Trans Mountain Pipeline ULC
Trans Mountain Expansion Project
NEB Hearing Order OH-001-2014
Follow-Up Responses to Information Request from Adams Lake Indian Band

2.02.0 SURFACE WATER QUALITY ROUND 2 IRS

F-IR 2.02.5 Defensible analysis of the fate and behaviour of diluted bitumen releases and spill impacts in river

Reference:

Trans Mountain 2013, Volume 7, Qualitative Ecological Risk Assessment of Pipeline Spill Technical Report (QERA); Trans Mountain 2013, Volume 7, Section 7, p 7-105, 7-117 and 7-130; Trans Mountain response to ALIB IR No. 1.2.5 (a) and (b)

Preamble:

In the hypothetical diluted bitumen spill scenarios assessed by Trans Mountain in the Athabasca River, North Thompson River and lower Fraser River, there are several subjective judgements made regarding the likely formation of oil-mineral aggregates (OMA) (e.g. in the form located at Volume 7, Section 7.1.2.2.1, p 7-105, Section 7.1.3.2.1, p 7-117 or at Section 7.1.4.2.1, p 7-130). The formation of OMA in the case of a spill of diluted bitumen in water influences whether bitumen will sink under the water surface, with significant implications for the extent of impacts and for mitigation and remediation efforts. TM has not provided a quantitative, more objective, comparison of the environmental conditions at each hypothetical spill location that will determine the likelihood of OMA formation. Instead, TM states that its subjective interpretation of oil mineral aggregate formation potential is merited and is sufficient to characterize the risks associated with a diluted bitumen spill into rivers.

We are aware of only one documented spill of diluted bitumen into a river (the Marshall Spill in the Kalamazoo River, Michigan in 2010). None of the other real-world spill case studies considered by TM involved a spill of diluted bitumen (Trans Mountain, Volume 7, QERA of Pipeline Spill Technical Report, p. i). Trans Mountain has not stated whether it employed experts on the Marshall Spill to conduct its river spill scenarios. For this reason, it is quite possible that the experts who contributed to the river spill scenarios have no experience with diluted bitumen spills into rivers. Moreover, even experts with experience in the Marshall Spill would only have experience with a single real-world case. In different terms, based on very little real-world experience, TM believes that it can rely on the qualitative judgement of consultants that have likely never completed such an analysis to predict the potential for OMA formation in different river systems. Given uncertainties regarding OMA formation in river systems, this assertion is unacceptable.

Request:

d) Please formulate and use a quantitative relationship between these parameters and OMA formation potential to calculate the probability of OMA formation in each hypothetical spill scenario.

e) Ensure that data, conditions and outcomes of the Environment Canada study on diluted bitumen behaviour in water is included in the comparison of OMA formation potential (Environment Canada 2013).

f) In completing this analysis, please provide complete and detailed information regarding assumptions and methods used to develop the quantitative model and any sources of uncertainty in parameter estimation.

Response:

d) The formation and stabilization of OMAs is described in rigourous scientific studies. The OMA formation approach was developed by Payne et al. (1987) and is presented in "Integration of Suspended Particulate Matter and Oil Transportation Study". Effects of water turbulence are incorporated. In addition, the calibration of the model was based on lab experiments conducted by Khelifa et al. (2008) and presented in "Effects of Dispersants on Oil-SPM Aggregation and Fate in US Coastal Waters". As described in ALIB IR No. 2.02.5c, a non-negligible number of unknowns exist regarding the environmental parameters during the Marshall spill. An attempt to extrapolate OMA formation, in the absence of sediment concentrations in the Kalamazoo, and in the absence of quantification of sediment pickup during the overland portion of the spill, would not be rigorous or defensible and therefore not useful. The calibration of the SPILLCALC model confirmed that it could replicate OMA formation, provided that a sufficient suspended sediment concentration and a sufficient level of turbulent energy dissipation was available. These conditions of sufficient suspended sediment concentration and turbulence energy level are rarely encountered along the marine transportation route, or indeed in the lower Fraser River, and so the formation of OMAs was extremely rare in the modelling that was conducted. A maximum of 0.08% of the spilled oil during a Credible Worst Case Scenario was found forming OMAs in the stochastic spill modelling. This maximum occured at the Strait of Georgia Site, and described in Technical Report TR 8C 12 Supplemental TR S9, Modelling the Fate and Behaviour of Marine Oil Spills for TMEP of Volume 8C (Filing ID A3S5G9).

References:

Khelifa, A., M. Fingas and C. Brown. 2008. "Effects of Dispersants on Oil-SPM Aggregation and Fate in US Coastal Waters". Final Report to the Coastal Research Response Center, University of New Hampshire, July 2008. 38 pp.

Payne, J.R., B.E. Kirstein, J.R. Clayton, C. Clary, R. Redding, D. McNabb and G. Farmer. 1987. Integration of Suspended Particulate Matter and Oil Transportation Study. Report Submitted to Minerals Management Service by Science Application International Corporation. 215 pp.

e) The Environment Canada Report considered extremely high sediment concentration to provide an upper bound on the potential OMA formation. They used a sediment concentration of 10,000 mg/L. As shown in Table 2.02.5e-1, suspended sediment concentration in the Fraser River would be at least two orders of magnitude lower.

TABLE 2.02.5e-1

SURFACE SEDIMENT CONCENTRATION

	Winter			Spring			Summer			Fall		
	min	median	max	min	median	max	min	median	max	min	median	max
	(mg/L)											
Westridge	0.1	0.3	2.6	0.8	1.6	11.9	0.5	1.0	4.4	0.3	0.7	5.1
Fraser River	26.5	31.0	54.2	48.6	50.1	79.6	25.5	28.7	41.3	30.2	34.3	44.3
Strait of Georgia	0.1	1.4	20.8	0.6	7.2	51.5	0.7	5.7	25.6	0.5	2.9	24.1
Arachne Reef	0.1	0.1	1.5	0.3	1.1	11.5	1.0	1.6	7.7	0.5	0.7	2.8
Race Rocks	0.0	0.0	0.1	0.0	0.3	2.2	0.4	0.7	2.0	0.1	0.2	0.6
Buoy J	0.0	0.0	0.0	0.0	0.1	0.6	0.1	0.3	0.8	0.0	0.0	0.3

Note:
All values are summarized from an area around the spill location corresponding to the median oil coverage after 24 hours. Minimum and Median values are computed as the median (during each season, in time) of modelled surface sediment concentration minimums or medians from the spatial extent. Maximum values are the highest in both space and time.

A maximum of 79.6 mg/L was observed for surface sediment concentration, and was found in the Fraser River. This number is representative of fine sediment concentrations during the freshet in the Fraser River. Total sediment concentration in the river would be higher, but OMA is a process that operates most efficiently with fine sediment. It should be noted that while the Fraser River Plume looks very muddy, it doesn't take particularly high concentrations of fine sediment to give the appearance of high sediment concentration.

f) No quantitative model was developed in light of the non-negligeable number of unknowns that exist regarding the environmental parameters during the Marshall spill. Rather, the formation and stabilization of OMAs in the oil spill model is based on rigourous published scientific studies. Refer to response to ALIB IR No. 2.02.5c, 2.02.5d and 2.02.5e for more details.

Intervenor's Explanation for Claiming IR Response to be Inadequate

d) The IR requested that TM formulate and use a quantitative relationship between the six parameters requested in ALIB IR 2.02.5 c (above) and OMA formation potential to calculate the probability of OMA formation in each hypothetical spill scenario. TM's response referred to a marine environment study on OMA formation (Payne et al. 1987) and calibration of an unnamed model. The response also refers to a "SPILLCALC" model that was not used in any of the hypothetical riverine spill scenarios. The response goes on to discuss suspended sediment concentrations along the marine transportation route, as well as in the lower Fraser River. The response is very confusing, as it is unclear what model TM is referring to, why it is referring to a model that was not used in the riverine hypothetical spill scenarios or why it is discussing OMA formation in marine environments at all. It appears that TM believed that this IR, requesting information about the hypothetical riverine scenarios, was in fact requesting information about marine spills. This is important because water turbulence, temperature, suspended sediment concentrations and salinity in river systems are quite distinct from marine systems. The answer is therefore not relevant to the IR.

