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1 Human Health Risks of Oil Spill Exposure

- Reference:**
- i) [A3S5Q3](#), Application Volume 8A, Marine Transportation, PDF pages 8-9 of 29
 - ii) [A3S4Y5](#), Application Volume 8A, Marine Transportation, PDF pages 37 to 43 of 43
 - iii) [A3S4Y6](#), Application Volume 8A, Marine Transportation, PDF pages 1 to 22 of 34

Preamble: Reference i) discusses the human health impacts of an oil spill.

References ii) and iii), provide a detailed description of four locations along the tanker transit route that were selected for modelling the expected behavior and impacts of spilled oil.

Request: a) As Trans Mountain stated in their response to Weaver A IR No. 1.02c., “the focus of the qualitative human health risk assessment (QHRA) was on determining the nature and extent of the potential health effects that could occur among people from **short-term** inhalation exposure to the chemical vapors released from the surface of the oil slick during the early stages of the spill before the arrival of first responders and the implementation of emergency and spill response measures.” Has Trans Mountain assessed the **long-term** health effects of an oil spill along the proposed route?

a.1) If so, please provide the findings in full.

a.2) If not, please discuss why this has not been assessed and if Trans Mountain has any intention of performing such an assessment as a part of this hearing process.

2 Effect of Storm Winds on Behaviour of Spilled Oil

- Reference:**
- i) [Trans Mountain Report](#) – Meteorological and Oceanographic Data Relevant to the Proposed Westridge Terminal Shipping Expansion (November 2013)
 - ii) [A3S5Q3](#), [A3S4Y7](#), [A3S4Y8](#), and [A3S4Y9](#), Application Volume 8A, Marine Transportation.
 - iii) [A3S5Q3](#), Application Volume 8A, Marine Transportation PDF pages 11-12 of 29
 - iv) [A3S5I9](#), Review of Trans Mountain Expansion Project: Future Oil Spill Response Approach Plan, Recommendations on Bases and Equipment, Full Report.

Preamble: Reference i) discusses the effects of storms and wind energy on the water properties of the Pacific Ocean. It states that “during a storm, the energy from the wind leads to mixing of waters, typically to a depth of tens or even hundreds of metres...This process of wind mixing is illustrated by the progressive deepening of the upper layer during a storm event...”

Reference ii) states multiple times that certain marine species will likely not be impacted, or will be minimally impacted, by an oil spill due to the depths at which they live in the ocean and the tendency for crude oils to remain near the surface of the ocean.

Reference iii) discusses the problem formulation and spatial boundaries used for the ecological risk assessment

Reference iv) provides an account of the current and recommended enhancements for oil spill response capacity in light of the Trans Mountain Expansion Project (TMEP).

Request: In response to Weaver A IR No.1.05c. Trans Mountain stated that “the reference to hundreds of metres that could be affected by wind mixing refers to the open ocean, which is out of the area of study for the application”. However, the same report also discusses the high amounts of vertical mixing in Haro Strait and Boundary Pass, which are both included along the tanker route.

a) What are the average and maximum depths of vertical mixing observed in Haro Strait and Boundary Pass?

a.1) Was vertical mixing to these average and maximum depths factored into Trans Mountain’s analysis? If so, how?

a.2) If not, please provide a detailed analysis of how the average and maximum depths of vertical mixing observed in Haro Strait and Boundary could have an effect on the ecological impacts of an 8,250 m³ diluted bitumen oil spill and a 16,500 m³ diluted bitumen oil spill, respectively

3 Oil Spill Cleanup Costs

Reference: i) [A3S5Q3](#), Application Volume 8A, Marine Transportation, PDF page 10 of 29
ii) [A3S4Y9](#), Application Volume 8A, Marine Transportation, PDF pages 21-25 of 28
iii) [A3S4Y5](#), Application Volume 8A, Marine Transportation, PDF pages 37 to 43 of 43
iv) [A3S4Y6](#), Application Volume 8A, Marine Transportation, PDF pages 1 to 22 of 34
v) [A3S5I9](#), Review of Trans Mountain Expansion Project: Future Oil Spill Response Approach Plan, Recommendations on Bases and Equipment, Full Report.

Preamble: Reference i) states that in the event of a spill, clean up demands will likely be put on local emergency responders, hospitals, and social services.

Reference ii) summarizes findings from a Qualitative Human Health Risk Assessment completed for Marine Transportation Spills at Location E: Arachne Reef

References iii) and iv), provide a detailed description of four locations along the tanker transit route that were selected for modelling the expected behavior and impacts of spilled oil

Reference v) provides an account of the current and recommended enhancements for oil spill response capacity in light of the Trans Mountain Expansion Project (TMEP).

- Request:**
- a) Can Trans Mountain please provide an estimate of the expected oil spill clean-up costs associated with a credible worst-case and smaller marine spill along the proposed tanker route? Please clarify what services and costs are included in this estimate and who will be responsible for covering these costs. If possible, please provide this analysis for a spill located at Arachne Reef.
 - b) Can Trans Mountain please provide an estimate of the expected oil spill clean-up costs associated with a total-loss scenario spill along the proposed tanker route? Please clarify what services and costs are included in this estimate and who will be responsible for covering these costs. If possible, please provide this analysis for a spill located at Arachne Reef.
 - c) Please provide your best estimate (in percentages) of where the financial costs would come from to clean up a credible worst case oil spill (16,500 m³) and a smaller spill (8250 m³) at Arachne Reef, including sources such as Trans Mountain and Federal, Provincial or municipal governments. The total of all percentages given should equal 100%.

