and pump station construction, and equipment demobilization);

	b) current traffic volumes and anticipated traffic volumes during the construction period for both day and night times; c) a description of the predicted traffic flows, including vehicle types and volumes, at key construction points, marshalling areas, access roads, and public roadways; d) an assessment of the potential impacts associated with the increased volume of construction-related traffic (e.g., safety hazards, noise, light, dust, etc.) and associated mitigation measures; and e) evidence of consultation with potentially affected municipal or provincial authorities regarding the Traffic Control Plans, including a summary of the results of these discussions, and, where concerns remain outstanding, an explanation of how Trans Mountain proposes to resolve them.
62	**Facilities Environmental Protection Plan** Trans Mountain must file with the NEB for approval, **at least 90 days prior to commencing construction**, an updated Project-specific Facilities Environmental Protection Plan for the construction of the facilities, including supporting infrastructure. The updated Environmental Protection Plan must be a comprehensive compilation of all environmental protection procedures, mitigation measures, and monitoring commitments, as set out in Trans Mountain's Project application, its subsequent filings, the evidence it provided during the OH-001-2014 proceeding, or as otherwise committed to during questioning or in its related submissions. The updated plan must describe the criteria for implementing all procedures and measures using clear and unambiguous language that confirms Trans Mountain's intention to implement all of its commitments. The updated Environmental Protection Plan must include the following: a) Environmental procedures (including site-specific plans), criteria for implementing these procedures, mitigation measures, and monitoring applicable to all Project phases and activities. b) Policies and procedures for environmental training and the reporting structure for environmental management during construction, including the qualifications, roles, responsibilities, and decision-making authority for each job title identified in the updated Environmental Protection Plan. c) Any additional measures arising from supplemental pre-construction studies and surveys. d) Updated contingency plans and management plans. e) Updated alignment sheets. f) A description of how Trans Mountain has taken available and applicable Aboriginal traditional land use and traditional ecological knowledge studies into consideration. g) A summary of Trans Mountain's consultation with appropriate government authorities and any potentially affected Aboriginal groups and stakeholders, including any issues or concerns raised and how Trans Mountain has addressed or responded to them.
63	**Pipeline Environmental Protection Plan** Trans Mountain must file with the NEB for approval, **at least 90 days prior to commencing construction**, an updated Project-specific Pipeline Environmental Protection Plan for the construction of the pipeline. The updated Environmental Protection Plan must be a comprehensive compilation of all environmental protection procedures, mitigation measures, and monitoring commitments, as set out in Trans Mountain's Project application, its subsequent filings, the evidence it provided during the OH-001-2014 proceeding, or as otherwise committed to during questioning and in its related submissions. The updated plan must describe the criteria for implementing all procedures and measures using clear and unambiguous language

	that confirms Trans Mountain's intention to implement all of its commitments. The updated Environmental Protection Plan must include the following: a) Environmental procedures (including site-specific plans), criteria for implementing these procedures, mitigation measures, and monitoring applicable to all Project phases and activities. b) Policies and procedures for environmental training and the reporting structure for environmental management during construction, including the qualifications, roles, responsibilities, and decision-making authority for each job title identified in the updated Environmental Protection Plan. c) Any additional measures arising from supplemental pre-construction studies and surveys. d) Updated contingency plans and management plans, including a plan that includes procedures for protecting identified vulnerable aquifers along the pipeline route and specific measures to mitigate any construction or operation impacts to these aquifers. e) Updated alignment sheets. f) A description of how Trans Mountain has taken available and applicable Aboriginal traditional land use and traditional ecological knowledge studies into consideration. g) A summary of Trans Mountain's consultation with appropriate government authorities and any potentially affected Aboriginal groups and stakeholders, including any issues or concerns raised and how Trans Mountain has addressed or responded to them.
64	**Westridge Marine Terminal Environmental Protection Plan** Trans Mountain must file with the NEB for approval, **at least 90 days prior to commencing construction**, an updated Project-specific Westridge Marine Terminal Environmental Protection Plan. The updated Environmental Protection Plan must be a comprehensive compilation of all environmental protection procedures, mitigation measures, and monitoring commitments, as set out in Trans Mountain's Project application, its subsequent filings, the evidence it provided during the OH-001-2014 proceeding, or as otherwise committed to during questioning and in its related submissions. The updated plan must describe the criteria for implementing all procedures and measures using clear and unambiguous language that confirms Trans Mountain's intention to implement all of its commitments. The updated Environmental Protection Plan must include the following elements: a) Environmental procedures (including site-specific plans), criteria for implementing these procedures, mitigation measures, and monitoring applicable to all Project phases and activities. b) Policies and procedures for environmental training and the reporting structure for environmental management during construction, including the qualifications, roles, responsibilities, and decision-making authority for each job title identified in the Environmental Protection Plan. c) Any additional measures arising from supplemental pre-construction studies and surveys. d) Updated contingency plans and management plans. e) Updated alignment sheets. f) A description of how Trans Mountain has taken available and applicable Aboriginal traditional land use and traditional ecological knowledge studies into consideration. g) A summary of Trans Mountain's consultation with appropriate government authorities and any potentially affected Aboriginal groups and stakeholders, including any issues or concerns raised and how Trans Mountain has addressed or responded to them.

65	**Marine Sediment Management Plan** In the event that dredging is required during the expansion of the Westridge Marine Terminal, Trans Mountain must file with the NEB, **at least 90 days prior to commencing construction,** and also include as part of its Westridge Marine Terminal Environmental Protection Plan, a Marine Sediment Management Plan. This plan must include: a) a summary of any supplemental marine sediment survey results; b) quantification of the area and the volume of marine sediment to be dredged; c) results of sediment plume modelling for any areas to be dredged; d) disposal options for dredged sediment, including the volumes of sediment that will be re-used or disposed of at sea or on land, as well the criteria and methods for determining how the dredged sediment will be disposed of; e) an update to any site-specific mitigation identified in the Westridge Marine Terminal Environmental Protection Plan; f) details of monitoring that will be undertaken during construction; g) a summary of consultation with appropriate government authorities and potentially affected stakeholders and Aboriginal groups; and h) details of monitoring (both abiotic and biotic parameters) that will be undertaken during operations, including a discussion on evaluating the level of contaminants in the marine environment and any changes from pre-construction levels, as well as a proposed reporting schedule.
66	**Light Emissions Management Plan for the Westridge Marine Terminal** Trans Mountain must file with the NEB**, at least 90 days prior to commencing construction**, a Light Emissions Management Plan for the Westridge Marine Terminal that includes: a) a summary of the results of an area lighting study, including how potential impacts on surrounding communities and safety and operational requirements were considered; and b) a description of the mitigation and best practice measures considered for the terminal lighting design and how the proposed design and operation will minimize the impacts from light on land-based residents and marine users; and c) a plan for how Trans Mountain will communicate its proposed terminal lighting design and associated mitigation measures to limit any nuisance lighting disturbances to land-based residents and marine users.
67	**Hydrology – notable watercourse crossings** Trans Mountain must file with the NEB, **at least 90 days prior to commencing construction,** revised flood frequency estimates for all notable watercourse crossings. These estimates must incorporate the results of field investigations and bathymetric surveys completed since the Project application was filed, and be presented in a format similar to that presented in Application Volume 4A, Appendix I – Route Physiography and Hydrology Report, Appendix B – Notable Water Crossing Catchment Details (Filing A56000).

68	**Quantitative Geohazard Frequency Assessment** Trans Mountain must file with the NEB, **at least 90 days prior to commencing construction**, an updated Quantitative Geohazard Frequency Assessment for the new Line 2 and delivery pipeline segments that contains a re-assessment of the Frequency of Loss of Containment (FLoC) values based on the results of site-specific field assessments and any required mitigation as determined in the detailed engineering and design process. Trans Mountain must provide a detailed justification or a plan for further mitigation for any location where the FLoC value is greater than 10^{-5}.
69	**Risk Management Plan for geohazards** Trans Mountain must develop and file with the NEB**, at least 90 days prior to commencing construction,** an updated Risk Management Plan for addressing the threats of existing and potential geohazards during construction of the new Line 2 and delivery pipeline segments, and related facilities. This plan must be updated as additional site-specific geotechnical information is obtained through detailed investigations, and modified as geohazards are encountered during construction. Trans Mountain must make any updates or modifications available to the NEB **upon request.**
70	**Outstanding horizontal directional drilling geotechnical and feasibility reports** Trans Mountain must file with the NEB, **at least 90 days prior to commencing construction**, Geotechnical Reports and Horizontal Directional Drilling Feasibility and Design Reports, along with final design drawings, for each of the following river crossings: a) Coldwater River 4 crossing. b) North Thompson River 6 crossing. c) North Thompson River 7 crossing. d) Pembina River crossing. e) Raft River crossing. f) Sumas River crossing (suitability for Direct Pipe® installation). g) Any additional river crossing along the new Line 2 pipeline segments where horizontal directional drilling or other trenchless crossing method is being considered.
71	**Seismic reports – liquefaction potential** Trans Mountain must file with the NEB, **at least 90 days prior to commencing construction,** a final report that identifies all sites on the new Line 2, delivery pipeline segments, transmission pipeline segments to be reactivated, and related facilities, that have "Very High," "High," and "Moderate" liquefaction-triggered ground movement potential, and that describes how the potential for liquefaction-triggered ground movement will be mitigated at each site.
72	**Fault studies** Trans Mountain must file with the NEB**, at least 90 days prior to commencing construction**, the results of fault-mapping studies that were ongoing during the OH-001-2014 proceeding, or undertaken after its conclusion, for use in the detailed design of the Project. This filing must include conclusions regarding possible seismic activity during the Holocene for Sumas Fault, Vedder Mountain Fault, Fraser River-Straight Creek Fault, and Rocky Mountain Trench, as well as other possible hidden faults.

73	**Field changes manual for geohazard mitigation** Trans Mountain must file with the NEB for approval, **at least 90 days prior to commencing construction**, a field changes manual for geohazard mitigation. This manual must include: a) decision criteria for implementing mitigation for any geohazards identified during construction; b) specific criteria for implementing changes to the designs, grading, special materials, protective structures, increased burial depth, installation procedures, erosion mitigation measures, and monitoring; and c) details regarding the required qualifications of the field staff that will implement the manual.
74	**Westridge Marine Terminal (offshore) – pile design** Trans Mountain must file with the NEB, **at least 90 days prior to commencing construction**, the final design basis for the offshore pile foundation layout of the Westridge Marine Terminal.
75	**Strain-based design** Trans Mountain must file with the NEB, **at least 90 days prior to commencing construction**, the following information related to strain-based design, where it is applied: a) The location and rationale for selecting strain-based design in each location. b) A report summarizing the adequacy of the strain-based design for various loading scenarios during pipeline construction and operation for each location provided in a). c) A list of standards and specifications, including testing procedures, that are used in the strain-based design.
76	**Emergency release system at the Westridge Marine Terminal** Trans Mountain must file with the NEB, **at least 90 days prior to commencing construction**, its conclusions on the necessity of an emergency release system for the loading arms at the Westridge Marine Terminal. The conclusions must be supported by a comprehensive study describing the advantages and disadvantages of incorporating an emergency release system. This study must: a) consider the application of i) emergency release couplers; and ii) an emergency release system, during both normal operating conditions and under abnormal conditions such as seismic events; and b) include a description of the final emergency release system design, if applicable.
77	**Plan for implementing, monitoring, and complying with marine shipping-related commitments** Trans Mountain must file with the NEB, **at least 60 days prior to commencing construction**, a plan describing how it will implement, monitor, and ensure compliance with its marine shipping-related commitments identified in Condition No. 114. The plan must be prepared in consultation with Transport Canada, the Canadian Coast Guard, the Pacific Pilotage Authority, Port Metro Vancouver, British Columbia Coast Pilots, Western Canada Marine Response Corporation, and Fisheries and Oceans Canada. Trans Mountain must provide the plan to the above-mentioned parties at the same time as it is filed with the NEB.

78	**Updates under the *Species at Risk Act*** Trans Mountain must file with the NEB, **at least 60 days prior to commencing construction,** a summary of any relevant updates under the *Species at Risk Act,* including new Schedule 1 listings and new or amended Recovery Strategies, Action Plans, and Management Plans for species that have the potential to be affected by the Project. For each species-specific update, the summary must include: a) a discussion of the Project activities' potential effects on the listed species or its critical habitat; b) identification of all reasonable alternatives to the Project activities referred to in a), including avoidance measures, and a discussion on the potential effects of the alternatives, the chosen approach, and the rationale for selecting the chosen approach; c) any additional site-specific mitigation; d) any monitoring to be undertaken and a commitment to include monitoring results as part of the post-construction environmental monitoring reports filed under Condition No. 140; e) confirmation that Trans Mountain, throughout the life of the Project, will continue to track (under its Environmental Protection Program) updates under the *Species at Risk Act*, to consult with the appropriate government authorities, and to consider changes to construction and operational measures, plans, and procedures; and f) a summary of Trans Mountain's consultation concerning a) to d) with appropriate government authorities, species experts, and any potentially affected Aboriginal groups, including any issues or concerns raised and how Trans Mountain has addressed or responded to them.
79	**Riparian Habitat Management Plan** Trans Mountain must file with the NEB for approval, **at least 60 days prior to commencing construction,** a Riparian Habitat Management Plan for any riparian areas that will be impacted by Project construction. This plan must include: a) a pre-construction assessment of riparian habitat functionality (e.g., for fish, wildlife, and rare plants) and a quantification of the riparian habitat within the Project footprint; b) measureable goals to determine that riparian habitat has returned to pre-construction functionality; c) site-specific reclamation plans, including a discussion on the length of time it will take to return riparian habitat to pre-construction functionality; d) details of monitoring that will be undertaken; e) a Preliminary Riparian Habitat Enhancement and Offset Plan for any riparian habitat that has not returned to pre-construction functionality, which must include: i) how the need for enhancement and offset measures will be determined and quantified, including offset ratios; ii) potential enhancement and offset measures, the process for selecting which will be implemented, and an evaluation of the probability of their success; and iii) how the effectiveness of enhancement and offset measures will be monitored, assessed, and reported on; f) a description of how Trans Mountain has taken available and applicable Aboriginal traditional land use and traditional ecological knowledge into consideration in developing the plan; and g) a summary of Trans Mountain's consultation concerning a) to e) with appropriate government authorities, species experts, and any potentially affected Aboriginal groups, including any issues or concerns raised and how Trans Mountain has addressed or responded to them.

80	**Water well inventory** Trans Mountain must file with the NEB, **at least 60 days prior to commencing construction**, an inventory of physically verified ("ground-truthed") water wells that are within 150 metres of either side of the centre of the pipeline right-of-way. The inventory must include a description of the methods used to identify and physically verify wells, including: a) each well's location in proximity to the right-of-way, including its GPS coordinates; b) a description of each well's type or use (e.g., drinking water, agricultural use, use by Aboriginal groups, any other uses); c) each well's tenure or ownership (e.g., private, municipal, Aboriginal community); d) each well's operational status, including abandoned or decommissioned wells; e) a plan for updating the inventory over the life of the Project, including: i) the methods for identifying and verifying abandoned or decommissioned wells, and new or replacement wells; and ii) the frequency of inventory updates; f) a list of any properties or sections of the right-of-way that were not physically verified, including; i) the reason why properties or right-of-way sections were not physically accessed; ii) an estimate of the potential number of wells that have not been physically verified; and iii) a proposed schedule for accessing properties or right-of-way sections; and g) a description of Trans Mountain's plans for communicating information about the locations of water wells to owners or affected users. Trans Mountain must continue to update this inventory for audit purposes for the operational life of the Project, **according to the frequency specified in e)**. Trans Mountain must make the inventory available to the NEB **upon request.**
81	**Consultation reports – protection of municipal water sources** Trans Mountain must file with the NEB, **at least 60 days prior to commencing construction**, **and on or before 31 January of each year during construction and of the first 5 years after commencing Project operations,** a report on Trans Mountain's consultations with municipalities, communities, and Aboriginal groups related to the protection of municipal and community water sources. Each report must include: a) The name of the municipality, community, or Aboriginal group consulted. b) The methods, dates, and locations of all meetings or consultations. c) A summary of all issues or concerns raised. d) A description of the measures taken, or that will be taken, to address or respond to concerns raised, or an explanation why no further action is required to address or respond to issues or concerns. e) A summary of any steps or measures that have been or will be undertaken, including groundwater modelling or monitoring, as a result of consultations with municipalities, communities, or Aboriginal groups. This summary must include: i) any updates or amendments to maintenance policies, systems, programs, procedures, practices, and activities aimed at preventing pipeline releases; ii) the criteria used to identify and select modelling or monitoring locations and parameters; iii) results of any modelling or monitoring; and

	iv) any measures that have been taken to address modelling or monitoring results.
82	**Heritage resources** Trans Mountain must file with the NEB, **at least 60 days prior to commencing construction**: a) confirmation, signed by an officer of the company, that it has obtained all of the required archaeological and heritage resource permits and clearances from the Alberta Department of Culture and the British Columbia Ministry of Forests, Lands and Natural Resource Operations; b) a description of how Trans Mountain will meet any conditions and respond to any comments and recommendations contained in the permits and clearances referred to in a); and c) a description of how Trans Mountain has incorporated any additional mitigation measures into its Environmental Protection Plans as a result of any conditions or recommendations referred to in b).
83	**Reports on engagement with Aboriginal groups – construction** Trans Mountain must file with the NEB, **at least 60 days prior to commencing construction and every 6 months thereafter until commencing operations,** a report on the engagement activities it has undertaken with potentially affected Aboriginal groups. Each report must include, at a minimum, for each Aboriginal group engaged: a) the name of the group; b) the method(s), date(s), and location(s) of engagement activities; c) a summary of any issues or concerns raised; and d) the measures taken, or that will be taken, to address or respond to issues or concerns, or an explanation why no further action is required to address or respond to issues or concerns. Trans Mountain must provide a copy of each report to each group engaged (and identified in a) above) at the same time that it is filed with the NEB.
84	**Traditional Land Use (TLU) and Traditional Marine Resource Use (TMRU) Investigation Report** Trans Mountain must file with the NEB for approval, **at least 60 days prior to commencing construction,** a report describing pre-construction TLU and TMRU investigations that were not reported during the OH-001-2014 proceeding. The report must include: a) the name of the potentially affected Aboriginal group to which each investigation pertains; b) a description of any identified potentially affected TLU or TMRU sites, resources, or activities; c) the methods used to identify the potentially affected TLU or TMRU sites, resources or activities; d) a summary of any mitigation measures that Trans Mountain will implement to reduce or eliminate (to the extent possible) Project effects on TLU or TMRU sites, resources or activities; e) a description of how Trans Mountain has incorporated mitigation measures into its Pipeline Environmental Protection Plan and/or Facilities Environmental Protection Plan (required by Condition Nos. 62, 63, and 64); f) a description of any outstanding concerns raised regarding potential Project effects on the current use of lands and resources or marine resource use for traditional purposes, including a description of how Trans Mountain will or address or respond to them, or an explanation why it will not address or respond to them; and

	g) a summary of any outstanding TLU or TMRU investigations or follow-up activities that will not be completed prior to commencing construction, including estimated completion date(s), if applicable, and a description of how Trans Mountain has already identified, or will identify, any potentially affected TLU and TMRU sites, resources or activities for these outstanding investigations. Trans Mountain must provide a copy of the report to each potentially affected group identified in a) at the same time that it is filed with the NEB.
85	**Plan for Aboriginal group participation in construction monitoring** Trans Mountain must file with the NEB, **at least 60 days prior to commencing construction,** a plan describing participation by Aboriginal groups in monitoring activities during construction for the protection of traditional land and resource use for the pipeline and facilities and traditional marine resource use at the Westridge Marine Terminal. The plan must include: a) a summary of engagement activities undertaken with Aboriginal groups to determine opportunities for their participation in monitoring activities; b) a list of potentially affected Aboriginal groups, if any, that have reached agreement with Trans Mountain to participate in monitoring activities; c) the scope, methodology, and justification for monitoring activities to be undertaken by Trans Mountain and each participating Aboriginal group identified in b), including those elements of construction and geographic locations that will involve Aboriginal Monitors; d) a description of how Trans Mountain will use the information gathered through the participation of Aboriginal Monitors; and e) a description of how Trans Mountain will provide the information gathered through the participation of Aboriginal Monitors to the participating Aboriginal group. Trans Mountain must provide a copy of the report to each potentially affected group identified in b) above at the same time that it is filed with the NEB.
86	**Landowner consultation records** Trans Mountain must maintain records of its landowner consultations that include: a) a description of landowner consultations, including the consultation methods, dates, and a summary of any issues or concerns raised by landowners; and b) a summary of actions that Trans Mountain has undertaken to address or respond to each of the issues or concerns raised, or an explanation for why no actions were taken, and any outstanding concerns. Trans Mountain must file with the NEB, **beginning at least 60 days prior to commencing construction, and every 6 months thereafter until completing construction,** its landowner consultation records. Trans Mountain must continue to file its landowner consultation records with the NEB **every 6 months for 5 years after commencing Project operations**.
87	**Emergency Response Plan for construction** Trans Mountain must file with the NEB**, at least 60 days prior to commencing construction**, a Project-specific Emergency Response Plan that would be implemented during the construction phase. The plan must include spill contingency measures that Trans Mountain will employ in response to accidental spills attributable to construction activities, 24-hour medical evacuation, fire response, and security.

88	**Consultation on improvements to Trans Mountain's Emergency Management Program** Trans Mountain must file with the NEB, **at least 60 days prior to commencing construction**, a consultation plan for its review of its Emergency Response Plans and equipment (including its availability), as referenced in Volume 7, Section 4.8.2 of its Project application (Filing A3S4V5). This plan must include: a) The consultation plan's scope; b) The consultation plan's objectives; c) A preliminary list of federal, provincial, and municipal authorities and other agencies that Trans Mountain will consult with; d) A preliminary list of communities and Aboriginal groups that Trans Mountain will consult with; e) A preliminary list of consultation locations and timing; and f) The methods that will be used to track commitments made during consultations and to incorporate them into Trans Mountain's Emergency Management Program, including its Emergency Response Plans.
89	**Uninterruptible Power Supply (UPS) and battery systems** Trans Mountain must file with the NEB, **at least 60 days prior to commencing construction**, confirmation that the UPS system design and operation is in compliance with the requirements of Canadian Standards Association (CSA) 22.1 – No. 15 or other applicable standard(s) that exceeds the requirements of CSA 22.1 – No. 15. If another standard is used, this filing must include the name of the standard and an explanation of why the standard was used and how it meets or exceeds the requirements of CSA 22.1 No. 15.
90	**Project organizational structure** Trans Mountain must file with the NEB, **at least 60 days prior to commencing construction**, a diagram of the Project's organizational structure (i.e., project management, design, and field staff) that clearly identifies roles, accountabilities, responsibilities, and reporting relationships for the applicable Project component.
91	**Authorization under paragraph 35(2)(b) of the *Fisheries Act* – Westridge Marine Terminal** If Fisheries and Oceans Canada determines that the Westridge Marine Terminal expansion requires an Authorization under paragraph 35(2)(b) of the *Fisheries Act* and it issues an Authorization, Trans Mountain must file with the NEB, **at least 10 days prior to commencing construction,** a copy of the Authorization.
Conditions with initial filings due prior to commencing operations / during construction	
92	**Quality assurance verification** Trans Mountain must file **monthly summary reports during construction** outlining non-conformances with its design, materials, and construction specifications and the disposition of these non-conformances.