TM's response did refer to the Marshall spill, indicating that a non-negligible number of unknowns exists regarding sediment concentrations and overland travel. TM states that an attempt to extrapolate OMA formation would not be rigorous or defensible. It should be noted that overland travel of spilled diluted bitumen was included in the spill scenarios for the Athabasca River, North Thompson River and Fraser River (Trans Mountain 2013). No mention of the Athabasca River, the North Thompson River or the Fraser River conditions was made, except as mentioned above. No reference to parameter estimates from OMA formation studies was made. No mention of the six parameters was made, apart from suspended sediment. As requested in the original IR, TM should provide the quantitative relationships for all six parameters and OMA formation potential at the three hypothetical spill locations. If TM is not able to complete such a formulation, or believes that insufficient data exists to complete such a formulation, it should state this.

e) This IR requested that TM ensure that data, conditions and outcomes of the Environment Canada (EC) study on diluted bitumen behaviour in water is included in the comparison of OMA formation potential. TM's response stated that the high sediment concentration considered in the EC study effectively make it not useful for such a comparison of OMA formation potential. Specifically, TM states that EC uses an upper bound sediment concentration of 10,000 mg/L, but does not provide a reference for this statement. We were unable to find such a figure in the EC report, and the response is incomplete. In addition, TM's response includes a comparison of this 10,000 mg/L figure with sediment concentrations in the Fraser River and at several marine sites. As with the response to ALIB IR 2.02.5 d (above), TM appears to believe that this IR was requesting information about marine spills, instead of riverine spills. **TM should provide a specific section and page number reference for the 10,000 mg/L figure that it cites. TM should also compare the sediment concentrations used in the EC report with those found at the Athabasca River, North Thompson River and Fraser River hypothetical spill sites.**

(Environment Canada. 2013. Properties, composition and marine spill behaviour, fate and transport of two diluted bitumen products from the Canadian oil sands. Federal Government Technical Report (Environment Canada, Fisheries and Ocean Canada, Natural Resources Canada), ISBN 978-1-100-23004-7. November 2013.)

f) This IR requested that TM provide the assumption and methods used to develop the requested quantitative model of OMA formation potential and sources of uncertainty in parameter estimation. TM's response states that no such model was developed, which is evident. However, the response goes on to state that *"the formation and stabilization of OMAs in the oil spill model is based on rigorous published scientific studies"*. This response is confusing and unclear because it refers to a model immediately after stating that no model was developed. **In order for ALIB to understand the response, TM should clarify whether the requested model of OMA formation potential for the riverine hypothetical spill scenarios was developed.**

Trans Mountain's Response to Motion

d) In accordance with Board Ruling No. 33 (Filing ID A63066), Trans Mountain's response provided sufficient information and detail for the Board in its consideration of the application and no further response is required

e) A clarification about the sediment concentration used in the Environment Canada experiments about OMA formation is provided here. In the Environment Canada Report about diluted bitumen, pp. 45 and 51 of 87, the concentration of sediment is mentioned to be 10 g/L, or 10,000 mg/L as indicated previously in the response to the IR. This value is well above what can be observed in the Fraser River or in the Athabasca River.

f) This is a misunderstanding from the Intervenor: a rigorous module about the formation of OMA was developed and incorporated in the spill modelling in the Lower Fraser River and in the marine environment. However, due to the lack of data for the Kalamazoo spill, no calibration of the module was conducted against Kalamazoo spill. Rather the calibration of the module was conducted against published literature, described in the February 2015 response.

Intervenor's Reply

d) Ruling No. 33 does not provide any basis to support Trans Mountain's argument that its response is sufficient. The Board should dismiss Trans Mountain's response as being non-responsive and order that Trans Mountain provide full and adequate response to ALIB's question.

e) The further information is appreciated, however, is incomplete.

f) None.

NEB Decision on Intervenor Motion

d) Grant – Motion sought information that met the Board's test for compelling a further and better response. The Board is compelling Trans Mountain to provide a clearer and expanded response to the original question asked.

e) Grant – Motion sought information that met the Board's test for compelling a further and better response. The Board is compelling Trans Mountain to provide a clearer and expanded response for the portions of the question pertaining to oil-mineral aggregate (OMA) formation in riverine environments and to sediment concentrations in the North Thompson River.

f) Grant – Motion sought information that met the Board's test for compelling a further and better response. The Board is compelling Trans Mountain to provide the assumptions and methods used in the analysis performed in the response to IR 2.5(d).

Trans Mountain's Follow-Up IR Response

d) The parameters controlling OMA formation, listed in ALIB IR No. 2.02.5c, are the following:

- concentration, type and size distribution of suspended sediment,
- dissipation rate of turbulent kinetic energy,
- temperature,
- oil characteristics,
- oil droplet size and number, and
- salinity.

The response to this IR is articulated over two sections: a discussion and a conclusion section. The following section is a discussion that reviews the quantitative relationship between these parameters and OMA formation potential to provide a research based evaluation of the probability of OMA formation in each of the hypothetical riverine spill scenario locations.

Discussion

First, Table F-IR 2.02.5d-1 shows a quantitative comparison of these parameters between the Kalamazoo River, MI, the Fraser River at Hope, BC, the North Thompson River at North Kamloops, BC, and the Athabasca River at Hinton, AB. The river flow has been added for comparison.

Table F-IR 2.02.5d-1

Comparison of OMA Formation Parameters

	Kalamazoo River	Fraser River at Hope	North Thompson River	Athabasca River
Turbidity (proportional to suspended sediment content)	Up to 1,200 NTU at New Richmond, MI, over the past four years (Figure F-IR 2.20.5d-1) - Unknown at the time of the Marshall spill	Up to 400 NTU at Hope, BC (Figure F-IR 2.20.5d-2)	Up to 16 NTU at North Kamloops, BC (Figure F-IR 2.20.5d-3) For comparison: Up to 41 NTU for the Thompson River at Spences Bridge, BC (based on 379 samples collected between 1984 and 2000) (Figure F-IR 2.20.5d-4)	Up to 400 NTU at Hinton, AB – usually below 100 NTU (Figure F-IR 2.20.5d-5) For comparison: 8.5 to 180 NTU (based on data collected from June to October 2012 by Environment Canada near Fort McMurray)
Concentration, Type and Size Distribution of Suspended Sediment	Unknown	See ALIB IR 2.02.5e	See ALIB IR 2.02.5e	See ALIB IR 2.02.5e
Turbulent kinetic energy dissipation rate (represented by river slope)	~ 0.88 m/km	~ 0.3 m/km	~ 0.5 m/km	~ 0.9 m/km
River Flow	Up to 330 m^3/s at New Richmond, MI, over the past four years	Up to 15,000 m^3/s at Hope, BC – average annual peak up to 7,000 m^3/s	Up to 2,300 m^3/s at McLure, BC	Up to 1,500 m^3/s at Hinton, AB
Temperature	Year around: 0 to 30 degC – Usually 20 to 30 degC in July	Year around: 0 to 21 degC	Year around: 0 to 20 degC in Thompson River	Year around: 0 to 17 degC
Oil Characteristics	Diluted Bitumen	Diluted Bitumen	Diluted Bitumen	Diluted Bitumen
Oil Droplet Size and Number	Unknown	N/A See ALIB IR 2.02.5f	N/A See ALIB IR 2.02.5f	N/A See ALIB IR 2.02.5f
Salinity	Freshwater	Freshwater	Freshwater	Freshwater

One can see that turbidity data at New Richmond, MI, for the Kalamazoo River reaches 1,200 NTU during freshet. In comparison, the Fraser River at Hope reaches about 400 NTU during the freshet, the North Thompson River reaches 16 NTU and the Athabasca River reaches 400 NTU. Hence, a factor of 3 to 75 separates turbidity levels between the Kalamazoo (the highest) and the other rivers.