4 Total Loss Scenario & Oil Spills Larger than 15% of a Ship's Cargo

- Reference:**
- i) [A3S5Q3](#), Application Volume 8A, Marine Transportation PDF page 29 of 29
 - ii) [A3S4Y7](#), Application Volume 8A, Marine Transportation, PDF pages 1-19 of 19
 - iii) [A3S4Y8](#), Application Volume 8A, Marine Transportation, PDF pages 1-19 of 19
 - iv) [A3S4Y9](#), Application Volume 8A, Marine Transportation, PDF pages 1-21 of 28
 - v) [A3S5F6](#), Application Volume 8C Pt.2, General Risk Analysis
 - vi) [A3S4T1](#), Application Volume 8C Pt. 1, Casualty Data Survey PDF page 9 of 38
 - vii) [A3S5I9](#), Review of Trans Mountain Expansion Project: Future Oil Spill Response Approach Plan, Recommendations on Bases and Equipment, Full Report.
 - viii) [A3K9I2](#), Filing Requirements Related to the Potential Environmental and Socio-Economic Effects of Increased Marine Shipping Activities, Trans Mountain Expansion Project, Full Report.

Preamble: References i) – iv) provide a discussion of the potential environmental effects of an oil spill on various marine life and habitats, including the ability of marine species populations to recover from spills.

Reference v) discusses total loss scenarios and factors or incidents that can contribute to a total loss scenario.

Reference vi) provides information on the number of world-wide total loss incidents that have occurred between the periods of 2002-2011.

Reference vii) provides an account of the current and recommended enhancements for oil spill response capacity in light of the Trans Mountain Expansion Project (TMEP).

Reference viii) provides the National Energy Board's filing requirements related to the potential environmental and socio-economic effects of increased marine shipping activities from the Trans Mountain Expansion Project.

- Request:**
- a) Recognizing Trans Mountain's view that "A total loss scenario is not a viable scenario as it is not considered credible [and that] Volume 8A of the Facilities Application focused on credible worst-case and smaller spills consistent with [reference viii]" ([source](#)), but given the fact that there are multiple historical cases of marine oil spills larger than 15% of a tanker's cargo (the credible worst-case scenario for Trans Mountain's current application), why has such a spill scenario not been incorporated into the risk analyses of an oil spill?
 - b) Given that Trans Mountain has not considered the possibility and impacts of a spill larger than 15% of the tankers cargo in their application, please discuss how it expects to be prepared to respond should a spill larger than the credible worst case scenario occur.

5 Risk of an Oil Spill

5.1 Global Oil Tanker Incident Frequency

- Reference:**
- i) [A3S4Y3](#), Application Volume 8A, Marine Transportation, PDF page 289.
 - ii) [A3S4T1](#), TERMPOL 3.8, Casualty Data Survey, PDF pages 5-18.
 - iii) [A3S4Z2](#), Application Volume 8A, Marine Transportation, Appendix B
 - iv) [A3Y3W4](#), Trans Mountain Responses to Weaver A IR No. 1.

Preamble: Reference i) states that: "based on the available data, DNV shows that the worldwide incident frequency involving oil tankers is among the lowest of all marine vessels for the period 2002 to 2011..."

Reference ii) gives the corresponding analysis that reference i) is based on.

Reference iii) provides a list of Marine vessel types that are present along the British Columbia coast.

Reference iv) is the document of responses to Weaver A IR No. 1, as provided by Trans Mountain.

Request:

a) Trans Mountain's response to Weaver A IR No. 1.10.1.a in reference iv) (page 75 of 148) states that "The comparison of marine casualties was made between tankers and bulk carriers and not the entire marine fleet. These are the most relevant vessel types to compare with, which gives the most relevant information regarding bulk and tanker transport." Please provide the complete list of criteria that were used to determine the relevancy of a given vessel type for the purpose of the comparison provided.

a.1) Please also provide any weighting or calculations that were applied to each criterion.

a.2) Please provide the full justification for choosing each criterion identified in Weaver A IR No. 2.5.1.a and for applying the given weighting or calculations identified in Weaver A IR No. 2.5.1.a.1

b) Trans Mountain's response to Weaver A IR No. 1.10.1.a.4 in reference iv) (page 76 of 148) states that: "It is not considered relevant to analyze casualty data of vessels that do not have cargo in bulk and thus not the risk for discharging any bulk cargo." Given that much of the analysis provided in reference ii) simply looks at incident frequencies, irrespective of whether a spill occurred or not, please provide the complete reasoning and justification for not comparing these incident frequencies to dry cargo and passenger vessels that have a similar size and scope of maneuverability to an oil tanker.

c) Please confirm that when the data on "serious incidents" involving oil tankers that is provided in response to Weaver A IR No. 1.10.1.e in reference iv) (page 77 of 148) is plotted on a graph with an accompanying trend line, the slope of the trend line is approximately 0.2806. If not, why not?

c.1) If yes, please confirm that this trend line demonstrates that over the period 2002-2009, the number of serious incidents involving oil tankers has increased annually by approximately 28.06%. If not, why not?

