Information Request To: Trans Mountain Pipeline ULC From: City of Vancouver

OH-001-2014 Trans Mountain Pipeline ULC (Trans Mountain) Application for the Trans Mountain Expansion Project (Project) File OF-Fac-Oil-T260-2013-03 02

City of Vancouver Information Request No. 2c to Trans Mountain

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### 1 General comments on geotechnical reports

### 1.1 Incomplete geotechnical assessments

### Reference

- i. DRAFT Preliminary Geotechnical Report on Westridge Marine Terminal Offshore Geotechnical Investigations, Proposed New Westridge Marine Terminal, Trans Mountain Expansion Project, Burnaby, BC, Canada. Golder Associates. February 20, 2015 (A4I6L5).
- DRAFT Preliminary Geotechnical Report on Westridge Marine Terminal Offshore Geotechnical Investigations, Proposed New Westridge Marine Terminal, Trans Mountain Expansion Project, Burnaby, BC, Canada. Golder Associates. February 20, 2015, Section 5.2 and 5.3 p.13 & 15(A4I6L5 at PDF p.16 & 18).
- iii. Preliminary Geotechnical HDD Feasibility Assessment, Fraser River Port Mann at V10 RK 1167.7. BGC Engineering Inc., February 20, 2015 (A4I6F1).
- iv. Fraser River Crossing Preliminary HDD Feasibility Report. Hatch Mott MacDonald Ltd. (A416E9).

### Preamble

In their January 2, 2015 response to IR from the NEB, Trans Mountain committed to filing "contingency reports for the remaining watercourses it is proposing to cross by horizontal directional drilling by March 31, 2015". The Fraser River Crossing Preliminary HDD Feasibility Report does not include a contingency plan.

In their January 2, 2015 response to IR from the NEB, Trans Mountain committed to filing "geotechnical reports for the terminals and pump stations by March 31, 2015". The geotechnical report submitted for the marine portion of the Westridge Terminal was preliminary and in draft format, acknowledged that an insufficient number of investigation locations and test holes were utilized in the assessment, and clearly stated significantly more "high quality" data was required to proceed with the design and feasibility study for the marine terminal. Further, the Preliminary Geotechnical HDD Feasibility Assessment, Fraser River-Port Mann report is based on data collected by other parties for a different purpose, and infers geologic conditions from 250-575m downstream of the proposed river crossing location. Site-specific data was not obtained for the study.

In their January 2, 2015 response to IR from the NEB, Trans Mountain also stated it "will not be in a position to submit the geotechnical reports for the Westridge Marine Terminal (land-based) or the Sumas Terminal by March 31, 2015. According to Trans Mountain, these reports will not be ready until Q2 and Q3 2015, respectively, and the only filing commitment that Trans Mountain has made is to file these reports with the NEB as a condition of any Certificate the NEB may issue." It is clear that Trans Mountain is not proposing to make these geotechnical reports available in time for review and questioning by the Board and Intervenors as part of the hearing process.

The Westridge Marine Terminal Offshore Geotechnical Investigation report states: "The global stability condition of the near-shore slope under seismic loading condition including its impact on the seismic stability of the terminal area should be evaluated". Given the risks identified by Trans Mountain's consultant and their recommendation

that further data is required prior to terminal design, it is also clear that critical information relevant to the Board's assessment of: (a) the suitability of design; (b) the potential impacts of the project; and (c) safety and security during construction and operation of the project, will not be available as evidence in this hearing.

The DRAFT Preliminary Geotechnical Report on Westridge Marine Terminal Offshore Geotechnical Investigations states "Overall, the number of investigation locations and test holes was reduced significantly, and depths of test holes were increased greatly to meet the geotechnical information acquisitions requirements that are suitable to the in-situ conditions as best as possible, and at the same time, respecting the budgetary constraint".