Second, it should be noted that the Kalamazoo River was in flood condition when the spill occurred. Attachment 1 (ALIB F-IR No. 2.02.5d-Attachment 1) shows a conceptual release diagram and Attachment 2 (ALIB F-IR No. 2.02.5d-Attachment 2) shows the type of vegetation the oil crossed before reaching the stream. Both are from Enbridge's Conceptual Site Model report, 2013. As Enbridge noted "Oil within the zone of active sediment and flood plain debris potentially incorporates materials and sinks to floodplain surface". As a result, a significant amount of organic debris and sediment was undoubtedly collected by the oil on its way to Talmadge Creek and then the Kalamazoo River. This is validated by stains left by the oil on tree trunks and by tarballs found on the ground in vegetated areas before reaching Talmadge Creek. These marks show the remnants of the interaction of oil with organic and inorganic debris prior to reaching the water stream.

It should be noted that to date the quantification of oil aggregate formation has focused on the interaction of oil and inorganic sediment, *e.g.* clays, which are correctly referred to as oil mineral aggregates, OMA. However, the composition of suspended solids in the Kalamazoo is not known, and during the spill also likely contained a large organic component. As well, as the oil moved from the spill site to the Kalamazoo, it was exposed to the organic materials forming the surface veneer of the flood plain. A quantitative relationship between floodplain debris and oil with respect to forming aggregates that would sink faster than oil on its own is not available because globally and regionally research has been oriented towards oil interactions with inorganic sediment (OMA) only.

The Kalamazoo River is quite a different river from the rivers in British Columbia, and Alberta, situated along the Trans Mountain route, based on slope, water temperature and turbidity, although the Athabasca River in Alberta has similar slope. To explain, the Kalamazoo River flows through different terrain than the other rivers: for example, the Fraser River at Hope (roughly 110 km inland) is located at an elevation of approximately 33 m above sea level and has an average slope for the lower river of about 0.3 m per kilometre; whereas the Kalamazoo River undergoes a similar fall in elevation over a distance of about 38 km between Marshall, MI, and the upstream end of the Morrow Lake impoundment, giving an average slope of about 0.88 m per kilometre. Finally, the typical flow rate in the Kalamazoo River is about one order of magnitude lower than flow rates in the Fraser, Athabasca and North Thompson rivers. This difference further supports the observation that the Kalamazoo River is a different type of system compared to rivers in British Columbia and Alberta.

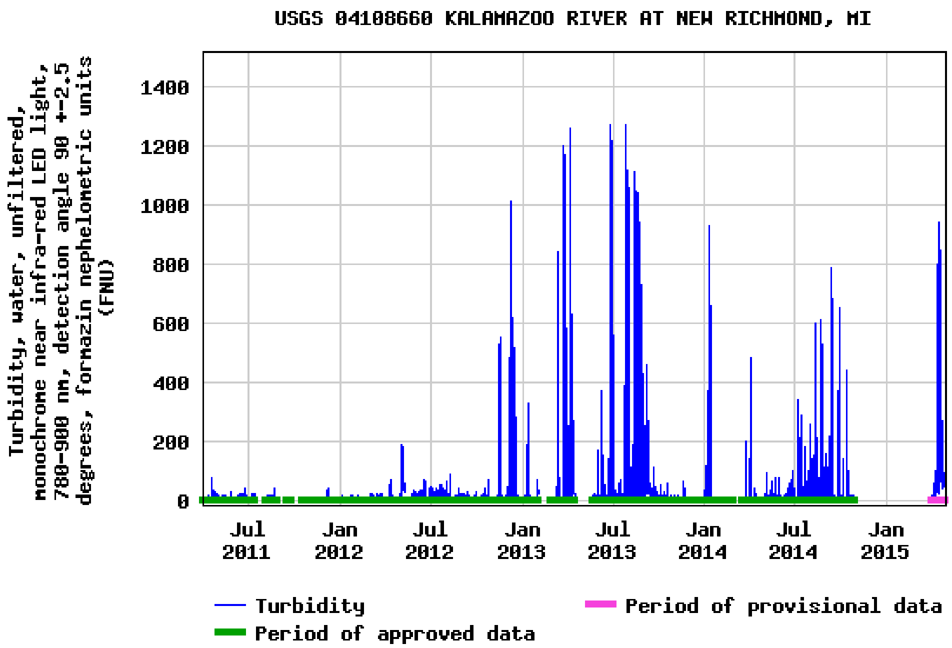

Figure F-IR 2.02.5d-1: Turbidity in the Kalamazoo River at New Richmond, MI (from USGS website accessed on April 29, 2015)

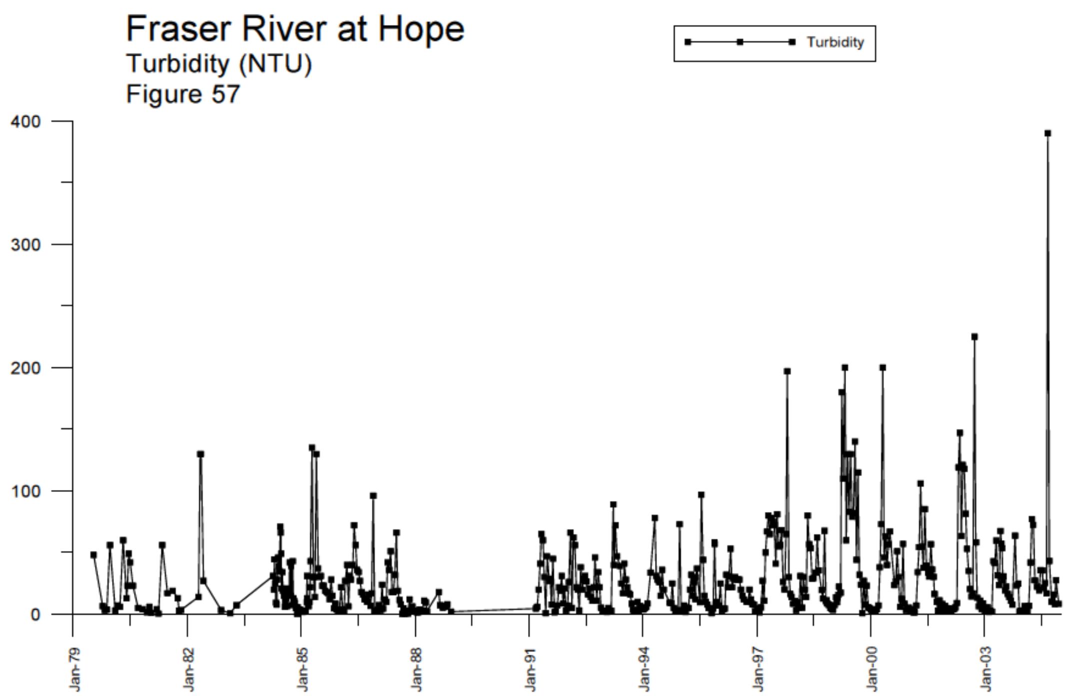

Figure F-IR 2.02.5d-2: Turbidity in the Fraser River at Hope, BC (source: Swain L.G., BC Ministry of Environment, Water Quality Assessment of Fraser River at Hope (1979-2004), Environment Canada, Aquatic Sciences Section, 2007, Fig.57)