d) Please confirm that when the data on "total loss incidents" involving oil tankers that is provided in response to Weaver A IR No. 1.10.1.e in reference iv) (page 77 of 148) is plotted on a graph with an accompanying trend line, the slope of the trend line is approximately 0.0097. If not, why not?

d.1) If yes, please confirm that this trend line demonstrates that over the period 2002-2009, the number of total loss incidents involving oil tankers has increased annually by approximately 0.97%. If not, why not?

e) Please confirm that when the data on “not serious incidents” involving oil tankers that is provided in response to Weaver A IR No. 1.10.1.e in reference iv) (page 77 of 148) is plotted on a graph with an accompanying trend line, the slope of the trend line is approximately -0.5861. If not, why not?

e.1) If yes, please confirm that this trend line demonstrates that over the period 2002-2009, the number of not serious incidents involving oil tankers has decreased annually by approximately 58.61%. If not, why not?

f) Weaver A IR No. 1.10.1.f in reference iv) (page 77 of 148), asked “how many shipyears would be equivalent to one year of operations of the fully-completed Kinder Morgan Expansion Project with the expected 408 tankers departing Westridge Marine Terminal annually.” Trans Mountain replied stating: “Based on an average of 5 days’ time spent within the marine study area, 408 tanker calls equates to approximately 5.6 shipyears annually.” Page 12 of reference ii) states that “exposure data for global oil tankers includes all the sailing of the tankers, also in high seas while the likelihood for an incident at high seas is much lower than in coastal waters.” Please provide the total number of shipyears, as requested in Weaver A IR No. 1.10.1.f but based on the entire tanker sailing route, not simply the amount of time spent in the marine study area.

5.2 Risk Analysis for Tanker Incidents and Oil Spill Accidents

- Reference:**
- i) [A3S5F4](#), TERMPOL 3.15, General Risk Analysis and Intended Methods of Reducing Risks, Full Report.
 - ii) [A3S5F6](#), TERMPOL 3.15, General Risk Analysis and Intended Methods of Reducing Risks, Full Report.
 - iii) [A3S5F6](#), TERMPOL 3.15, General Risk Analysis and Intended Methods of Reducing Risks, PDF page 17.
 - iv) [A3S5F8](#), TERMPOL 3.15, General Risk Analysis and Intended Methods of Reducing Risks, Full Report.
 - v) [A3Y3W4](#), Trans Mountain Responses to Weaver A IR No. 1.

Preamble: References i), ii) and iv) provide the general risk analysis of a marine incident, including an oil spill under various conditions. The report also offers methods for reducing risks and calculates the projected impact such measures would have on the overall risk assessment. It offers a description of the MARCS model used to calculate the risk assessments and the parameters and inputs used by this model. Reference iv) includes “Appendix 4: Effectiveness of Risk Reduction Options” in which DNV provides an account of the risk reduction inputs they used in the MARCS model.

Reference iii) identifies the four factors used in MARCS to estimate the probability that an incident leads to an oil spill accident. The following criteria are quoted: “ [1] Ship Structure, whether it is a single or double hull (all Trans Mountain tankers are double hull). / [2] The probability of grounding on rocky shore versus soft bottom shore. This probability distribution is equal to the presence of distribution of rocky shoreline versus soft bottom shoreline as shown in Figure 13), grounding on rocks will increase the likelihood of a loss of containment. / [3] Wave and wind affects the probability that a grounding incidents leads to an oil spill. Wave height also affects the probability for a structural failure leading to foundering. / [4] In case of collision, the momentum of a colliding ship affects whether the incident becomes an oil spill accident.”

Reference v) is the document of responses to Weaver A IR No. 1, as provided by Trans Mountain.

- Request:**
- a) In reference v), Trans Mountain’s response to Weaver A IR No. 1.10.5.e offers the rationale behind applying a 100 times risk reduction factor to mechanical failure rate of a tethered tug. Neither Trans Mountain’s response to Weaver A IR No. 1.10.5.e nor its response to Weaver A IR No. 1.10.5.e.1 confirms if this risk reduction factor has been validated for the Trans Mountain tanker sailing route. Please confirm if this risk reduction factor has been validated for the Trans mountain tanker sailing route. If yes, please provide this validation. If no, please explain why not.
 - b) Please confirm whether the risk reduction factor of 2 that was applied to tethered escort tugs responding to prevent a powered grounding incident, as described on PDF page 11 of reference ii), has been validated for the Trans Mountain tanker sailing route. If yes, please provide this validation. If no, please explain why not.
 - c) In section 3 of Appendix 4 in reference iv), the report states that: “As discussed in Section 2.3 above, the basic parameters in MARCS represent North Sea average shipping operations in the mid to late 1990s.” Please provide an exhaustive account of how the MARCS model has been updated to represent current and local shipping operations in British Columbia since 2010, including the process of validating the model for these conditions.
 - d) In response to Weaver A IR No 1.10.5.r in reference v), Trans Mountain notes that “the effect of traffic separation schemes and movement restriction areas in the marine RSA sailing route is estimated in the MARCS model by modelling only one-way traffic in the TSS area. However, the directional sailing lanes are modelled with some overlap to account for potential stray vessels.” (p. 102 of 148). Please provide an account of how this approach has been validated for the Trans Mountain tanker sailing route.