- a. Confirm that the Fraser River Crossing Preliminary HDD Feasibility Report does not include a contingency plan.
- b. Explain why a contingency report for the Fraser River Crossing has not been prepared for Trans Mountain.
- c. Advise when Trans Mountain will be applying for leave to file the required contingency reports.
- d. Explain why Golder Associates has provided the Preliminary Geotechnical Report on Westridge Marine Terminal in draft form only.
- e. Advise whether budgetary constraints were a factor in Golder Associates failure to provide a final, signed version of the Preliminary Geotechnical Report on Westridge Marine Terminal.
- f. Advise whether Golder Associates has been instructed by Trans Mountain to complete the engineering analyses referred to in Section 5.0 of the Preliminary Geotechnical Report on Westridge Marine Terminal and, if so, when those instructions were given.
- g. If Trans Mountain has not instructed Golder Associates to complete the engineering analyses referred to in Section 5.0 of the Preliminary Geotechnical Report on Westridge Marine Terminal, explain why not.
- h. Advise when a final, signed version of the Preliminary Geotechnical Report on Westridge Marine Terminal will be completed.
- i. Explain why a final, signed version of the Preliminary Geotechnical Report on Westridge Marine Terminal has not already been completed.
- j. Advise when Trans Mountain will be applying for leave to file the Preliminary Geotechnical Report on Westridge Marine Terminal, including the engineering analyses referred to in Section 5.0 of the report.

- k. If Trans Mountain will not be applying for leave to file the Preliminary Geotechnical Report on Westridge Marine Terminal, please confirm this and explain why not.
- 1. Confirm that Golder Associates has not yet obtained "high quality, site-specific field data" necessary to complete the Preliminary Geotechnical Report on Westridge Marine Terminal.
- m. Advise whether it is Golder Associates' opinion that the appropriateness of the design of the proposed Westridge Marine Terminal expansion cannot be assessed in the absence of "high quality, site-specific field data".
- n. Provide details of all additional work that, in the opinion of Golder Associates, is required to be completed prior to finalizing the Preliminary Geotechnical Report on Westridge Marine Terminal.
- o. Is it Golder Associates' expert opinion that the Preliminary Geotechnical Report on Westridge Marine Terminal, as filed by Trans Mountain, provides sufficient information to make a determination as to the appropriate siting for the proposed Westridge Marine Terminal expansion?
  - a. If not, explain what additional work would be required prior to making a determination about siting;
  - b. If so, please explain the basis for this view
- p. Is it Golder Associates' expert opinion that the analysis presented in the Preliminary Geotechnical Report on Westridge Marine Terminal provides sufficient information to complete an assessment of the seismic design requirements for the Westridge Marine Terminal expansion?
  - a. Explain why or why not.

### 2 Westridge Marine Terminal Offshore Geotechnical Assessment

### 2.1 Investigation assumptions

### Reference

- DRAFT Preliminary Geotechnical Report on Westridge Marine Terminal Offshore Geotechnical Investigations, Proposed New Westridge Marine Terminal, Trans Mountain Expansion Project, Burnaby, BC, Canada. Golder Associates. February 20, 2015 Section 2.0, Site and Proposed Development p.1 (A4I6E9 at PDF p. 4).
- DRAFT Preliminary Geotechnical Report on Westridge Marine Terminal Offshore Geotechnical Investigations, Proposed New Westridge Marine Terminal, Trans Mountain Expansion Project, Burnaby, BC, Canada. Golder Associates. February 20, 2015 Section 3.1.1, Test Hold Locations and Elevations p.4 (A4I6E9 at PDF p. 7).
- iii. DRAFT Preliminary Geotechnical Report on Westridge Marine Terminal Offshore Geotechnical Investigations, Proposed New Westridge Marine Terminal, Trans Mountain Expansion Project, Burnaby, BC, Canada. Golder Associates. February 20, 2015 Section 4.1, Key Stratigraphic Units p.7 (A4I6E9 at PDF p. 10).

### Preamble

The report does not clearly state if the assumed terminal expansion location has been confirmed or remains to be so. The report states "the structural links between the berths will likely be supported on foundation piles installed into the underlying competent soil strata."

The report states that the "more accurate" GPS units on VanPile's marine construction vessel were not available for a period of time during the investigation and that handheld GPS units were relied upon instead.

The report states "soil stratigraphy between test hole locations has been inferred, and potential variations from those shown in the stratigraphic sections should be anticipated."