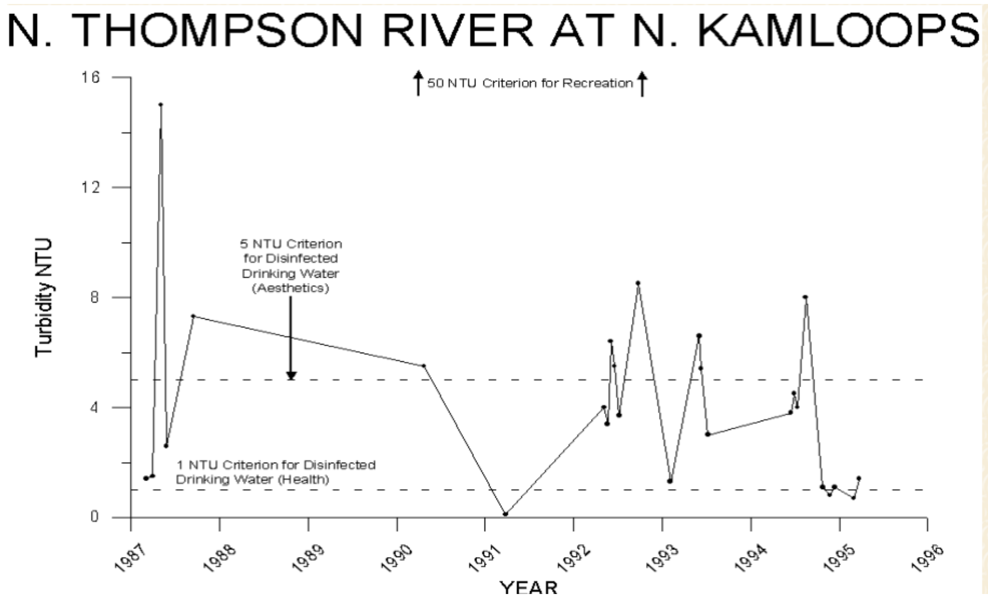

Figure F-IR 2.02.5d-3: Turbidity in the North Thompson River at North Kamloops, BC (source: Brewer L., State of Water Quality of North Thompson River at North Kamloops (1985-1995), Environment Canada, Aquatic Sciences Section, 1997, Fig.46)

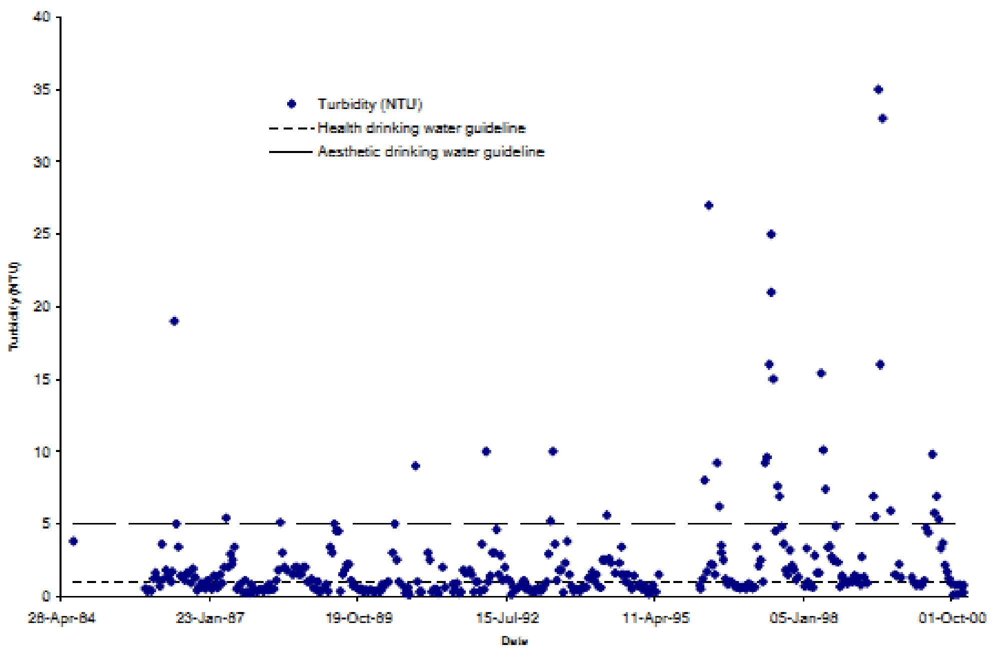

Figure F-IR 2.02.5d-4: Turbidity in the Thompson River at Spences Bridge, BC (source: Phippen B., BWP Consulting, Water Quality Assessment of Thompson River at Spences Bridge (1985-2000), Environment Canada, 2002, Fig.45)

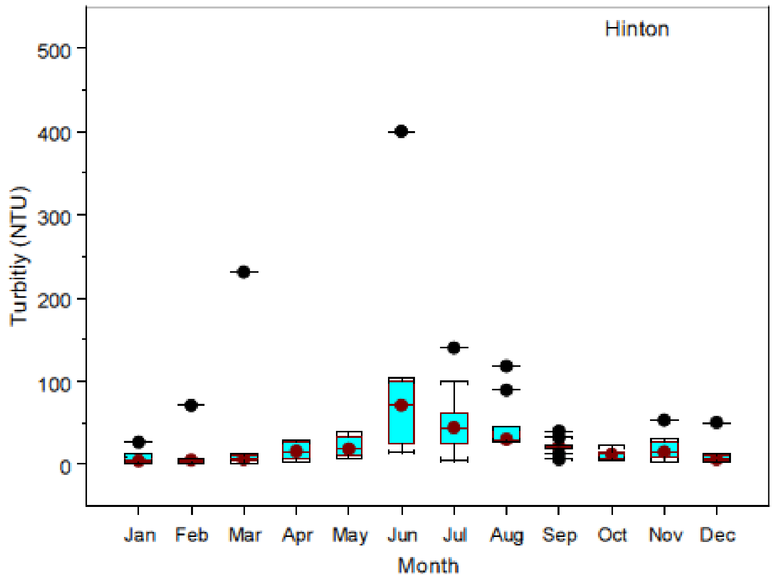

Figure F-IR 2.02.5d-5: Turbidity in the Athabasca River at Hinton, AB (source: Hebben T., Analysis of Water Quality Conditions and Trends for the Long-Term River Network Athabasca River (1960-2007), Alberta Environment, 2009, Fig.41)

As described in Table F-IR 2.02.5d-1 of this IR, a non-negligible number of unknowns exist regarding the environmental parameters during the Marshall spill, such as the absence of quantification of mineral sediment and organic debris pickup during the overland portion of the spill. Furthermore, as shown in Table F-IR 2.02.5d-1, the turbidity conditions in the Kalamazoo River during flow conditions similar to those which occurred during the spill, are significantly different, *i.e.* much higher, than the Fraser, North Thompson and Athabasca rivers. Based on this information only, the potential for OMA or other oil aggregates formation was much greater in the Kalamazoo River.

Finally, it should be noted that a NEBA (Net Environmental Benefit Analysis) would be conducted following a spill prior to any remediation operation. In the case of the Marshall spill, where oil likely interacted with a significant amount of organic material during its course on the flooded areas, several operations were undertaken such as stirring sediments to release the sunken oil, which proved to be not the most effective in terms of net environmental impact.

Conclusion

Based up on the discussion above, a quantitative relationship between the parameters listed above and OMA formation potential to calculate the probability of OMA formation in each hypothetical riverine spill cannot be obtained. Extensive research to date has focused on OMA, *i.e.* Oil Mineral Aggregates, but not on other pathways for the oil to sink and reach the river bed such as Oil and Organic Aggregates. Clearly, the Kalamazoo Spill had oil interacting with both minerals and organic materials. To date, there has been no quantification of these interactions: concentration of suspended sediment at time of the spill in the Kalamazoo is not known, amount of organic debris picked-up overland is not known, amount of oil that sank following the onland course is not known. The number of unknowns (both parameters and theory) is too high to provide a reliable conceptual model. Should in the future appropriate observational data be available, a conceptual model might be established, and could then be developed into a quantitative, predictive model.

Because marine spills might directly encounter minerals and because the theory behind OMA formation is understood, the probability of OMA formation in the marine environment (Marine Transportation) was computed for each of the hypothetical marine spill scenarios. However, the riverine system is different, with oil often running overland prior to reaching the water course, and due to the lack of data, the probability of oil interacting with organic materials is impossible to quantify in the riverine system. Table F-IR 2.02.5d-2 summarizes the availability of parameters that are necessary to establish a quantitative relationship in support of the calculation of OMA formation.

Table F-IR 2.02.5d-2

Parameters Necessary to Calculate Probability of OMA Formation in Other Riverine Systems Based Upon Kalamazoo Spill Incident (2010)

Kalamazoo Spill Parameters	Availability
Theory about Oil – Mineral Interaction	Available
Theory about Oil – Organic Material Interaction	Not Available
Information on the spilled product	Available
Information on Suspended Sediment Concentration in Kalamazoo River at Time of Spill	Not Available
Information on Amount of Organic Debris near Talmadge Creek Floodplain Area at Time of Spill	Not Available
Complete Quantification of Amount of Oil – Mineral/Debris Aggregates at Bottom of Talmadge Creek	Not Available
Complete Quantification of Total Amount of OMA /OOA being formed	Not Available

References:

Payne, J.R., B.E. Kirstein, J.R. Clayton, C. Clary, R. Redding, D. McNabb and G. Farmer., 1987. Integration of Suspended Particulate Matter and Oil Transportation Study. Report Submitted to Minerals Management Service by Science Application International Corporation. 215 pp.