93	**Construction progress reports** Trans Mountain must file with the NEB **monthly construction progress reports from the start of clearing until commencing operations**. The reports must include information on the progress of activities carried out during the reporting period. These reports must include safety, environmental, and security non-compliances that occurred during each reporting period and the measures undertaken to resolve them. These reports must also include a description and the locations of any changes made to geohazard mitigation measures (required by Condition No. 73), the location of any pressure tests carried out during the reporting period, and a description of any unsuccessful pressure tests and their cause.
94	**Aboriginal, local, and regional employment and business opportunity monitoring reports** a) Trans Mountain must file with the NEB, **within 90 days after commencing construction**, **and every 6 months thereafter until completing construction**, monitoring reports for Aboriginal, local, and regional employment and business opportunities for the Project. The reports must include: i) a summary of the elements or indicators monitored; ii) a summary and analysis of Aboriginal, local, and regional employment and business opportunities during the reporting period; and iii) a summary of Trans Mountain's consultation with relevant Aboriginal, local, and regional communities, and industry groups or representatives regarding employment and business opportunities for the reporting period. This summary must include any issues or concerns raised regarding employment and business opportunities and how Trans Mountain has addressed or responded to them. b) Trans Mountain must file with the NEB, **within 6 months after completing construction**, a final report on employment during the construction phase.
95	**Air Emissions Management Plan – Burnaby Mountain tunnel construction** Trans Mountain must file with the NEB for approval, **at least 4 months prior to commencing construction of the Burnaby Mountain tunnel**, an Air Emissions Management Plan for tunnel construction. The plan must include: a) proposed hours for daytime and nighttime work; b) sources that would generate air emissions; c) an Air Emissions and Dust Emissions Management Plan that includes mitigation measures, their predicted effectiveness, and implementation timeframes; d) a summary of consultation with appropriate government authorities and with potentially affected residents and businesses regarding tunnel construction air emissions, including any concerns raised and how Trans Mountain has addressed or will address those concerns; and e) a description of Trans Mountain's program for addressing complaints received during tunnel construction with respect to air and dust emissions, including a communication and notification plan.
96	**Tunnel Construction Noise Management Plan for Burnaby Mountain** Trans Mountain must file with the NEB for approval, **at least 90 days prior to commencing construction of the Burnaby Mountain tunnel**, a Tunnel Construction Noise Management Plan for Burnaby Mountain that includes: a) proposed hours of daytime and nighttime work;

	b) baseline daytime and nighttime ambient sound levels at noise sensitive areas within 500 metres of the entry and exit sites for the tunnel; c) predicted noise levels at the most affected residences and businesses caused by tunnel construction without mitigation; d) proposed noise mitigation measures, including all technologically and economically feasible mitigation measures; e) predicted noise levels at the most affected residences and businesses with mitigation measures implemented, including noise contour map(s) showing the potentially affected residences and businesses; f) a tunnel construction noise monitoring program, including locations, methodology, and schedule; g) criteria that will be used to determine when tunnel construction would be shut down due to noise; h) a summary of consultation with appropriate government authorities and potentially affected residents and businesses regarding tunnel construction noise, including any concerns raised and how Trans Mountain has or will address those concerns; i) a description of Trans Mountain's program for addressing complaints received during tunnel construction with respect to noise, including a communication and notification plan; and j) a contingency plan that contains proposed mitigation measures for addressing noise complaints, which may include the temporary relocation of specific residents.
97	**Groundwater Seepage Management Plan** Trans Mountain must file with the NEB for approval, **at least 45 days prior to commencing construction of the Burnaby Mountain tunnel**, a Groundwater Seepage Management Plan for tunnel construction. The plan must include: a) an estimate quantifying the anticipated average and maximum amounts of groundwater seepage into the tunnel, and an assessment of any potential impacts on the water table; b) a discussion of Trans Mountain's proposed pumping, treatment, and disposal options; and c) a description of measures that Trans Mountain would implement during the operations phase in the event that there is groundwater seepage into the tunnel.
98	**Authorizations under paragraph 35(2)(b) of the *Fisheries Act* and *Species at Risk Act* permits – pipeline** a) For those watercourse crossings that will require Authorization under paragraph 35(2)(b) of the *Fisheries Act,* Trans Mountain must file with the NEB*,* **at least 5 months prior to commencing their construction,** the following: i) A draft *Application Form for Paragraph 35(2)(b) Fisheries Act Authorization*; ii) A draft application package for authorization that includes all the information detailed in Fisheries and Oceans Canada's *Applicant's Guide to Submitting an Application for Authorization under Paragraph 35(2)(*b*) of the Fisheries Act,* including (as per the guide): • contact information; • a description of the proposed work, undertaking, or activity; • detailed design; • the timeline;

	• location; • a description of fish and fish habitat (aquatic environment); • a description of effects on fish and fish habitat; • measures and standards to avoid or mitigate serious harm to fish; • a description of the monitoring measures; • residual serious harm to fish after implementing avoidance and mitigation measures and standards; • an offsetting plan; and • proof of a letter of credit. iii) A summary of Trans Mountain's consultation with appropriate government authorities and any potentially affected Aboriginal groups and stakeholders regarding the works proposed to be authorized, as well as any offsetting measures proposed. This summary must include any issues or concerns raised regarding these works and how Trans Mountain has addressed or responded to them. b) Trans Mountain must file with the NEB, **at least 10 days prior to commencing construction of each of the watercourse crossings identified in a),** a copy of the *Fisheries Act* paragraph 35(2)(b) Authorization and any *Species at Risk Act* permits issued by Fisheries and Oceans Canada.
99	**Nooksack Dace and Salish Sucker Management Plan** Trans Mountain must construct all watercourse crossings located within nooksack dace and salish sucker critical habitat using trenchless crossing methods. For those watercourse crossings where a trenchless crossing method is not feasible, Trans Mountain must file with the NEB, **at least 90 days prior to commencing their construction,** the following: a) A summary of the feasibility studies completed and a discussion of the risks and constraints associated with the trenchless watercourse crossing. b) Any updates to the primary and contingency watercourse crossing methods proposed in the Project application and the rationale for not employing a trenchless method. c) Any site-specific mitigation and a commitment to include it in the relevant Environmental Protection Plans. d) A discussion on how the site-specific mitigation relates to Fisheries and Oceans Canada Recovery Strategies and Action Plans. e) Details on any monitoring to be undertaken and a commitment to include any results in the post-construction environmental monitoring reports filed under Condition No. 140.
100	**Watercourse crossing inventory** Trans Mountain must file with the NEB, **at least 60 days prior to commencing <u>any</u> watercourse crossing construction activities,** the following: a) An updated inventory of all watercourses to be crossed, including, for each crossing: i) the name of the watercourse being crossed and an identifier for the crossing; ii) the location of the crossing; iii) the primary and contingency crossing methods;

	iv) planned construction timing; v) information on the presence of fish and fish habitat; vi) the fisheries timing window of least risk; and vii) an indication of whether all of Fisheries and Oceans Canada's applicable "Measures to Avoid Causing Harm to Fish and Fish Habitat" will be implemented. b) Detailed generic design drawings of trenchless, dry open-cut, frozen open-cut, and isolation crossings of various watercourse types. c) For each non-trenchless watercourse crossing that will be conducted outside of the fisheries timing window of least risk (both primary and contingency methods), or for any crossings that will be conducted in non-isolated flowing water conditions, please provide: i) detailed crossing-specific design drawings; ii) photographs of the crossing location; iii) an indication of the fish species that may be present and if fish spawning is likely to occur within the immediate area; iv) site-specific mitigation and habitat enhancement measures to be used to minimize impacts to fish; v) any potential residual effects; vi) proposed reclamation measures; and vii) a discussion of the potential impacts to local fisheries resources within the immediate area as a result of the crossing's construction. d) A description of how Trans Mountain has taken available and applicable Aboriginal traditional land use and traditional ecological knowledge into consideration in developing the watercourse crossing designs.
101	**Contingency watercourse crossings** a) For any watercourse crossing where Trans Mountain will employ a contingency crossing method instead of its proposed primary method, and where that contingency will likely require a *Fisheries Act* paragraph 35(2)(b) Authorization, Trans Mountain must file with the NEB, **at least 60 days prior to commencing the contingency crossing,** the following: i) Confirmation of the contingency watercourse crossing method that will be employed, the rationale for employing that method, and a summary of the differences between the primary and contingency watercourse crossing methods. ii) A draft application package for authorization that includes all the information detailed in the Fisheries and Oceans Canada's *Applicant's Guide to Submitting an Application for Authorization under Paragraph 35(2)(b) of the Fisheries Act*. iii) A summary of Trans Mountain's consultation with appropriate government authorities and any potentially affected Aboriginal groups and stakeholders regarding the works proposed to be authorized, as well as any offsetting measures proposed. This summary must include any issues or concerns raised regarding these works and how Trans Mountain has addressed or responded to them.

	b) For all other instances where a contingency crossing method will be employed, Trans Mountain must file with the NEB a notification, **at least 15 days prior to commencing the contingency crossing**, that the contingency method will be employed. With this notification, Trans Mountain must explain why the contingency method is being employed and provide a summary of the differences between the primary and contingency watercourse crossing methods.
102	**Updated engineering alignment sheets and drawings** Trans Mountain must file with the NEB, **at least 90 days prior to commencing pipe installation**, updated engineering alignment sheets and drawings and, **as they become available and prior to their implementation**, any modifications to those sheets and drawings.
103	**NDE of final tie-in welds** Trans Mountain must delay NDE of final tie-in welds and any repairs to them **for 48 hours following weld completion**. Trans Mountain must include this requirement in the NDE specification of its Joining Program required by Condition No. 12.
104	**Pressure testing** a) Trans Mountain must pressure test the pipelines and Project facilities with a liquid medium. b) Trans Mountain must file with the NEB for approval, **at least 90 days prior to commencing pressure testing**, a Pressure Testing Program that demonstrates compliance with applicable codes, standards, and regulatory requirements.
105	**Hydrostatic Testing Plan** Trans Mountain must file with the NEB, **at least 60 days prior to pressure testing any Project component**, a Hydrostatic Testing Plan for the Project that includes: a) the locations of all water withdrawal and discharge sites; b) a discussion of any clearing activities or any other associated works, if required, that will allow for the transportation of the hydrostatic test water; c) water withdrawal rates; d) water withdrawal volumes; e) the flow rate/volume of water at the withdrawal sites; and f) site-specific mitigation measures to be implemented at the water withdrawal and discharge sites or at any other locations required to allow for the transportation of hydrostatic test water.
106	**Post-construction greenhouse gas (GHG) assessment report** Trans Mountain must file with the NEB for approval, **prior to applying for leave to open**, an updated GHG assessment report specific to the Project. The report must include: a) the methodology used for the assessment, including the sources of GHG emissions, assumptions, and methods of estimation; b) the total direct GHG emissions generated from Project construction, including land-clearing; c) a breakdown of direct GHG emissions generated by the construction of individual Project components (pipeline, pump stations, and Westridge marine terminal) and by land-clearing activities; and

	d) a comparison and discussion of the direct GHG emissions calculated in b) with the predicted emissions in Trans Mountain's application and subsequent submissions.
107	**GHG Emissions Offset Plan – Project construction** Trans Mountain must file with the NEB for approval, **prior to applying for leave to open,** a plan for providing offsets for all direct GHG emissions generated from Project construction, as determined in Condition No. 106. The plan must include: a) a list and discussion of all possible offset options considered; b) the criteria against which each option was assessed for viability; c) a description of the offset option(s) selected for direct GHG emissions generated from Project construction, and the rationale for selecting the option(s); d) confirmation that the selected offset option is registered under the approved/quantification protocols and has been verified by an accredited "verification body[7];" e) a schedule indicating when the selected offset options(s) will be initiated; and f) an accounting of offsets confirming no net GHG emissions from Project construction.
108	**Financial Assurances Plan – operations phase** a) Trans Mountain must file with the NEB for approval, **at least 6 months prior to applying for leave to open,** a Financial Assurances Plan that includes details of the financial resources and secured sources of funds that will be capable of covering the costs of liabilities for, without limitation, cleanup, remediation, and other damages caused by the Project facilities during the operations phase.[8] These costs may arise from, among other things, potential accidents, malfunctions, and failures during the Project operations phase, including all spills originating from the pipeline and the Westridge Marine Terminal, up to and including spills of a quantity that have the potential of being a catastrophic event. The Financial Assurances Plan must be signed by an officer of the company, verifying that it is accurate, complete, and, at a minimum, meets the criteria and coverage levels described below: i) Criteria for financial assurance instruments and plan: • Any letter of credit that forms part of the Financial Assurances Plan must be unconditional and irrevocable, segregated from Trans Mountain's day-to-day business activities, and be dedicated to providing funds to cover the costs of liabilities for, without limitation, cleanup, remediation, and other damages. • Third party liability insurance must be current, and broad, respecting the scope of environmental damages covered by the policy (i.e., only exceptional/non-standard perils, taking into account the Project's nature and scope, would be excluded from coverage). Such insurance must be structured on a multi-year basis, recognizing potential loss of income by persons sustaining damage caused by Trans Mountain, over a reasonable number of years after the event.

[7] In these conditions, "verification body" means a competent and independent person, or persons, with responsibility for performing and reporting on the verification process (as defined by ISO 14064).

[8] In the context of this condition, "operations phase" refers to the period after the Project receives leave to open approval and prior to it being fully abandoned.

- A portion of cash reserves or a portion of future cash flows of the Project may be included as instruments in the Financial Assurances Plan, provided they are secured by a commitment letter from a senior officer of the company confirming that the funds will be dedicated to the Financial Assurances Plan without restrictions for the period specified by the officer.
- Immediately after a catastrophic event, sales of Project assets used for transporting hydrocarbons will not be eligible as financial assurance instruments in the Financial Assurances Plan unless Trans Mountain intends to abandon the facilities rather than continuing to use them in operating the Project.
- Parental and other third party guarantors must be registered within a Canadian jurisdiction and must have financial strength that is demonstrated in balance sheet values and ratios and credit ratings. For example, total assets less total liabilities of the guarantor should be several multiples of the liability assumed in the Trans Mountain guarantee.

ii) Financial assurance components and coverage levels:

Trans Mountain's Financial Assurances Plan must provide a total coverage of $1.1 billion[9] for the costs of liabilities for, without limitation, cleanup, remediation, and other damages caused by the Project during the operations phase. The plan should include the following components and minimum coverage levels:

- Ready cash: Trans Mountain must have unfettered access to at least $100 million to cover costs, including compensation to third parties for losses and damages in the near term, while insurance claims are being processed. Once used, this source of cash must be replenished immediately to cover the costs of a potential future spill. This can be in the form of a letter of credit, surety bond or other form acceptable to the NEB.
- Core coverage: Trans Mountain must put in effect and maintain current at all times a core financial coverage of at least $1 billion that includes third party liability insurance and other financial assurance instruments that comply with the criteria. Core coverage must be a portfolio approach with multiple financial instruments used and may not be composed of a single financial instrument (e.g., only third party liability insurance). At least one component of core coverage must be funds that are readily accessible to Trans Mountain (e.g., cash reserves held by the general partner and not distributed to the limited partners).

Below are some illustrative financial and insurance instruments that could be potential candidates for the Financial Assurances Plan:

- Irrevocable, unfettered letter of credit.
- Secured line of credit.
- Cash reserves held by the general partner and not distributed to the limited partners (and verifiable on Trans Mountain Pipelines Limited Partnership's balance sheet).
- Internal cash flow, committed by Trans Mountain to financial assurances.
- Industry pooled fund.
- Third party liability insurance with exclusions for only exceptional/non-standard perils.
- No fault third party liability insurance.
- Parental and other third party guarantees provided by parties demonstrating financial strength through balance sheets and credit ratings.

[9] The NEB's basis for any final coverage level will be described in its report to Governor in Council.

	• Other instruments developed by Trans Mountain and the insurance and financial markets. b) Trans Mountain must file the following with the NEB: i) **At least 6 months prior to applying for leave to open**, a report from an appropriate third party that has assessed the Financial Assurances Plan and its key components against the criteria and actual experiences of industry damage claims. The report must summarize the key features of each financial and insurance instrument proposed for inclusion in the Financial Assurances Plan. ii) **At least 90 days prior to applying for leave to open**, a supplement to the report described in b)i) that provides verification of any third party liability insurance coverage, a copy of the insurance certificate, and a summary of the insurance policy's key features. This summary must include: limits on insurance coverage, deductible amounts, the risks and perils and properties covered by the insurance policy, the exclusions from coverage, Trans Mountain's obligations, effective dates, and names of insurers and reinsurers. iii) **With its leave to open application**, a report describing the steps it took to eliminate any deficiencies in its Financial Assurances Plan that were identified in the third party report in b)i) and the NEB's subsequent review. iv) **On or before 31 January of each year after its leave to open application is approved**, a letter signed by an officer of the company verifying that all components of the Financial Assurances Plan remain complete and as the NEB approved. v) **At least 60 days prior to any intended change(s) to the Financial Assurances Plan during the Projects operations phase**, a letter, for approval, detailing the intended change(s) and how the change(s) provides the same or greater level of protection. vi) **Within 30 days after accessing any component of the Financial Assurances Plan**, a report detailing the component accessed, the reason for accessing it, and Trans Mountain's plan to ensure that it continues to meet the requirements of its NEB-approved Financial Assurances Plan.
109	**Terminal fire protection and firefighting systems** a) Trans Mountain must file with the NEB for approval, **at least 90 days prior to applying for leave to open**, a report prepared by an independent body confirming the adequacy of the proposed fire protection and firefighting systems implemented or planned to be implemented at the Edmonton Terminal West Tank Area, the Burnaby Terminal, the Sumas Terminal, and the Westridge Marine Terminal. The report must demonstrate that the resources and firefighting systems are capable of suppressing fires associated with all scenarios identified in the above-mentioned terminals' final risk assessments (required by Condition No. 112). b) Trans Mountain must file with the NEB for approval, **at least 60 days prior to beginning the assessment leading to the report in a),** the name and qualifications of the proposed independent body that will prepare the report in a).
110	**Offset Measures Plan for residual effects on caribou habitat** Trans Mountain must file with the NEB for approval, in accordance with the timelines below, an Offset Measures Plan for each affected caribou range, the goal of which is to offset all unavoidable and residual direct and indirect Project-related effects on caribou habitat, after taking into account the implementation of Trans Mountain's Post-Construction Environmental Monitoring Program and CHRP (see Condition No. 21) measures.

	a) A preliminary version, to be filed **at least 90 days prior to applying for leave to open**, with the plan's criteria and measurable goals and that includes: i) an initial quantification of the area of caribou habitat directly and indirectly disturbed; ii) a list of the potential offset measures available; iii) each potential offset measure's appropriate offset ratio, based on consultation with expert federal and provincial authorities and on a review of the literature on conservation offsets; iv) each potential offset measure's expected effectiveness; v) each potential offset measure's relative qualitative and quantitative value toward achieving the offset; and vi) a conceptual decision-making tree(s) or decision framework(s) that will be used to select which specific potential offset measures and accompanying offset ratios will be used under what circumstances. b) A final version, to be filed **on or before 31 January after the second complete growing season after commencing operations**, including: i) the preliminary Offset Measures Plan, with any updates identified in a revision log that includes the rationale for any changes; ii) a detailed decision-making tree(s) or process that will be used to select which specific potential offset measures and accompanying offset ratios will be used under what circumstances; iii) a tabular list of the potential offset measures and appropriate offset ratios to be implemented or already underway, including a description of site-specific details and maps showing the locations; iv) a schedule indicating when potential offset measures will be initiated and their estimated completion dates; v) either an assessment of the potential offset measures' effectiveness and their value in offsetting residual effects, or a plan for completing an assessment of the potential offset measures' effectiveness and value; and vi) an update on the restoration success to support offset measure decisions. Both the preliminary and final versions of the plan must also include the following: 1) A summary of Trans Mountain's consultation with appropriate government authorities and any potentially affected Aboriginal groups regarding the Offset Measures Plan. This summary must include any issues or concerns raised regarding the plan and how Trans Mountain has addressed or responded to them. 2) A description of how Trans Mountain has taken any available and applicable Aboriginal traditional land use and traditional ecological knowledge studies into consideration in developing the plan. 3) Evidence of Trans Mountain's consideration of any updates to the applicable Recovery Strategy, as well as to range boundaries and identified critical habitat made prior and up to the date on which leave to open is granted.
111	**Pipeline risk assessment** Trans Mountain must file with the NEB**, at least 90 days prior to applying for leave to open**, the following information for Line 1, Line 2, and the new delivery pipelines: a) The results of the updated risk assessment in a tabular format similar to that provided in its Line 2 Consequence Report (Filing A3Z8G5). The risk assessment tables must also include:

	i) any updates to High Consequence Areas; ii) the risk mitigation method(s); iii) the mitigated Environmental Risk Scores; iv) current maximum outflow volumes; and v) the outflow volumes after mitigation. b) A detailed description of the adequacy of the following from its Line 2 Consequence Report (Filing A3Z8G5): i) the coefficients used in the scoring system equations; and ii) the values from the scoring tables. c) A detailed comparison between the Line 1 and Line 2 risk assessment approaches.
112	**Final terminal risk assessments** Trans Mountain must file with the NEB for approval, **at least 90 days prior to applying for leave to open**, final risk assessments for the Edmonton Terminal West Tank Area, the Sumas Terminal, the Burnaby Terminal, and the Westridge Marine Terminal, including all implemented mitigation measures. Trans Mountain must demonstrate in each risk assessment that mitigation measures will reduce the risks to levels that are As Low As Reasonably Practicable (ALARP) while complying with the Major Industrial Accidents Council of Canada (MIACC) criteria for risk acceptability. The Edmonton Terminal West Tank Area, Sumas Terminal, and Burnaby Terminal must include the elements listed in Condition No. 29.
113	**Slack flow conditions** Trans Mountain must file with the NEB, **at least 60 days prior to applying for leave to open**, for both Line 1 and Line 2, the following: a) A list of locations having potential for slack flow when each of the pipelines is operated at 100 per cent of its maximum operating pressure (MOP), 80 per cent of its MOP, and 50 per cent of its MOP. b) A description of the following regarding detecting and preventing slack flow conditions: i) Operational measures on Line 1 and Line 2. ii) Design measures on Line 2.
114	**Marine shipping-related commitments** Trans Mountain must file with the NEB, **at least 90 days prior to loading the first tanker at the Westridge Marine Terminal with oil transported by the Project**, confirmation, signed by an officer of the company, that it has implemented or caused to be implemented the following commitments related to oil tanker traffic and enhanced oil spill response: a) Enhanced tug escort through developing a tug matrix and including it as part of Trans Mountain's Tanker Acceptance Standard. The tug matrix would prescribe minimum tug capabilities required to escort tankers between the Westridge Marine Terminal and the limit of Canada's territorial sea, as described in Section 5.3.2.1 of Volume 8A of Trans Mountain's Project application (Filing A3S4Y4), Trans Mountain's response to NEB Information Request No. 1.59 (Filing A60392), and Trans Mountain's response to the NEB's Information Request regarding the TERMPOL report (Filing A65273).

	b) An enhanced marine oil spill response regime capable of delivering 20,000 tonnes of capacity within 36 hours of notification, with dedicated resources staged within the study area, as described in Volume 8A of Trans Mountain's application and Trans Mountain's response to NEB Information Request No. 1.64 (Filing A3W9H8). c) Inclusion of any future guidelines, standards, or best management practices designed to reduce underwater noise from commercial vessels within Trans Mountain's Tanker Acceptance Standard, as amended from time to time, and as described in Trans Mountain's response to NEB Information Request No. 2.065(a) (Filing A3Z4T9). Trans Mountain must also include and report on the above-noted marine shipping-related commitments in its commitments tracking table (required by Condition No. 8).
115	**Updated Tanker Acceptance Standard** Trans Mountain must file with the NEB, **at least 90 days prior to loading the first tanker at the Westridge Marine Terminal with oil transported by the Project, and on or before 31 January of each of the first five years after commencing operations,** an updated Tanker Acceptance Standard and a summary of any revisions made to the Standard.
116	**Pre-operations full-scale emergency response exercises** a) **Prior to commencing operations**, Trans Mountain must complete full-scale exercises for the following scenarios: i) a 160-cubic-metre diluted bitumen release into Burrard Inlet as a result of a release from the Westridge Marine Terminal; and ii) a credible worst case release volume at the Burnaby Tank Farm. b) Trans Mountain must notify the NEB, **at least 45 days prior to the date of each exercise in a)**, of: i) the exercise's date(s) and location(s); ii) the exercise's objectives; iii) the participants in the exercise; and iv) the scenario for the exercise. c) Trans Mountain must file with the NEB, **within 60 days after completing each exercise in a)**, a report on the exercise that includes: i) the results of the completed exercise; ii) areas for improvement; iii) steps to be taken to correct deficiencies; and iv) confirmation that an independent third party has evaluated and assessed the emergency response exercises and that Trans Mountain will consider the comments generated for future exercises.
117	**Reporting on improvements to Trans Mountain's Emergency Management Program** Trans Mountain must file with the NEB, **at least 2 years, 1 year, and 6 months prior to commencing operations**, detailed updates for the company's review of its Emergency Management Program referenced in Condition No. 122. This filing must include: a) A summary of work undertaken to-date; b) The approximate timing for completing remaining work; and

	c) A summary of interested parties that were consulted and how their comments and feedback were considered in improving the program.
118	**Firefighting capacity at terminals** Trans Mountain must file with the NEB, **at least 1 year prior to commencing operations,** information regarding developing appropriate firefighting capacity for a safe, timely, and effective response to credible worst case for a fire at the Westridge Marine Terminal and at the Edmonton, Sumas, and Burnaby Terminals. This information must include: a) An assessment of resources and equipment; and b) A Firefighting Capacity Framework, informed by the assessment in a), that includes: i) a summary of Trans Mountain's consultation with appropriate municipal authorities and first responders that includes any issues or concerns raised regarding each municipality's respective firefighting capacity and how Trans Mountain has addressed or responded to them; and ii) a timeline for completing key activities and milestones, including the report required by Condition No. 112.
119	**Emergency Preparedness and Response Exercise and Training Program** Trans Mountain must file with the NEB, **at least 1 year prior to commencing operations**, an Emergency Preparedness and Response Exercise and Training Program for the pipeline; the Edmonton, Sumas, and Burnaby Terminals; and the Westridge Marine Terminal. The program's objective is to demonstrate the continual improvement of responder competencies (including control centre personnel) at all levels of the company to prepare for, respond to, recover from, and mitigate the potential effects of emergencies of any type, including tank fires and earthquakes. The program must include the following: a) A defined scope, other objectives in addition to those noted above, and program targets that address responder turn-over and ensure responders' ongoing training and practice. b) A list of mandatory courses for responders. c) A discussion of how Trans Mountain will train its personnel to respond to all hydrocarbon spill scenarios in various seasons, including releases of hydrocarbons in mountain regions during winter conditions, into ice covered watercourses, and into watercourses under varying flow conditions. d) A description of, and schedule for, all emergency response exercises (full-scale, tabletop, drills, functional) that Trans Mountain will conduct prior to operations to test a variety of scenarios. e) A plan, including rationales, for determining the schedule and frequency of all emergency response exercises (full-scale, tabletop, drills, functional) to test a variety of scenarios during the Project's operational life. f) A discussion of how emergency response exercises will meet the objectives of testing Trans Mountain's: i) emergency response procedures; ii) company personnel training; iii) communications systems; iv) response equipment; v) safety procedures; and vi) the effectiveness of its liaison and continuing education programs.