d.1) Please also provide a sensitivity analysis of the MARCS model with respect to the uncertainty inherent in this approach to modelling the traffic separation scheme.

e) Regarding reference iii), please provide a comprehensive account of how “collision momentum” was factored into the MARCS model. Please also provide a detailed account of how this input was validated for the Trans Mountain tanker sailing route.

f) Please provide a detailed account of how the wind rose data provided on PDF page 33 of reference i) has been validated for accuracy as a predictive input in the model.

g) Please provide a comprehensive account of how the extended escort tug that is proposed under Case 1a in reference ii) is factored into the MARCS model.

h) In section 7.5.2 of reference ii), the report compares incident frequencies to conclude that under Case 1b, the incident frequency of Trans Mountain tankers will be below the global average for the past 10 years. The report cited in reference ii) does not provide similar incident frequencies for Case 0, Case 1, Case 1a or Case 2. Given that the parameters of Case 1b are not a certainty for the project, please provide an analysis of the annual projected oil cargo spill accident frequency for Trans Mountain tankers under Case 0, Case 1, Case 1a and Case 2.

i) In section 7.5.3 of the reference ii), the report compares the Danish Strait to the Salish Sea, concluding that “the sailing route is relatively similar to the Trans Mountain tanker sailing route” and therefore that the “likelihood of a marine transit incident and the likelihood for an oil cargo spill accident are therefore considered relatively low [along the Trans Mountain tanker sailing route] compared with other well established sailing routes.” Please provide:

i.1) A comprehensive comparison of the oceanographic observations in the Danish Strait and along the entire Trans Mountain tanker sailing route, in support of this conclusion.

i.2) A comprehensive comparison of the meteorological observations in the Danish Strait and along the entire Trans Mountain tanker sailing route, in support of this conclusion.

i.3) A comprehensive comparison of the topographic observations in the Danish Strait and along the entire Trans Mountain tanker sailing route, in support of this conclusion.

i.4) A comprehensive comparison of the risk controls in place in the Danish Strait and along the entire Trans Mountain tanker sailing route, in support of this conclusion.

i.5) A comprehensive comparison of the navigational hazards in the Danish Strait and along the Trans Mountain sailing route, in support of this conclusion.

6

Human Health Risk Assessments

Reference: i) [A3Y1E9](#), HHRA Facility and Marine Spill Scenarios Technical Report Part 1
ii) [A3Y1F0](#), HHRA Facility and Marine Spill Scenarios Technical Report Part 2
iii) [A3Y1F1](#), HHRA Facility and Marine Spill Scenarios Technical Report Part 3
iv) [A3Y1F2](#), HHRA Facility and Marine Spill Scenarios Technical Report Part 4

Preamble: Reference i) through iv) is Kinder Morgan's Qualitative Human Health Risk Assessment of Facility and Marine Spill Scenarios Technical Report.

Request: a) Page 1-1 of the report cited in reference i) reads: "Emphasis is given to the types of health effects that people could potentially experience from exposure to hydrocarbon vapours released during the early stages of a spill, before the arrival of first responders and the implementation of emergency and spill response measures aimed at quickly isolating, containing and recovering the spilled oil." Please confirm that this report only examines exposure prior to the arrival of first responders and implementation of emergency spill response measures, and that therefore exposure ceased immediately upon their arrival.

a.1) Page 4-2 of the report cited in reference i) reads: "In all cases, the spill was assumed to occur during the summer months when the warmer water and air temperatures would facilitate more rapid dissolution and volatilization of the lighter hydrocarbon components of the spilled oil into the ocean water column and overlying air, respectively. In addition, the generally lower wind speeds that mark the summer months would result in less wave action, and hence, less vertical mixing of the water column contributing to higher concentrations of dissolved hydrocarbons in the surface water layer as well as less dilution of hydrocarbon vapours in air. Under these conditions, a heightened prospect exists for the occurrence of effects on the marine environment and resources and human health." Please comment on how quickly Kinder Morgan expects health impacts to dissipate after first responders implement emergency spill response measures.

b) Page 3-1 of the report cited in reference i) reads: "The difference in approach is due principally to the fact that, unlike HHRAs that tend to focus on routine operations consisting of planned activities for which chemical exposures and any corresponding health risks can be anticipated and assessed on the basis of known or reasonably well-defined exposure scenarios, spills represent low probability, unpredictable events for which the exposures and any associated risks must necessarily be assessed on the basis of strictly hypothetical scenarios. For the purposes of the present assessment, rather than attempting to combine

the probability of occurrence of these unpredictable events with the consequences of exposure to arrive at quantitative risk estimates, it was assumed a priori that the oil spill events had taken place, leaving the assessment to focus on the potential health effects that could occur under each simulated spill scenario.” Please confirm that it meets industry best practice to conduct qualitative HHRA’s, as opposed to quantitative studies when examining the human health impacts of a spill.

b.1) Please confirm that Trans Mountain does not have the necessary quantitative information to accurately conduct a quantitative HHRA.

b.2) Please confirm that Trans Mountain is suggesting that because oil spills are not planned events with known factors, they do not feel that a quantitative HHRA is necessary.