The report states that "a significant adjustment to the offshore geotechnical investigation program was made at the early stage of the fieldwork upon encountering ground conditions that are significantly different from that anticipated during the proposal preparation stage".

The report provides three cross-sections analyzing soil conditions underlying the site. The north-south section (C-C') contains a substantial break near the toe of the shoreline slope, stretching approximately 15% of the section's length. This break includes the inferred termination of soil Unit 2; and, the initiation of soil Unit 1 and Unit 3, when moving away from the shoreline. This section also includes the only nearshore borehole, which is also the only borehole to encounter soil Unit 2.

- a. Advise whether the proposed siting for the Westridge Marine Terminal expansion as identified in the Preliminary Geotechnical Report on Westridge Marine Terminal has been confirmed by Trans Mountain. If not:
  - a. Explain why not; and
  - b. Provide details of all alternate sites for the Westridge Marine Terminal expansion that have been identified;
- b. Advise whether the structural links between the berths will be supported on foundation piles and, if not, how will they be supported?
- c. Identify which of the test locations identified in the Preliminary Geotechnical Report on Westridge Marine Terminal were positioned using hand-held GPS.
- d. Provide details of the range of potential error (in metres) in location coordinates recorded with the hand-held GPS units and explain the potential implications of the error on the analysis in the report.
- e. Provide Golder Associates' explanation of the potential impact or repercussions of stratigraphic variations on the analysis in their report, given the small number of test holes and minimal data collected from each test hole.
- f. Provide Golder Associates' explanation of the reliability of inferences regarding prevalence (or lack thereof) of soil units comprising the toe of the existing shoreline slope when the soil is encountered only once (i.e. Unit 2) in the testing completed. Please include in the explanation consideration of the "significantly different than anticipated" ground conditions described in the report.

# 2.2 Geotechnical Investigation

## Reference

- DRAFT Preliminary Geotechnical Report on Westridge Marine Terminal Offshore Geotechnical Investigations, Proposed New Westridge Marine Terminal, Trans Mountain Expansion Project, Burnaby, BC, Canada. Golder Associates. February 20, 2015 Section 3.1, Offshore Geotechnical Investigation p.3 (A4I6E9 at PDF p. 6).
- ii. [DRAFT Preliminary Geotechnical Report on Westridge Marine Terminal Offshore Geotechnical Investigations, Proposed New Westridge Marine Terminal, Trans Mountain Expansion Project, Burnaby, BC, Canada. Golder Associates. February 20, 2015 Section 4.0 Subsurface Conditions p.7 (A4I6E9 at PDF p. 9).
- iii. DRAFT Preliminary Geotechnical Report on Westridge Marine Terminal Offshore Geotechnical Investigations, Proposed New Westridge Marine Terminal, Trans Mountain Expansion Project, Burnaby, BC, Canada. Golder Associates. February 20, 2015 Section 4.1.4 Glacial Till/Till-like Deposit (Unit 4) p.11 (A4I6E9 at PDF p. 14).
- iv. DRAFT Preliminary Geotechnical Report on Westridge Marine Terminal Offshore Geotechnical Investigations, Proposed New Westridge Marine Terminal, Trans Mountain Expansion Project, Burnaby, BC, Canada. Golder Associates. February 20, 2015 Section 4.2 Summary p.12 (A4I6E9 at PDF p. 15).

- v. DRAFT Preliminary Geotechnical Report on Westridge Marine Terminal Offshore Geotechnical Investigations, Proposed New Westridge Marine Terminal, Trans Mountain Expansion Project, Burnaby, BC, Canada. Golder Associates. February 20, 2015 Section 5.1 Prominent Site Condition and Key Geotechnical Challenge p.13 (A4I6E9 at PDF p. 16).
- vi. DRAFT Preliminary Geotechnical Report on Westridge Marine Terminal Offshore Geotechnical Investigations, Proposed New Westridge Marine Terminal, Trans Mountain Expansion Project, Burnaby, BC, Canada. Golder Associates. February 20, 2015 Section 5.2.1 Further Field Investigation and Laboratory Testing p.14 (A4I6E9 at PDF p. 17).
- vii. DRAFT Preliminary Geotechnical Report on Westridge Marine Terminal Offshore Geotechnical Investigations, Proposed New Westridge Marine Terminal, Trans Mountain Expansion Project, Burnaby, BC, Canada. Golder Associates. February 20, 2015 Section 5.2.2 Further Geotechnical Engineering Analysis p.14 (A4I6E9 at PDF p. 17).