	g) A learnings implementation plan for exercises that considers how Trans Mountain will update and amend its Emergency Response Plans and related documents following exercises. The learnings implementation plan must consider three main purposes: i) To validate plans. ii) To develop responder competencies (including control centre personnel) and provide them with the opportunity to carry out and understand their roles in emergency response. iii) To test Project-specific and well-established emergency response procedures. h) A plan for addressing the training requirements contained within the *National Energy Board Onshore Pipeline Regulations*. i) Confirmation that an independent third party has reviewed and assessed the Emergency Preparedness and Response Exercise and Training Program and that Trans Mountain has considered and incorporated the comments generated by that review and assessment into the program.
120	**Notification and reporting on emergency response exercises** For any tabletop, functional, and full-scale emergency response exercises undertaken as part of its Emergency Preparedness and Response Exercise and Training Program required by Condition No. 119: a) Trans Mountain must notify the NEB, **at least 45 days prior to the date of each exercise**, of: i) the exercise's date and location(s); ii) the exercise's objectives; iii) the participants in the exercise; and iv) the scenario for the exercise. b) Trans Mountain must file with the NEB, **within 60 days after completing each exercise**, a report on the exercise that includes: i) the results of the completed exercise; ii) areas for improvement; and iii) steps to be taken to correct deficiencies.
121	**Evacuation Plans** a) Trans Mountain must file with the NEB, **at least 6 months prior to commencing operations**, an Evacuation Plan for people present in areas potentially affected by an incident at each of Trans Mountain's Edmonton, Sumas, and Burnaby tank facilities. Each Evacuation Plan must, at a minimum: i) describe how areas for evacuation were determined; ii) describe the circumstances under which evacuation may be required, as well as the respective methods and procedures for public notification; iii) describe specific evacuation routes, methods, and destinations; iv) be prepared in consultation with local municipalities and first responders; v) state how input from local municipalities and first responders was considered in preparing the plan; vi) define the roles, responsibilities, and jurisdictional authority all parties involved in implementing an evacuation; and

	vii) confirm that an independent third party has reviewed and assessed the plan and that Trans Mountain has considered and incorporated comments generated by the review and assessment into the plan. b) Trans Mountain must include with its Evacuation Plan for the Burnaby tank facilities a plan specific to Simon Fraser University that includes the requirements in a)i) to vii) above.
122	**Implementing improvements to Trans Mountain's Emergency Management Program** Trans Mountain must file with the NEB, **at least 6 months prior to commencing operations**, a detailed summary of its review of its Emergency Response Plans and equipment (including its availability), as referenced in Volume 7, Section 4.8.2 of its Project application (Filing A3S4V5). This filing must include a description of changes made to Trans Mountain's Emergency Management Program, as required under the *National Energy Board Onshore Pipeline Regulations*, as a result of the review, including changes to: a) The pipeline Emergency Response Plan; b) Facility Emergency Response Plans for the Edmonton, Sumas, and Burnaby Terminals, as well as the Westridge Marine Terminal; and c) An updated list of all related and accompanying site-specific plans and documents, such as control point mapping and tactical plans for high consequence areas.
123	**Emergency Response Plan for the pipeline and the Edmonton, Sumas, and Burnaby Terminals** Trans Mountain must file with the NEB, **at least 6 months prior to commencing operations**, an Emergency Response Plan for the pipeline to verify compliance with its commitments regarding emergency preparedness and response. The plan must demonstrate Trans Mountain's ability to prepare for, respond to, recover from, and mitigate the potential effects of emergencies of any type and in any geographic region or season and must include the following: a) The following relevant emergency preparedness and response documents: i) an emergency response plan to include the pipeline expansion. ii) updated facility response plans for the Edmonton, Sumas, and Burnaby Terminals. iii) all related and accompanying site-specific plans and documents, such as control point mapping, tactical plans, volunteer management plans, and fire safety plans. b) An emergency response and preparedness table for the pipeline (including facilities) indicating which plans will be referred to in an emergency response for each 10-kilometre-long pipeline segment. For each pipeline segment, the table must also identify, at a minimum: i) high consequence areas, including environmentally sensitive areas; ii) potentially affected persons or groups; iii) available access to the right-of-way and high consequence areas; iv) nearest control point(s); v) nearest available equipment cache(s); vi) response times for deployment of equipment and Trans Mountain personnel, mutual aid personnel, and third party contractors; and vii) geological, meteorological, and geographical hazards (e.g., snow avalanche, mud slides, rock slides, and steep slopes). c) Maps depicting the information identified in b).

	d) A description of the models used in response planning, including oil trajectory, fate and behavior, and air dispersion models. e) A discussion of how the results of research initiatives, such as the Scientific Advisory Committee work noted in Trans Mountain's response to NEB Information Request No. 1.63 (Filing A3W9H8) and other research noted during the OH-001-2014 proceeding, have been considered and incorporated into Trans Mountain's emergency response planning. f) A discussion of how the plan conforms to the requirements contained within the *National Energy Board Onshore Pipeline Regulations*. g) A discussion of how the plan considers, and would allow coordination with, relevant provincial and municipal disaster response plans. h) Confirmation that an independent third party has reviewed and assessed the Emergency Response Plan and that Trans Mountain has considered and incorporated the comments generated by the review and assessment into the plan.
124	**Emergency Response Plan for the Westridge Marine Terminal** Trans Mountain must file with the NEB, **at least 6 months prior to commencing operations**, an Emergency Response Plan for the Westridge Marine Terminal to verify compliance with its commitments regarding emergency preparedness and response. The plan must demonstrate geographic familiarity with the area and the response needed to prepare for, respond to, recover from, and mitigate the potential effects of emergencies of any type and must include: a) All related and accompanying site-specific plans and documents, such as geographic response plans, geographic response strategies, volunteer management plans, and fire safety plans; b) A list of high consequence areas, including environmentally sensitive areas; c) A list of potentially affected persons or groups; d) Nearest available equipment cache(s); e) Response times for equipment and personnel to the water and high consequence areas; f) Maps depicting the information identified in a) to e); g) A description of models used in response planning, including oil trajectory, fate and behavior, and air dispersion models; h) A discussion of how the results of research initiatives such as the Scientific Advisory Committee work noted in Trans Mountain's response to NEB Information Request No. 1.63 (Filing A3W9H8) and other oil fate and behavior research noted during the OH-001-2014 proceeding, have been considered and incorporated into Trans Mountain's emergency response planning; i) A discussion of how the plan conforms to the requirements contained within the *National Energy Board Onshore Pipeline Regulations*; j) A discussion of how the plan considers, and would allow coordination with, relevant provincial and municipal disaster response plans; and k) Confirmation that an independent third party has reviewed and assessed the Emergency Response Plans and that Trans Mountain has considered and incorporated comments generated by the review and assessment into the plan.

125	**SCADA and leak detection system design** Trans Mountain must file with the NEB, **at least 90 days prior to commencing operations**, a report describing the final design of the expanded Trans Mountain Pipeline System's SCADA and leak detection systems. This report must include: a) Trans Mountain's plan to validate the performance of the leak detection system and alarms within the first year of Project operations; b) an update on the status of alternate leak detection technologies that Trans Mountain is considering and any decisions made about their implementation for the Project; c) a description of how Trans Mountain's revised procedures have introduced a rule directing the Control Center Operator to perform a controlled shutdown of the pipeline when a leak cannot be ruled out in a given time period after initial indication; and d) Trans Mountain's plan for upgrading the existing measurement instrumentation that supports the acquisition of input data to improve the performance of leak detection capabilities on Line 1.
126	**Marine Public Outreach Program** Trans Mountain must file with the NEB, **at least 90 days prior to commencing operations**, a report describing completed activities and observed outcomes of Trans Mountain's Marine Public Outreach Program, and any further planned activities for this program. The report must also include: a) a summary of Trans Mountain's consultation with the Pacific Pilotage Authority regarding the scope of work and activities to be undertaken through the program, including: i) the resources and information that Trans Mountain has provided or will provide to the Pacific Pilotage Authority to addresses the impacts of increased Project-related tanker traffic in the Salish Sea; ii) the activities or actions that Trans Mountain will undertake to communicate applicable information on Project-related vessel timing and scheduling to fishing industry organizations, Aboriginal groups, and other affected stakeholders, in conjunction with the Pacific Pilotage Authority's activities; and iii) any issues or concerns raised by the Pacific Pilotage Authority and how Trans Mountain has or will address them; b) a description of the actions or activities that Trans Mountain has or will undertake to incorporate into its own public engagement efforts the activities of the Pacific Pilotage Authority regarding enhanced safe boating practice education for small vessel operators; c) a plan and schedule for all ongoing and future activities and actions under the program, including anticipated completion dates; and d) a summary of Trans Mountain's consultation with Transport Canada, the Chamber of Shipping for British Columbia, Western Canada Marine Response Corporation's Fisherman's Oil Spill Emergency Team program members, commercial and tourism associations, other appropriate stakeholders, and potentially affected Aboriginal groups regarding the scope of work to be undertaken, any issues or concerns raised, and how Trans Mountain has or will address them.
127	**Groundwater Monitoring Program** Trans Mountain must file with the NEB for approval, **at least 90 days prior to commencing operations**, a Groundwater Monitoring Program that pertains to all facilities (pump stations, tank terminals, and Westridge Marine Terminal). For each facility, the program must include, at a minimum:

	a) locations of groundwater monitoring wells, their depths, the rationales for well locations (including how groundwater flow direction was considered [indicate if there is more than one flow regime]), groundwater flow velocity, parameters to be monitored, frequency of monitoring, applicable regulatory criteria for comparing monitoring results, and a process outlining what steps will be followed should monitoring results indicate a negative change in groundwater quality; b) if there is an existing Groundwater Monitoring Program for the facility, a description of any changes required to meet this condition; and c) a summary of consultation with appropriate government authorities, landowners, and any potentially affected Aboriginal groups, including any issues or concerns raised with respect to the Groundwater Monitoring Program and how Trans Mountain has addressed or responded to them.
128	**Marine Mammal Protection Program** Trans Mountain must file with the NEB, **at least 60 days prior to commencing operations,** a Marine Mammal Protection Program that focuses on effects from the operations of Project-related marine vessels. The program must include: a) the goals and objectives of the program, including a discussion on how they align with the applicable Fisheries and Oceans Recovery Strategies and Action Plans; b) a summary of the issues related to marine mammals from Project-related marine vessels; c) a summary of the initiatives that Trans Mountain has supported or undertaken to-date, including the goals of each initiative and how they relate to the objectives of the program; address d) a discussion on the outcomes of the initiatives in c), and how these outcomes have met the objectives of the program; e) a discussion on how the relevant outcomes of the initiatives in c) are being or will be applied to Project-related marine vessels. f) any other initiatives that Trans Mountain intends to undertake or support in the future that are relevant to the program; g) a summary of consultation with appropriate government authorities any potentially affected stakeholders and Aboriginal groups; and h) a proposed schedule that outlines when Trans Mountain will file updated versions of the Marine Mammal Protection Program with the NEB and other appropriate regulatory bodies.
129	**Confirmation of firefighting capacity at terminals** Trans Mountain must file with the NEB, **at least 30 days prior to commencing operations**, confirmation that appropriate firefighting capacity, in accordance with Condition No. 118, is in place.
130	**Tank roof design for tanks at the Edmonton Terminal** Trans Mountain must install steel pontoon internal floating roofs and fixed roofs with odour control systems on all of its five proposed tanks at the Edmonton Terminal. Trans Mountain must file with the NEB, **30 days prior to commencing operations,** a letter signed by an officer of the company that confirms that these roofs were installed.

131	**Control system, SCADA, instruments, and communication** Trans Mountain must file with the NEB, **at least 60 days prior to completing commissioning activities**, the block diagrams of the control system for its proposed pipeline that include the interconnection between various devices and components such as: • programmable logic controllers (PLCs); • flow meters, and pressure and temperature measuring devices; • critical protective elements; • emergency shut-down systems (ESD); • variable frequency drives (VFDs); • control valves; • block valves; and • local human machine interface (HMI). The block diagrams must demonstrate the primary and backup communication systems, supervisory and control layers of software, firewalls, and how all elements are integrated with the SCADA system.
Conditions with initial filings due after commencing operations	
132	**Post-construction noise surveys** Trans Mountain must file with the NEB, **within 90 days after commencing operations,** the results of post-construction noise surveys conducted at the Sumas and Burnaby Terminals and at the Westridge Marine Terminal, demonstrating compliance with the British Columbia Oil and Gas Commission's *British Columbia Noise Control Best Practices Guideline (2009)*, and any further mitigation that Trans Mountain will undertake to achieve compliance.
133	**Baseline inspections** a) Trans Mountain must conduct the following pipeline inspections on Line 2 and the new delivery pipeline, at the times indicated: i) a high-resolution in-line caliper inspection (i.e., a GEOPIG™ inspection) **within 6 months after commencing operations** to establish accurate pipeline position and to detect pipe deformations; ii) an in-line ultrasonic crack detection inspection **within 2 years after commencing operations**; iii) an in-line corrosion magnetic flux leakage inspection in both the circumferential and longitudinal directions **within 2 years after commencing operations**; iv) an in-line ultrasonic wall measurement inspection **within 2 years after commencing operations;** and v) an above-ground coating survey **within 2 years after commencing operations**. b) Trans Mountain must file with the NEB, **within 6 months after completing each inspection in a)**, a report that includes a summary of the inspection results, the proposed re-inspection interval, and mitigation measures for the anomalies detected through any of the inspections, if required.
134	**Natural hazard assessment** Trans Mountain must file with the NEB, **within 1 year after commencing operations:** a) the results of the baseline natural hazard assessment for the new Line 2 and delivery pipeline segments, the reactivated Line 1 pipeline segments, and related facilities; and

	b) confirmation that the natural hazard assessment will be updated no less than every five years, and that the assessment will be integrated into the existing Natural Hazard Management Program for the Trans Mountain Pipeline system.
135	**Pipeline Geographic Information System (radio) data** Trans Mountain must file with the NEB, **within 1 year after commencing operations**, Geographic Information System data in the form of an Esri® shape file that contains pipeline segment centre lines, where each segment has a unique outside diameter, wall thickness, MOP, external coating, field-applied girth weld coating, and pipe manufacturing specification. If the above values of the pipeline change at any point along the length of the Project, the pipeline(s) should be segmented at that point. Trans Mountain must also provide Geographic Information System locations and names of pump stations, terminals, custody transfer meters, tunnel entrances, pipeline bridges, check valves, and block valves, as applicable. The datum must be NAD83 and projection must be geographic (latitudes and longitudes).
136	**Full-scale emergency response exercises during operations** a) **Within 5 years after commencing operations**, Trans Mountain must complete full-scale exercises to test each of the following five scenarios: i) A full-bore rupture under ice and snow conditions in the Coquihalla Mountain Range. ii) A full-bore rupture into the Athabasca River during high spring flow conditions. iii) A full-bore rupture into Fraser River at the Port Mann Bridge, under peak flow conditions. iv) A full-bore rupture into the North Thompson River during high spring flow conditions. v) A tank fire at the Burnaby Terminal. b) Trans Mountain must notify the NEB, **at least 45 days prior to the date of each exercise in a)**, of: i) the exercise's date and location(s); ii) the exercise's objectives; iii) the participants in the exercise; and iv) the scenario for the exercise. c) Trans Mountain must file with the NEB, **within 60 days after completing each exercise in a)**, a report on the exercise that includes: i) the results of the completed exercise; ii) areas for improvement; iii) steps to be taken to correct deficiencies; and iv) confirmation that an independent third party has evaluated and assessed the emergency response exercises and that Trans Mountain will consider the comments generated for future exercises.

137	**Ongoing implementation of marine shipping-related commitments** Trans Mountain must file with the NEB, **on or before 31 January of each year after commencing operations**, a report, signed by an officer of the company, documenting the continued implementation of Trans Mountain's marine shipping-related commitments noted in Condition No. 114, any non-compliances with the requirements of these commitments, and the actions taken to correct these non-compliances. Trans Mountain must provide each report to Transport Canada, the Canadian Coast Guard, the Pacific Pilotage Authority, Port Metro Vancouver, British Columbia Coast Pilots, Western Canada Marine Response Corporation, and Fisheries and Oceans Canada at the same time as it is filed with the NEB. If a particular party mentioned above requests that it not be provided the annual report, Trans Mountain may cease providing it to that party.
138	**Community Benefits Program progress reports** Trans Mountain must file with the NEB, **on or before 31 January of each of the first 5 years after commencing Project operations, and every fifth year thereafter for the life of the Project,** a progress report summarizing the initiatives and activities undertaken as benefits that are in addition to compensation for access and potential impacts to community lands, and/or that exceed regulatory requirements. The report must summarize initiatives supported, at a minimum, in the areas of community programs and infrastructure improvements, environmental stewardship, and education and training during the reporting period, including local emergency management enhancements, improvements to community parks, as well as support for events. This report must include: a) a description of the initiatives undertaken or supported; b) a list of participants or beneficiaries, including Aboriginal groups, local and regional communities, service providers, or others; c) an update on the timing, status, and outcomes of each initiative, including its estimated completion date, if applicable; and d) a summary of Trans Mountain's consultation activities regarding the Community Benefits Program initiatives.
139	**Reports on engagement with Aboriginal groups – operations** Trans Mountain must file with the NEB, **on or before 31 January of each of the first 5 years after commencing Project operations,** a report on the engagement activities it has undertaken with Aboriginal groups. Each report must include, at a minimum, for each Aboriginal group engaged: a) the name of the group; b) the method(s), date(s), and location(s) of engagement activities; c) a summary of any issues or concerns raised; and d) the measures taken, or that will be taken, to address or respond to issues or concerns, or an explanation why no further action is required to address or respond to issues or concerns. Trans Mountain must provide a copy of each report to each group engaged (and identified in a) above) at the same time that it is filed with the NEB.
140	**Post-construction environmental monitoring reports** Trans Mountain must file with the NEB, **on or before 31 January following the first, third, and fifth complete growing seasons after completing final clean-up,** a post-construction environmental monitoring report that must include: a) a description of the valued components or issues that were assessed or monitored;

	b) measurable goals for each valued component or issue; c) monitoring methods for each valued component or issue, results of the monitoring, and a comparison to the defined measurable goals; d) corrective actions taken, their observed success, and their current status; e) identification on a map or diagram of the locations where corrective actions were taken; f) any further corrective actions planned and a schedule for monitoring and reporting; and g) a summary of Trans Mountain's consultation with appropriate government authorities, and any potentially affected Aboriginal groups and stakeholders, including any issues or concerns raised and how Trans Mountain has addressed or responded to them. In the environmental monitoring report filed after the fifth full growing season after completing clean-up, Trans Mountain must include: i) an assessment of the effectiveness of mitigative and corrective actions and how learnings have been or will be applied to Trans Mountain's Environmental Protection Program; ii) a detailed description of all valued components or issues for which the measurable goals have not been achieved during the duration of the post-construction monitoring program; and iii) information on the need for any further corrective actions, measurable goals, assessments, or monitoring of valued components or issues, including a schedule for those. All filed post-construction environmental monitoring reports must address issues related, but not limited, to soils, weeds, watercourse crossings, riparian vegetation, wetlands, rare plants and ecosystems, wildlife and wildlife habitat, fish and fish habitat, and species at risk.
141	**Riparian Habitat Enhancement and Offset Plan** Trans Mountain must file with the NEB for approval, **on or before 31 January after the fifth complete growing season after completing final clean-up,** a Riparian Habitat Enhancement and Offset Plan for all riparian habitat that has not returned to pre-construction functionality or greater. This plan must include: a) an evaluation of performed reclamation activities against the identified measureable goals (required by Condition No. 79), including a quantification of riparian habitat to be enhanced or offset; b) a list and discussion of possible enhancement and offset options considered; c) a description of the enhancement and offset option(s) selected and the rationale for the selected option(s); d) a schedule for when the enhancement measures and offsets will be initiated and an estimated timeline for completion; e) monitoring plans to determine the success of enhancement and offset measures and the need for corrective actions, and a proposed reporting schedule; f) a description of how Trans Mountain has taken available and applicable Aboriginal traditional land use and traditional ecological knowledge into consideration in developing the plan; and g) a summary of Trans Mountain's consultation concerning a) to e) with appropriate government authorities, species experts, and any potentially affected Aboriginal groups, including any issues or concerns raised and how Trans Mountain has addressed or responded to them.

142	**Rare Ecological Community and Rare Plant Population Mitigation Evaluation and Offset Plan** Trans Mountain must file with the NEB for approval, **on or before 31 January after the fifth complete growing season after completing final clean-up**, a Rare Ecological Community and Rare Plant Population Mitigation Evaluation and Offset Plan that includes: a) for ecological communities of concern; rare plants and lichens; and draft, candidate, proposed, or final critical habitat for plant and lichen species under the *Species at Risk Act*, an evaluation of mitigation success with reference to the measurable goals outlined in the Rare Ecological Community and Rare Plant Population Management Plan required by Condition No. 50; b) identification of any residual effects on ecological communities and rare plant and lichen species that have an at-risk status of S1 or S1S2 or that are listed under federal or provincial legislation for protection, or on any draft, candidate, proposed, or final critical habitat under the *Species at Risk Act*; c) for the residual effects identified in b), a Final Rare Ecological Community and Rare Plant Population Offset Plan that updates the preliminary plan required by Condition No. 50, and that also includes details on the amount and type of offsets required, and on the offset measures to be implemented, including a timeline for their implementation and monitoring; d) a description of how Trans Mountain has taken available and applicable Aboriginal traditional land use and traditional ecological knowledge into consideration; and e) a summary of Trans Mountain's consultation concerning a) to d) with appropriate government authorities, species experts, and any potentially affected Aboriginal groups, including any issues or concerns raised and how Trans Mountain has addressed or responded to them.
143	**Wetland Reclamation Evaluation and Offset Plan** Trans Mountain must file with the NEB for approval, **on or before 31 January after the fifth complete growing season after completing final clean-up**, a Wetland Reclamation Evaluation and Offset Plan that includes: a) the extent (in hectares), by wetland type, that was impacted by pipeline and facilities construction and associated activities; b) for each wetland impacted, an evaluation of reclamation success with reference to the measurable goals outlined in the Wetland Survey and Mitigation Plan required by Condition No. 52; c) for any wetland that has achieved the intended degree of reclamation success, an evaluation of any temporary loss of each individual functional condition (e.g., habitat, hydrology and biogeochemistry); d) an identification of any wetlands that have not yet achieved the intended degree of reclamation success; e) for those wetlands that have had a temporary loss in any individual functional condition and for those that have not yet achieved reclamation success, a Final Wetland Offset Plan that updates the preliminary plan required by Condition No. 52, and that also includes details on the amount and type of further offsets required, and the offset measures to be implemented including a timeline for their implementation and monitoring; f) a description of how Trans Mountain has taken available and applicable Aboriginal traditional land use and traditional ecological knowledge into consideration in developing the plan; and g) a summary of Trans Mountain's consultation concerning a) to f) with appropriate government authorities and any potentially affected Aboriginal groups, including any issues or concerns raised and how Trans Mountain has addressed or responded to them.

144	**Caribou Habitat Restoration and Offset Measures Monitoring Program** Trans Mountain must file with the NEB for approval, **on or before 31 January after the first complete growing season after commencing operations**, a program for monitoring and verifying the effectiveness of caribou habitat restoration and offset measures implemented as part of the CHRP (Condition No. 21) and the Offset Measures Plan (Condition No. 110). This program must include: a) the scientific methods or protocols for short- and long-term monitoring of the restoration and offset measures, including their effectiveness; b) monitoring frequency, timing, and locations, and the rationale for each; c) protocols for how restoration and offset measures will be adapted, as required, based on the monitoring results from the program's implementation; and d) a proposed schedule for filing reports on monitoring results and the adaptive management responses to the NEB, Environment Canada, and appropriate provincial authorities.
145	**Caribou habitat restoration and offset measures monitoring report(s)** Trans Mountain must file with the NEB, **based on the approved schedule for the Caribou Habitat Restoration and Offset Measures Monitoring Program** (required by Condition No. 144), a report(s) describing the monitoring program's results, including the observed effectiveness of habitat restoration and offset measures for each affected caribou range, and how those measures will be adapted, as required, based on monitoring results. Any proposed changes to the NEB-approved reporting schedule must be included within the relevant report prior to any reporting on a revised schedule.

93	**Construction progress reports** Trans Mountain must file with the NEB **monthly construction progress reports from the start of clearing until commencing operations**. The reports must include information on the progress of activities carried out during the reporting period. These reports must include safety, environmental, and security non-compliances that occurred during each reporting period and the measures undertaken to resolve them. These reports must also include a description and the locations of any changes made to geohazard mitigation measures (required by Condition No. 73), the location of any pressure tests carried out during the reporting period, and a description of any unsuccessful pressure tests and their cause.
94	**Aboriginal, local, and regional employment and business opportunity monitoring reports** a) Trans Mountain must file with the NEB, **within 90 days after commencing construction**, **and every 6 months thereafter until completing construction**, monitoring reports for Aboriginal, local, and regional employment and business opportunities for the Project. The reports must include: i) a summary of the elements or indicators monitored; ii) a summary and analysis of Aboriginal, local, and regional employment and business opportunities during the reporting period; and iii) a summary of Trans Mountain's consultation with relevant Aboriginal, local, and regional communities, and industry groups or representatives regarding employment and business opportunities for the reporting period. This summary must include any issues or concerns raised regarding employment and business opportunities and how Trans Mountain has addressed or responded to them. b) Trans Mountain must file with the NEB, **within 6 months after completing construction**, a final report on employment during the construction phase.
95	**Air Emissions Management Plan – Burnaby Mountain tunnel construction** Trans Mountain must file with the NEB for approval, **at least 4 months prior to commencing construction of the Burnaby Mountain tunnel**, an Air Emissions Management Plan for tunnel construction. The plan must include: a) proposed hours for daytime and nighttime work; b) sources that would generate air emissions; c) an Air Emissions and Dust Emissions Management Plan that includes mitigation measures, their predicted effectiveness, and implementation timeframes; d) a summary of consultation with appropriate government authorities and with potentially affected residents and businesses regarding tunnel construction air emissions, including any concerns raised and how Trans Mountain has addressed or will address those concerns; and e) a description of Trans Mountain's program for addressing complaints received during tunnel construction with respect to air and dust emissions, including a communication and notification plan.
96	**Tunnel Construction Noise Management Plan for Burnaby Mountain** Trans Mountain must file with the NEB for approval, **at least 90 days prior to commencing construction of the Burnaby Mountain tunnel**, a Tunnel Construction Noise Management Plan for Burnaby Mountain that includes: a) proposed hours of daytime and nighttime work;

	b) baseline daytime and nighttime ambient sound levels at noise sensitive areas within 500 metres of the entry and exit sites for the tunnel; c) predicted noise levels at the most affected residences and businesses caused by tunnel construction without mitigation; d) proposed noise mitigation measures, including all technologically and economically feasible mitigation measures; e) predicted noise levels at the most affected residences and businesses with mitigation measures implemented, including noise contour map(s) showing the potentially affected residences and businesses; f) a tunnel construction noise monitoring program, including locations, methodology, and schedule; g) criteria that will be used to determine when tunnel construction would be shut down due to noise; h) a summary of consultation with appropriate government authorities and potentially affected residents and businesses regarding tunnel construction noise, including any concerns raised and how Trans Mountain has or will address those concerns; i) a description of Trans Mountain's program for addressing complaints received during tunnel construction with respect to noise, including a communication and notification plan; and j) a contingency plan that contains proposed mitigation measures for addressing noise complaints, which may include the temporary relocation of specific residents.
97	**Groundwater Seepage Management Plan** Trans Mountain must file with the NEB for approval, **at least 45 days prior to commencing construction of the Burnaby Mountain tunnel**, a Groundwater Seepage Management Plan for tunnel construction. The plan must include: a) an estimate quantifying the anticipated average and maximum amounts of groundwater seepage into the tunnel, and an assessment of any potential impacts on the water table; b) a discussion of Trans Mountain's proposed pumping, treatment, and disposal options; and c) a description of measures that Trans Mountain would implement during the operations phase in the event that there is groundwater seepage into the tunnel.
98	**Authorizations under paragraph 35(2)(b) of the *Fisheries Act* and *Species at Risk Act* permits – pipeline** a) For those watercourse crossings that will require Authorization under paragraph 35(2)(b) of the *Fisheries Act*, Trans Mountain must file with the NEB, **at least 5 months prior to commencing their construction,** the following: i) A draft *Application Form for Paragraph 35(2)(b) Fisheries Act Authorization*; ii) A draft application package for authorization that includes all the information detailed in Fisheries and Oceans Canada's *Applicant's Guide to Submitting an Application for Authorization under Paragraph 35(2)*(b) *of the Fisheries Act*, including (as per the guide): • contact information; • a description of the proposed work, undertaking, or activity; • detailed design; • the timeline;

131	**Control system, SCADA, instruments, and communication** Trans Mountain must file with the NEB, **at least 60 days prior to completing commissioning activities**, the block diagrams of the control system for its proposed pipeline that include the interconnection between various devices and components such as: • programmable logic controllers (PLCs); • flow meters, and pressure and temperature measuring devices; • critical protective elements; • emergency shut-down systems (ESD); • variable frequency drives (VFDs); • control valves; • block valves; and • local human machine interface (HMI). The block diagrams must demonstrate the primary and backup communication systems, supervisory and control layers of software, firewalls, and how all elements are integrated with the SCADA system.
Conditions with initial filings due after commencing operations	
132	**Post-construction noise surveys** Trans Mountain must file with the NEB, **within 90 days after commencing operations,** the results of post-construction noise surveys conducted at the Sumas and Burnaby Terminals and at the Westridge Marine Terminal, demonstrating compliance with the British Columbia Oil and Gas Commission's *British Columbia Noise Control Best Practices Guideline (2009)*, and any further mitigation that Trans Mountain will undertake to achieve compliance.
133	**Baseline inspections** a) Trans Mountain must conduct the following pipeline inspections on Line 2 and the new delivery pipeline, at the times indicated: i) a high-resolution in-line caliper inspection (i.e., a GEOPIG™ inspection) **within 6 months after commencing operations** to establish accurate pipeline position and to detect pipe deformations; ii) an in-line ultrasonic crack detection inspection **within 2 years after commencing operations**; iii) an in-line corrosion magnetic flux leakage inspection in both the circumferential and longitudinal directions **within 2 years after commencing operations**; iv) an in-line ultrasonic wall measurement inspection **within 2 years after commencing operations;** and v) an above-ground coating survey **within 2 years after commencing operations**. b) Trans Mountain must file with the NEB, **within 6 months after completing each inspection in a)**, a report that includes a summary of the inspection results, the proposed re-inspection interval, and mitigation measures for the anomalies detected through any of the inspections, if required.
134	**Natural hazard assessment** Trans Mountain must file with the NEB, **within 1 year after commencing operations:** a) the results of the baseline natural hazard assessment for the new Line 2 and delivery pipeline segments, the reactivated Line 1 pipeline segments, and related facilities; and

Appendix A Additional draft conditions for comment

In these draft conditions, the following terms are defined as:

Trans Mountain	Trans Mountain Pipeline ULC
NEB	National Energy Board
the Project	The proposed Trans Mountain Expansion Project, in all its applied-for components.
for approval	When a condition requires a filing for NEB approval, Trans Mountain must not commence the indicated activity until the NEB issues its written approval of that filing.
including	Use of this term, or any variant of it, is not intended to limit the elements to just those listed. Rather, it implies minimum requirements with the potential for augmentation, as appropriate.