c) Page 3-2 of the report cited in reference i) reads: “This principle forms the basis of the so-called ‘dose-response relationship’ that defines the nature and extent of health effects that can be caused by a chemical as a function of both its intrinsic toxicity and the exposure received.” Please confirm that the “dose-response relationship” represents industry best practice in studies of a similar nature. If not confirmed please provide scientific justification for its use.

d) Please comment on why Trans Mountain chose the specific inputs that were used for wind direction when conducting this assessment. Do the wind direction inputs represent a worst case scenario and/or are they representative of the average wind direction for a calendar year and/or summer months?

d.1) Please provide the information that was used to determine the average wind speed, direction and wave height in order to map out how and where spilled oil and toxic air pollution would travel in the scenario provided.

d.2) Please confirm if a spill during the winter months would create different exposure pathways, or increased risk of exposure via pathways that were not considered in this report.

e) Please explain why there is such a large difference between Table 4.2 and Table 4.3 with regards to the chemicals that were examined.

f) Page 4-8 of the report cited in reference i) reads: “These personnel will be trained in emergency preparedness and response, will be equipped with appropriate personal protective equipment (PPE), will be trained and prepared for such situations, and will take appropriate precautions to avoid physical contact with the spilled oil itself as well as to limit exposure to any chemical vapours that might be present. These measures will act to limit any chemical exposures and corresponding health effects that might be experienced by first responders and other response personnel. Provided these individuals take appropriate measures to minimize any exposures, no obvious opportunity will

exist for their health to be adversely affected by the chemicals released as a result of a spill.” Please confirm that the necessary resources exist to ensure that all personnel responding to a spill will be equipped with appropriate personal protective equipment (PPE), including a response to a credible worst case spill. If not confirmed or if unknown, please comment on how Trans Mountain is certain that responders will be adequately equipped.

f.1) Please provide examples of what “appropriate measures to minimize exposures” would be and confirm that “appropriate measures to minimize exposures” is consistent with what a responder would be required to do in responding to a spill.

g) Please comment on how broadly the conclusions reached in this report should be interpreted given that Trans Mountain acknowledges on page 4-20 that “The results of the assessment necessarily apply to the specific scenarios that were chosen”?

g.1) Please confirm that this report only provides a qualitative look at health impacts of a spill during idealized conditions in the summer, without taking into account average wind speed, direction present at the locations chosen.

g.2) Please provide how many days of the year the conditions used in this study are present in the locations used for modeling a spill.

g.3) Page 4-20 of the report cited in reference i) reads: “However, uncertainty remains as to how well the results reflect the potential exposures to the COPC vapours and associated health effects that could be experienced by people under different spills scenarios because of differences in circumstances.” Please expand on what is meant by “uncertainty remains as to how well the results reflect the potential exposures to the COPC vapours and associated health effects that could be experienced by people under different spills scenarios because of differences in circumstances.”

h) Page 5-2 of the report cited in reference i) reads: “In all cases, the predicted one-hour average concentrations of the COPC were only seen to exceed the corresponding Exposure Limits over water, suggesting that individuals on land would not experience any health effects as a result of the spill.” Please confirm that the results detailed in section 5 do not represent conclusions that can be extrapolated to any scenario outside of the precise conditions used in this study. If they can be extrapolated, please confirm.

i) Please confirm that the statement on page 5-8, which read: “For the respiratory irritant and neurotoxicant mixtures, the coverage was predominantly over water; whereas the eye irritant mixture coverage extended over both land and water. The areal extent of the mixtures did not differ substantially from the

maximum extent of the individual COPC comprising the mixtures” cannot be extrapolated beyond the spill modelled in this study and the exact conditions used in this study. If it can be extrapolated, please explain.

7 Oil Spill Response and Recovery

7.1 Oil Spill Response and Recovery Plan

- Reference:**
- i) [A3S5I9](#), Review of Trans Mountain Expansion Project: Future Oil Spill Response Approach Plan, Recommendations on Bases and Equipment, Full Report.
 - ii) Federal Government Technical Report: Properties, composition and marine spill behavior, fate and transport of two diluted bitumen products from the Canadian oil sands. November 30, 2013, ISBN 978-1-100-23004-7, 85pp.
 - iii) [A3Y3W4](#), Trans Mountain Responses to Weaver A IR No. 1.

Preamble: Reference i) provides an account of the recommended enhancements for oil spill response capacity in light of the Trans Mountain Expansion Project (TMEP). These are recommendations only and their implementation is not guaranteed under the TMEP.

Reference ii) is a federal government technical report on the properties, composition and marine spill behavior, fate and transport of two diluted bitumen products from the Canadian oil sands. The study shows that diluted bitumen can sink in the presence of suspended particulate matter.

Reference iii) is the document of responses to Weaver A IR No. 1, as provided by Trans Mountain.