### Preamble

The report states that the field investigation assessed 10 offshore locations, of which: 2 were assessed with an "unsuitable tool" (dynamic cone penetration testing ("DCPT")), 1 was completed 180-200m away from proposed new terminal footprint, none encountered bedrock, 7 had refusal in or near till, and only 1 advanced into till.

The report states "the presence of a thick deposit of very weak, fine-grained soils at the project site is considered to be one of the most prominent site condition which has a major impact on almost all key aspects of the geotechnical foundation design".

The report states "Unit 1 and Unit 4 are inferred to be the predominant soil units underlying the project site". Only one investigation location borehole was advanced into till.

The report states "The presence of Unit 4 [till] appeared to be also relatively consistent across the site within the test holes that were advanced into it", though only one test hole (BH14-09) was advanced into the till; "most of the boreholes were terminated above or a short distance into this unit".

The report states "All additional boreholes should be advanced a sufficient depth into Unit 4, a minimum of 3m to 5m beyond the maximum depth of the design pile tip, depending on the diameter of the foundation pile. Drilling using a suitable Sonic rig is recommended to obtain continuous or nearly continuous soil core samples, especially within Units 3 and 4. The information obtained from the new boreholes, together with the currently available geotechnical information, will be provided as input into the geotechnical foundation design, and more importantly, as input to the assessment on the feasibility of pile installation into the dense/hard soil Units 3 and 4. Special attention should be paid to the presence of large-size boulders, which could potentially affect the constructability of the piled foundation."

The report states "A combination of the very weak soils and significant water depths in the proposed new berth area further increases the degree of challenges to the marine

structural design. The foundation piles will need to be designed taking into consideration the increased effective freestanding length due to the low lateral support the weak soils can offer to the foundation piles. In addition to the challenges associated with the weak soil and deep water, the site of the proposed new terminal is located within a zone of high seismic hazards, and the anticipated high demands from seismic loading needs to be taken into consideration also."

The report states "In addition to the anticipated low lateral support, the contribution of the weak fine-grained soils to the vertical load-carrying capacities of the foundation piles will be very limited also, and the foundation piles will need to be installed at sufficient depths into the underlying competent soil units, such as the Glacial Till or Till-like deposit."

The report states "Due to the very weak nature of the soft fine-grained soils present at the project site, the soils will likely undergo large strain and behave in a highly nonlinear manner when subjected to loads applied by the foundation piles or seismic shaking".

- a. Having determined that DCPT is "an unsuitable tool", is it the opinion of Golder Associates that the data obtained through DCPT is unreliable or otherwise unsuitable for use in the geotechnical investigation? Explain why or why not.
- b. What, in the opinion of Golder Associates, are the risks associated with using data obtained from an investigation location that is not in or near the footprint of the proposed Westridge Marine Terminal expansion (BH14-09) to undertake an assessment of a suitable structural design for the terminal facilities?
- c. What, in the opinion of Golder Associates, are the limitations of the geotechnical assessment in its report taking into account the fact that bedrock was not encountered during the investigation?
- d. What, in the opinion of Golder Associates, are the limitations of the geotechnical assessment in its report taking into account the fact that, in all but one location, the investigation was unable to determine the depth of an underlying competent soil unit, such as till?
- e. In the opinion of Golder Associates, is further geotechnical investigation required before a conclusion can be reached as to whether or not the geotechnical challenges presented by the presence of the thick, very weak, fine-grained soils can be overcome in the foundation design of the proposed Westridge Marine Terminal facilities?
  - a. If further geotechnical investigation is not required, explain what design requirements need to be in place to overcome the challenges presented by the presence of the thick, very weak, fine-grained soils.