Conditions with initial filings due prior to commencing construction	
146[1]	**Commercial Support for the Project** Trans Mountain must file with the Board, at least 90 days prior to commencing Project construction, signed confirmation by a responsible officer of the company that as of that date: 1. the Project has secured agreements or contracts that remain in force with shippers for a minimum term of 15-years for no less than 60 per cent of its total capacity (890,000 barrels per day); and 2. any rights to terminate held by shippers that may have existed in any agreements or contracts between Trans Mountain and shippers (which may have reduced the Project's contracted total capacity to less than 60 percent for a minimum term of 15 years) have lapsed and or expired because their conditions precedent have been satisfied or waived.
147	**Horizontal directional drilling (HDD) Noise Management Plan** Trans Mountain must file with the NEB for approval, **at least 90 days prior to commencing construction**, an HDD Noise Management Plan that includes: a) proposed hours of daytime and nighttime work; b) baseline daytime and nighttime ambient sound levels at noise sensitive areas within 500 metres of the HDD entry and exit sites; c) predicted noise levels caused by HDD at the most affected receptors without mitigation measures implemented; d) proposed HDD noise mitigation measures, including all technologically and economically feasible mitigation measures; e) predicted noise levels at the most affected receptors with mitigation measures implemented, including noise contour map(s) showing potentially affected receptors; f) an HDD noise monitoring program, including locations, methodology, and schedule; g) a description of the public and Aboriginal communication and complaint response process; h) a contingency plan that contains proposed mitigation measures for addressing noise complaints, which may include the temporary relocation of specific residents; and i) confirmation that Trans Mountain will provide notice to nearby residents in the event that a planned blowdown is required, and that the planned blowdown will be completed during daytime hours whenever possible.

1 On 12 August 2015, the Board released Procedural Direction No. 17 with 145 draft conditions for comment. These draft conditions reflect a continuation of that numbering.

148	**Noise Management Plan for construction at pump stations, tank terminals, and the Westridge Marine Terminal** Trans Mountain must file with the NEB for approval, **at least 90 days prior to commencing construction**, a Noise Management Plan for construction at pump stations and terminals, where residences are within 300 metres of the proposed construction activities. The plan must include: a) proposed hours of daytime and nighttime work; b) noise mitigation measures, including all technologically and economically feasible mitigation measures; c) a noise monitoring program, including locations, methodology, and schedule; d) a description of the public and Aboriginal communication and complaint response process; and e) a contingency plan that contains proposed mitigation measures for addressing noise complaints, which may include the temporary relocation of specific residents.
149	**Grasslands Survey and Mitigation Plan** Trans Mountain must file with the NEB for approval, **at least 4 months prior to commencing construction**, a pre-construction Grasslands Survey and Mitigation Plan that applies to native grasslands in the British Columbia interior and that includes: a) a description of the extent of overlap of the Project with native grasslands in the British Columbia interior; b) a summary of survey results for such grasslands potentially affected by the Project, including but not limited to native plant species diversity, the density and distribution of existing invasive plant species, and the presence of cryptogamic crust; c) a description of the mitigation and reclamation measures to be implemented for potentially affected grasslands, including the extent to which native seed will be used, with rationales and unambiguous criteria explaining under what circumstances each such measure will be applied; d) measurable goals against which the success of grassland mitigation and reclamation will be evaluated, including goals related to cryptogamic crust recovery, invasive species control, and access control; e) a description of how the i) avoidance, mitigation, and offset hierarchy, and ii) the goal of no net loss for grasslands, were considered in developing the plan;

f) details of the post-construction monitoring plan for grasslands for the first ten years of operations, including corrective actions that might be necessary and the circumstances under which each such action would be taken;

g) a Preliminary Grasslands Offset Plan for those grasslands that, after ten years of operations, have not achieved reclamation success – this plan must include:

   i) an explanation of how the need for offset measures will be determined and quantified, including offset ratios;

   ii) the potential offset measures, the process for selecting which will be implemented, and an evaluation of the probability of their success; and

   iii) a discussion of how the effectiveness of offsets measures will be monitored, assessed, and reported on;

h) a description of how Trans Mountain has taken available and applicable Aboriginal traditional land use and traditional ecological knowledge into consideration in developing the plan;

i) a summary of Trans Mountain's consultation concerning a) to h) with appropriate government authorities and any potentially affected Aboriginal groups and stakeholders, including any issues or concerns raised and how Trans Mountain has addressed or responded to them; and

j) confirmation that the relevant Environmental Protection Plans will be updated to include any relevant information from the Grasslands Survey and Mitigation Plan.

Conditions with initial filings due after commencing operations

150

Grasslands Reclamation Evaluation and Offset Plan

Trans Mountain must file with the NEB for approval, **on or before 31 January after the tenth complete growing season after completing final clean-up**, a Grasslands Reclamation Evaluation and Offset Plan that applies to native grasslands in the British Columbia interior and that includes:

a) the extent (in hectares) of grasslands that were impacted by pipeline and facilities construction and associated activities;

b) an evaluation of reclamation success with reference to the measurable goals outlined in the Grasslands Survey and Mitigation Plan required by Condition No. 149;

c) an identification of any grasslands that have not yet achieved the intended degree of reclamation success, and an evaluation of the need for ongoing monitoring and corrective actions;

d) for those grasslands that have not yet achieved reclamation success, a Final Grasslands Offset Plan that updates the preliminary plan required by Condition No. 149, and that also includes details on the amount and type of offsets required and the offset measures to be implemented, including a timeline for their implementation and monitoring;

e) a description of how Trans Mountain has taken available and applicable Aboriginal traditional land use and traditional ecological knowledge into consideration in developing the plan; and

f) a summary of Trans Mountain's consultation concerning a) to e) with appropriate government authorities and any potentially affected Aboriginal groups and stakeholders, including any issues or concerns raised and how Trans Mountain has addressed or responded to them.

- Frequency: isolated to continuous – the events resulting in potential effects on climate change occur over a range of frequencies from isolated construction activities to continuous electricity use by pump assemblies.
- Reversibility: permanent – potential effects on climate change are considered irreversible.
- Magnitude: negligible – changes in environmental parameters (*e.g.*, increase in global average temperature) resulting from Project-related activities are not detectable from existing (baseline) climate variability.
- Probability: high – Project-related activities will contribute, albeit a small amount, to global GHG emissions and resultantly global climate change.
- Confidence: high – determination of significance is based on a good understanding of cause-effect relationships between GHG emissions from Project activities and overall climate change. Observational and numerical modelling data also support the significance determination.

7.2.5.7 Summary

As identified in Table 7.2.5-8, there are no situations where there is a high probability of occurrence of a permanent or long-term residual environmental effect on GHG emissions indicators of high magnitude that cannot be technically or economically mitigated. Consequently, it is concluded that the residual environmental effects of Project construction and operation on GHG emissions will not be significant.

7.2.6 Acoustic Environment

This assessment considers both sound and vibrations as components of the Acoustic Environment. The Project will employ heavy equipment for construction of the Project and mechanical equipment for the tanks, pump stations and Westridge Marine Terminal operations. These are all sources of sound that may change the acoustic environment at sensitive locations (primarily places people live) and so are evaluated in the assessment of Project effects. Similarly, blasting may be required for pipeline construction which may generate vibrations at sensitive locations. This subsection evaluates the effects due to the Project on the Acoustic Environment.

7.2.6.1 Assessment Indicators and Measurement Endpoints

Assessment indicators identified for the acoustic environment element are sound levels and vibrations. Sound levels refer to the amount of sound in the outdoor environment, as may be experienced by people or wildlife. Vibrations refer to airborne or ground borne vibrations that occur from blasting, as may be experienced by people or wildlife. Assessment indicators and measurement endpoints for acoustic environment are listed in Table 7.2.6-1.

The NEB *Filling Manual* also requires that potential for cumulative effects with residual sound be evaluated. Specific noise criteria are not cited in the NEB *Filing Manual*, however, the guidance provided specifically refers to the Alberta Energy Regulator (AER) and BC Oil and Gas Commission (OGC) noise limits. Though not specifically referenced in the NEB *Filing Manual*, the Health Canada guidance can be used to provide context around sound level changes, specifically in urban areas with multiple receptors.

The assessment indicators and endpoints for sound in the acoustic environment are those defined in AER *Directive 038: Noise Control* (Alberta Energy Resources Conservation Board [ERCB] 2007) and the BC OGC *Noise Control Best Practices Guideline* (BC OGC 2009). These methods are focussed on the human environment, specifically residences.

The indicators for the acoustic environment are sound levels, specifically at noise sensitive receptors. As defined in AER *Directive 038* and the BC OGC *Noise Control Best Practices Guideline*, noise sensitive receptors are any dwelling or residence occupied at least six weeks per year within 1.5 km of the Project Footprint. From the wildlife perspective, noise sensitive receptors are habitat areas where sensitive species are present.

Since both Alberta and BC do not have generally accepted guidelines for the evaluation of airborne/ground-borne vibration, guidance from another Canadian province was used. The *Cautionary Limit from the Noise Pollution Control Publication 119 (NPC-119)* by the Ontario Ministry of Environment (ON MOE) guidance was found to be the most stringent, therefore, was used to compare against the calculations of airborne/ground-borne vibration from blasting for the Project.

No direct feedback regarding noise indicators was received from the ESA Workshops, except that some participants sought assurance that existing provincial requirements were to be used. Since the provincial noise requirements are well defined, there was no additional consultation with provincial regulatory authorities about the indicators. PMV was consulted, as ports are federal facilities that are not required to meet provincial or municipal regulations or guidance. PMV noted that it has no specific noise criteria but generally follows Health Canada and municipal bylaws regarding noise issues. BC and Alberta provincial requirements as well as Health Canada and municipal bylaws are all considered in the assessment.

Endpoints represent measureable attributes of the assessment endpoints that can be quantified, predicted and compared to existing conditions, guidelines or other similar criteria suitable for evaluating change. One endpoint from the AER/BC OGC criteria has been selected for sound in the acoustic environment:

- the energy equivalent (L_{eq}) sound level measured in A-weighted decibels.

Two endpoints from the ON MOE NPC-119 criteria have been selected for the airborne and ground-borne vibration acoustic environment:

- the Peak Pressure Level or L_{peak} measured in linear (un-weighted) decibels (airborne); and
- the Peak Particle Velocity or PPV measured in millimeters per second (ground-borne).

TABLE 7.2.6-1

ASSESSMENT INDICATORS AND MEASUREMENT ENDPOINTS FOR ACOUSTIC ENVIRONMENT

Acoustic Environment Indicators	Measurement Endpoints	Rationale for Indicator Selection
Sound levels	• Energy equivalent (Leq) sound level measured in A-weighted decibels	Indicator as defined by the assessment methods cited under the acoustic environment element in Table A-2 of the NEB *Filing Manual*.
Vibration	• Peak Pressure Level or Lpeak measured in linear (un-weighted) decibels • Peak Particle Velocity or PPV measured in millimeters per second	Both indicators are used to define the potential affects from blasting. Methods from ON MOE used in absence of guidance in other documentation.

7.2.6.2 Spatial Boundaries

The spatial boundaries used in the effects assessment of acoustic environment considered one or more of the following areas:

- a Footprint Study Area (as defined in Section 7.1.3);
- an Acoustic Environment LSA; and
- an Acoustic Environment RSA.

As defined in AER *Directive 038* and the BC OGC *Noise Control Best Practices Guideline*, the Acoustic Environment LSA is defined as 1.5 km from the fenceline or Footprint of the Project. For construction, this includes the pipeline, pump stations and terminals. For operations, this includes the pump stations and terminals only.

2.12.7 Noise Management Plan

Reference:

i. Volume 6D, Appendix C *Management Plans* (A56013, A3S2S9, p.96)

ii. Volume 6D, Appendix G *Details* (A56013, A3S2S9, p.164)

iii Trans Mountain Response to City of Vancouver Information Request No.1 question 3.15d. (A3Y2G6 at pdf page 48).

Preamble:

The Environmental Facility Drawing (Appendix F) was not included in the application; the application says: "information to be added prior to construction" and the IR response stated it would be filed and made available to the public 90 days prior to construction. Timely provision of this outstanding document is critical for the City of Vancouver to assess its adequacy, provide comment, and to plan and prepare for gaps. The proposed timeline also does not provide sufficient time for Trans Mountain to consider comments/concerns from the public about the facility.

Request:

a. Please provide details of the methodology for developing the Noise Management Plan.

b. Please submit the Environmental Facility Drawing and advise if/how Trans Mountain will incorporate comments received.

Response:

a. The development of methodology for the Noise Management Plan as well as specific content is planned for later in the design/construction planning process when more detailed information is available. As described in the responses to City of Vancouver IR No. 1.03.15a and No. 1.03.15b (Filing ID A3Y2G6), the construction plan for the Westridge Marine Terminal continues to be refined during the Application review process as detailed engineering design progresses through the detailed construction planning stage.

The NEB Draft Conditions No. 29 and 33 (Noise Management Plan for pump stations, tank terminals and the Westridge Marine Terminal) of the NEB *Draft Conditions and Regulatory Oversight* (NEB 2014; Filing ID A3V8Z8) outlines the elements that would be considered in the Noise Management Plan.

In addition, as outlined in the response to City of Burnaby IR No. 1.09.04c (Filing ID A3Y2E6), Noise Management Plans may contain the following elements:

- specific equipment engineering control or sound emission requirements;
- secondary noise control (e.g., berms or barriers) locations, effectiveness and rules for use;

- administrative controls such as activity re-scheduling;
- communication requirements around noise generating activity;
- detail on complaint processes, investigation and reporting;
- compliance monitoring program requirements; and
- reporting requirements, including noise level compliance, complaint investigation, contract equipment maintenance logs or sound emission performance.

The noise management plans for the Project will encompass any elements outlined in the final conditions issued by the NEB.

Reference:

National Energy Board. 2014. Draft Conditions and Regulatory Oversight. Hearing Order OH-001-2014. Trans Mountain Pipeline ULC (Trans Mountain) Application for the Trans Mountain Expansion Project (Project). April 16, 2014.

b. As described in the responses to City of Vancouver IR No. 1.03.15a and No. 1.03.15b (Filing ID A3Y2G6), the construction plan for the Westridge Marine Terminal continues to be refined during the Application review process as detailed engineering design progresses through the detailed construction planning stage. Development of the Noise Management Plan requires that construction planning be sufficiently advanced so that the types and sizes of equipment for each construction stage plus preliminary activity schedules be known. The plan will be developed to identify specific receptor locations or areas along the pipeline route, or specific activities, which require additional controls and include a list of requirements for specific affected locations. Once the plan is developed, which includes the Environmental Facility Drawing, it will be submitted to the NEB for review. The NEB's *Letter – Draft Conditions and Regulatory Oversight (April 16, 2014)* (NEB 2014; Filing ID A3V8Z8) requires that the completed plans be provided to the NEB at least 90 days prior to construction.

Consultation with the City of Vancouver is continuing throughout the NEB approval process. As mitigation plans are developed in the course of the construction planning, they will be discussed with the City of Vancouver as part of the ongoing consultation any input from those discussions would be considered in the final management plans.

Reference:

National Energy Board. 2014. Draft Conditions and Regulatory Oversight. Hearing Order OH-001-2014. Trans Mountain Pipeline ULC (Trans Mountain) Application for the Trans Mountain Expansion Project (Project). April 16, 2014.

- Frequency: isolated to continuous – the events resulting in potential effects on climate change occur over a range of frequencies from isolated construction activities to continuous electricity use by pump assemblies.
- Reversibility: permanent – potential effects on climate change are considered irreversible.
- Magnitude: negligible – changes in environmental parameters (*e.g.*, increase in global average temperature) resulting from Project-related activities are not detectable from existing (baseline) climate variability.
- Probability: high – Project-related activities will contribute, albeit a small amount, to global GHG emissions and resultantly global climate change.
- Confidence: high – determination of significance is based on a good understanding of cause-effect relationships between GHG emissions from Project activities and overall climate change. Observational and numerical modelling data also support the significance determination.

7.2.5.7 Summary

As identified in Table 7.2.5-8, there are no situations where there is a high probability of occurrence of a permanent or long-term residual environmental effect on GHG emissions indicators of high magnitude that cannot be technically or economically mitigated. Consequently, it is concluded that the residual environmental effects of Project construction and operation on GHG emissions will not be significant.

7.2.6 Acoustic Environment

This assessment considers both sound and vibrations as components of the Acoustic Environment. The Project will employ heavy equipment for construction of the Project and mechanical equipment for the tanks, pump stations and Westridge Marine Terminal operations. These are all sources of sound that may change the acoustic environment at sensitive locations (primarily places people live) and so are evaluated in the assessment of Project effects. Similarly, blasting may be required for pipeline construction which may generate vibrations at sensitive locations. This subsection evaluates the effects due to the Project on the Acoustic Environment.

7.2.6.1 Assessment Indicators and Measurement Endpoints

Assessment indicators identified for the acoustic environment element are sound levels and vibrations. Sound levels refer to the amount of sound in the outdoor environment, as may be experienced by people or wildlife. Vibrations refer to airborne or ground borne vibrations that occur from blasting, as may be experienced by people or wildlife. Assessment indicators and measurement endpoints for acoustic environment are listed in Table 7.2.6-1.

The NEB *Filling Manual* also requires that potential for cumulative effects with residual sound be evaluated. Specific noise criteria are not cited in the NEB *Filing Manual*, however, the guidance provided specifically refers to the Alberta Energy Regulator (AER) and BC Oil and Gas Commission (OGC) noise limits. Though not specifically referenced in the NEB *Filing Manual*, the Health Canada guidance can be used to provide context around sound level changes, specifically in urban areas with multiple receptors.

The assessment indicators and endpoints for sound in the acoustic environment are those defined in AER *Directive 038: Noise Control* (Alberta Energy Resources Conservation Board [ERCB] 2007) and the BC OGC *Noise Control Best Practices Guideline* (BC OGC 2009). These methods are focussed on the human environment, specifically residences.

The indicators for the acoustic environment are sound levels, specifically at noise sensitive receptors. As defined in AER *Directive 038* and the BC OGC *Noise Control Best Practices Guideline*, noise sensitive receptors are any dwelling or residence occupied at least six weeks per year within 1.5 km of the Project Footprint. From the wildlife perspective, noise sensitive receptors are habitat areas where sensitive species are present.

Since both Alberta and BC do not have generally accepted guidelines for the evaluation of airborne/ground-borne vibration, guidance from another Canadian province was used. The *Cautionary Limit from the Noise Pollution Control Publication 119 (NPC-119)* by the Ontario Ministry of Environment (ON MOE) guidance was found to be the most stringent, therefore, was used to compare against the calculations of airborne/ground-borne vibration from blasting for the Project.

No direct feedback regarding noise indicators was received from the ESA Workshops, except that some participants sought assurance that existing provincial requirements were to be used. Since the provincial noise requirements are well defined, there was no additional consultation with provincial regulatory authorities about the indicators. PMV was consulted, as ports are federal facilities that are not required to meet provincial or municipal regulations or guidance. PMV noted that it has no specific noise criteria but generally follows Health Canada and municipal bylaws regarding noise issues. BC and Alberta provincial requirements as well as Health Canada and municipal bylaws are all considered in the assessment.

Endpoints represent measureable attributes of the assessment endpoints that can be quantified, predicted and compared to existing conditions, guidelines or other similar criteria suitable for evaluating change. One endpoint from the AER/BC OGC criteria has been selected for sound in the acoustic environment:

- the energy equivalent (L_{eq}) sound level measured in A-weighted decibels.

Two endpoints from the ON MOE NPC-119 criteria have been selected for the airborne and ground-borne vibration acoustic environment:

- the Peak Pressure Level or L_{peak} measured in linear (un-weighted) decibels (airborne); and
- the Peak Particle Velocity or PPV measured in millimeters per second (ground-borne).

TABLE 7.2.6-1

ASSESSMENT INDICATORS AND MEASUREMENT ENDPOINTS FOR ACOUSTIC ENVIRONMENT

Acoustic Environment Indicators	Measurement Endpoints	Rationale for Indicator Selection
Sound levels	• Energy equivalent (Leq) sound level measured in A-weighted decibels	Indicator as defined by the assessment methods cited under the acoustic environment element in Table A-2 of the NEB *Filing Manual*.
Vibration	• Peak Pressure Level or Lpeak measured in linear (un-weighted) decibels • Peak Particle Velocity or PPV measured in millimeters per second	Both indicators are used to define the potential affects from blasting. Methods from ON MOE used in absence of guidance in other documentation.

7.2.6.2 Spatial Boundaries

The spatial boundaries used in the effects assessment of acoustic environment considered one or more of the following areas:

- a Footprint Study Area (as defined in Section 7.1.3);
- an Acoustic Environment LSA; and
- an Acoustic Environment RSA.

As defined in AER *Directive 038* and the BC OGC *Noise Control Best Practices Guideline*, the Acoustic Environment LSA is defined as 1.5 km from the fenceline or Footprint of the Project. For construction, this includes the pipeline, pump stations and terminals. For operations, this includes the pump stations and terminals only.

In the absence of a setback distance listed in the Health Canada guidance document, the AER and BC OGC criteria was used at all locations. The AER and BC OGC criteria require that noise be controlled at the 1.5 km distance from the fenceline or Footprint. Therefore, potential effects of the Project on human receptors are not anticipated to extend beyond the Acoustic Environment LSA, however, cumulative effects from other developments could occur within 1.5 km of those other developments, so an Acoustic Environment RSA of 5 km is considered. Vibration levels are discussed within the Acoustic Environment RSA, which is the area potentially affected by construction vibration, consisting of a 10 km wide band extending from the proposed pipeline corridor (*e.g.,* Footprint plus 5 km on both sides of the proposed pipeline corridor). The Acoustic Environment RSA is shown in Figures 5.4-1 to 5.4-4.

The Acoustic Environment LSA and RSA for sound levels were discussed during the ESA Workshops held in March 2013. No specific comments or suggestions were received regarding the sound level LSA and RSA boundaries.

7.2.6.3 Acoustic Environment Context

The acoustic environment will vary based on the level of development and geography along the proposed pipeline corridor. Human developments, the presence of infrastructure, the amount of foliage, the density of wildlife and weather all influence sound level in the outdoor environment. It is normal for sound levels to fluctuate over the course of a day or night, with the amount and timing of those fluctuations being influenced by the local sources of sound.

The proposed pipeline corridor travels through varying levels of human development, such as urban, sub-urban, rural and unoccupied areas. Urban and sub-urban areas will be influenced by people's daily activities and local industry. Rural areas are influenced by local infrastructure (*e.g.,* traffic or trains) and existing pipeline sources (*e.g.,* pump stations or maintenance activities) equally with the natural environment while the natural environment dominates in undeveloped areas. Noise will have greater natural fluctuations in rural and undeveloped areas. Urban areas will have more consistent sound levels over time, but also higher sound levels due to the level of local activity.

The AER *Directive 038* and BC OGC *Noise Control Best Practices Guideline* used as the basis for the assessment in the Terrestrial Noise and Vibration Technical Report (Volume 5C) define both an expected existing environment and allowable thresholds for sound levels at homes. The Health Canada guidance also used, either looks at an upper limit or bases the degree of change on existing conditions. The directive and guidelines all take into account the natural fluctuations in outdoor sound.