Brewer L., State of Water Quality of North Thompson River at North Kamloops (1985-1995), Environment Canada, Aquatic Sciences Section, 1997.

Hebben T., Analysis of Water Quality Conditions and Trends for the Long-Term River Network Athabasca River (1960-2007), Alberta Environment, 2009.

Phippen B., BWP Consulting, Water Quality Assessment of Thompson River at Spences Bridge (1985-2000), Environment Canada, 2002.

Swain L.G., BC Ministry of Environment, Water Quality Assessment of Fraser River at Hope (1979-2004), Environment Canada, Aquatic Sciences Section, 2007.

e) Table F-IR 2.02.5e-1 shows a comparison of sediment concentrations used in the Environment Canada study and found in the rivers. The Environment Canada Report considered extremely high sediment concentration to provide an upper bound on the potential OMA formation. They used a sediment concentration of 10 g/L or 10,000 mg/L, which is orders of magnitude above typical and maximum values found on the West Coast. This value is clearly described in p.45 of Environment Canada's report: "The sediment loading chosen was 10 g sediment/L brine. While high, this level of suspended sediment has been found in coastal river outflows". On page 51 of Environment Canada's report, the use of 10 g/L is repeated. These pages of the Environment Canada's report have been presented in Attachment 1 (ALIB F-IR IR No. 2.02.5e–Attachment 1).

Table F IR 2.02.5e-1

Comparison of Sediment Concentration for Potential OMA Formation

	Environment Canada	Fraser River	North Thomson River	Athabasca River
Sediment Concentration	10,000 mg/L	Up to 700 mg/L at Hope, BC (Figure F-IR 2.02.5e-1) For comparison, Table 2 shows the surface sediment concentration in the Lower Fraser River and the marine sites	Up to 175 mg/L at North Kamloops, BC (Figure F-IR 2.02.5e-2) For comparison: Up to 80 mg/L for the Thompson River at Spences Bridge, BC (based on 379 samples collected between 1984 and 2000) (Figure F-IR 2.02.5e-3)	Up to 600 mg/L at Hinton, AB – usually below 100 mg/L (Figure F-IR 2.02.5e-4)

As Environment Canada conducted their experiment with sediment concentration values that are one to two orders of magnitude greater than what is observed in the Fraser, North Thompson and Athabasca Rivers, data and conditions used by Environment Canada could not be used. They are not representative of river conditions in the West Coast; rather they provide an upper bound on the potential OMA formation.

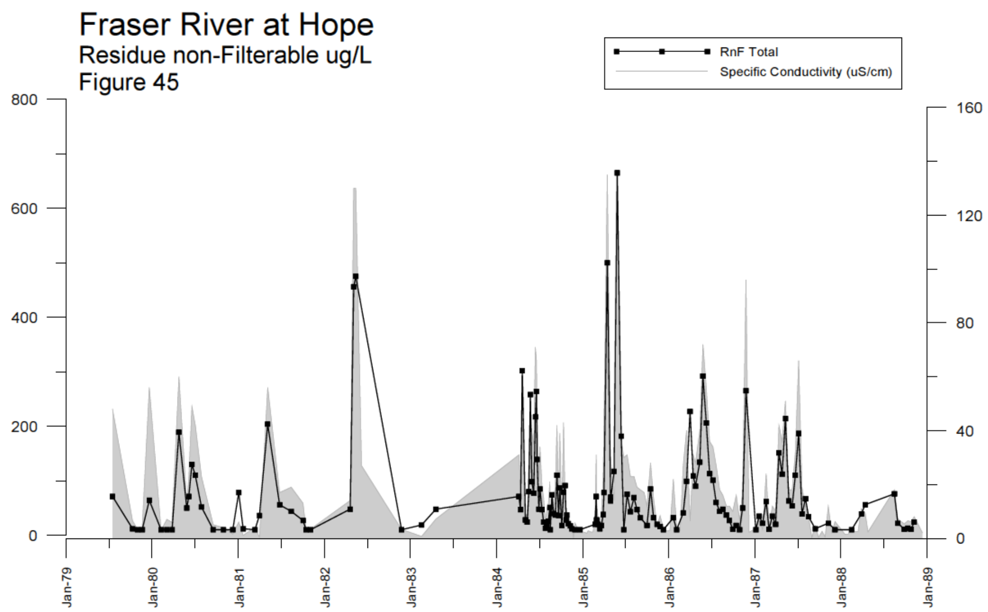

Figure F-IR 2.02.5e-1: Residue non-Filterable in the Fraser River at Hope, BC (source: Swain L.G., BC Ministry of Environment, Water Quality Assessment of Fraser River at Hope (1979-2004), Environment Canada, Aquatic Sciences Section, Fig.45)

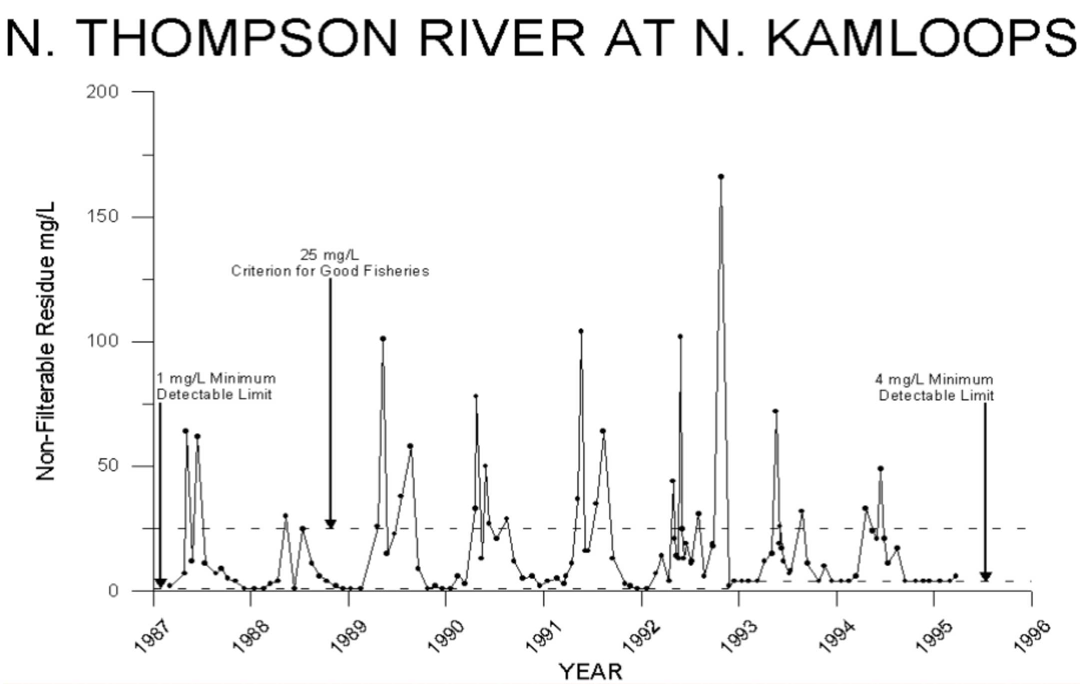

Figure F-IR 2.02.5e-2: Total Suspended Sediment Concentration (*i.e.,* Non-Filterable Residue) in the North Thompson River at North Kamloops, BC (source: Brewer L., State of Water Quality of North Thompson River at North Kamloops (1985-1995), Environment Canada, Aquatic Sciences Section, Fig.35)