- f. In the opinion of Golder Associates, what depth will foundation piles need to extend into the underlying competent soil unit to adequately support the expanded Westridge Marine Terminal facilities?
- g. Does Golder Associates recommend that Trans Mountain's structural engineers rely on the geotechnical data obtained from a single test hole which advanced into the underlying competent soil? Explain why or why not.
- h. In the opinion of Golder Associates, what further geotechnical analytical data is required to address the low lateral support that the weak soils beneath the project site will provide for foundation piles?
  - a. Explain in detail the additional work that is required to obtain this data.
  - b. Explain why this work has not yet been done.
  - c. Advise whether or not Golder Associates has received instructions to undertake this work and, if so, provide the timeline for the work.
- i. In the opinion of Golder Associates, what additional geotechnical data and analysis is required to determine the seismic loading needs of a marine terminal in the proposed location, taking into consideration the fact that it will be sited within a zone of high seismic hazards?
  - a. Explain in detail the additional work that is required to obtain this data and undertake this analysis.
  - b. Explain why this work has not yet been done.
  - c. Advise whether or not Golder Associates has received instructions to undertake this work and, if so, provide the timeline for the work.
- j. In the opinion of Golder Associates, how many additional test holes are required to complete the geotechnical assessment of the soils beneath the proposed Westridge Marine Terminal facilities?
  - a. Advise whether or not Golder Associates has received instructions to undertake this work and, if so, provide details of those instructions, including budgetary restrictions and depth of advancement of the test holes.
- k. Confirm that an assessment of the feasibility of pile installation will not be completed in the absence of the additional geotechnical data and analysis recommended by Golder Associates' in its report.
- I. Confirm that the geotechnical foundation design will not be completed in the absence of the additional geotechnical data and analysis recommended by Golder Associates' in its report.
- m. Confirm that further geotechnical investigation and analysis is required before an assessment of the proposed Westridge Marine Terminal facilities can be undertaken to determine if the facilities can be designed to mitigate the risks associated with:
  - a. the presence of thick, very weak, fine-grained soils; and

- b. the location of the terminal in a zone of high seismic hazards.
- n. Provide documentation of the engineering analysis results referenced in section 5.0 of the Golder Associates' report, at page 12.

## 3 Fraser River Crossing Geotechnical Assessments

## 3.1 Geotechnical Assessment

### Reference

- i. Preliminary Geotechnical HDD Feasibility Assessment, Fraser River Port Mann at V10 RK 1167.7. BGC Engineering Inc., February 20, 2015. Section 2.0 Scope of Work p.1 (A4I6F1 at PDF p. 9).
- Preliminary Geotechnical HDD Feasibility Assessment, Fraser River Port Mann at V10 RK 1167.7. BGC Engineering Inc., February 20, 2015. Section 3.0 Background Information p.3 (A4I6F1 at PDF p. 10).
- iii. Preliminary Geotechnical HDD Feasibility Assessment, Fraser River Port Mann at V10 RK 1167.7. BGC Engineering Inc., February 20, 2015. Section 3.5 Existing Borehole Data p.6 (A4I6F1 at PDF p. 13).
- iv. Preliminary Geotechnical HDD Feasibility Assessment, Fraser River Port Mann at V10 RK 1167.7. BGC Engineering Inc., February 20, 2015. Section 4.0 Hydrotechnical Assessment p.9 (A4I6F1 at PDF p. 16).

### Preamble

The scope of work included "compilation and analysis of previously drilled geotechnical boreholes provided by Metro Vancouver and located approximately 250m to 450m away from the proposed borepath" but that six of the twenty boreholes which were drilled by EBA were located approximately 250m to 575m downstream of the proposed HDD crossing".

The report comments on the success of the BC Gas HDD pipeline crossing 1km downstream but not on the Metro Vancouver Port Mann water supply tunnel, installed much closer (250m west/downstream) to the proposed Trans Mountain pipeline crossing.

The report states that the boreholes drilled by Golder "were drilled using mud rotary and sonic drilling methods. Standard Penetration Test (SPT) N values were not collected during sonic drilling: for these holes, relative densities were inferred from soil descriptions".

The report states that "piezometers completed in till recorded artesian pressures".