- Request:**
- a) Provide a list of all total loss incidents involving single-hull and double-hull tankers in the past 50 years.
 - b) Based on the findings in reference ii) and the answers provided to Weaver A IR No. 1 Section 11 in reference iii), does Trans Mountain feel it is important to update its consideration of adequate enhanced response times, as provided in section 3.3 of reference i) (PDF page 14)? If not, why not?
 - c) On PDF page 29 of reference i), the report states that: “In the United States, the vessel or planholder must certify resources for the removal of the Worst Case Discharge (WCD), defined as the loss of the ship’s entire cargo and fuel complicated by adverse weather.” Please explain why Trans Mountain does not feel it necessary to consider what would be required for, or to prepare for, a response capacity sufficient to cover a total loss scenario in adverse weather, as is required in Washington State?

d) In response to Weaver A IR No 1.13.1.o on page 142 of reference iii), Trans Mountain states that “...as with other heavy oils, factors can contribute to oil submergence and/or sinking. As such, oil spill response plans and Response Organizations include strategies, tactics and equipment to respond promptly, minimize the potential for oil submergence or sinking and address submerged or sunken oil.” Please provide a comprehensive account of:

d.1) Any and all equipment owned and operated by WCMRC to recover sunken oil.

d.2) Any and all strategies and tactics used by WCMRC to recover sunken oil.

7.2 Oil Spill Response Scenario: Arachne Reef

Reference:

- i) [A3S5J0](#), TMEP Oil Spill Response Simulation Study, Arachne Reef and Westridge Marine Terminal, Full Report.
- ii) [A3S4T7](#), TERMPOL 3.5 & 3.12 Route Analysis & Anchorage Elements, Full Report
- iii) [A3S5I9](#), Review of Trans Mountain Expansion Project: Future Oil Spill Response Approach Plan, Recommendations on Bases and Equipment, Full Report.
- iv) [A3Y3W4](#), Trans Mountain Responses to Weaver A IR No. 1.
- v) [A3S5F6](#), TERMPOL 3.15 General Risk Analysis and Intended Methods of Reducing Risks, PDF page 44.
- vi) [A3Y3W4](#), Trans Mountain Responses to Weaver A IR No. 1.

Preamble: Reference i) provides a simulation of a “credible worst-case” oil spill scenario at Arachne Reef and at Westridge Marine Terminal, assuming, among other things, the full implementation of the recommended enhanced spill response capacity.

Reference ii) provides a description of the Trans Mountain tanker sailing route.

Reference iii) provides an account of the recommended enhancements for oil spill response capacity in light of the Trans Mountain Expansion Project (TMEP). These are recommendations only and their implementation is not guaranteed under the TMEP.

Reference iv) is the document of responses to Weaver A IR No. 1, as provided by Trans Mountain.

Reference v) provides the rationale for applying the assumption that in the event of an oil spill, 25% of cargo would breach within the first hour in the case of a collision and the remaining oil would flow out over the next 12 hours. This assumption was applied to the oil spill scenario documented in reference i).

Reference vi) is the document of responses to Weaver A IR No. 1, as provided by Trans Mountain.

- Request:**
- a) Given that reference ii) describes significant differences in the nature of the route east and west of Race Rocks, and given that reference iii) describes the need to prepare a spill response plan that accommodates the differences east and west of Race Rocks, please provide an oil spill scenario comparable to what is provided in reference i) for a spill that occurs west of Race Rocks.
 - b) Given that reference iii) makes it clear that the enhanced oil spill response scenario is not a guaranteed scenario under the Trans Mountain Expansion Project, please provide a separate oil spill scenario for the two locations given in reference i), plus the third location west of Race Rocks as requested in request a) of this section, applying the condition that only current spill response capacity is enlisted, with no new or enhanced capacity applied.
 - c) In response to Weaver A IR No 1.13.2.h on page 146 of reference vi), Trans Mountain states that “The model used in reference (i) incorporates a mechanism for oil to become submerged or sink. Oil can become submerged or sunken if its density, through weathering, exceeds that of the ambient waters.” Please confirm: Did any oil submerge or sink in the simulation provided in reference i). If yes, please describe how much sank/submerged, where it sank/submerged, under what conditions it sank/submerged and how it was recovered.
 - d) Reference v) provides the rationale for the oil cargo discharge rates applied in the oil spill scenario provided in reference i). Reference v) however does not provide any sources or supporting evidence to back up DNV’s assumption. Please provide any and all data, sources and supporting evidence that was used to determine DNV’s assumption of the oil cargo discharge rates.
 - e) In the Arachne Reef Scenario on PDF page 19 of reference i) the report states that: “The 4 days length period was selected based on the slick thickness on water, which then becomes too thin to be efficiently recoverable after the end of the fourth day.” In response to Weaver A IR No 1.13.2.i Trans Mountain reiterates that “It became evident as the simulation progressed that by the end of day 4, the remaining oil on water was in the form of a very thin slick, for which skimmer operations, even with boom concentration, were not effective.” Please:
 - e.1) Confirm that the simulation provided in reference i) is a computer simulation that is based on a computer model.
 - e.2) If no to Weaver A IR No 2.7.2.e.1, please provide a comprehensive account of how the simulation was conducted?
 - e.3) If yes to Weaver A IR No 2.7.2.e.1, please confirm that the observation that after 4 days “the remaining oil on the water was in the form of a very thin slick, for which skimmer operations...were not effective”, would have been the result of inputs and assumptions applied to the computer model.
 - e.4) If no to Weaver A IR No 2.7.2.e.3, why not?

e.5) If yes to Weaver A IR No 2.7.2.e.3 please confirm if the model inputs that contributed to this result were based off of any existing studies of diluted bitumen in marine environments. If yes, please provide a list of these studies and explain why a standard 10-day response period is still being proposed instead of a four-day response period, given these studies. If no, please explain why this parameter was used in the model if it does not reflect a scientific understanding of diluted bitumen.