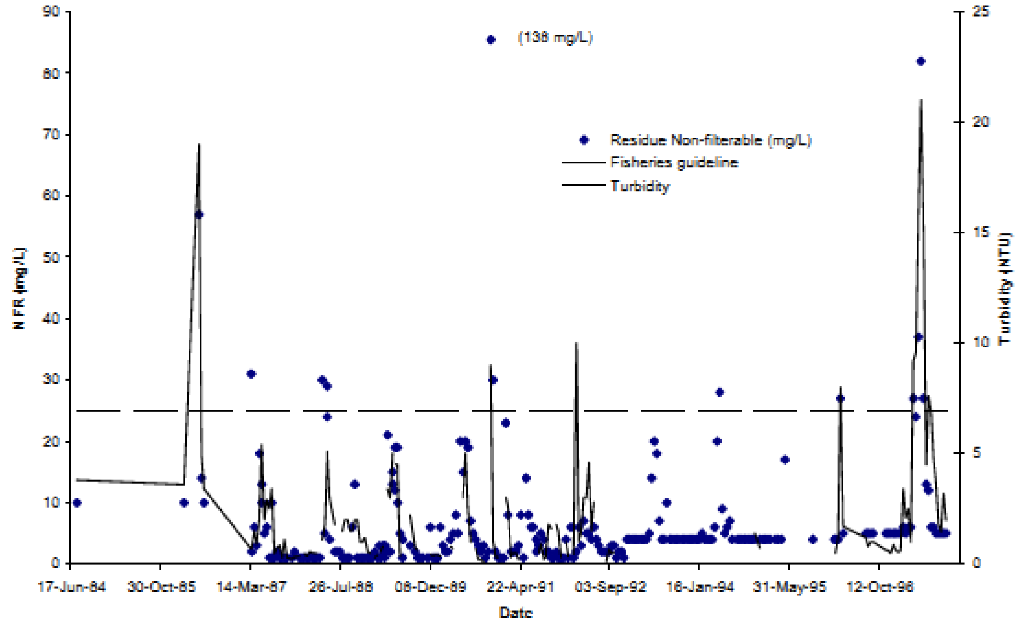

Figure F-IR 2.02.5e-3: Total Suspended Sediment Concentration (*i.e.,* Non-Filterable Residue) in the Thompson River at Spences Bridge, BC (source: Phippen B., BWP Consulting, Water Quality Assessment of Thompson River at Spences Bridge (1985-2000), Environment Canada, Fig.39)

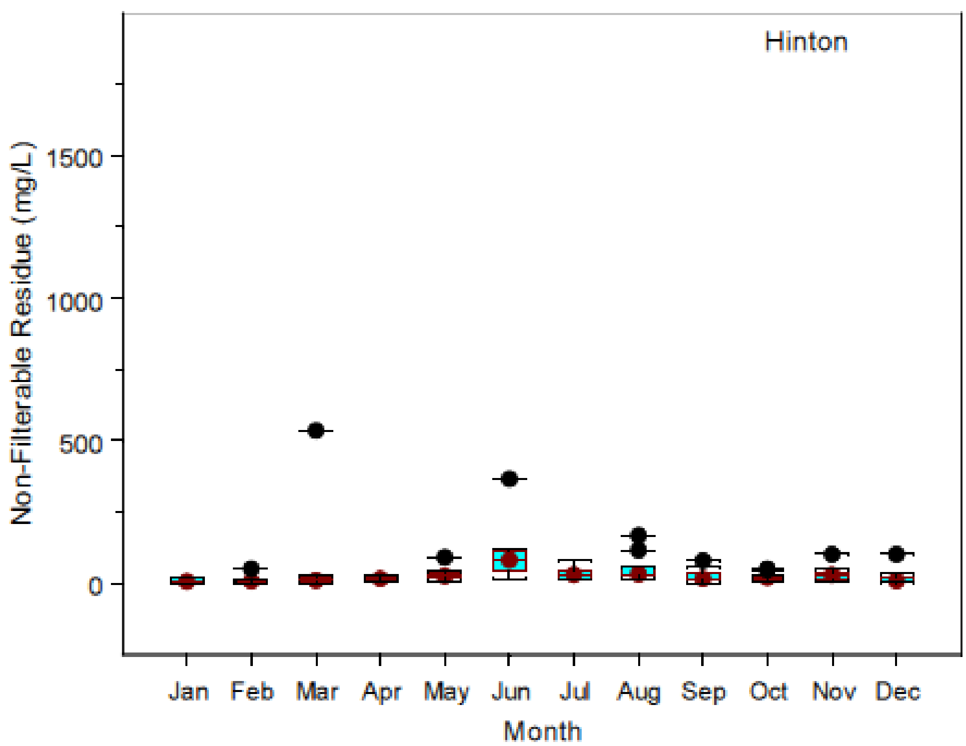

Figure F-IR 2.02.5e-4: Total Suspended Sediment Concentration (*i.e.,* Non-Filterable Residue) in the Athabasca River at Hinton, AB (source: Hebben T., Analysis of Water Quality Conditions and Trends for the Long-Term River Network Athabasca River (1960-2007), Alberta Environment, Fig.45)

f) Trans Mountain clarifies that a riverine model is described and used in the Application, Volume 7 – ERA Pipeline – (Filing ID A3S4W9) to assess the behaviour and fate of hypothetical spills in riverine systems. Trans Mountain further clarifies that no additional quantitative model was developed to specifically assess OMA formation potential for the hypothetical riverine spill scenarios. Such a quantitative model was not developed because of the lack of relevant observational information concerning the fate of the oil between the spill point and the Kalamazoo River, as well as its course in the Kalamazoo River. In addition, the river system of the Kalamazoo River is different from the river system on the West Coast, primarily the turbidity in the Kalamazoo River is much greater than conditions found in the Fraser, North Thompson and Athabasca Rivers. More details can be found in response to ALIB IR No. 2.02.5d. These factors did not support development of a robust and valid quantitative model. For this reason, detailed information regarding assumptions and methods on OMA formation as requested cannot be provided. However, ALIB IR No. 2.02.5d does contain a discussion that reviews the various parameters that are known to affect OMA formation. The intervenor is requested to refer to that discussion.

Assumptions used in the riverine model described and used in the Application, Volume 7 – ERA Pipeline – (Filing ID A3S4W9) are the following:

- The overland course of the oil before reaching the river is characterized by evaporation and oil adhesion to land.
- The amount of oil retention varies between 2 and 200 mm per metre of land for the range of land cover types typically encountered.
- When reaching the water, evaporation and shore retention were simulated. In inland waters, the following conditions prevail:
  - salinity is low,
  - there is low to moderate total suspended solids concentrations or turbidity,
  - oils are viscous when reaching water either due to weathering or low temperatures.

The rationale behind these assumptions to quantify OMA in the river can be found in pages 6-28 and 6-29 in the Application, Volume 7 – ERA Pipeline – (Filing ID A3S4W9). Based upon these assumptions and expert judgement it was determined that OMA formation involving diluted bitumen (which has high asphaltene and resin content) will be limited. Hence no oil and sediment interaction was modelled in the riverine scenarios. More details on the parameters needed to establish the calculation of OMA formation can be found in ALIB IR 2.02.5d.

Trans Mountain Pipeline ULC
Trans Mountain Expansion Project
NEB Hearing Order OH-001-2014
Follow-Up Responses to Information Request from
Adams Lake Indian Band

2.06.0 MONITORING AND FOLLOW-UP ROUND 2 IRS

F-IR 2.06.1 Demonstrate effectiveness of mitigation

Reference:

Trans Mountain Response to ALIB IR No. 1 – 1.6.01

Preamble:

As TM is clearly aware, monitoring and follow-up programs are critically important in order to determine whether project-related and cumulative impacts have been effectively mitigated, regardless of the predictions from the impact analyses. Having comprehensive monitoring programs in place helps hedge against uncertainty, especially regarding effectiveness of mitigation measures. Relying solely on compliance monitoring is not an appropriate approach to evaluating the effectiveness of mitigation measures as outlined in the CEAA Policy on Follow-up Programs (CEA Agency 2011). TM states that effectiveness of mitigation measures have been demonstrated through construction of other pipelines but TM presents no concrete examples or demonstrations of effectiveness other than a preliminary report for the TMX Anchor Loop Project. This report does not provide evidence of success beyond a single year of monitoring (see IR 6.7 below). TM does state that the baseline data and field information gathered for the proposed Project "*provides a benchmark for Post-Construction Environmental Monitoring Programs*." (pg 106) This is a good intention, but requires that TM acquire high quality, quantitative baseline data to act as the "*benchmark*". ALIB has expressed concerns throughout the EA review process that TM has not collected appropriate baseline data to be used as benchmark for monitoring programs (see IRs 2.2, 2.3, 2.4, 3.2, 3.3, 3.5, 3.6, 3.15, 3.16, 5.2 above).