The report states that a conventional scour analysis could not be performed and that instead, relative scour was assessed using historical data. Furthermore, that survey data was not available for all years and that there were modifications to the survey data collection methods in 1997 which limited BGC's "ability to compare depth directly for data collected pre-1997 and post-1997".

- a. Explain why the report comments on the success of the BC Gas HDD pipeline crossing 1km downstream but not on the Metro Vancouver Port Mann water supply tunnel, installed 250m from the proposed Trans Mountain pipeline crossing.
- b. Confirm which boreholes were utilized in the desktop analysis, and their respective distances from the proposed pipeline crossing.
- c. Given the complex geology and ever-changing conditions in an active river such as the Fraser River:
  - a. provide BGC's opinion regarding the variation in the surficial geology that can occur over the course of the 6 to 13 years since the boreholes were first drilled;
  - b. Provide details of all assumptions that BGC made concerning the variation in the surficial geology over the course of the 6 to 13 years since the boreholes were first drilled;
  - c. Advise whether BGC assumed that the surficial geology was static over the course of the 6 to 13 years since the boreholes were first drilled; and
  - d. If BGC assumed that the surficial geology was static, provide BGC's opinion as to the impact of this assumption on the reliability of the analysis and conclusions in BGC's report.
- d. Does BGC agree that borehole data collected 250m to 575m downstream of the proposed HDD pipeline crossing may not be representative of the geology at the proposed site? Explain why or why not.
- e. Provide BGC's opinion regarding the potential for error when inferring soil densities as part of the geotechnical feasibility assessment for HDD installation and operation of an oil pipeline.
- f. What, in BGC's opinion, are the potential impacts of and complications associated with artesian pressures in till for HDD installation and pipeline operation.
- g. Explain why BGC was unable to perform a conventional scour analysis.
- h. What, in BGC's opinion, are the benefits of completing a conventional scour analysis over use of historic data to complete a relative scour assessment?
- i. Given the challenges and data gaps acknowledged by BGC in its report, how reliable is the relative scour analysis that BGC completed using historic data?
- j. Advise whether a seismic liquefaction assessment report has been completed for Trans Mountain and, if none has been completed, advise:
  - a. Whether an expert has been retained to prepare a seismic liquefaction assessment report;
  - b. The name of the expert;

- c. The date of the retainer; and
- d. The current status of the assessment.
- k. If the seismic liquefaction assessment report has been completed, advise when it was completed and explain why Trans Mountain has not yet sought leave to file it.
- l. Will the additional geotechnical drilling investigation work recommended by BGC be conducted and, if so, when will the report be completed?

## 3.2 **Geologic Interpretation**

## Reference

- Preliminary Geotechnical HDD Feasibility Assessment, Fraser River Port Mann at V10 RK 1167.7. BGC Engineering Inc., February 20, 2015. Section 7.0 Geologic Interpretation and Inferred Geotechnical Conditions Along the HDD Borepath (p. 18) (A4I6F1 at PDF p.25).
- Preliminary Geotechnical HDD Feasibility Assessment, Fraser River Port Mann At V10 RK 1167.7. BGC Engineering Inc., February 20, 2015. Section 8.1 General Considerations (p. 20) (A4I6F1 at PDF p.27).
- iii. Preliminary Geotechnical HDD Feasibility Assessment, Fraser River Port Mann At V10 RK 1167.7. BGC Engineering Inc., February 20, 2015. Section 7.2.1 Inferred Conditions along the HDD Borepath (p. 18) (A4I6F1 at PDF p.25).

## Preamble

The report states "The interpreted geologic contact boundaries are provided with considerable uncertainty, particularly at depth."

The report states "The interpreted thickness of the glaciolacustrine unit is based solely on boreholes drilled more than 400m downstream. Conditions at the HDD borepath are likely to differ somewhat."

The report states "The borepath is expected to intersect the till approximately 175m from the entry point. The contact angle is anticipated to be low, and the depth of drilling into the till is anticipated to be small, however, inadequate data are currently available to better resolve this detail. The till may contact in gravel and cobbles and may have artesian pressures."