The perception of change in sound levels for people will depend on the amount of sound that occurs on average over time, rather than moment by moment. People can typically start to notice a change in sound level of 3 dBA (Crocker 2007). The assessment looked at thresholds for noise on day and night average basis given by the guidelines as well as the potential for long-term of average sound level changes of 3 dBA.

Vibration from blasting is experienced as singular events. The airborne and ground-borne vibration can result in a physical sensation if the blast impulse is strong enough. Blasting may be required for some segments of the pipeline construction, and the vibrations from blasts could be noticed by nearby residents if present. However, blast designs for the Project construction also need to consider existing infrastructure, so the blasts will be limited in size and scope.

7.2.6.4 Potential Effects and Mitigation Measures

<u>Effects Considerations</u>

The review of regulatory requirements and the outcome of the ESA Workshops indicate that no indicators, other than those outlined in the AER *Directive 038* and BC OGC N*oise Control Best Practices Guideline* are to be considered in the evaluation of effects on the Acoustic Environment. Both these documents use similar indicators for long-term average sound levels (on a day and night basis).

The potential for Low Frequency Noise (LFN) is a consideration for sound emitted from industrial facilities. Both the AER *Directive 038* and BC OGC *Noise Control Best Practices Guideline* indicate that LFN should be evaluated where data is available at the initial assessment stage and the detailed analysis of

LFN is a requirement when investigating complaints. Equipment sound emissions of sufficient detail to evaluate LFN are typically not available until a later stage of design or construction planning, generally after vendor and contractor selection. Therefore, the potential for LFN based on the theoretical values used in this assessment was studied in the Terrestrial Noise and Vibration Technical Report (Volume 5C). However, the LFN indicator was not carried into the effects assessment since compliance with this indicator is not a primary requirement of the AER or BC OGC, and due to the theoretical nature of the data used in the assessment.

Identified Potential Effects

Potential effects associated with the construction and operations of the proposed pipeline on acoustic environment indicators are listed in Table 7.2.6-2. These interactions are based on the results of the literature review, desktop analysis, modelling, Aboriginal engagement and consultation with landowners, regulatory authorities and other stakeholders (Section 3.0), and the professional experience of the assessment team.

A summary of mitigation measures provided in Table 7.2.6-2 was principally developed in accordance with Trans Mountain standards as well as provincial regulatory guidelines including BC MOE (2012a).

TABLE 7.2.6-2

POTENTIAL EFFECTS, MITIGATION MEASURES AND RESIDUAL EFFECTS OF PIPELINE CONSTRUCTION AND OPERATIONS ON THE ACOUSTIC ENVIRONMENT

Potential Effect	Pipeline Segment(s)	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
1. Acoustic Environment Indicator – Sound Levels				
1.1 Changes in sound level during construction	All	LSA	• Adhere to all federal (*i.e.,* Environment Canada, *Motor Vehicle Safety Act*, *Oil and Gas Occupational Safety and Health Regulations*, Health Canada) and provincial (*i.e.,* Directive 038: Noise Control, *BC Noise Control Guideline Best Practices Guideline*, *Worker's Compensation Act*, section 7.2 of the *Occupational Health and Safety Regulations* [BC Reg 296/97 as amended] Section 7.2 [BC Reg. 382/2004, s.1]) guidelines and regulations and legislation for noise management [Section 7.0]. • Noise abatement and construction scheduling will be considered at noise sensitive locations (*i.e.,* neighbouring landowners) and during noise sensitive periods [Section 7.0]. • Schedule intermittent noise producing events to avoid, where feasible, important habitat of wildlife species at risk/sensitive species/livestock during sensitive periods, where feasible [Section 7.0]. • Enforce vehicle speed limits and inform contractor truck drivers and equipment operators that engine retarder braking in urban areas is prohibited [Section 7.0]. • Maintain equipment in good working condition and in accordance with manufacturer guidelines [Section 7.0]. • Maintain noise suppression equipment on all construction machinery and vehicles in good order [Section 7.0]. • Enclose noisy equipment and use baffles, where and when feasible, to limit the transmission of noise beyond the construction site [Section 7.0]. • Use only the size and power of tools necessary limit noise from power tool operations. Locate stationary equipment, such as compressors and generators located away from noise receptors, to the extent feasible, and follow applicable municipal, provincial and federal guidelines [Section 7.0]. • Implement mitigation measures where residences are located within 300 m of the construction right of way or facility site as outlined in the Noise Management Plan [Section 7.0].	• Increase in sound levels during construction period.

TABLE 7.2.6-2 Cont'd

Potential Effect	Pipeline Segment(s)	Spatial Boundary[1]	Key Recommendations/Mitigation Measures [EPP Reference][2]	Potential Residual Effect(s)
1.1 Changes in sound level during construction (cont'd)	See above	See above	• Implement mitigation measures where night time activity (*e.g.,* HDD) on the construction right of way or facility site is located within 500 m of residences as outlined in the Noise Management Plan [Section 7.0].	• See above
1.2 Changes in sound level during operation	All	LSA	• Limit helicopter inspections to weekdays only to the extent practical. • Use of off-road vehicles for inspection should be limited to weekdays if feasible. • Maintain equipment in good working condition and in accordance with manufacturer guidelines. • Maintain noise suppression equipment on all construction machinery and vehicles in good order.	• Periodic noise events due to maintenance and inspections.
2. Acoustic Environment Indicator – Vibrations				
2.1 Changes in vibrations during construction	All	RSA	• Implement mitigation measures where residences are located within 300 m of the construction right of way or facility site as outlined in the Noise Management Plan [Section 7.0]. • Noise Management Plan will limit vibrations to acceptable levels.	• Increase in airborne/ground-borne vibrations during blasting aspects of construction period.
2.2 Changes in vibrations during operation	All	RSA	• None required, buried pipeline.	• No residual effects identified.

Notes: 1 LSA = Acoustic Environment LSA; RSA = Acoustic Environment RSA.

2 Detailed mitigation measures are outlined in the Pipeline EPP (Volume 6B).

7.2.6.5 Potential Residual Effects

The potential residual environmental effects on acoustic environment indicators associated with the construction and operations of the pipeline (Table 7.2.6-2) are:

- increase in sound levels during construction;
- periodic noise events due to maintenance and inspections; and
- increase in airborne/ground-borne vibrations during blasting aspects of construction period.

No residual effects associated with changes in vibrations during operations were identified since the pipeline will be buried and largely unaffected by above ground noise sources.

7.2.6.6 Significance Evaluation of Potential Residual Effects

A quantitative assessment of the acoustic environment was determined to be the most appropriate approach to evaluate the significance of potential residual environmental effects. The evaluation of significance of each of the potential residual effects for the acoustic environment relies primarily on the magnitude, duration and frequency of the potential change. The general definitions for these criteria are provided in Table 7.1-2. However, magnitude of residual effects requires further definition for the acoustic environment evaluation and is indicator specific. Magnitude for sound level has been defined based on the degree of compliance with provincial and Health Canada guidelines. Magnitude for vibration levels have been defined based on the degree of compliance with the ON MOE blasting guidance NPC-119. The evaluation is also based on the professional judgment of the assessment team. Details on the guidelines and legislation used to establish the magnitude ratings can be found in the Terrestrial Noise and Vibration Technical Report of Volume 5C.

The definitions of magnitude for the L_{eq} in dBA sound level indicator are:

Negligible: Below BC OGC and AER ambient sound level (ASL).

Low: Below BC OGC/AER permissible sound level (PSL) limits and Health Canada limit.

Medium: Less than Health Canada 75 dBA guideline limit for construction but greater than the temporary activity AER/BC OGC daytime PSL of 60 dBA in rural areas to 76 dBA in heavily urbanized areas.

High: Greater than the Health Canada 75 dBA guideline limit for construction.

The definitions of magnitude for the vibration indicators are:

Negligible: No change to ambient vibration levels.

Low: Below ON MOE limits of 120 dBL (airborne) and 10 mm/s (ground-borne).

Medium: Equal to or slightly below ON MOE limits of 120 dBL (airborne) and 50 mm/s (ground-borne).

High: Greater than ON MOE limits of 120 dBL (airborne) and/or 50 mm/s (ground-borne).

Table 7.2.6-3 provides a summary of the significance evaluation of the potential residual environmental effects of the construction and operations of the proposed pipeline on the acoustic environment. The rationale used to evaluate the significance of each of the residual environmental effects is provided below.

TABLE 7.2.6-3

SIGNIFICANCE EVALUATION OF POTENTIAL RESIDUAL EFFECTS OF PIPELINE CONSTRUCTION AND OPERATIONS ON ACOUSTIC ENVIRONMENT

Potential Residual Effects	Impact Balance	Spatial Boundary[1]	Temporal Context			Magnitude	Probability	Confidence	Significance[2]
			Duration	Frequency	Reversibility				
1. Acoustic Environment Indicator – Sound Levels									
1(a) Increase in sound levels during construction period.	Negative	LSA	Short-term	Isolated	Short-term	Low to medium	High	Moderate	Not significant
1(b) Periodic noise events due to maintenance and inspections.	Negative	LSA	Short-term	Periodic	Immediate to short-term	Negligible to medium	High	Moderate	Not significant
1(c) Combined effects on the sound level indicator (1[a] and 1[b].)	Negative	LSA	Short-term	Isolated	Short-term	Low to medium	High	Moderate	Not significant
2. Acoustic Environment Indicator – Vibration									
2(a) Increase in airborne/ground-borne vibrations during blasting aspects of construction period.	Negative	LSA	Short-term	Isolated	Short-term	Low to medium	High	Moderate	Not significant

Notes: 1 LSA = Acoustic Environment LSA; RSA = Acoustic Environment RSA.

2 Significant Residual Environmental Effect: A high probability of occurrence of a permanent or long-term residual effect of high magnitude that cannot be technically or economically mitigated.

Acoustic Environment Indicator – Sound Levels

The following provides the evaluation of significance of potential residual effects on the sound level indicator.

Increase in Sound Levels During Construction Period

The potential for the increase in daytime or night time sound levels for human receptors associated with pipeline construction is considered to have a negative impact balance. Participants of several of the Community Workshops (*e.g.*, Edmonton, Wabamun, Edson, Valemount, Blue River, Clearwater, Kamloops Merritt, Hope, Abbotsford, Langley, Surrey) noted that construction was a concern for local

residents and could potentially affect other users in the area (*e.g.*, recreational users in provincial parks, campers, hunters) if construction were to coincide with summer months. The latter concern is further discussed under the human occupancy and resource use element in Volume 5B and in the Socio-Economic Technical Report (Volume 5D). Based on the results of the analysis in the Terrestrial Noise and Vibration Technical Report (Volume 5C), the spatial extent of changes to sound levels from pipeline construction were limited to the Acoustic Environment RSA. However, the significance of changes is based on the compliance with regulatory guidance for noise. Compliance with regulatory requirements occurs within the Acoustic Environment LSA.

The duration of the sounds experienced at receptors is dependent on the activity; each type of sound will last only for the particular phase of construction (*e.g.,* clearing, trenching, welding, and reclamation). As described in Section 2.0, construction is expected to last for approximately 3 months at any location along the propose pipeline corridor. However, within that period, the various phases of construction will occur consecutively. Given the need to transition each phase, the time for maximum activity during each phase is limited. Maximum activity from construction phases may occur within the closest proximity of a particular residential receptor for one to two weeks. In urban areas, activities are expected to be limited to one week.

The frequency of sound emissions during each construction phase will be isolated, as construction is cyclic and involves use of mobile equipment and intermittent use of tools. The period over which the change in noise extends is the construction period and, therefore, the residual effect is conservatively considered to be of short-term reversibility. However, as soon as construction activity stops, the sound level changes are reversed.

The results of predictive modelling for construction of the pipeline indicates the magnitude of changes in sound levels that will be experienced by people living within 1.5 km of the proposed pipeline corridor for a variety of construction activities. Noise controls that will be in use during the construction phase, particularly the use of silencers on mobile equipment and executing a communications plan with receptors are expected to control the amount of sound to within acceptable levels as established in the Terrestrial Noise and Vibration Technical Report of Volume 5C. Controlling the magnitude of sound level changes also limits the spatial extent of the potential change.

A generic model for various types of construction activities was developed, which indicates the maximum expected sound levels from an activity at various distances from that activity on an hourly basis. Given the normal variation in activity during the day for construction, actual sound levels over the full day are expected to be less, although planning for activity cycles is not conducted until later in the Project development process. The maximum hour is being compared to longer term (15 hour day) criteria as an indication of the potential for effect. The summary of results for construction activity is shown in Figure 7.2.6-1.

As shown in Figure 7.2.6-1, the magnitude of effect due to sound from Project construction varies depending on the distance between the construction activities and the surrounding receptors. As such, the evaluation of magnitude has been broken down into each of the applicable five segments of proposed pipeline corridor to allow for consideration of receptors along the length of the corridor.

The types of equipment used and in turn, the sound emissions used for the assessment are similar to those used for construction of other developments such as highways or industrial parks. Day-long sound levels and the degree of variation in sound levels experienced from pipeline construction are expected to be similar to sounds perceived near these types of activities.

Edmonton to Hinton Segment

The setback distances from edge of the proposed pipeline corridor to the noise sensitive receptors along the Edmonton to Hinton Segment of the proposed pipeline corridor ranges from close by in urban areas, such as the City Edmonton, Town of Hinton and the Town of Edson, to distant, as far as the boundary of the Acoustic Environment LSA in rural areas. The closest urban receptor to the proposed pipeline corridor was found to be approximately 40 m away in the City of Edmonton near RK 33. The closest rural receptor is immediately adjacent to the pipeline corridor (less than 20 m) located near RK 79. Based on Figure 7.2.6-1, the anticipated sound level at the closest receptor is greater than 85 dBA depending on

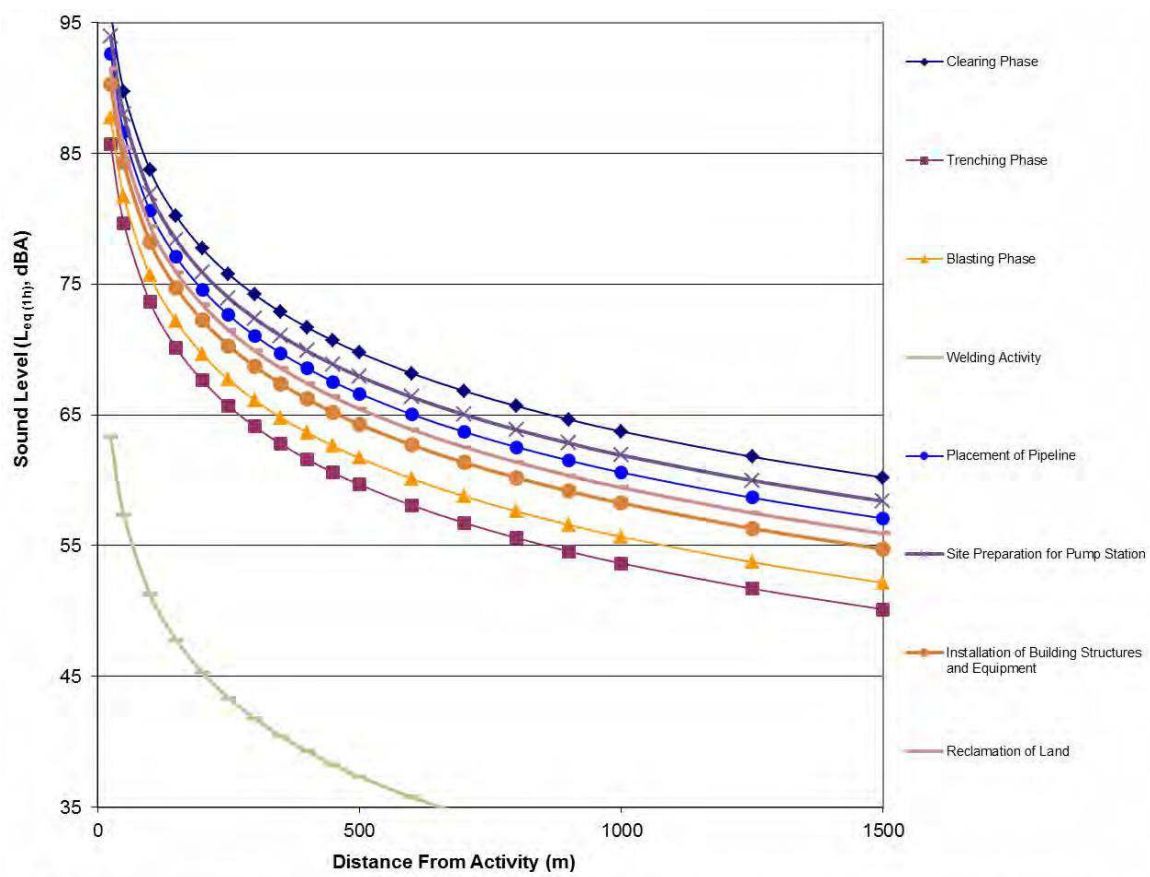
the activity. The magnitude for this receptor is rated as high. The number of potentially affected receptors at various distances from the proposed pipeline corridor was estimated through review of available mapping and land use data. Estimates rounded to the nearest 50 homes are presented in Table 7.2.6-4. Note that the number of potentially affected receptors is conservative as it is based on available map data. Actual numbers are anticipated to be lower based on a finalized route and receptor ground-truthing.

TABLE 7.2.6-4

DISTANCES TO NOISE SENSITIVE RECEPTORS WITHIN THE ACOUSTIC ENVIRONMENT LSA OF PROPOSED PIPELINE CORRIDOR WITHIN THE EDMONTON TO HINTON SEGMENT

Distance from Proposed Pipeline Corridor (m)	Number of Potentially Affected Receptors (approximate)	Magnitude of Potential Residual Effects
0-300	8,150	High
300-1,500	54,300	Low to medium

Figure 7.2.6-1 Predicted Construction Sound Level Estimates



Notes:
- Predicted noise levels account for distance attenuation (geometric spreading) only. Actual sound levels at distances greater than 300 m would be expected to be much less than those shown.
The quantity and type of each equipment used in each actvity phase is presented in the Terrestrial Noise and Vibration Technical Report (Volume 5C)

While the prediction results indicate there is potential for high magnitude effects at homes within 300 m of the proposed pipeline corridor due to construction noise, these sounds will vary throughout the day, and can be controlled to meet municipal bylaws. The detailed construction planning required to fully assess urban sound levels is not available at this stage of Project planning. However, should specific and localized construction activities necessitate operating on a 24 hour basis to completion, such as horizontal directional drilling of a watercourse, a noise management plan will be prepared in the event human receptors are present within 300 m of the watercourse. In addition, a noise management plan to be prepared for use during construction in urban environments is expected to bring potential sound levels to within levels that result in medium magnitude effects.

Hargreaves to Darfield Segment

The setback distances from the edge of the proposed pipeline corridor to the noise sensitive receptors along the Hargreaves to Darfield Segment of the proposed pipeline corridor range from close, in moderately urbanized areas such Village of Valemount, Community of Blue River, Community of Avola and the Hamlet of Blackpool, to distant, as far as the boundary of the Acoustic Environment LSA in rural areas. The closest identified receptor to the proposed pipeline corridor was found to be adjacent to the corridor (less than 20 m away) near RK 614. Based on Figure 7.2.6-1, the anticipated sound level at the closest receptor is greater than 85 dBA, depending on the type of activity. The magnitude for this receptor is rated as high. The number of potentially affected receptors at various distances from the proposed pipeline corridor was estimated through review of available mapping and land use data. Estimates rounded to the nearest 50 homes are presented in Table 7.2.6-5. Note that the number of potentially affected receptors is conservative as it is based on available map data. Actual numbers are anticipated to be lower based on a finalized route and receptor ground-truthing.

TABLE 7.2.6-5

DISTANCES TO NOISE SENSITIVE RECEPTORS WITHIN THE ACOUSTIC ENVIRONMENT LSA OF PROPOSED PIPELINE CORRIDOR WITHIN THE HARGREAVES TO DARFIELD SEGMENT

Distance from Proposed Pipeline Corridor (m)	Number of Potentially Affected Receptors	Magnitude of Potential Residual Effects
0-300	750	High
300-1,500	2,100	Low to medium

While the prediction results indicate there is potential for high magnitude effects at homes within 300 m of the proposed pipeline corridor due to construction noise, these sounds will vary throughout the day, and can be controlled to meet municipal bylaws. The detailed construction planning required to fully assess urban sound levels is not available at this stage of Project planning. However, should specific and localized construction activities necessitate operating on a 24 hour basis to completion, such as horizontal directional drilling of a watercourse, a noise management plan will be prepared in the event human receptors are present within 300 m of the watercourse. In addition, a noise management plan to be prepared for use during construction in urban environments is expected to bring potential sound levels to within the 75 dBA threshold that results in medium magnitude effects.

Black Pines to Hope Segment

The setback distances from the edge of the proposed pipeline corridor to the noise sensitive receptors along the Black Pines to Hope Segment of the proposed pipeline corridor range from close in urban areas such as the City of Kamloops, City of Merritt and the District of Hope to the boundary of the Acoustic Environment LSA in rural areas. The closest identified receptor to the proposed pipeline corridor was found to be adjacent to the corridor (less than 20 m away) near RK 845. Based on Figure 7.2.6-1, the anticipated sound level at the closest receptor is greater than 85 dBA, depending on the type of activity. The magnitude for this receptor is rated as high. The number of potentially affected receptors at various distances from the proposed pipeline corridor was estimated through review of available mapping and land use data. Estimates rounded to the nearest 50 homes are presented in Table 7.2.6-6. Note that the number of potentially affected receptors is conservative as it is based on available map data. Actual numbers are anticipated to be lower based on a finalized route and receptor ground-truthing.

TABLE 7.2.6-6

DISTANCES TO NOISE SENSITIVE RECEPTORS WITHIN THE ACOUSTIC ENVIRONMENT LSA OF PROPOSED PIPELINE CORRIDOR WITHIN THE BLACK PINES TO HOPE SEGMENT

Distance from Proposed Pipeline Corridor (m)	Number of Potentially Affected Receptors	Magnitude of Potential Residual Effects
0-300	2,300	High
300-1,500	9,450	Low to medium

While the prediction results indicate there is potential for high magnitude effects at homes within 300 m of the proposed pipeline corridor due to construction noise, these sounds will vary throughout the day, and can be controlled to meet municipal by-laws. The detailed construction planning required to fully assess urban sound levels is not available at this stage of Project planning. However, should specific and localized construction activities necessitate operating on a 24 hour basis to completion, such as horizontal directional drilling of a watercourse, a noise management plan will be prepared in the event human receptors are present within 300 m of the watercourse. In addition, a noise management plan to be prepared for use during construction in urban environments is expected to bring potential sound levels to within levels the 75 dBA threshold that results in medium magnitude effects.

Hope to Burnaby Segment

The setback distances from the edge of the proposed pipeline corridor to the noise sensitive receptors along the Hope to Burnaby Segment of the proposed pipeline corridor range from close in urban areas, such as the Township of Langley, the City of Surrey and the City of Burnaby, to distant, as far as the edge of the Acoustic Environment LSA in rural areas. The closest urban receptors to the proposed pipeline corridor were found to be adjacent to the corridor (less than 20 m away) and occur at multiple locations along the proposed pipeline corridor, particularly as the corridor enters urban areas east of Burnaby. Based on Figure 7.2.6-1, the anticipated sound level at the closest receptors is greater than 85 dBA, depending on the type of activity. The magnitude for this receptor is rated as high. The number of potentially affected receptors at various distances from the proposed pipeline corridor was estimated through review of available mapping and land use data. Estimates rounded to the nearest 50 homes are presented in Table 7.2.6-7. Note that the number of potentially affected receptors is conservative and actual numbers are anticipated to be lower based on a finalized route.

TABLE 7.2.6-7

DISTANCES TO NOISE SENSITIVE RECEPTORS WITHIN THE ACOUSTIC ENVIRONMENT LSA OF PROPOSED PIPELINE CORRIDOR WITHIN THE HOPE TO BURNABY SEGMENT

Distance from Proposed Pipeline Corridor (m)	Number of Potentially Affected Receptors	Magnitude of Potential Residual Effects
0-300	14,00	High
300-1,500	57,100	Low to medium

While the prediction results indicate there is potential for high magnitude effects at receptors within 300 m of the proposed pipeline corridor due to construction noise, these sounds will vary throughout the day, and can be controlled through detailed planning and use of sound reduced equipment in densely populated areas. The detailed construction planning required to fully assess urban sound levels is not available at this stage of project planning. A detailed noise management plan to be prepared for use during construction in urban environments is expected to bring potential sound levels to within the 75 dBA threshold that results in medium magnitude levels.

Burnaby to Westridge Segment

The setback distances from the edge of the proposed pipeline corridor to the noise sensitive receptors along the Burnaby to Westridge Segment of proposed pipeline corridor are considered short due to the degree of urbanization along this segment of the proposed pipeline corridor. The closest identified

receptors to the proposed pipeline corridor were found to be adjacent to the corridor (less than 20 m away) and were locations along the final 1.5 km of the pipeline. Based on Figure 7.2.6-1, the anticipated sound level at the closest receptor is greater than 85 dBA, depending on the type of activity. The magnitude for this receptor is rated as high. The number of potentially affected receptors at various distances from the proposed pipeline corridor was estimated through review of available mapping and land use data. Estimates rounded to the nearest 50 homes are presented in Table 7.2.6-8. Note that the number of potentially affected receptors is conservative as it is based on available map data. Actual numbers are anticipated to be lower based on a finalized route and receptor ground-truthing.

TABLE 7.2.6-8

DISTANCES TO NOISE SENSITIVE RECEPTORS WITHIN THE ACOUSTIC ENVIRONMENT LSA OF PROPOSED PIPELINE CORRIDOR WITHIN THE BURNABY TO WESTRIDGE SEGMENT

Distance from Proposed Pipeline Corridor (m)	Number of Potentially Affected Receptors	Magnitude of Potential Residual Effects
0-300	1,376	High
300-1,500	6,950	Low to medium

While the prediction results indicate there is potential for high magnitude effects at receptors within 300 m of the proposed pipeline corridor due to construction noise, these sounds will vary throughout the day, and can be controlled through detailed planning and use of a noise management plan. The detailed construction planning required to fully assess urban sound levels is not available at this stage of project planning. A detailed noise management plan to be prepared for use during construction in urban environments is expected to bring potential sound levels to within medium magnitude levels.

Residential dwellings are located within sufficient proximity of construction activity for sound level changes to occur along much of the proposed pipeline corridor. Therefore, the probability of occurrence is high.