8 Science Underpinning Analysis of Fate and Behavior of Diluted Bitumen in Water

- Reference:**
- i) [A3S5G2](#), [A3S5G4](#) A Study of Fate and Behaviour of Diluted Bitumin Oils on Marine Waters
 - ii) [A3S5G7](#) A Comparison of the Properties of Diluted Bitumen Crudes with Other Oils
 - iii) [A3S5G9](#), [A3S5H1](#), [A3S5H3](#), [A3S5H4](#), [A3S5H7](#), [A3S5H8](#), [A3S5H9](#), [A3S5I0](#), [A3S5I1](#) Modelling the Fate and Behaviour of Marine Oil Spills for the Trans Mountain Expansion Project (including figures and appendices)
 - iv) [A3S4V5](#), [A3S4V6](#) Section 5. Fate and Behaviour of a Hydrocarbon release.
 - v) [A3S4Y5](#) Section 5.4: Fate and Behaviour of an Oil Spill in a Marine Environment
 - vi) Baschek, B., D.M. Farmer and C. Garrett, 2006: Tidal fronts and their role in air-sea gas exchange. *Journal of Marine Research*, **64**, 483-515.
 - vii) Johannessen, S.C., D. Masson and R.W. Macdonald, 2006: Distribution and cycling of suspended particles inferred from transmissivity in the Strait of Georgia, Haro Strait and Juan de Fuca Strait. *Atmosphere-Ocean*, **44(1)**, 17-27.
 - viii) Farmer, D.W., E.A. D'Asaro, M.V. Trevorrow and G.T. Dairiki, 1995: Three-dimensional structure in a tidal convergence zone. *Continental Shelf Research*, **15(13)**, 1649-1673.
 - ix) Farmer, D., R. Pawlowicz, R. Jiang, 2002: Tilting separation flows: a mechanism for intense vertical mixing in the coastal ocean. *Dynamics of Atmospheres and Oceans*, **36**, 43-58.
 - x) Federal Government Technical Report: Properties, composition and marine spill behavior, fate and transport of two diluted bitumen products from the Canadian oil sands. November 30, 2013, ISBN 978-1-100-23004-7, 85pp.
 - xi) White, B.L. and K.R. Helfrich, 2013: Rapid gravitational adjustment of horizontal shear flows. *Journal of Fluid Mechanics*, **721**, 86-117.
 - xii) Zhang, Z., O. B. Fringer, and S. R. Ramp (2011), Three-dimensional, nonhydrostatic numerical simulation of nonlinear internal wave generation and propagation in the South China Sea. *Journal of Geophysical Research*, **116**, C05022, doi:10.1029/2010JC006424
 - xiii) <http://wcmrc.com/news/federal-government-releases-dilbit-study/>

Preamble: Reference [iv] presents the evidence put forward with respect to the physical, chemical and weathering properties of hydrocarbons released in a marine

environment. It draws heavily on the tank experiments in the Gainford Study (reference [i]) and provides cursory information on the interaction between oil and particulates suspended in the water column. This interaction is expanded upon slightly in section 5.4.1.1.4 and section 5.4.1.1.6 of reference [v] where the potential for tar ball formation is also mentioned. Reference [ii] compares and contrasts the properties of dilbit with other oils.

Reference [v] provides further information on the potential fate and behavior of diluted bitumen (dilbit) spilled into a marine environment. It too heavily relies upon the Gainford Study. Reference [v] also describes the numerical modelling simulations detailed in reference [iii] that were undertaken in order to determine the fate and behavior of dilbit spilled in any one of a number of potential marine locations.

The Gainford study undertook tank experiments using saline water that did not include suspended sediments. It is clear from the recently completed Federal study (reference [x]) that in the presence of suspended sediments “high-energy wave action mixed the sediments with diluted bitumen, causing the mixture to sink or be dispersed as floating tarballs” (page 5 of reference [x]). In addition, on page 6 of reference [x] it states:

“Under conditions simulating breaking waves, where chemical dispersants have proven effective with conventional crude oils, a commercial chemical dispersant (Corexit 9500) had quite limited effectiveness in dispersing dilbit.

Application of fine sediments to floating dilbit was not effective in helping to disperse the products.”

Western Canada Marine Response Corporation has recognized these conclusions (reference [xiii]). Reference [vii] clearly documents the presence of suspended particles in Strait of Georgia, Haro Strait and Juan de Fuca Strait, yet it is unclear how this information was incorporated in the submission.

Some of the parameters used in the numerical model (reference [iii]) were determined based on the analyses outlined in references [i] and [ii]. It is unclear how the model, used to predict the path of oil spills, was validated in light of the prevalence of very complex oceanographic conditions in the Strait of Georgia, Haro Strait and Juan de Fuca Strait (references [vi, viii, ix, xi]). In particular, a hydrostatic model was used that may not be able to represent the complex downwelling conditions, tidal fronts and whirlpools which are common features in the region. Reference (xii) provides an example of a non-hydrostatic numerical model that has been used recently.