- a. In BCG's opinion, is it possible to undertake a geotechnical HDD feasibility assessment of the Fraser River Port Mann at V10 RK 1167.7 which does not result in "considerable uncertainty" around the geologic contact boundaries?
  - a. If so, provide a detailed description of the steps that would BCG recommend be followed to complete a geotechnical HDD feasibility assessment of the Fraser River - Port Mann at V10 RK 1167.7 with certainty; and
  - b. Explain why BCG did not follow this recommended approach.

- b. In BCG's opinion, what problems or challenges might arise during the HDD process as a result of differences between the actual and the interpreted thickness of the glaciolacustrine unit?
  - a. How and to what extent can these problems or challenges be overcome?
- c. In BCG's opinion, what problems or challenges might arise during the HDD process as a result of the lack of adequate data to resolve the borepath's intersect with the till unit?
  - a. How and to what extent can these problems or challenges be overcome?
- d. In BCG's opinion, what problems or challenges might arise during the HDD process as a result of the presence of cobbles and/or boulders and artesian pressures when drilling in the till unit?
  - a. How and to what extent can these problems or challenges be overcome?
- e. What is BCG's opinion of the feasibility of HDD in till which is likely to contain cobbles or boulders?

## 4 Fraser River Crossing Preliminary HDD Feasibility Report

## 4.1 Anticipated Geotechnical Conditions

### Reference

- i. Fraser River Crossing Preliminary HDD Feasibility Report. Hatch Mott MacDonald Ltd. Section 1 Introduction (p. 1) (A4I6E9 at PDF p.5).
- ii. Fraser River Crossing Preliminary HDD Feasibility Report. Hatch Mott MacDonald Ltd. Section 2 Anticipated Geotechnical Conditions (p. 1) (A4I6E9 at PDF p.5).
- iii. Fraser River Crossing Preliminary HDD Feasibility Report. Hatch Mott MacDonald Ltd. Section 3.4.3 Hydraulic Fracture Evaluation (p. 11) (A4I6E9 at PDF p.15).
- iv. Fraser River Crossing Preliminary HDD Feasibility Report. Hatch Mott MacDonald Ltd. Section 3.5 State of Practice in the HDD Industry (p. 17) (A4I6E9 at PDF p.21).
- v. Fraser River Crossing Preliminary HDD Feasibility Report. Hatch Mott MacDonald Ltd. Section 4 Trenchless Risk Characterization (p. 18) (A4I6E9 at PDF p.22).

### Preamble

The feasibility assessment report states "Additional refinements to the alignment will continue as site specific subsurface investigation information is made available and the detailed engineering progresses."

The report states "The geology of the Fraser River Valley is highly complex, the product of a number of periods of glaciation and isostatic changes (changes in ground levels), as well as deposition and down cutting by rivers in the inter-glacial and the post-glacial periods."

The report states "The boundaries between geologic units are provided with considerable uncertainty, particularly at depth."

Of the 20 borehole logs Trans Mountain obtained from Metro Vancouver, 14 boreholes were drilled by Golder Associates Ltd. using mud rotary and sonic drilling methods. Standard Penetration Test N values were not collected from the boreholes drilled using sonic.

The report states "A proper HDD execution plan based on HDD industry standard construction practices can reduce the risk of a hydraulic fracture from occurring."

The report states that "when comparing a specific crossing to those completed projects within the HDD industry, the site-specific geotechnical and crossing risks need to be thoroughly considered and evaluated to ensure comparison to the completed project listings is deemed to be adequate" but later states that "from a feasibility standpoint, the Fraser River Crossing is deemed to be within a zone of typical experience of what has been accomplished to date within the HDD industry."

The report states "The major challenges to a trenchless installation for the Fraser River involve risks associated with the anticipated geotechnical conditions;

specifically, the presence of coarse grained soils and possible cobbles under artesian conditions at depths beneath the river. Risk identification and mitigation is paramount to successfully completing the Fraser River Crossing."

The report states "Soils containing gravels and larger size particles (cobbles) range from marginally acceptable to unacceptable in terms of feasibility depending on the percentage of gravels by weight and particle size" and that "gravels were observed in the boreholes at various depths and percent composition up to 20 percent of the soil composition. These gravels should not pose a high risk to the Fraser River HDD crossing" but does not acknowledge that the boreholes utilized in the desktop geotechnical assessment were drilled 250m to 575m from the proposed crossing location.