The predictive modelling used in the assessment of the acoustic environment has a level of uncertainty that is dependent on three factors: the accuracy of the sound source data; the precision of the noise propagation model; and the accuracy of locations and quantities of noise sources. Conservative choices were made regarding the sound source data. Where practical, measured data of similar equipment were used but often theoretical data was required which increases uncertainty in the results. A model that uses key international standards for outdoor sound propagation with a known uncertainty was used and the locations and quantities of sources are based on Section 2.0 of Volume 5A. The confidence that the results are conservative, yet representative is considered moderate.

A summary of the rationale for all of the significance criteria is provided below (Table 7.2.6-3, point 1[a]).

- Spatial Boundary: Acoustic Environment LSA – compliance with the AER *Directive 038* and BC OGC *Noise Control Best Practices Guideline* are achieved within the Acoustic Environment LSA.
- Duration: short-term – the events causing changes in sound levels occur only during the construction phase.
- Frequency: isolated – the events causing changes in sound level occur at residential dwellings occur during the construction phase.
- Reversibility: short-term – the period over which the change in sound level extends is the construction period. However, at any specific location along the proposed pipeline corridor, all sound level changes will cease when construction activities have finished.
- Magnitude: low to medium – in urban areas, with the implementation of a detailed noise management plan for construction, the changes in sound level are considered to be medium while in rural areas, the change in sound level ranges from low to medium depending on the distance from construction activity.

- Probability: high – based on the proximity of residences to the proposed pipeline corridor.
- Confidence: moderate – based on the nature of data inputs.

Periodic Noise Events Due to Maintenance and Inspections

Noise from pipeline operations is limited to regular aerial and ground patrols vegetation management and integrity digs. Sounds would be similar to those already heard in areas where the proposed pipeline corridor is adjacent to the existing TMPL right-of-way. Similar to noise during construction, noise resulting from periodic site-specific maintenance will be limited to the same receptors in close proximity to the proposed pipeline corridor.

The spatial extent of the change sound level is limited to the Acoustic Environment LSA. Since maintenance activities are typically completed at any given location within a few minutes to hours (aerial patrols, vegetation management) or within several weeks (*e.g.*, integrity digs), the duration of the maintenance and inspection activities is short-term. The frequency of maintenance activities occur intermittently but repeatedly over the assessment period and, therefore, are considered to be periodic. The effect is reversible in the immediate to short-term as sound level changes due to maintenance activity will cease as soon as the maintenance activity stops.

While aerial patrols or vegetation management during operations may cause momentary sound levels to increase, the day and night average levels are not expected to change due to such short duration events. Although integrity digs may extend over several weeks, the amount and size of the equipment used during this activity is generally smaller than that used during pipeline construction. Nevertheless, the magnitude of the change in sound level during operations of the pipeline is considered to be of negligible magnitude for most operational activities and of medium magnitude for integrity digs where there are nearby human receptors.

The inspections and maintenance are essential to safe pipeline operations so the probability of occurrence is rated as high. The confidence is considered moderate based on the uncertainty in the data used for the evaluation of fly-by noise. A summary of the rationale for all of the significance criteria is provided below (Table 7.2.6-3, point 1[b]).

- Spatial Boundary: Acoustic Environment LSA – the change in sound level during operations is confined to the Acoustic Environment LSA.
- Duration: short-term – the events causing changes in sound levels during operations (*i.e.*, maintenance activities) are completed within any 1 year during operations.
- Frequency: periodic – the events causing changes in sound levels during operations (*i.e.*, aerial patrols, vegetation management, integrity digs) occur intermittently but repeatedly over the assessment period.
- Reversibility: immediate to short-term – the changes in sound level associated with maintenance activities at any given location range from a few minutes to hours for aerial patrols and vegetation management (immediate) to a few weeks for integrity digs (short-term). All sound level changes are reversible as the sound will cease when the inspection/maintenance is finished.
- Magnitude: negligible to medium – the sound level events associated with aerial patrols and vegetation management will have a short timeline, so changes to the day or night average levels are not expected. However, integrity digs that occur near residents may result in sound level changes that could affect day or night average levels.
- Probability: high – changes to sound levels will occur since inspections and maintenance are essential to safe pipeline operation.
- Confidence: moderate – based on the uncertainty in the data used for the evaluation of fly-by noise.

Combined Effects on Sound Levels

The evaluation of the combined effects of pipeline construction and operations on the acoustic environment considers collectively the assessment of the likely potential residual effects on the sound levels indicator. The residual effects for changes in sound level do not combine between the two elements to result in new ratings. Both effects are different types of sounds as well as time periods for occurrence; they do not combine into a singular effect. Therefore, the combined effects on sound levels in Table 7.2.6-3 point 1(c) represents the worst-case or most adverse effect for each evaluation criteria between the two residual effects. Effectively, this reflects effects from pipeline construction, as pipeline operations have comparatively lower sound generating activity.

A summary of the rationale for all of the significance criteria of combined effects on sound levels is provided below.

- Spatial Boundary: Acoustic Environment LSA – compliance with the AER *Directive 038* and BC OGC *Noise Control Best Practices Guideline* are achieved within the Acoustic Environment LSA.
- Duration: short-term – the events causing combined effects on sound level occur only during the construction phase.
- Frequency: isolated – the events causing combined effects on sound level will occur at residential dwellings during the construction phase
- Reversibility: short-term – the period over which the combined effects on sound levels extend is the construction period. However, at any specific location along the proposed pipeline corridor, all sound level changes will cease when construction activities have finished.
- Magnitude: low to medium – in urban areas, with the implementation of a detailed noise management plan for construction, the combined effects on sound level are considered to be medium while in rural areas, the combined effects on sound level ranges from low to medium depending on the distance from construction activity.
- Probability: high – combined effects on sound level is likely to occur based on the proximity of residences to the proposed pipeline corridor.
- Confidence: moderate – based on the nature of data inputs.

Acoustic Environment Indicator – Vibration Levels

The following provides details on the significance of the potential residual effects that are present in the acoustic environment due to vibration levels cause by the blasting activities of the proposed pipeline construction component of the Project.

Increase in Airborne/Ground-Borne Vibrations During Blasting Aspects of Construction Period

The potential for the increase in vibration (airborne and ground-borne) levels for human receptors associated with increased Project construction is considered to have a negative impact balance. Based on the results of the analysis in the Terrestrial Noise and Vibration Technical Report of Volume 5C, the spatial extent of changes to vibration levels from pipeline construction are limited to a blast design specification of 50 mm/sec peak particle velocity (PPV) at the nearest structure or infrastructure within or near the proposed pipeline corridor. This is usually the existing pipe at a minimum 5 m distance. Blast size is modified to ensure the 50 mm/s requirement is met. Where the 50 mm/s requirement is met, the airborne component of the vibration meets 120 dB at 50 m distance. This results in medium magnitude effects. The duration of the vibration levels experienced at receptors is very short (dependent on size and formation of blasting pattern). The frequency of vibration emissions during construction will be limited, since it should only be used in areas that are needed and where ripping is not feasible (heavy equipment limitations, bedrock). All changes in vibration levels are immediately reversible. As soon as blasting construction activity stops, the vibration level changes are reversed.

Vibration controls that will be in use during the construction phase, limit blasting to daytime hours, vary shape and charge with respect to proximity to local receptors and executing a communications plan with receptors are expected to limit vibration levels to within acceptable levels as established in the Terrestrial Noise and Vibration Technical Report. Controlling the magnitude of vibration level also limits the spatial extent of the potential change.

The only variation in residual effects along the pipeline corridor is the magnitude of potential effects. The magnitude of the effect will vary depending on the distance between the blasting zone and the surrounding receptors. As the exact blasting zones have not been determined, the closest potential rural receptor in each segment has been used for evaluation. Blasting will not occur in urbanized areas. This resulted in the most conservative estimates for the highest magnitude of potential effects. A summary of potential magnitude of effects from vibration is provided in Table 7.2.6-9. The analysis lists each of the five segments along with both the estimated distance to receptor and the resulting magnitude of potential effects. As presented in Table 7.2.6-9, the magnitude of residual effect from vibration is medium for all segments of the proposed pipeline corridor.

TABLE 7.2.6-9

SUMMARY OF DISTANCES TO NOISE SENSITIVE RECEPTORS WITHIN EACH SEGMENT OF THE PROPOSED PIPELINE CORRIDOR

Pipeline Segment	Distance from Proposed Pipeline Corridor (m)	Magnitude of Potential Residual Effects
Edmonton to Hinton	<20	Medium
Hargreaves to Darfield	<20	Medium
Black Pines to Hope	<20	Medium
Hope to Burnaby	<20	Medium
Burnaby to Westridge	N/A (no rural receptors)	N/A (no rural receptors)

Residences are within sufficient proximity of construction activity for vibration level changes to occur along most of the proposed pipeline corridor. Therefore, the probability of occurrence is high.

The predictive modelling used in the assessment of the acoustic environment has a level of uncertainty that is dependent on three main factors: the blasting source data; the precision of the vibration propagation model; and the accuracy of locations of blasting locations. Blasting configuration and design data were not available at this stage of the Project. The blasting limit for effects on the existing pipeline corridor was used to estimate vibration levels at each representative receptor along each segment of proposed pipeline corridor. Modelling was completed that uses key international standards for outdoor vibration propagation with a known uncertainty. Therefore, the confidence in the results was considered moderate.

A summary of the rationale for all of the significance criteria is provided below (Table 7.2.6-3, point 2[a]).

- Spatial Boundary: Acoustic Environment LSA – effects associated with changes to vibration level extend to less than 100 m from the right-of-way in most areas, but are dependent on the location of the activity. In an area that is greenfield with no existing rights-of-way, or where receptors are more distant, higher charge weights may be used. The type of blasting required for a pipeline uses smaller charges. Charge weights sufficient for vibrations to reach 1,500 m (the edge of the LSA) would be greater than 1,000 kg which would not occur for this Project.

- Duration: short-term – the changes to vibration levels occur only during the construction phase.

- Frequency: isolated – the event causing changes to vibration levels occur only during the construction phase in which the activity is planned.

- Reversibility: short-term – the changes to vibration levels are associated with blasting activities which may occur over a period longer than two days. All vibration level changes are reversible as the vibration will cease when construction is finished.

- Magnitude: low to medium – based on the anticipated effects at receptors, PPV at residences is expected to be less than the 50 mm/s design specification due to the blasting limit for the existing pipeline corridor.
- Probability: high – based on the proximity of receptors to the proposed pipeline corridor.
- Confidence: moderate – based on the nature of data inputs.

7.2.6.7 Summary

As identified in Table 7.2.6-3, there are no situations where there is a high probability of occurrence of a permanent or long-term residual environmental effect on the acoustic environment indicators of high magnitude that cannot be technically or economically mitigated. Consequently, it is concluded that the residual environmental effects of pipeline construction and operations on the acoustic environment will be not significant.

7.2.7 Fish and Fish Habitat

This subsection describes the potential Project effects on fish and fish habitat. The Fisheries (Alberta) Technical Report and Fisheries (British Columbia) Technical Report of Volume 5C provide further information pertaining to fish and fish habitat at watercourses affected by the Project.

Pipeline construction and maintenance activities have the potential to directly and indirectly affect fish and fish habitat through riparian and instream habitat contamination, loss or alteration of riparian and instream habitat during construction and maintenance, contamination of instream or riparian habitat from spills and increase the risk of contamination through accidental drilling mud release during construction.

Fish mortality or injury may increase during construction due to an increase in suspended sediment concentration, increased site access, blockage of fish movements and effects on fish species of concern. Pipeline construction and maintenance may also result in combined effects on each indicator species resulting from contamination, loss or alteration of riparian or instream habitat and mortality or injury.

The assessment of effects on fish and fish habitat has been conducted considering all the Project components in an integrated manner (*e.g.,* pipeline, temporary facilities, pump stations [including power lines], tanks and pipeline reactivation), since potential effects related to riparian habitat, instream habitat and fish mortality and injury are experienced in a combined manner on fish indicator species and cannot be meaningfully disaggregated by Project component. Construction of the Westridge Marine Terminal will not cause any interactions with fish and fish habitat.

7.2.7.1 Assessment Indicators and Measurement Endpoints

Assessment indicators identified for the fish and fish habitat element are: riparian habitat (Alberta and BC); instream habitat (Alberta and BC); fish mortality or injury (Alberta and BC); Arctic grayling (Alberta); Athabasca rainbow trout (Alberta); bull trout (Alberta); burbot (Alberta); northern pike (Alberta); walleye (Alberta); bull trout/Dolly Varden (BC); Chinook salmon (BC); coho salmon (BC); cutthroat trout (BC); and rainbow trout/steelhead (BC). Assessment indicators and measurement endpoints for fish and fish habitat are listed in Table 7.2.7-1. Potential effects related to the fish and fish habitat are considered under Section 7.2.7.4.

The selection of indicators for fish and fish habitat included; consideration of the filing requirements in the NEB *Filing Manual*; experience gained during previous projects with similar conditions/potential issues; feedback from Aboriginal communities, regulatory authorities and stakeholders; feedback from ESA Workshops; available research literature; public issues raised through media; and the professional judgment of the assessment team.

It was determined by the assessment team that each province traversed by the proposed pipeline corridor (*i.e.*, Alberta and BC) should have its own set of fish species indicators. This is due to a variety of factors, including regional differences in fish community compositions, species abundance, and species important for recreational, commercial or traditional use. Three general fish and fish habitat indicators (*i.e.*, riparian habitat, instream habitat and fish mortality and injury) were determined to be appropriate for both

1.3 Regulatory Standards

1.3.1 Federal Standards

The single main federal standard/document that the Project must follow is the NEB *Filing Manual* (2013). In addition to the NEB document, the Health Canada (HC) *Guidance for Evaluating Human Health Impacts in EA: Noise*, dated 2011 (HC method) was used for guidance purposes where needed. Both are described in more detail in the following subsections.

Specific noise or sound level criteria are not cited in the NEB *Filing Manual*; however, it does specifically refer to the Alberta Energy Resource Conservation Board (ERCB) and British Columbia Oil and Gas Commission (BC OGC) noise limits. The ERCB has recently changed name to the Alberta Energy Regulator (AER) which is the reference that will be used in this report. Both the AER and BC OGC methods use threshold based criteria to establish an accepted ceiling or maximum sound level that can be directly compared to measured data to determine compliance or acceptability. The HC method approach uses annoyance based criteria which relates sound levels to subjective human responses in order to establish criteria.

The Westridge Marine Terminal also falls under the jurisdiction of Port Metro Vancouver (PMV). The PMV does not set specific standards for noise; however, it does expect terminal operators to comply with local regulation and guidance wherever possible.

1.3.1.1 NEB Filing Manual

The NEB *Filing Manual*. (2013), provides content guidance regarding the acoustic environment where a detailed submission is required component of the ESA. Specifically, Table A-2 of the NEB *Filing Manual* indicates that construction related sound levels be assessed where a public concern has been addressed and that operation noise be assessed for any project that may result in an increase in noise emissions during operations or maintenance. It outlines needs for noise management plans and follow-up monitoring when issues are found or concerns are raised regarding sound levels. sound levelsound levelThe NEB *Filling Manual* also requires that potential for cumulative effects with residual sound be evaluated.

1.3.1.2 HC Guidance

The second federal document that can be applied from an acoustic environment perspective is the HC: *Guidance for Evaluating Human Health Impacts in EA: Noise* (HC guidance)(HC 2011). This alternate assessment approach uses annoyance based criteria which relates sound levels to subjective human responses in order to establish criteria. Measured data is altered using penalties or coefficients to provide a noise 'indicator' that represents a value that relates to the subjective response. According to the HC guidance, calculations are mainly based on the International Standards Organization ISO 1996-1 standard (ISO 2003). The HC guidance also describes specific methods for assessing low frequency noise (LFN) or high energy impulsive sound (blasting).

This method can apply to sound from normal operations as well as construction activities associated with the Project. While not specifically referenced in the NEB *Filing Manual*, this method can provide more context around sound level changes, specifically in urban areas with multiple receptors and in relation to construction activity.

1.3.2 Provincial Standards

1.3.2.1 Provincial Standards in Alberta

Noise from oil and gas activity in Alberta is regulated by the AER, formerly the ERCB, through Directive 038: *Noise Control* (2007) and is the guidance specifically cited by the NEB. This regulation outlines specific requirements for the content of noise impact assessments, assessment methods, and noise monitoring requirements. The regulation defines noise sensitive receptors as residences or dwellings, and details specific criteria to be met at noise sensitive receptors. Directive 038 also requires that noise be controlled even when no receptors are present and sets criteria to be met at distance from a facility.

AER Directive 038 applies to noise from operations and does not specifically regulate noise from construction although the expectation that construction related sound levels will be managed is stated.

1.3.2.2 Provincial Standards in British Columbia

The noise created by the Project in BC is based on the methods and limits outlined in the BC OGC document (2009). This guideline outlines acceptable prediction methods, directions for the consideration of ambient sound, and requirements for the consideration of cumulative effects (BC OGC 2009) and was developed by the BC OGC to establish reasonable levels around facilities to minimize the effect of energy resource developments on the acoustic environment.

The document is heavily based on AER Directive 038 resulting in consistency in criteria across jurisdictions for the Project. This means it also applies to noise from operations and does not specifically regulate noise from construction although the expectation that construction related sound levels will be managed is stated.

1.3.2.3 Provincial Standards for Blasting

As both the Alberta and BC provinces do not have generally accepted guidelines for the evaluation of effects of airborne/ground-borne vibration on people, guidance from other Canadian provinces was used. The Ontario Ministry of Environment (ONMOE 1979) guidance was found to be the most stringent, therefore was used to compare against the calculations of airborne/ground-borne vibration from blasting for the Project.

SECTION 4 GROUNDWATER REFERENCES

80	**Water well inventory** Trans Mountain must file with the NEB, **at least 60 days prior to commencing construction**, an inventory of physically verified ("ground-truthed") water wells that are within 150 metres of either side of the centre of the pipeline right-of-way. The inventory must include a description of the methods used to identify and physically verify wells, including: a) each well's location in proximity to the right-of-way, including its GPS coordinates; b) a description of each well's type or use (e.g., drinking water, agricultural use, use by Aboriginal groups, any other uses); c) each well's tenure or ownership (e.g., private, municipal, Aboriginal community); d) each well's operational status, including abandoned or decommissioned wells; e) a plan for updating the inventory over the life of the Project, including: i) the methods for identifying and verifying abandoned or decommissioned wells, and new or replacement wells; and ii) the frequency of inventory updates; f) a list of any properties or sections of the right-of-way that were not physically verified, including; i) the reason why properties or right-of-way sections were not physically accessed; ii) an estimate of the potential number of wells that have not been physically verified; and iii) a proposed schedule for accessing properties or right-of-way sections; and g) a description of Trans Mountain's plans for communicating information about the locations of water wells to owners or affected users. Trans Mountain must continue to update this inventory for audit purposes for the operational life of the Project, **according to the frequency specified in e)**. Trans Mountain must make the inventory available to the NEB **upon request.**
81	**Consultation reports – protection of municipal water sources** Trans Mountain must file with the NEB, **at least 60 days prior to commencing construction**, **and on or before 31 January of each year during construction and of the first 5 years after commencing Project operations,** a report on Trans Mountain's consultations with municipalities, communities, and Aboriginal groups related to the protection of municipal and community water sources. Each report must include: a) The name of the municipality, community, or Aboriginal group consulted. b) The methods, dates, and locations of all meetings or consultations. c) A summary of all issues or concerns raised. d) A description of the measures taken, or that will be taken, to address or respond to concerns raised, or an explanation why no further action is required to address or respond to issues or concerns. e) A summary of any steps or measures that have been or will be undertaken, including groundwater modelling or monitoring, as a result of consultations with municipalities, communities, or Aboriginal groups. This summary must include: i) any updates or amendments to maintenance policies, systems, programs, procedures, practices, and activities aimed at preventing pipeline releases; ii) the criteria used to identify and select modelling or monitoring locations and parameters; iii) results of any modelling or monitoring; and

Activity/Concern	Potential Mitigation Measures
Trenching (cont'd)	19. Limit the length of open trench and the time the trench will be left open to reduce the amount of trench sloughing, frost penetration and interference with wildlife, landowners and livestock. 20. Ensure that trenching does not encroach upon the riparian buffer area at watercourse and wetland crossings. Allow adequate space for the excavation of a bellhole to complete the tie-in following watercourse/wetland crossing construction without disturbance of the riparian buffer. 21. Leave or install soft plugs in the trench, in the event that the pipeline trench separates livestock from water supply. If the livestock are reluctant to cross the trench, make arrangements to provide a temporary water supply (trucked in water and troughs) in the area where the livestock are located. 22. Keep trench spoil pile separate from topsoil/root zone material pile. Maintain a minimum separation distance of 1 m between topsoil and trench spoil piles on agricultural lands (see Drawing [Conventional Right-of-Way Configuration] provided in Appendix R). 23. Place a barrier (*e.g.,* approximately 15 cm thick straw barrier, tarps or other material approved by the Environmental Inspector[s]) at localized areas where a 1 m (minimum) separation cannot be maintained between topsoil/root zone material and subsoil piles due to workspace limitations. 24. Leave gaps in the spoil pile and trench line, where requested, to allow farm equipment and livestock to cross the construction right-of-way. Gaps will be coincident with gaps in welded pipe and topsoil/root zone material, snow (if present) and rollback windrows (if present). For temporary crossing, soft plugs may be installed following trenching. 25. Leave hard plugs or install soft plugs at locations where the open trench could dewater a wetland or flood other areas. Allow access for excavators to remove hard and soft plugs. 26. Install soft plugs across the open trench, where warranted, in areas of high wildlife use and where the trench will be left open for a longer than typical period (*e.g.,* locations where blasting or boulder excavation will be or has been conducted) in order to provide access across the trench for wildlife, livestock and equipment. Locations where trench plugs for wildlife and/or livestock movement are to be installed will be identified by a Wildlife Resource Specialist, the Inspector(s) or as shown on the Environmental Alignment Sheets. 27. Remove any trapped animals from the trench before conducting construction activities. 28. Refer to environmental resource-specific mitigation tables for wildlife crossings in Appendix L. 29. Ensure an environmental monitor with experience in contaminated sites is present to check for indications of potential groundwater contamination (*i.e.,* sheen, adjacent soil staining) during pipeline trench excavation in areas where there is higher potential for encountering contamination (*e.g.*, urban areas). Where groundwater contamination is suspected, the groundwater should be sampled and analyzed by an accredited laboratory.

Activity/Concern	Potential Mitigation Measures
Topsoil/Root Zone Material/Subsoil Separation	43. Maintain the spoil pile separately from the topsoil/root zone material pile. Maintain a minimum separation distance of 1 m between topsoil/root zone material and spoil piles on agricultural lands (see Drawing [Conventional Right-of-Way Configuration] provided in Appendix R). 44. Maintain a separation distance between the topsoil and the upper subsoil piles as well as between upper and lower subsoil piles, where three-lift soils handling is conducted.
Wildlife and Livestock	45. Report the location and species of wildlife or livestock trapped in the trench if present, to the Environmental Inspector(s) if wildlife or livestock are discovered in the trench. The Lead Environmental Inspector or the Environmental Inspector(s) will contact the appropriate regulatory authority (AESRD Fish and Wildlife, BC MOE) or the land agent, who in turn will contact the landowner, if necessary.
Unstable Trench Walls	46. Store salvaged topsoil or root zone material at a sufficient distance from the trench so that topsoil or root zone material is not lost in the trench, if trench instability is anticipated. 47. Suspend trenching and salvage a wider area of topsoil/root zone material if the trench walls slough into the trench and the potential for topsoil/root zone material/subsoil mixing exists. Backslope the trench walls until stable. Equip backhoe with a swamp bucket, if practical, to avoid or reduce trench sloughing.
Potential Springs	48. Monitor water encountered in the trench during trenching to determine if groundwater flow is being intercepted. If spring flow has been disrupted, seek and follow the advice of the Hydrogeological or Geotechnical Resource Specialist to maintain cross drainage within the trench (*e.g.,* installation of subdrains, trench breakers, etc.). 49. Refer to environmental resource-specific mitigation tables for hydrologic features provided in Appendix G.
High Water Table	50. Delay trenching until immediately prior to lowering-in at locations with a high water table or where there is a risk of sloughing. 51. Assess the need for well points or other dewatering methods, prior to commencing trenching, to intercept groundwater at site-specific locations before it enters the trench.
Dewatering Trench	52. Ensure that no wetlands are dewatered. Water will not be permanently removed from the wetland. Options for trench dewatering within wetlands will be discussed with the Lead Environmental Inspector, the Environmental Inspector(s) and the appropriate regulatory authority in order to develop the appropriate plans.

Technical Report TR-22

Vancouver Fraser Port Authority Development Permit Application

Consultation Summary – Westridge Marine Terminal

Appendix P

TRANSMOUNTAIN

Proposed Expansion
Current Pipeline Operations
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- Trans Mountain Updates
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TERMPOL REVIEW COMMITTEE SUPPORTS SEVERAL SAFETY MEASURES PROPOSED BY TRANS MOUNTAIN

February 18, 2015

back to all news

As part of its Facilities Application review process, Trans Mountain has received TERMPOL-related Intervenor Information Requests (IRs) submitted by the National Energy Board (NEB) on behalf of approved Intervenors. Received on February 18, the IRs provide Intervenors with the opportunity to ask questions and find out more about Trans Mountain's *TERMPOL Review* and its findings. Trans Mountain's responses to the TERMPOL IRs must be filed with the NEB by March 17, 2015.

The TERMPOL (Technical Review Process of Marine Terminal Systems and Transhipment Sites) Review is a voluntary process that focuses on vessel safety and vessel operation safety in Canadian waters along the proposed shipping routes. The review examines vessel characteristics, the proposed routes, navigability, other waterway users and the marine terminal operations associated with vessel operations. It is a technical analysis designed to assess the risks to navigation as well as public and environmental safety associated with shipping and navigation. Trans Mountain conducted a prescribed set of studies and submitted these to the TERMPOL Review Committee (TRC), which is chaired by Transport Canada and includes representatives of other federal agencies including the Canadian Coast Guard, Fisheries and Oceans Canada and Environment Canada.

TERMPOL Review Committee findings

After reviewing Trans Mountain's studies and taking into account Trans Mountain's commitments, the TRC did not identify regulatory concerns for the tankers, tanker operations, the proposed route, navigability, other waterway users and the marine terminal operations associated with tankers supporting the Project.