Request:

c) Please provide benchmarks and targets for VECs of key concern to ALIB against which future monitoring results could be compared so as to concretely indicate to ALIB that residual impacts to traditional resources and lands are at or below predicted levels.

Response:

c) Refer to responses to ALIB IR Nos. 2.06.1a, 2.06.6a, and 2.06.6e.

Intervenor's Explanation for Claiming IR Response to be Inadequate

c) A brief description of TM's wetland assessment is provided, but it does not demonstrate to ALIB how the PCEM will work when only qualitative data has been collected, or how the baseline data collected by TM to date will be quantitatively used as a benchmark and compared to data collected in the PCEM programs in order to assess effectiveness of mitigation measures. This is especially true for areas where insufficient baseline data has been collected. For example, it appears that only wetlands *"where access was available"* were assessed for any quantitative habitat, hydrological, and biogeochemical function parameters. Additionally, as stated above in the IRs for wildlife, vegetation and reclamation, surface water quality, and fisheries comprehensive baseline data have not been collected for areas that will be disturbed by the project footprint. It is therefore unclear how TM will meet these stated goals:

"The goal for similarity between pre- and post- construction conditions is considered to have been achieved when the environment has been assessed to be functionally comparable to pre-construction conditions or adjacent conditions off the right-of-way, or if a community or disturbed area has achieved an early trajectory that will in time resemble the pre-construction condition."

And *"the long-term target of PCEM is to return the disturbed portion of the construction footprint to a state where it can be used by the same species or for the same purposes as were used in a similar manner prior to construction"* (TM response to ALIB 2.06.6e, emphasis added). The question remains how any of these goals or targets are remotely achievable when pre-construction conditions have not been quantitatively assessed? If there is no baseline data on what species use an area of the footprint or for what purpose, how can TM assess whether they have achieved the stated long-term goal of the PCEM?

Additionally, TM oddly states that *"more detailed information about the state of the environment prior to construction would not necessarily improve the post-construction monitoring program or reclamation practices"* but TM also states that the data they collect will be used as an indication of the baseline state of the environment during the PCEM program. Therefore, having *"more detailed information about the state of the environment prior to construction"* would absolutely improve PCEM programs, indeed it is necessary. **Keeping in mind the above noted concerns about the IR response, please respond to the original IR, specifically focussing on a theoretical example where quantitative baseline data has not been collected.**

Trans Mountain's Response to Motion

c) In accordance with Board Ruling No. 33 (Filing ID A63066), Trans Mountain's response provided sufficient information and detail for the Board in its consideration of the application and no further response is required.

Intervenor's Reply

c) ALIB's motion to compel a full and adequate response sought answers to the original IRs.

Ruling No. 33 does not provide any basis to support Trans Mountain's argument that its response is sufficient. The Board should dismiss Trans Mountain's response as being non-responsive and order that Trans Mountain provide full and adequate response to ALIB's question.

NEB Decision on Intervenor Motion

Grant – Motion sought information that met the Board's test for compelling a further and better response. The Board is compelling Trans Mountain to provide a full and adequate response to the original question asked.

Trans Mountain's Follow-Up IR Response

c) Although the terminology of Valued Ecosystem Components is not used by Trans Mountain, the requested information has been provided for environmental elements assessed in the Application.

Pre-construction environmental information that will be used as a benchmark can be found in Volume 5C, Biophysical Technical Reports. Each technical report contains baseline information collected that can be used, if needed, to determine the pre-construction environmental state.

Temporary and extra temporary workspaces will be planted with timber tree species within forested land uses along with seeding of native or agronomic grass species. The permanent operational right-of-way will be seeded with native or agronomic grass species and naturally regenerating woody tree and shrub species will be managed (mechanically or chemically treated) to a level that will facilitate regularly scheduled aerial reconnaissance of the pipeline center as well as vehicle and equipment access for operational maintenance of the pipeline facility. The Post-Construction Environmental Monitoring program will commence with a review of the Environmental Issues List (EIL) developed by Environmental Inspectors during the construction phase of the Project. Qualitative and quantitative assessment of selected environmental elements will be completed during the post-construction environmental monitoring period to identify the effectiveness of mitigation implemented during the pre-construction, construction and post-construction phases. In addition, where new disturbances are identified or where known effects of construction are beyond what was predicted, this information will be used to plan and implement appropriate corrective mitigation. On the operational right-of-way, woody vegetation will be managed to facilitate operational activities. In some instances, the developing plant community on the operational right-of-way may look similar to the plant community adjacent to the right-of-way; such as within a grassland land use. Alternatively, where naturally regenerating woody vegetation is managed on the operational right-of-way to allow for pipeline operational activities (aerial view of pipeline, and vehicle and equipment access), this plant community will develop along an alternate trajectory to the plant community establishing within the reclaimed temporary workspace or the adjacent natural land use.

Please see Table F-IR 2.06.1c-1 for the elements to be investigated during post-construction environmental monitoring and the parameters and targets that are associated with those elements. Items listed in the "parameter" column are types of data that would be collected after construction to determine if effects are similar to predicted effects and whether mitigation has been effective. However, not all parameters will be measured at all areas along the right-of-way. The level of detail of post-construction environmental monitoring at any location will be determined by the sensitivity of the area, the results of any ground visits and helicopter overflights, the results of environmental as-built reports and any concerns received from landowners or land administrators. High sensitivity areas including but not limited to major fish-bearing watercourses, locations with known species at risk, urban areas and parks protected areas will undergo a higher level of post-construction environmental monitoring.

Although quantitative targets are not feasible for some parameters, qualitative assessments of the environment after construction and reclamation can provide useful information about whether the effects are at or below predicted levels, including effects to traditional and cultural resources and lands.

Trans Mountain notes that monitoring programs are still being developed in consultation with applicable regulatory authorities.

Table F-IR 2.06.1c-1

Parameters and Targets for Post-Construction Environmental Monitoring

VEC of Concern	Parameter(s)	Target(s)
Soils and Terrain	Quantitative · Annual crop density, height, phenological stage, vigour, distribution and colour on cultivated lands (*i.e.,* differences in crop characteristics on and off right-of-way would indicate problem soils, such as compaction or ad-mixing) · Total percent of live cover of desirable species on hay and tame pasture lands (*i.e.,* as above) · Soil moisture, stoniness, admixing and compaction (soil characteristics are measured if problems in crop characteristics are detected) · Acceleration of the spread of clubroot or other soil pathogens, as requested by landowners. Qualitative · Landscape variation (topography) · Line-of-sight · Bare soil exposure, visible erosion, surface vegetation and litter, grazing pressure and plant vigour on hay, tame pasture, native pasture, native grasslands and treed pasture lands	· Comparable to similar areas off the right-of-way, and comparable to pre-construction conditions where recorded
Vegetation	Quantitative · Vegetation establishment, color, density and height · Annual crop density, height, phenological stage, vigour, distribution and colour on cultivated lands · Total percent of live cover of desirable species on hay and tame pasture lands · Presence of rare plants, lichens and rare ecological communities where previously observed and mitigation was applied. · Presence and abundance of invasive or Noxious/Prohibited Noxious weeds Qualitative · Native grass/forb, shrub and tree re-establishment (I.e. colonization of native species not seeded or planted during reclamation) · Indicators of rare plant, lichen and rare ecological community health including abundance and signs of stress in plant populations. · Acceleration of the spread of forest health pathogens	· Comparable to similar areas off the right-of-way, and comparable to pre-construction conditions where recorded · Established on an early successional trajectory towards conditions similar to pre-construction, given operational requirements
	Quantitative · Ecosystem, landscape and stand level attributes of potentially impacted Old Growth Management Areas (OGMAs).	· Level of windthrow does not exceed levels associated with the natural disturbance regime of the biogeoclimatic zone that contains the OGMA.