- a. Provide the dates by which subsurface investigation will be complete, and reports available, as deemed necessary by Hatch Mott MacDonald to refine the crossing alignment.
- b. Explain why Trans Mountain did not require a site-specific geotechnical assessment at the proposed pipeline crossing location given the complex and variable geology, and the potential challenges associated with HDD under these geological conditions.
- c. Advise which boreholes were drilled using sonic method and what the potential implications are of not having Standard Penetration Test N values from those test holes.
- d. Identify the risks associated with an HDD execution plan that is based on uncertain geology and geotechnical conditions, including but not limited to how this affects the ability to identify and mitigate the risk of hydraulic fracture.
- e. Provide a detailed explanation of the potential consequences of a hydraulic fracture during HDD.
- f. Provide a detailed description of HDD industry standard design practices.
- g. Do the industry standard practices for HDD design allow for the extrapolation of geological and geotechnical conditions from sites that are 250 to 575 m distant from proposed crossing location?
  - a. If yes, provide details of the industry standard practices which allow for this along with documentation and references.
- h. In the opinion of Hatch Mott MacDonald, what problems or challenges might arise during the HDD process if the subsurface materials encountered are not the anticipated "soft to very soft silty clay to clayey silt"?

- i. Does Hatch Mott MacDonald agree that in the absence of site-specific geological and geotechnical data it is not possible to design an HDD installation that is suitable for the actual site conditions? If Hatch Mott MacDonald does not agree, explain why.
- j. Does Hatch Mott MacDonald agree that in the absence of site-specific geological and geotechnical data it is not possible to develop mitigation measures that will be responsive to the actual site conditions? If Hatch Mott MacDonald does not agree, explain why.

## 4.2 HDD Feasibility

## Reference

- i. Fraser River Crossing Preliminary HDD Feasibility Report. Hatch Mott MacDonald Ltd. Section 3.5 State of Practice in the HDD Industry (p. 17)
- ii. Fraser River Crossing Preliminary HDD Feasibility Report. Hatch Mott MacDonald Ltd. Section 5 HDD Feasibility Summary (p. 20) (A4I6E9 at PDF p.24).

### Preamble

The feasibility summary states "Based on the crossing-specific geotechnical information, no fatal deterrents have been identified" but the geotechnical information is not site/crossing-specific but rather, was collected 250m-575m away from the proposed crossing location and was collected for a different purpose, by different parties.

The report states that "there are a number of successfully completed HDD installations of similar lengths within the HDD contracting community in North America" but states earlier in Section 3.5 that comparisons of proposed projects to completed projects can only be done if the site-specific geotechnical and crossing risks have been thoroughly considered and evaluated to ensure comparison to the completed project listings is deemed adequate.

The contingency plan for unsuccessful HDD installation is to make an additional attempt after holding a risk mitigation workshop. The report states that "completing a crossing of the Fraser River using an open trench is not a feasible alternative."

- a. Describe HDD industry best practice for the development of contingency plans.
- b. Does HDD industry best practice for the development of contingency plans include identification of an alternate installation method?

- c. In the opinion of Hatch Mott MacDonald, does the brief plan provided in its report meets industry best practices for the development of contingency plans? Explain why or why not. , and if industry standard for contingency would include an alternate installation method.
- d. Explain why an open trench installation method is not feasible for crossing the Fraser River.
- e. Advise whether other crossings of the Fraser River have been made using an open trench method. If so, provide details of the crossing locations.

## 4.3 **Drilling Fluids**

### Reference

i. Fraser River Crossing Preliminary HDD Feasibility Report. Hatch Mott MacDonald Ltd. Section 4.1 Specific Crossing Risks and Mitigation Measures (p. 18) (A4I6E9 at PDF p.22).

### Preamble

There are several references throughout the report with respect to the loss of drilling fluids, but no discussion of the type(s) and contents of fluids, nor associated impacts and risks.

- a. Provide details of the various types of drilling fluids that could be used in the HDD process.
- b. For each of the drilling fluids identified in a. above, describe the potential environmental and/or ecological impacts of fluid loss during the HDD process.