The TRC in its reports noted it did not consider the overall increase in marine traffic levels to be an issue; however, it does support additional measures to promote shared safe use of the Project's preferred shipping route.

In response to the submission, the TRC also identified several findings and recommendations and has proposed actions for Trans Mountain that would provide a high level of safety for tanker operations. Key measures to reduce risk and enhance awareness include:

- Extended use of tethered and untethered tug escort
- Extension of the pilot disembarkation zone
- Safety calls by laden tankers when in transit

- Guidance on communication between masters and watch-keeping personnel to support strong communication between tankers and their escort tugs
- Clear guidance to industry on enhancements to the marine safety regime that will impact their operations
- An engagement and awareness strategy to promote safe navigation and interaction between Project tankers and recreational boaters, fishing vessel operators and operators of small vessels

A complete list of the TRC's findings and recommendations can be found in the TERMPOL Review Committee report submitted to the National Energy Board on December 11, 2014.

The TERMPOL studies can be found in Volume 8C of the *facilities application*.

prev *2015 Field Studies* *BC 'commuters' could get more family ...* *next*

We want to hear from you:

1.866.514.6700

info@transmountain.com

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Burnaby, BC V5A 4T9

Blog Posts

Green Marine: A Commitment to Continuous Improvement

NOVEMBER 17, 2016 / UNCATEGORIZED / 1 COMMENT

Guest post: Michael Davies, Senior Director of Marine Development At Trans Mountain we take our commitment to environmental protection seriously. When ...

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Three facts about the Expansion Project's impact on marine traffic

OCTOBER 27, 2016 / UNCATEGORIZED / LEAVE A COMMENT

Approval of the Trans Mountain Expansion Project (TMEP) would bring an increase in oil tanker calls to Westridge Marine Terminal ...

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Meet Captain Robert Scott, Loading Master

OCTOBER 12, 2016 / UNCATEGORIZED / LEAVE A COMMENT

I feel that I'm making a difference here in keeping the environment safe. Captain Robert Scott is Loading Master at ...

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Your Top 7 Questions about the economic benefits of the Trans Mountain Expansion Project for the Lower Mainland-Fraser Valley

OCTOBER 6, 2016 / UNCATEGORIZED / LEAVE A COMMENT

What primary economic benefits does the Trans Mountain Expansion Project (TMEP) bring to the Lower Mainland and Fraser Valley region? ...

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Video Insight: Kinder Morgan Canada regularly tests and practices Emergency Management Program

OCTOBER 6, 2016 / UNCATEGORIZED / 1 COMMENT

Approximately 30 personnel took part in an emergency response training exercise on the Sumas River in Abbotsford in September 2016, ...

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Emergency Response: Now and for the future

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Guest post: Jamie Kereliuk, Director of Emergency Management, Kinder Morgan Canada Trans Mountain strives to be a leader in the ...

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Industry collaboration key to protecting at-risk

Major Spill Response Investment Includes New Vancouver Harbour Base

The History of WCMRC: Honouring 40 Years of Spill Response

SEPTEMBER 15, 2016 / UNCATEGORIZED / LEAVE A COMMENT

Western Canada Marine Response Corporation (WCMRC) is honouring 40 years of

Your Top 5 Questions about the Trans Mountain Expansion Project for Coastal Communities

AUGUST 17, 2016 / UNCATEGORIZED / LEAVE A COMMENT

What overall economic benefits does the Project create? On the national scale, the Project will create a long-term legacy of ...

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Video Insight: Risk is a Combination of Probability and Consequence

AUGUST 4, 2016 / UNCATEGORIZED / LEAVE A COMMENT

In the National Energy Board's Recommendation Report for the Trans Mountain Expansion Project, the Board carefully analyzed the risks associated ...

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Michael Davies: Protecting our Coast is Paramount

Your Top 8 Questions about the Trans Mountain Expansion Project for North Shore communities

AUGUST 10, 2016 / UNCATEGORIZED / LEAVE A COMMENT

What community benefits does Kinder Morgan Canada bring to North Shore communities? Kinder Morgan has a long history of investing in ...

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Michael Davies: Marine environment one of our most important considerations

JULY 28, 2016 / UNCATEGORIZED / 1 COMMENT

As someone who grew up in the Lower Mainland, I value our marine environment. Trans Mountain shares this value and ...

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Focus on Conditions: Marine

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Your Top 6 Questions about the Trans Mountain Expansion Project for Vancouver

AUGUST 10, 2016 / UNCATEGORIZED / LEAVE A COMMENT

What overall economic benefits does the Project create? On the national scale, the Project will create a long-term legacy of ...

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Marine Safety Enhancements Already Underway in Local Waters

AUGUST 10, 2016 / UNCATEGORIZED / LEAVE A COMMENT

Bikramjit Kanjilal, Consulting Lead for Marine Development, Trans Mountain Expansion Project As a Master Mariner with more than 40 years ...

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Focus on Conditions: Environment and Climate

JULY 19, 2016 / UNCATEGORIZED /

Your Top 7 Questions on Marine Safety

JUNE 23, 2016 / UNCATEGORIZED / LEAVE A COMMENT

Trans Mountain has loaded vessels at our Westridge Marine Terminal since 1956 without a single spill from tanker operations. The ...

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Opening the door to safer work conditions for all marine pilots on BC's southern shipping route

APRIL 7, 2016 / UNCATEGORIZED / LEAVE A COMMENT

Marine pilots are essential to the safe movement of ships on the coast, providing expert knowledge of local waters to ...

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Consistent dialogue with stakeholder groups a priority for new BC Chamber of Shipping President

MARCH 16, 2016 /

Mike Davies: 60 Years of Safe Operations Make Expanding Westridge the Best Option

JUNE 21, 2016 / UNCATEGORIZED / LEAVE A COMMENT

We have been safely loading tankers from our facility since the 1950s without incident. There is an existing, well-established marine ...

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Cenovus Energy shares the public's concern about protection of the marine environment

MARCH 24, 2016 / UNCATEGORIZED / LEAVE A COMMENT

We understand people's concerns about ensuring the marine environment is protected. In part one of our interview with Claus Thornberg, Cenovus ...

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Market access drives new marine strategy for Cenovus Energy

Supporter Spotlight: Aqua-Guard Spill Response Inc.

MAY 12, 2016 / UNCATEGORIZED / LEAVE A COMMENT

Aqua-Guard Spill Response Inc. is a company that is based in North Vancouver and Coquitlam, BC. The company manufactures ..

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Marine safety: Enhancements already underway in local waters

APRIL 28, 2016 / UNCATEGORIZED / LEAVE A COMMENT

Since 1956 we've loaded vessels from our Burnaby marine terminal without a single spill from tanker operations. The region's already ...

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Meet Richard Wiefelspuett, Executive Director of Clear Seas

MARCH 9, 2016 / UNCATEGORIZED / LEAVE A COMMENT

Video: New measures to further improve safety for marine shipping industry

FEBRUARY 24, 2016 /
UNCATEGORIZED /
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The safety of our coastline is paramount. If an oil spill occurs in the marine environment, multiple organizations quickly take ...

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West coast spill response organization adding high-tech capacity, new boats and staff. Trans Mountain expansion would add even more.

JANUARY 7, 2016 /
UNCATEGORIZED /
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British Columbia's Transport Canada-certified marine oil spill response organization has been busy in recent months adding new boats, high-tech gear ...

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Video: Crews practice

Video: Marine Safety is an Important Priority for Expansion Project

FEBRUARY 11, 2016 /
UNCATEGORIZED /
LEAVE A COMMENT

Kinder Morgan Canada conducted its largest Emergency Response Exercise at our Westridge Marine Terminal in Burnaby, BC in October, 2015 ...

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Trans Mountain's marine safety proposals go above and beyond existing requirements

JANUARY 19, 2016 /
UNCATEGORIZED /
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Trans Mountain, together with WCMRC, has proposed enhancements to the current oil spill response regime, specific to this region, that ...

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Industry Insight: World class in every sense of the word

Disappearing act by small boat operators the focus of new safety campaign by Pacific Pilotage Authority and Trans Mountain

FEBRUARY 3, 2016 /
UNCATEGORIZED /
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The view from the bridge of a freighter moving slowly through Vancouver Harbour tells a disturbing but familiar story. It's ...

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Top 5 of 2015

DECEMBER 31, 2015 /
UNCATEGORIZED /
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Covering a range of topics, including jobs, the behaviour of diluted bitumen and the ways we keep the pipeline operating safely, these ...

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60 year milestone: First offshore shipment loaded at Westridge Marine Terminal

DECEMBER 31, 2015 /

At the helm of operations and safety at Port Metro Vancouver

OCTOBER 20, 2015 / UNCATEGORIZED / LEAVE A COMMENT

Regardless of the percentage of total traffic tankers may represent at our port, the safety and environmental protection of our ...

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Captain John Armstrong discusses the qualifications and training needed to become a tug captain

JUNE 17, 2015 / UNCATEGORIZED / LEAVE A COMMENT

The tankers that come to Westridge are similar in shape and size to the dry bulk carriers we see in ...

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Video: Captain Stephen Brown, Chamber of Shipping of British Columbia President

NEB Draft Conditions: Taking a closer look

AUGUST 20, 2015 / UNCATEGORIZED / LEAVE A COMMENT

For more than three years, Trans Mountain has been carrying out extensive environmental and technical studies, engineering and design work, ...

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Chris Badger, Master Mariner, discusses the impact a $100 million investment from the Trans Mountain Expansion Project would have on marine safety for BC's coast

JULY 29, 2015 / UNCATEGORIZED / LEAVE A COMMENT

The ocean is where I have worked and played for almost my whole life. It's how I've defined myself. Using ...

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Your Feedback in Action: Westridge Marine Terminal Expansion

Senior Director Greg Hill discusses an innovative solution for managing ship loading emissions at the expanded Westridge Marine Terminal

AUGUST 12, 2015 / UNCATEGORIZED / LEAVE A COMMENT

With the measures we are putting in place, we do not anticipate nuisance odours from our expanded operations. One of ...

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Tugs have flawless record supporting tanker movements in Port Metro Vancouver

JUNE 10, 2015 / UNCATEGORIZED / LEAVE A COMMENT

There have probably been 30,000-plus ships with tug escorts through that area, and there have been no groundings, contact or ...

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Oil tanker pilots have decades of local experience

Meet Kevin Obermeyer, President and CEO of the Pacific Pilotage Authority

MAY 27, 2015 / UNCATEGORIZED / LEAVE A COMMENT

You cannot bring a ship from deep sea anywhere on the west coast of Canada without taking a pilot Kevin ...

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3 Things You Need to Know About Tankers

JANUARY 15, 2015 / UNCATEGORIZED / 1 COMMENT

There's a lot being said about tankers and tanker traffic in BC, sometimes it's difficult to tell fact from fiction. These ...

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Marine Safety is the Top Priority in Local Canadian Waters

JANUARY 15, 2015 / UNCATEGORIZED / 1 COMMENT

Marine safety is always a top priority whenever we're talking to people not just on the coast but across the ...

WCMRC: The Future of Spill Response on the West Coast

MAY 6, 2015 / UNCATEGORIZED / 2 COMMENTS

Following the recent bunker fuel spill in English Bay we asked Western Canada Marine Response Corporation (WCMRC) to fill us ...

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Meet Calum Bonnington, fisheries lead for the Trans Mountain Expansion Project

MARCH 11, 2015 / UNCATEGORIZED / LEAVE A COMMENT

It's incredibly rewarding when you have a hands-on interaction with the environment and ensuring all elements are addressed when working ...

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Meet Bikram Kanjilal, Master Mariner

OCTOBER 20, 2014 / UNCATEGORIZED / 1 COMMENT

Conversations That Matter: Marine safety

APRIL 29, 2015 / UNCATEGORIZED / LEAVE A COMMENT

Our Senior Director of Marine Development Michael Davies recently sat down with Stuart McNish for an interview that is part ...

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Meet Capt. Stephen Brown, President, Chamber of Shipping of British Columbia

APRIL 28, 2015 / UNCATEGORIZED / 4 COMMENTS

We have a great deal of room to grow before traffic density becomes an issue. We do actually have some ...

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Video: Marine Safety

JANUARY 14, 2015 / UNCATEGORIZED / 1 COMMENT

We're very proud of the safety record we have at the Westridge Marine Terminal. In it's entire operating history the ...

Marine Safety Enhancements Already Underway in Local Waters

AUGUST 10, 2016 UNCATEGORIZED LEAVE A COMMENT

Bikramjit Kanjilal, Consulting Lead for Marine Development, Trans Mountain Expansion Project

As a Master Mariner with more than 40 years of experience in the marine industry, I know first-hand the importance of a strong safety regime at sea. For more than four years a team of marine experts and risk assessors has been involved in identifying and addressing marine transportation risks related to the Expansion Project.

The region's marine safety regime is robust, well managed, with important risk controls for all traffic and for oil tankers in particular, and meets or exceeds global standards. The frequency and size of tanker oil spills globally has been steadily declining. However, just because the safety records are good today, we should not simply accept the status quo. I'm a great believer in continual improvement.

Trans Mountain has proposed additional measures that, once implemented, are expected to raise the level of care and safety in the region to well above globally-accepted shipping standards. Let me explain with some examples.

All movements of commercial vessels in the Salish Sea take place under the watchful eyes of Coast Guard operators. In near coastal waters, the vessels are guided by skilled and experienced local pilots and tug operators who undergo regular training, including simulator training, to continually hone their vessel manoeuvering skills and ability to respond in case abnormal conditions are encountered.

Vessels calling at our Westridge Terminal must be double hulled and checked in advance to confirm they can operate to high safety and environmental standards. The vessels are operated

by trained crews under a safety management system that is audited and certified. Standards are set by the International Maritime Organization and are reviewed regularly.

Highly-trained and qualified local pilots ensure all large commercial vessels, including tankers, navigate our local waters safely. Already, laden tankers carry two pilots. If this Project is approved, outbound piloting of laden tankers will be extended further west of the Victoria pilot station to Race Rocks at the eastern entry to the Juan de Fuca Strait. To make it safer and easier for pilots to disembark, Trans Mountain has contributed to training for them to disembark by helicopter.

Professional mariners serving in the local tug fleets assist all vessels while in harbour and in the case of laden tankers, escort them through the Gulf Islands. Tug escort of laden tankers will be extended all the way to the western entrance of the Juan de Fuca Strait to Buoy J, located near the 12 nautical mile limit of Canada's territorial sea.

Safe shipping is a passion I've pursued my entire career and I am proud to say the Project has demonstrated it is also committed to that. It's my belief the Project will set a higher benchmark in marine safety in the region, a lasting legacy that will benefit all users of our local waters.

https://blog.transmountain.com/marine-safety-enhancements-already-underway-in-local-waters-2/

Michael Davies: Protecting our Coast is Paramount

JUNE 30, 2016 UNCATEGORIZED LEAVE A COMMENT

We understand the concerns raised about tanker traffic, spill prevention and emergency response, and that's why we've carefully developed measures to protect communities and our ecosystems.

Trans Mountain knows protecting the coast is paramount to British Columbians, and we couldn't agree more. As someone who grew up in the Lower Mainland, I share the value you place on the environment. I have a deep appreciation for the cultural, environmental and economic value our waterways provide to the people who live and work here.

We understand the concerns raised about tanker traffic, spill prevention and emergency response, and that's why we've carefully developed measures to protect communities and our ecosystems.

We've been safely loading vessels for more than 60 years at our terminal in Burnaby without a single spill from a tanker. While the region's existing safety regime already meets global standards, Trans Mountain has committed to additional measures that will further improve safety for all vessels using our waterways.

The proposals include a $100 million investment in Western Canada Marine Response Corporation to create new response bases, fund new equipment and employ 100 new people. This will double the spill response capabilities and cut mandated response times in half. And, an expanded tug escort regime will cover the entire tanker route – from Burnaby through the Strait of Georgia and the Strait of Juan de Fuca. Combined with the measures to prevent spills, our goal is to have an industry-leading emergency response plan that's never used.

Close to 6,000 commercial vessels transit through the Salish Sea annually and of those about 600 are tankers. On average, about five tankers per month call at the Westridge Marine Terminal and our Project proposes an increase to up to 34. Today, we're only a small part of the existing traffic – less than two per cent – and we'll remain a small portion of all traffic even after the expansion. It's also worth mentioning that our expansion proposes the same sized tankers, shipping the same products as we do today.

The National Energy Board concluded our Project is in the national public interest and should proceed with 157 conditions. The recommendation is the culmination of a lengthy and thorough regulatory review process and considers the many thousands of hours of environmental and technical studies, scientific evidence and community engagement that have been part of this assessment.

We know, however, there's still more work to do. Our team continues to build upon an extensive four-year consultation program and many of the enhancements to our marine safety program are in response to community and Intervenor feedback.

These conversations have resulted in hundreds of commitments made by us to address concerns. Should the Project be approved by the Government of Canada, we'll ensure each of those commitments are met.

I encourage you to ask us questions and provide feedback. By working together we can build an expansion that balances social, environmental and economic interests, and delivers lasting benefits for our entire country.

https://blog.transmountain.com/michael-davies-protecting-our-coast-is-paramount/

Opening the door to safer work conditions for all marine pilots on BC's southern shipping route

APRIL 7, 2016 UNCATEGORIZED LEAVE A COMMENT

Marine pilots are essential to the safe movement of ships on the coast, providing expert knowledge of local waters to foreign vessels.

Under Pacific Pilotage Regulations, every ship over 350 gross tons that is not a pleasure craft and every pleasure craft over 500 gross tons is subject to compulsory pilotage along the British Columbia coast.

A common practice for getting a pilot on board a vessel coming into port is to ferry the pilot to it by launch boat. Alongside, the pilot ascends the side of the ship on a rope ladder. On an outbound ship such as a laden oil tanker, the process is reversed with the pilot disembarking to a launch when the assignment is complete.

In bad weather and heaving seas, moving between a ship and a launch that's rising or falling with 10-metre swells is challenging even for an expert. Globally, this is recognized as the most dangerous part of a pilot's daily job and it takes courage, skill and experience on the pilot's part to get on and off a ship safely.

It can also be time consuming to travel to or from the ship — sometimes the equivalent of an entire workday for someone with a job in an office or a factory — before the actual pilot assignment begins.

The Pacific Pilotage Authority (PPA) and the British Columbia Coast Pilots (BCCP) are working on a new program — using a helicopter instead of a launch boat — that would make it safer, easier

and more cost-effective for these exceptional mariners to carry out assignments such as piloting laden oil tankers departing from Port Metro Vancouver.

With heli-hoisting, instead of descending a ladder onto a launch waiting alongside, a disembarking pilot goes to the top of the ship or a clear area on deck, steps into a full harness, clips into a hoisting cable from a helicopter hovering overhead and is quickly taken inside the helicopter and away.

Last year the Authority introduced heli-hoisting for pilots serving the north coast. Recently the PPA put out tenders for a contract to shuttle pilots who work on the southern shipping route in the Salish Sea, which includes Port Metro Vancouver.

The PPA has been working on a heli-hoisting initiative for five years. It was further prompted to pursue this initiative upon request of the Trans Mountain Expansion Project (TMEP) as part of TMEP's marine safety proposals — heli-hoisting from near Race Rocks was evaluated as part of the TERMPOL Review Process. TERMPOL, led by Transport Canada, is a voluntary process focused on the increase in marine transportation related to the Project.

Trans Mountain wanted to extend the outbound piloting of laden tankers further west of the Victoria pilot station that is currently used. According to TMEP's risk assessors, extending the pilot's conduct of the tanker until near Race Rocks at the eastern entry to the Strait of Juan de Fuca will increase navigation safety in the area.

PPA President and CEO Kevin Obermeyer said the introduction of heli-hoisting on the north coast, in advance of anticipated LNG export facility development in the region, has been a success. He expects similar positive results on the southern shipping route used by tankers and other commercial vessels.

"It's up and running in the north," Obermeyer said. "We did the tender and we chose a helicopter operator, Great Slave Helicopters. They pick the pilots up right from the bridge wing on the ships, both inbound and outbound."

“It has cut our travel time on the launches from just over an hour and fifteen minutes from dock to ship to 14 minutes. So it’s much more efficient and really appreciated by the pilots because of the added safety and convenience.”

The logistics of getting pilots on and off ships can be arduous. In one of the most extreme circumstances, a BC pilot has to drive down to Tacoma or even Seattle to board a container ship headed to Vancouver, ride it north and then take the conduct when it crosses into Canadian waters. Switching to heli-hoisting in the south will eliminate many wasted hours.

Obermeyer notes that although all ships will benefit, the project becomes cost-effective because of Trans Mountain’s proposed expansion.

The expansion, which involves a near tripling of capacity in the Trans Mountain pipeline, is expected to increase the number of tankers calling at Westridge Marine Terminal from about five per month to about 34 per month.

“If it wasn’t for Trans Mountain and for the LNG proposals up north, we may not have gotten this far into this. It makes heli-hoisting viable when you have one tanker departing Westridge every day,” Obermeyer said.

Only one other North American port, the dangerously turbulent mouth of the Columbia River between Washington State and Oregon, uses heli-hoisting. The PPA developed its program after visiting Columbia Bar operations, Obermeyer said.

“The seas there are horrendous. A number of Bar pilots have been injured in the past, falling off the ladders, falling off the boat; but since the inception of the helicopter, not a one. It’s been huge boon to them, a total lifesaving exercise. So they’re the ones we’ve been trying to emulate.”

“We will put pilots on board in up to 45 and 50 knot winds, so it’s pretty rough. You’re probably rising and falling 20 to 30 feet in the launch next to the ship. It’s a lot of physical labour.

“With heli-hoisting, there is no ladder to worry about. A helicopter flies over the vessel and lowers the pilot right onto the bridge wing in most cases. It’s a very safe operation. You’re over the ship for maybe 10 seconds and the helicopter’s gone and you’re on deck. It’s the same when picking you up. You arrive and 10 seconds later you’re inside the helicopter and you’re gone.”

https://blog.transmountain.com/opening-the-door-to-safer-work-conditions-for-all-marine-pilots-on-bcs-southern-shipping-route/

Disappearing act by small boat operators the focus of new safety campaign by Pacific Pilotage Authority and Trans Mountain

FEBRUARY 3, 2016 UNCATEGORIZED LEAVE A COMMENT

The view from the bridge of a freighter moving slowly through Vancouver Harbour tells a disturbing but familiar story.

It's an overcast, rainy morning. Window wipers methodically sweep clear the big front pane of the bridge. A pair of tugs approach to help the pilot bring the ship safely to dock. It's a common manoeuvre, carried out dozens of times each day in Port Metro Vancouver.

There's one problem.

The operator of a pleasure boat, a cabin cruiser, is not interested in waiting for the ship to pass or going around its stern. Instead the operator decides to shave a few seconds from a trip through the port by cutting across the path of the approaching ship.

To a casual observer, it's like watching a motorist snake around guardrails at a railway crossing. As a video of the event shows, the pleasure boat disappears on the starboard side of the freighter's bow and does not emerge on the port side for 14 seconds — an eternity to the pilot and ship's bridge team.

What many recreational boat operators — as well as operators of other pleasure craft and commercial fishing vessels — don't appreciate is that if a small boat gets very close, it's no longer visible to the pilot or any of the ship's navigating team from the ship's bridge. This is because from the bridge, a pilot's view of the water is obscured by the bow of the ship for hundreds of metres out ahead.

For a coal ship like the one in this video, or a general cargo ship or oil tanker, the obscured distance can be about 350 metres. In case of a large container ship carrying a high load of containers on deck, the blind spot can extend to one kilometre or more ahead of the ship. As container ships get bigger, the distance becomes more critical.

This means a small boat's manoeuvre is a dangerous game. If for some reason it stalls in front of an approaching ship, it can be life altering for anyone travelling on the small boat.

Pacific Pilotage Authority (PPA) President and CEO Capt. Kevin Obermeyer, who shot the video, likens the risk to those warning signs you often see on the back box or bumper of a delivery truck or transport vehicle: 'If you can't see my mirrors, I can't see you.'

"It's the same for us on the deep sea vessels. If you can't see the bridge, we can't see you," Obermeyer explained.

"I'd only joined the pilot when we were at anchor in English Bay and we brought that ship through First Narrows and alongside to load coal. The one I shot was the third or fourth boat to

do that. Earlier, as we approached First Narrows we'd had the same thing happen and the captain pushed the foghorn five times, warned the guy and everything."

It's a lot more intense in summer when a more casual group of boaters, "people with no idea about collision regulations," take to the water, Obermeyer added. "I don't think the general boating public — even those that are more experienced — realize the danger in cutting across the bow, that we can't see them and can't take manoeuvring action. It's a huge issue."

Marine safety should be a concern for every mariner. A small boat is more vulnerable in front of a large ship. At the same time, a large ship, if forced to deviate from its route due to a boat in its way, could become vulnerable as well. As Obermeyer observed, "In a recent incident a ship's pilot and master decided to run the vessel aground to avoid colliding with a fishing boat. Luckily no one was hurt and there was no pollution due to that incident."

He went on to say, "Everyone who has responsibility over a vessel's navigation is required to follow the 'rules of the road.' These rules are international, they apply in all waters and they help keep everyone safe."

Kinder Morgan Canada is actively supporting PPA's work to raise awareness about small boat safety in the marine community. Trans Mountain Expansion Project (TMEP) team members are already connecting with the marine community to deliver the pilot authority's message of caution. Trans Mountain is joining the pilotage authority in circulating a new brochure that explains the dangers and offers safety tips boaters can employ to avoid risks.

Draft condition 126 for the Trans Mountain Expansion Project requires the Project to conduct a marine public outreach campaign to inform boat operators — everyone from kayakers and wind surfers to sport fishing guides and commercial fishermen — about their responsibilities for safe navigation in and around shipping routes and the need for safety when large ships are moving through.

Although a visual check is the best way to confirm the location of a large vessel, this might not always be possible, especially during periods of low visibility and fog. At such times, ensuring the boat displays appropriate navigation lights and keeps a good lookout will go a long way towards keeping everyone on the water safe.

Boaters can also add equipment to increase their safety. If possible, fit a radar reflector to the boat and carry an AIS (Automatic Identification System). The radio transponder of the AIS shows the boat's position to the ship's navigators. At the same time, the large ship is displayed on the AIS of the boat.

Trans Mountain is committed to marine safety as a high priority. TMEP's contribution to large ship traffic will remain small — Project tankers will form about 6.6 per cent of large ship traffic on the southern shipping route post-expansion.