Request: a) Has Trans Mountain conducted any new tank studies or other scientific studies exploring how diluted bitumen behaves in saline water in the presence of suspended particles since the first round of intervenor information requests were submitted? If no, why not? If yes, please provide a copy of each new study.

9 Environmental Conditions for Marine Oil Spill Response

- Reference:** i) [A3W9H8](#), Trans Mountain Responses to NEB IR No. 1, pp. 365-372 of 481.
- ii) [A3S5I9](#), Review of Trans Mountain Expansion Project: Future Oil Spill Response Approach Plan, Recommendations on Bases and Equipment, Full Report.

Preamble: Reference i) contains Trans Mountain's response to NEB IR No. 1.65 on the topic of Environmental conditions for marine oil spill response.

Reference ii) provides an account of the recommended enhancements for oil spill response capacity in light of the Trans Mountain Expansion Project (TMEP). These are recommendations only and their implementation is not guaranteed under the TMEP. This reference contains information on the operating conditions of oil spill response equipment.

Request: a) Section 8.2 of reference ii) notes that "Although WCMRC equipment is capable of operating in sea states greater than 2, the effectiveness of those countermeasures is reduced. For example, at Sea State 3 (Beaufort Scale 4) wave heights exceed 1 m and the wind velocities range from 11 to 16 knots. At this magnitude, containment booming and skimming is difficult to execute and become less effective." In response to NEB IR 1.65, Trans Mountain provides Table 1.65A-1, which offers the wind speed frequency recorded at various locations along the study route over the course of a calendar year. Please provide these frequencies for each individual Beaufort Scale level including the distinct, separate frequencies for Beaufort Scales 0, 1, 2, 3 and 4 at the various locations provided in Table 1.65A-1.

10 Oil Spill Response Capacity

- Reference:** i) [A4E2V0](#), Table 1 Intervenor Requests for Information from the Western Canada Marine Response Corporation.
- ii) [A4E2W3](#), Development of Bottom Oil Recovery Systems – Final Project Report, Full.
- iii) [A4E2V3](#), Western Canada Marine Response Corporation "At a Glance" North Coast Operations.
- iv) [A4E2V4](#), Western Canada Marine Response Corporation "At a Glance" South Coast Operations.
- v) [A4E2V5](#), Western Canada Marine Response Corporation "At a Glance" Vancouver Island Operations.

Preamble: Reference i) contains information from Western Canada Marine Response Corporation in response to intervenor information requests.

Reference ii) is a U.S. Coast Guard report on issues associated with recovering submerged or sunken oils.

References iii), iv), and v) offer a list of WCMRC's equipment for the North Coast, South Coast and Vancouver Island Operations, respectively.

Request: a) In response to Province of British Columbia IR 1.1.67.a and IR 1.1.67.e [pp. 8 to 10 of 18 in reference i)], WCMRC provides a list of organizations it currently has mutual aid agreements with as well as information on the equipment that can be "cascaded in" to support its response efforts in the event of an oil spill. For instance, WCMRC notes that, within 24-hours of notification, National Response Corporation could contribute a total de-rated recovery capacity of 3,819 tonnes per day. Please provide the total recovery capacity and length of containment boom that could be contributed for each organization with which WCMRC has a mutual aid agreement and within the following time frames:

a.1) Within 24 hours of notification.

a.2) Within 96 hours of notification.

a.3) Within 10 days of notification.

b) In response to Province of British Columbia IR 1.1.73.o and IR 1.1.73.q WCMRC [pp. 12 to 15 of reference i)] WCMRC outlines several technologies and techniques for recovering or responding to submerged or sunken oil. Please provide a comprehensive list of the equipment owned by WCMRC that can be used to respond to a submerged or sunken oil spill. Please also include the oil recovery rate of each piece of equipment.

c) In reference iii) WCMRC states it has the capacity to skim 92.3 tonnes of oil per hour with a total storage capacity of 138.7 tonnes in its North Coast Operations. Where will WCMRC store additional oil after its storage capacity is exhausted in the first hour and a half of skimming operations?

d) In reference iv) WCMRC states it has the capacity to skim 224.6 tonnes of oil per hour with a total storage capacity of 5477.3 tonnes in its South Coast Operations. Where will WCMRC store additional recovered oil after its storage capacity is exhausted in the first twenty four hours of skimming operations?

f) In reference v) WCMRC states it has the capacity to skim 100.5 tonnes of oil per hour with a total storage capacity of 2446.2 tonnes in its Vancouver Island Operations. Where will WCMRC store additional oil after its storage capacity is exhausted in the first twenty four hours of skimming operations?

g) Does WCMRC have any additional storage capacity that is not listed in references iii), iv) or v)?

h) Regarding references iii), iv) and v), all primary and secondary storage units are full, what is the process and timeline for emptying those units so they may be made available for additional recovery efforts?

11 Other Information Requests from Constituents not Already Covered

- Request:**
- a) What study has been made of triple- or double-hull pipeline technology to reduce risk of spill?
 - b) What study has been made of fault lines along the course of the pipeline or tsunami risk along the shipping route?
 - c). What progress has been made in leak detection; is it true leak detection hasn't improved in 50 years, despite the existence of mobile communication and sensing technology?
 - d) Have any evaluations been conducted on the benefits of refining dilbit in Alberta or in BC at the BC-Alberta border with a view towards reducing the risks of transporting heavy oil?