Table F-IR 2.06.1c-1

Parameters and Targets for Post-Construction Environmental Monitoring (Continued)

VEC of Concern	Parameter(s)	Target(s)
Wetlands	Quantitative · Percent open/standing water coverage · Wetland landscape functional assessment (qualitative observations used to determine a quantitative outcome [functional condition]). Please see NEB IR No. 2.051a (Filing ID A3Z4T9) for the methods used to determine the functional condition category quantitative outcomes through a tier system that examines several functional components. Qualitative · Grade and substrate composition (erosion, admixing, compaction) · Surface water presence (ponding) /absence (drying) and water quality (increased turbidity) · Hydrophytic vegetation re-establishment · Establishment success of site-specific woody riparian fringe reclamation efforts · Land use changes by landowners or developers that prohibit the return of wetland function	· No net loss of wetland function · Comparable to similar areas off the right-of-way, and comparable to pre-construction conditions (post-construction functional condition is at least equal to pre-construction functional condition) where recorded. By employing similar wetland landscape functional assessment criteria as used during the pre-construction study, a quantitative measurement of overall wetland function can be determine (compare pre-construction to post-construction functional condition over time).
Watercourses	Quantitative · Water quality monitoring during construction and turbidity measurements Qualitative · Terrain stability, soil productivity and erosion control on the banks and approach slopes · Success of riparian vegetation re-establishment (*i.e.,* re-establishment of a diverse mix of forbs and shrubs and minimal bare ground) · Continued function of any instream habitat enhancement carried out and the absence of any barriers to the movement of fishes at fish-bearing watercourses · Natural flow pattern (*i.e.,* an alteration to the natural flow pattern will trigger mitigation)	· Water quality data are measured and recorded upstream of the crossing and throughout the duration of construction. · Comparable to similar areas off the right-of-way, and comparable to pre-construction conditions where recorded
Wildlife and wildlife habitat	Quantitative/Qualitative · Habitat availability and quality, based on the results of post-construction environmental monitoring for vegetation, watercourses and wetlands	· Please see the targets for vegetation, wetlands and watercourses in this table
Noise	Quantitative · Noise levels (dBA) at selected facilities	· Noise levels within municipal, provincial and federally legislated targets
Air	Quantitative · Ambient concentrations of chemicals of regulatory concern, such as criteria air contaminants, volatile organic compounds, particulate matter, hydrogen sulphide, and mercaptans at selected facilities	· Ambient air quality within municipal, provincial and federally legislated targets
Water wells	Quantitative · Water quality and quantity, including flow rates, total and dissolved metals, iron related bacteria, sulphur related bacteria, heterotrophic plate count, total coliforms, E. Coli and other routine water quality parameters as requested by the landowner	· Within regulatory guidelines and comparable to measured pre-construction levels, where available

Trans Mountain Pipeline ULC
Trans Mountain Expansion Project
NEB Hearing Order OH-001-2014
Follow-Up Responses to Information Request from
Adams Lake Indian Band

2.06.0 MONITORING AND FOLLOW-UP ROUND 2 IRS

F-IR 2.06.3 Commitment to understand ALIB concerns and needs lacking

Reference:

Trans Mountain Response to ALIB IR No. 1 – 1.6.03

Preamble:

TM states that "*Although some of the residual effects are long term, it does not preclude the ALIB from using the land for traditional subsistence purposes*" (pg. 109) and that they "*do not believe it would be necessary for ALIB to suspend their traditional land use activities in parts of their traditional territory for many decades as the result of the Project*." (pg. 109). TM should substantiate both of these statements with evidence. Overall, statements such as these indicate a glaring lack of understanding by TM of Aboriginal land use activities and resource use needs. TM states that they will continue to engage Aboriginal communities through all phases of the Project and that they are interested in incorporating site-specific concerns in project planning. However, concrete engagement commitments with ALIB have yet to be made and consideration of only site-specific mitigation measures is inadequate to allow for continued traditional resource and land use by ALIB community members.

Request:

b) Please substantiate using concrete evidence the statement that "*Although some of the residual effects are long term, it does not preclude the ALIB from using the land for traditional subsistence purposes.*" (pg. 109).

Response:

b) Refer to response to ALIB IR No. 2.03.3a.

Intervenor's Explanation for Claiming IR Response to be Inadequate

b) TM provided Table 2.06.3A-1 that, according to TM, shows all current and past TLRU locations identified by ALIB. Although the accuracy of the information in this table is in question (see IR 2.08.04), the list includes numerous current activities in the project area such as fishing and camping on Adams Lake, Adams River and South Thompson River, as well numerous sacred areas and plant gathering areas. TM also states that their *"comprehensive suite of mitigation measures"* will *"reduce the effects of the Project on the environment and in turn, on the use of those lands by others, including the TLRU locations identified by ALIB"*. However, as demonstrated throughout the comments in this adequacy review, ALIB has little confidence in the stated effectiveness of many of

TM's mitigation measures because TM has repeatedly failed to demonstrate their success, nor present comprehensive and effective monitoring programs to assess success of mitigation.

In their response, TM concludes again that *"although some of the residual effects are long term, it does preclude participating First Nations using the land for traditional subsistence purposes".* The requested substantiation for this culturally insensitive statement remains outstanding and this IR has not yet been answered. In fact, the response provided by TM appears to contradict itself, thereby indicating that TM does not understand Aboriginal land and resource use and is not in a position to be making such strong assertions about potential impacts of the project on Aboriginal peoples. **Please provide fulsome responses to the original IRs.**

Trans Mountain's Response to Motion

b) In accordance with Board Ruling No. 33 (Filing ID A63066), Trans Mountain's response provided sufficient information and detail for the Board in its consideration of the application and no further response is required.

Intervenor's Reply

b) Ruling No. 33 does not provide any basis to support Trans Mountain's argument that its response is sufficient. The Board should dismiss Trans Mountain's response as being non-responsive and order that Trans Mountain provide full and adequate response to ALIB's question.

NEB Decision on Intervenor Motion

Grant – Motion sought information that met the Board's test for compelling a further and better response. The Board is compelling Trans Mountain to provide a full and adequate response to the original question asked.

Trans Mountain's Follow-Up IR Response

b) Trans Mountain understands that Adams Lake Indian Band continues to use land in the Project area for traditional activities. Trans Mountain acknowledges the importance of effective mitigation, particularly as it relates to continued First Nations' traditional resource use. Since the request refers to those residual effects that were determined to be long term, the response does not include residual effects that were determined to be short term such as disturbance of gathering places and sacred areas.

The proposed mitigation measures for wildlife and wildlife habitat (see Section 7.2.10.6 of Volume 5A, Filing ID A3S1Q9) were developed in accordance with industry and regulatory guidelines and are therefore considered standard best practices. Considering current knowledge on natural successional patterns of ecosystems, Trans Mountain will be responsible for ensuring that an early seral native vegetation community is established, and, with the exception a portion of the right-of-way which will remain cleared, that ecosystems will follow a natural successional trajectory, and in time will return to conditions similar to pre-disturbance conditions in the absence of disturbance. The Post Construction Monitoring Program will monitor the effectiveness of the proposed mitigation measures and, if necessary, adjust mitigation measures to ensure re-establishment of vegetation within operational constraints. Similarly for other linear projects where equivalent mitigation measures and post-construction monitoring have been implemented at watercourse crossings complete recovery has been documented at each watercourse crossing. The only temporal component that is still visible post-construction is the riparian vegetation which takes longer to restore. All in-stream habitat is restored immediately following installation of the pipeline.

Most of the disturbance will be restricted to the right-of-way, which does not preclude Adams Lake Indian Band from hunting, fishing and plant gathering in the LSA and RSA. For those residual effects that are long term, such as alteration of subsistence resources, the magnitude is medium and is dependent on each target species' sensitivities. Therefore, there will be environmental resources available throughout the LSA and RSA for traditional use by Adams Lake Indian Band, while the long term effects are evident. It is, therefore, expected that Adams Lake Indian Band will not be precluded from using the land for traditional purposes in the future.