Safety tips for small boat operators

- Maintain a proper lookout at all times.
- Ensure the correct navigational lights are displayed between sunset and sunrise.
- Avoid travelling or fishing in a shipping lane or designated traffic separation scheme or keep as near to the outer edge as possible.

- Avoid crossing ahead of a large ship. If a small boat breaks down the large ship has very little chance of avoiding it.
- Keep a listening watch on the appropriate VHF channel.
- During a fishing opening keep the centre of the channel as open as possible to allow large ships to pass safely.
- Consider fitting your small craft with AIS (Automatic Identification System) or a radar reflector to be more visible to large vessels.

https://blog.transmountain.com/disappearing-act-by-small-boat-operators-the-focus-of-new-safety-campaign-by-pacific-pilotage-authority-and-trans-mountain/

Video: New measures to further improve safety for marine shipping industry

FEBRUARY 24, 2016 UNCATEGORIZED LEAVE A COMMENT

The safety of our coastline is paramount. If an oil spill occurs in the marine environment, multiple organizations quickly take co-ordinated action to mitigate its impacts. Trans Mountain has extensiveemergency response plans ready to activate in the unlikely event of a spill at Westridge Marine Terminal.

Western Canada Marine Response Corporation (WCMRC) is the Transport Canada-certified oil spill response organization for the west coast of Canada and the WCMRC team of spill response professionals are trained to swiftly respond with carefully designed strategies and countermeasures.

For this purpose, WCMRC maintains a large inventory of sophisticated spill response equipment, including 28 response vessels, more than 50 response trailers and several types of innovative oil spill surveillance equipment.

Should the Trans Mountain Expansion Project be approved, Trans Mountain will support WCMRC to expand significantly, including making a $100 million investment to create new response bases, fund new equipment and employ 100 new people. This will double the mandated spill response capabilities along the main shipping route and at the same time cut response times in half.

While the region's existing safety regime already meets global standards, the additional measuresproposed by Trans Mountain will further improve safety for the entire marine shipping community because marine spill response is about all the vessels using our waterways.

https://blog.transmountain.com/video-new-measures-to-further-improve-safety-for-marine-shipping-industry/

Tugs have flawless record supporting tanker movements in Port Metro Vancouver

JUNE 10, 2015 UNCATEGORIZED LEAVE A COMMENT

There have probably been 30,000-plus ships with tug escorts through that area, and there have been no groundings, contact or collision incidents

Tugboats are the hardest working vessels in Port Metro Vancouver, responsible for assisting about 6,000 vessel movements each year in just the Inner Harbour alone. Oil tankers make up just a tiny fraction of the activity. Generally, tankers are required to have more tug escort and support than most other vessels — not because they are less capable ships, but because traditionally more restrictions are placed on tanker and oil movements. We recently sat down with Captain John Armstrong, Vice-President Operations for Saam Smit Towage, who explained that the tug industry has an exemplary record — and with Trans Mountain Expansion Project, an opportunity to create more well-paying jobs in this critical sector of the Canadian economy.

How many ships, including container ships, oil tankers and other vessels do tugboats assist and escort each year in and out of Vancouver Harbour?

In the Inner Harbour, which is everything east of First Narrows including Kinder Morgan's Westridge Marine Terminal loading facility, there are about 2,700 ships a year that visit. Almost all of these ships require at least one tug — but more normally, two or three when they dock, and again when they undock. As well, ships sometimes move between docks with the assistance of tugs before they finally depart. So I would say in the Inner Harbour there are

probably more than 6,000 actual ship movements per year and every one of those moves has at least one tug associated with it.

So oil tankers are only a small part of the work for tugs?

Yes. I think in 2014 there were probably just over 200 tankers that called the Burrard Inlet, only a few of those called Kinder Morgan's Westridge Marine Terminal. Most tankers that came through the Inner Harbour are not crude oil tankers. Tankers regularly load or discharge refined oil products and chemicals such as jet fuel, gasoline and ethylene glycol, as well as caustic soda and canola oil at various terminals.

Although tankers represent a smaller percentage of the total number of ships, they generally require more tug services. Port Metro Vancouver, similar to many ports globally, insists that tankers are more carefully handled. This requires more tug assist and escort. Specific to large vessel movements in the Burrard Inlet, every loaded or empty ship moving through Second Narrows, whether it's a tanker or another kind of ship, has to be escorted by a minimum of two tugs. One of those tugs must be a tractor tug tethered at the stern of the ship, and larger ships require an additional tethered tractor tug at the stern and one tug running free off the bow.

So whether it's a loaded bulk carrier full of sulphur coming from Pacific Coast Terminals in Port Moody, a ship loaded with salt destined for Canexus on the North Shore or an oil tanker visiting one of the oil terminals east of Second Narrows, it requires a tug escort at Second Narrows. There are probably 500 or 600 of those escorts each year. These requirements are set out by Port Metro Vancouver and are called Second Narrows Movement Restriction Area Procedures or MRA for short. These procedures have been reviewed and upgraded to reflect changes in technology and risk profiles. Kinder Morgan has actively supported development of these procedures by helping with a contribution to upgrade the BCIT full mission bridge simulator on which the pilots and tug operators train and practice their skills on an ongoing basis.

How often do ships moving through Second Narrows make contact with something other than a tug that's helping them manoeuvre?

Before 1980, there was no requirement for ships to have tug escorts when moving through Second Narrows. In the late 1970s, there was an incident — a ship transiting Second Narrows in the fog collided with the railway bridge. After that restrictions were put in place requiring mandatory tug escorts — and all ship transits were prohibited during periods of limited visibility. There have been no such incidents since then. To put things in perspective, since escorts became mandatory, there have probably been 30,000-plus ships with tug escorts through that area, and there have been no groundings, contact or collision incidents.

Often the public discussion around economic benefits of Trans Mountain is direct jobs. How would the Project impact your company?

If you start adding that up, it's a fair amount of tug activity. For each tug that escorts a tanker all the way out to the open sea, as is being proposed by Trans Mountain, it's a more than 24-hour trip for a tug with a five- or six-person crew. It will take one tug operating continuously every day of the year with a second tug providing back up during timing conflicts and maintenance

periods. To provide adequate time off, holidays and illness relief, it would take close to three full crews to keep just one tug fully manned 365 days per year. Add the additional back up escort tug and terminal assist tug requirements, pilots, maintenance and operational staff and you can start to see the potential for up to 50 new jobs.

They're all permanent positions, really good, well paying jobs. The people that do this work are passionate and proud of what they do and enjoy it. They do a really good job of it.

https://blog.transmountain.com/tugs-have-flawless-record-supporting-tanker-movements-in-port-metro-vancouver/

Trans Mountain's marine safety proposals go above and beyond existing requirements

JANUARY 19, 2016 UNCATEGORIZED 1 COMMENT

Trans Mountain, together with WCMRC, has proposed enhancements to the current oil spill response regime, specific to this region, that will half response time and double the capacity required under the current standards.

With some 40 years of expertise in the marine industry, Master Mariner Bikramjit Kanjilal has been working hard to make sure the proposed Trans Mountain Expansion Project's marine safety plans are second to none. Bikram sat down with us to talk about his background and why he's excited about the Project's proposed marine safety enhancement proposal.

Can you tell us about your role in developing the marine safety enhancements being proposed for the Trans Mountain Expansion Project?

My role as a consultant to this project is fairly diverse and I've been involved in all aspects of marine transportation associated with the Project.

I have more than four decades of experience in the marine industry, with more than two of those decades spent in oil and gas ship operations. As a Master Mariner, certified by Transport Canada, my skills and experience in the marine industry have been accumulated since I went out to sea in my youth. I have served in many capacities, including as master of VLCC tankers sailing internationally to many ports.

My career then led me to become increasingly involved in the management of ships, finally as a senior ship manager responsible for the safe management of one of the largest fleets of oil and gas carriers in the world. Since coming on to the Trans Mountain Expansion Project team, my aim has been to provide advice and guidance, applying my many years of experience to ensure the safest possible marine oil transportation regime to support the Project. This has included working with a highly competent team of individuals as part of the marine risk assessment TERMPOL process, each an expert in their field, be it navigation risk assessment, oil testing, oil spill modelling or oil spill response.

Every aspect of prevention and mitigation has been thoroughly assessed and included in the overall marine transportation plan where applicable and based upon risk. Trans Mountain's submission to the NEB and the TERMPOL Review Committee incorporates all of this information. The marine transportation plan is a comprehensive and practical review of current shipping practices together with a number of proposed enhancements in risk control and mitigation, which will improve marine safety of all shipping in the area, not just for Project tankers.

If the proposed Trans Mountain Expansion Project is approved, how will that affect tanker traffic and the size of vessels in PMV?

There will be no increase to the current size of tankers or the type of cargo. The largest vessels will continue to be partially-laden Aframax class of tankers. An Aframax tanker can carry approximately 110,000 tonnes when fully laden, but Project tankers will be only 85 per cent loaded due to restrictions in the Port of Vancouver at the Second Narrows. Every year about 600 tankers currently enter the Juan de Fuca Straits with destinations to Canada and the United States. Only about 60 of those come to the Westridge Marine Terminal. That number is forecasted to increase. Trans Mountain estimates that 408 partly-loaded Aframax tankers will call on Westridge Marine Terminal each year if the Trans Mountain Expansion Project goes ahead, which means annually, on average, about one tanker a day either entering or departing Burrard Inlet.

The number of other vessels in the region, unrelated to the Project, is also expected to increase between now and the time the proposed Project becomes operational. Thus, while Westridge-bound tankers constitute about 1.1 per cent of all large commercial ships entering the Salish

Sea today, in the future it's estimated that would increase to about 6.6 per cent of all such large vessels.

What kind of risk assessment activities were undertaken and what were the outcomes?

As part of a comprehensive review of the marine transportation needs of the Project, DNV GL, an internationally reputed marine risk expert organization, was engaged to assess the risk of an oil cargo spill from oil shipping in the region. The area studied extends between Westridge and the western entrance to the Juan de Fuca Strait, taking into account typical weather conditions in this area. This assessment involved several elements including the analysis of the shipping traffic, then calculating the frequency of all shipping incidents and furthermore, the frequency of cargo oil spill accidents resulting from tanker related incidents. The risk assessment shows that once additional risk control measures are implemented for Project tankers, despite the increase in tanker traffic, the likelihood of a cargo oil spill in the region will continue to remain low probability. At the same time, DNV GL simulated various grounding and collision damage conditions to a double-hull Aframax tanker (50,000 simulations were undertaken) and from that a cargo oil outflow assessment was carried out. The 90th percentile oil outflow volume, 16,500 m3, about 15,500 tonnes, caused by a collision accident was found to be the more conservative assumption. It is equivalent to the loss of the entire contents of two cargo tanks of the tanker, a highly unlikely scenario for a double-hull tanker. This volume has been considered as Credible Worst Case (CWC) for Project tankers. However, the equivalent for a fully-laden Aframax was found to be 21,000 m3, about 20,000 tonnes, and since these vessels transit the Salish Sea to call on terminals in Washington, this was adopted as the planning standard for the spill response enhancements that resulted from the assessment. A CWC volume cargo oil spill from a Project tanker is estimated as a possibility once in 2,841 years. I'll speak about the additional measures a bit later.

Using advanced oil spill simulation modelling, oil spill simulations of various sizes were carried out at five selected locations, including Westridge Marine Terminal. Given the concerns heard about the fate and behaviour of diluted bitumen crude oils, tests had been carried out by the Project team using representative samples of diluted bitumen oils; the results of these tests had been applied in developing the oil spill simulation model. Previous and subsequent tests and research carried out by other scientists, including government scientists, have found similar results.

The results of oil spill modelling showed that a large cargo oil spill in the shipping route could quite quickly affect large areas of shoreline. As such, early and efficient response was necessary in order for response to be effective. Such an approach has been used to develop the enhanced oil spill response regime.

What are the safety measures you'd most like the public to be aware of? What will change with Trans Mountain's expansion?

The first requirement is for all tankers to be of double-hull construction, which is a Canadian and international regulation. Prior to arrival, using submitted information and review of

international databases, the tanker is assessed against Trans Mountain's Tanker Acceptance Standard. A tanker cannot call at Westridge Marine Terminal unless it has met all the criteria, including certificate and insurance requirements. The tanker is boarded by a BC coast pilot near Victoria who then directs the vessel's navigation to Westridge. Along the way, through Burrard Inlet to the berth, tugs tie up to the ship to ensure its transit is always in a well-controlled manner. In addition, the tanker as well as the terminal is required to have its own oil spill response plans. That includes having pre-arrangements with WCMRC for on-water oil spill response if required. WCMRC is the government-certified response organization (RO) for the entire west coast of Canada. They are based close to Westridge in Burnaby.

At the berth, the tanker must undergo a number of safety checks in line with international tanker operating best practices. The vessel is always enclosed within a pre-deployed oil spill boom and the entire cargo loading takes place under the supervision of a Loading Master who stays onboard for the entire time. A second boom remains ready to be deployed in case any oil is spilled from the tanker to the water during the cargo transfer. A tanker oil spill has never happened during the 60 years Westridge has been operating. These practices will continue in future as well.

The new marine terminal will be built to high modern codes and standards. To ensure tankers can arrive and depart safely and efficiently from the future Westridge Marine Terminal, we reviewed various designs and then tested arrival and departure manoeuvres using computer simulation. One beneficial fallout of testing several designs was we were able to reduce the overall footprint of the terminal, making it more compact and less obtrusive to the residents of nearby communities.

The navigation safety regime in this area is already of a high standard. It constitutes internationally accepted best practices such as a well defined Traffic Separation Scheme with direct oversight and supervision by two of the world's most competent maritime authorities, Transport Canada and the United States Coast Guard. Experienced marine pilots compulsorily guide all large commercial ships; every pilot is equipped with a PPU (Personal Pilotage Unit) that provides navigation information redundancy.

Laden tankers leaving Westridge must carry two pilots. In addition, there are requirements for tug escort in Port Metro Vancouver and at critical portions of a laden tanker's route. In its navigation risk assessment report, DNV GL commented that the existing "controls are in line with global best practices." These risk controls reduce the frequency of critical situations (e.g., the traffic separation scheme will reduce the frequency of encounters (the critical situation for collision) and reduce the probability of an incident given a critical situation (e.g., pilotage will reduce the probability of collision given an encounter); escort tugs reduce the frequency of vessel grounding.

Trans Mountain has proposed additional risk controls, specific to Project tankers, to further prevent navigation incidents. Key among the proposed risk control measures is the expansion of tug escort of laden Project tankers to the entire shipping route and extension of the time the pilot is onboard. In fact, a tug will escort the laden tanker to Buoy J where the Juan De Fuca Strait ends at the Pacific Ocean. The pilot will in future be taken off by a helicopter near Race Rocks, some distance beyond Victoria. Taken together these measures significantly reduce the

likelihood of navigation incidents, which in turn reduces the likelihood of a cargo oil spill accident resulting from an incident.

How is risk of an oil spill mitigated by the marine safety enhancements Trans Mountain is proposing?

From the description above, I'm sure it will be clear that a lot of thought has gone into preventing accidents. I firmly believe an ounce of prevention is worth more than a pound of cure. However, the principles of risk management dictate that zero risk can never be assumed. As such, oil spill response arrangements must be timely, efficient and of adequate capacity. Trans Mountain, together with WCMRC, has proposed enhancements to the current oil spill response regime planning standards, specific to this region, that will half the response time and double the capacity required relative to the current standards. Although the enhancements are being proposed for the Project, all marine users and coastal communities along the shipping route will benefit from these enhancements.

Some of the proposed safety measures have already been put into place – can you tell us what those are?

We've found some of the improvements can be put in place now at a relatively low cost. For example, a tug now remains tethered to the departing tanker until the vessel has entirely cleared English Bay. Thereafter the tug remains in close escort of the tanker through the entire Strait of Georgia.

As well, all pilots have already been trained on leaving a ship safely by helicopter. Helicopter operations are expected to start on a trial basis in 2016.

Are there any additional benefits you'd like to convey to the public about the marine safety measures being proposed?

The increased safety measures all cost money and in turn generate investments and well-paying jobs. There are several examples of benefits – all of which are exciting opportunities. For one, the enhancements to the oil spill response regime to be undertaken by WCMRC will require building a number of new bases along the shipping route, new equipment and close to 100 employees, with an anticipated cost of more than $100 million. Next, the proposal for more tug escorts will increase business for tug operators who might require additional tugs and more mariners to operate those tugs. Engaging helicopters to take pilots off the departing tankers is another new development and opportunity. All of these measures will entail significant investments as well as create jobs on the coast.

https://blog.transmountain.com/trans-mountains-marine-safety-proposals-go-above-and-beyond-existing-requirements/

Captain John Armstrong discusses the qualifications and training needed to become a tug captain

JUNE 17, 2015 UNCATEGORIZED LEAVE A COMMENT

The tankers that come to Westridge are similar in shape and size to the dry bulk carriers we see in the port picking up grain or coal; in fact, many of the bulk carriers are larger than the Aframax tanker.

Teamwork and experience are fundamental to the safe movement of large cargo vessels, including oil tankers, through the bustling Vancouver Inner Harbour. High-powered and highly manoeuvrable tractor tugboats operated by Transport Canada-certified tug captains work in tandem, tethered to ships piloted by licensed BC Coast Pilots, assist and escort large vessels safely and smoothly through the harbour, including the Second Narrows. Without the tugs, port operations would become highly inefficient. We sat down with Captain John Armstrong, Vice-President of Operations, Saam Smit Towage/Saam Smit Canada Inc. to learn how the tugs work — and how this sector would be enhanced by the Trans Mountain Expansion Project.

What qualifications/certifications do you need to become a tug captain?

Certifications for tug captains are determined by the tug size (tonnage), voyage area and are regulated by Transport Canada. There are written and oral examinations, and you also have to have a specified amount of time spent working on the water before you can qualify.

To get a Masters certificate that qualifies an individual to be the captain on a medium-sized tug up to 150 tons you'll need to work full time for a minimum of four years as a seaman, followed by about one year of schooling, several written exams and an oral examination. After that, there's about one year of on-the-job Masters training, several assessments and electronic and

live simulation training. Candidates are then available for promotion to Master with operating restrictions limiting the tug size, ship size and job difficulty.

After about two years of continuous work as a tug Master, you would have enough additional sea time to return to school, write more exams and do another oral examination to achieve a 500 Gross Tonnage Masters certificate, which will cover the larger tugs operating in our fleet. It usually takes our people a minimum of 10 – 12 years to reach that level.

How well do your tug Masters know the pilots they are working with in an escort through Second Narrows?

Tanker movements are highly regulated. There are protocols and layers of regulation that have to be followed. Every ship has at least one pilot on board, all laden large tankers have two, who will have a great deal of experience in the harbour and on the BC coast.

Many pilots are ex-tug boat captains who may have sailed with our tug crews in the past. Pilots also take part in full mission bridge simulation training with tug Masters and often ride the tugs to or from a ship, allowing one-on-one time with our tug Masters. This results in solid relationships that enhance clear communication — each knows what the other is expecting and doing.

How do you communicate during an escort?

Protocols include dedicated VHF radio channels for communication, so the only people talking on the radios are the pilots and the tugs involved in a ship assist or escort. There is a standard language to describe situations and every manoeuvre so there is no chance of miscommunication about what the pilot is asking for and what the tug is doing.

If the radio fails, the tugs and the ships can revert to a time trusted system of internationally established sound signals using the ship and tug whistles to communicate.

What’s the most challenging aspect of assisting or escorting a ship?

Assisting a ship to arrive alongside a dock is probably more difficult than assisting its departure. Working at the direction of the pilot, the tug Master needs to be very precise as the ship is coming alongside the dock, which is a solid object and you want to do it very gently.

The tankers that come to Westridge are similar in shape and size to the dry bulk carriers we see in the port picking up grain or coal; in fact, many of the bulk carriers are larger than the Aframax tanker. They have straight, parallel sides compared to the flared shaped hulls of container ships, which means it’s relatively simple for a tug to come alongside, connect the towline and push or pull as required.

Trans Mountain is proposing two tethered escort tugs for each laden tanker, with a third escort tug through Second Narrows. Is this a change from existing protocols?

In current Port procedures two tractor tugs must be tethered to the stern of large oil tankers through the Second Narrows, with a third escort tug running free at the bow. Two tugs must also escort the ship through and clear of First Narrows but they are not required to be tethered.

What Trans Mountain has requested is to keep the two tethered tractor tugs from the Second Narrows escort tethered at the stern of the ship through Vancouver Harbor and First Narrows to a position off Point Grey and well clear of English Bay. We've already begun these extended escorts to Point Grey after the Pacific Pilotage Authority, which participated in the TERMPOL review, determined that this was good practice and recently issued an official notice making this a requirement. Trans Mountain also proposes to increase the use of tug escorts to cover the entire route of a laden tanker. This means the total tug escort portion of a tanker's transit to sea will increase from approximately 54 nautical miles to 145 nautical miles. While this will require more tug use, it will surely take the level of marine safety a few notches higher.

What training do tug Masters have to assist in the event that a ship needs support?

If the ship were to experience a steering or propulsion failure during an escort, the pilot must be confident in the tug's ability to apply the necessary forces and the correct manoeuvres to keep the ship under control.

To achieve this, we put our tug Masters through tanker escort full mission bridge simulation with pilots and about once every second escort, our tugs execute what we call a powered indirect escort manoeuvre to prove out the tug and crew performance and to ensure everyone stays trained and familiar.

https://blog.transmountain.com/captain-john-armstrong-discusses-the-qualifications-and-training-needed-to-become-a-tug-captain/

Meet Kevin Obermeyer, President and CEO of the Pacific Pilotage Authority

MAY 27, 2015 UNCATEGORIZED LEAVE A COMMENT

You cannot bring a ship from deep sea anywhere on the west coast of Canada without taking a pilot

Kevin Obermeyer fell in love with ships during a three-year stint in the South Africa navy, and never looked back. Today Kevin is President and CEO of the Pacific Pilotage Authority, a federal Crown corporation responsible for ensuring the safe, reliable and efficient movement of large vessels in BC's coastal waters.

How did you become involved in the marine transportation industry?

I was on the path to become a chartered accountant. In South Africa, where I'm from, they have military conscription. I ended up going into the navy for three years military service and loved it. When my three-year term was up and I left the navy, I decided that I would continue with the sea and make it my career.

What's the Pacific Pilotage Authority?

We're a federal Crown corporation, financially self-sufficient, with a mandate to provide a safe, efficient and cost-effective marine pilotage operation on the West Coast of Canada. We make sure that everybody complies with the Pilotage Act of 1972. BC Coast Pilots Limited is contracted to supply pilots for the entire coast except for the Fraser River, which is covered by eight employee pilots.

When did you join the PPA?

I've been here for 15 years. I joined in 1999 as the director of marine operations. I sat on the pilot training and exam committee (PTEC) and the safety and operational review committee (SORC). In 2006, the CEO at the time retired and I was promoted by the board and made CEO.

How difficult or easy is it to become comfortable at the helm of each ship that must be piloted through the harbour?

When you get on board the ship you do a Master-Pilot exchange. The master and the crew are a resource to the pilot and the pilot is a resource to them. The master and crew know the equipment. What the pilot shares with them is his expert local knowledge such as the kind of currents they're going to get as they go around East Point or Turn Point, what to watch out for, what traffic is expected and so on. They jointly work to make sure that the vessel gets from deep sea to the dock and back out again safely.

Is Vancouver's inner harbour the 'most regulated' spot along the coast?

Second Narrows with the Marine Restricted Area does have a lot of regulation. But it's not the only area with specific restrictions. There are regulations up and down the coast for specific areas where there is a higher concern about safety.

Besides Vancouver's inner harbour, where else along to the BC coast are pilots needed?

If you take this coast and draw a two-mile distance off every major point of land all the way around Vancouver Island, right the way through between Vancouver Island and the Mainland,

everything is compulsory pilotage from about two miles off the coast on average. So you cannot bring a ship from deep sea anywhere on the West Coast of Canada without taking a pilot.

What's the most interesting aspect of work as a pilot?

Ship handling and doing the job well. Now I'm not a pilot but I love ship handling. It's a challenge and it's a lot of science, but it's also a lot of art. It's almost a dance to get that ship alongside safely, and the pilots make it look so easy.

Port Metro Vancouver expects greater traffic through the port in the years ahead. Does PPA have plans to expand the number of pilots to meet greater demand?

With all the energy-related projects on the rise, and we've been monitoring this very closely, we are looking at getting a net increase of five pilots per year for the next four to five years. For example in 2014, we actually hired 12 pilots and in 2015 we are looking at hiring another 12.

How many pilots does a ship require?

If the bridge watch is going to be more than eight hours or more than 105 nautical miles, it's a two-pilot job. One pilot is sleeping and one pilot is working. And then every five hours or so they will change over.

Are the requirements different for oil tankers?

A loaded crude oil tanker is different than the rest of the vessels. There are two pilots on the bridge working together on a loaded crude oil carrier leaving Westridge Terminal. One will be watching the track on a Portable Pilot Unit and monitoring the helmsman, and the other will be the lead pilot looking out the window, making sure that all of vessel lineups are correct and has the conduct of the vessel.

Once the vessel gets out of Vancouver Harbour and off of Point Atkinson, we change pilots, take those two off and put two new pilots on. One pilot will go and get some rest, one will stay on the bridge all through Georgia Strait until three miles to the north of East Point, at which point the tug gets re-tethered, both pilots come to the bridge and for the rest of the voyage two pilots are on the bridge with tethered tug.

https://blog.transmountain.com/meet-kevin-obermeyer-president-and-ceo-of-the-pacific-pilotage-authority/

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Westridge-bound tankers would increase from 1.1% of all large commercial ships entering the Salish Sea to about 6.6% ow.ly/F0n9305KfrD

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.@KM_Canada's Senior Director of Marine Development talks about how marine enhancements are minimizing risk.

How marine safety enhancements are minimizing risk
Michael Davies, Senior Director of Marine Development, discusses how risk is defined and what the Trans Mountain Expansion Project is doing to mitigate risk.
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Increasing the number of #tankers calling at Westridge equates to $127 million per year into the local economy ow.ly/i1B7305Ebbh

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83% of these jobs would be in BC, including escort tugs and pilot services for #tankers ow.ly/OAk5306373W

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Rob discusses our approach to marine safety & his personal commitment to keeping the marine environment safe. ow.ly/h0Dm305jprB

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Master Mariner Bikram discusses a number of marine safety enhancements that are already underway in local waters ow.ly/yZYv304Trz2

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