

ISSUED FOR USE

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Date: November 15, 2017

c: Mr. Tom Kneale, P.Eng. (BC MoTI)

Memo No.: K13103273-05-05

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File: 704-K13103273-05

Subject: Westside Road Improvements – La Casa to Muir Road
Water main Replacement Geotechnical Recommendations

1.0 INTRODUCTION

The British Columbia Ministry of Transportation and Infrastructure (BCMoTI) retained Tetra Tech Canada Inc. (Tetra Tech) to provide geotechnical services for the upgrade of Westside Road from La Casa to Muir Road, which is located north of West Kelowna, on the western side of Lake Okanagan. This technical memorandum presents geotechnical engineering design and construction recommendations for the 150 mm diameter and 300 mm diameter C900 polyvinyl chloride replacement water main in the La Casa to Muir Road segment.

The scope of work that was undertaken by Tetra Tech is in accordance with that outlined in Consulting Services Contract 256CS1118, issued by BCMoTI and for this memorandum, the scope is limited to the geotechnical conditions along the replacement water main section (approximately Station 1335+06.947 to Station 1337+20).

As part of developing the geotechnical design and construction recommendations, Tetra Tech reviewed information in the following:

- Tetra Tech Canada Westside Road Improvements – *La Casa to Muir Road, Geotechnical Data Report IFU*, August 2017 (Tetra Tech 2017a).
- Tetra Tech Canada Westside Road Improvements – *La Casa to Muir Road, Geotechnical Design Report Rev B IFU*, August 2017 (Tetra Tech 2017b).
- CH2M Westside Road Improvements – La Casa to Muir Road Plan, Drawing. No. R2-976-105, September 2017.
- CH2M Westside Road Improvements – La Casa to Muir Road Water mains, Drawing. No. R2-976-506, April 2017.
- BCMoTI – Standard Specifications for Highway Construction, 2016 (BCMoTI 2016).

2.0 ANTICIPATED GROUND CONDITIONS

Where the replacement main will be trenched and installed in native ground (approximately Station 1335+06.947 to Station 1335+20, and Station 1336+90 to Station 1337+20), a general description of the anticipated ground condition is compact to dense glaciofluvial deposits.

Where the replacement main is to be installed in the new embankment section (approximately Station 1335+20 to Station 1336+90), the anticipated ground condition is dense to very dense, well-graded sand and gravel embankment fill. No bedrock was encountered during the subsurface exploration, and is not anticipated to be encountered during construction.

Detailed information on the subsurface ground conditions, and embankment geotechnical recommendations, are presented in Tetra Tech (2017a) and Tetra Tech (2017b), respectively.

3.0 DESIGN RECOMMENDATIONS

3.1 Minimum Depth

To limit the amount of excavation required, as well as the potential disturbance to adjacent infrastructure, the anticipated frost-penetration depth, and traffic loading. Tetra Tech recommends the top of the water main should be located at a minimum depth of 1.0 m below grade.

3.2 Bearing and Settlement

The subgrade soils beneath the proposed invert of the water main will provide suitable bearing for the water main if prepared as discussed in Section 4.1. The water main (when full) and the compacted trench backfill will have a total weight, which is roughly equivalent to that of the existing soil.

However, due to presence of two different bearing strata over the length of the water main (native material and controlled embankment fill material), and the disturbance to the subgrade which will likely occur during construction, there is the potential for differential settlement.

Tetra Tech recommends that the water main be designed with an allowance for approximately 15 mm of total settlement and approximately 10 mm of differential settlement over a 6 m pipe section length.

3.3 Groundwater

No groundwater was encountered during the subsurface exploration, and the exploration findings show that groundwater is deep. The groundwater level in this area may experience seasonal fluctuations, and surface water infiltration and snow melt could result in temporary perched water conditions.

Tetra Tech recommends these groundwater variations be considered during detailed design and the use of surface grading during construction to divert surface water runoff away from the trench.

3.4 Traffic Loading

As the proposed replacement water main will be installed immediately adjacent to the new roadway, the water main will be subjected to horizontal and vertical traffic loading. Checks must be performed to confirm that the water main has sufficient structural capacity for the anticipated loads. Tetra Tech recommends the work should be undertaken by a BCMoTI structural engineer, or a BCMoTI appointed structural engineer, as structural analysis is beyond the scope of work of this geotechnical memo.

4.0 CONSTRUCTION RECOMMENDATIONS

4.1 Site Preparation

Each segment of the trench should be excavated to the design invert grade. The subgrade material (embankment and native material) should then be over-excavated by a minimum of 150 mm below design invert grade. Where the water main alignment trench is in native material, unsuitable material, such as soft spots, water softened soils, and organics observed on the bottom of the excavation are to be subexcavated.

Any subexcavation is to be backfilled to within 150 mm of the invert of the water main with material meeting the gradation specified for Granular Sub-Base material in Section 202 of BCMoTI (2016), and placed in discrete lifts of 200 mm, which are moisture treated and compacted to a minimum of 95% of MPMDD (ASTM D1557).

Tetra Tech assumes that installation of the water main from approximately Station 1335+20 to Station 1336+90 will be after construction of the new embankment; therefore, trench excavations in this section should not encounter unsuitable material, and therefore subexcavation and backfilling should not be required.

4.2 Pipe Embedment Material

The pipe embedment material should meet the gradation presented in Table 1 (as specified for embedment material as per Table 303-A in BCMoTI [2016]);

Table 1 Pipe Embedment Material Gradation

Sieve Size (mm)	Percentage Passing
31.5	100
25	60-100
19	15-100
2.36	10-100
0.075	0-5

The embedment material should extend a minimum of 150 mm below the culvert invert, and a minimum of 300 mm above the finished top of pipe grade. The embedment material shall extend a minimum of 1.0 m beyond the culvert sections on each end during installation and should be placed in layers not exceeding 150 mm in depth when compacted.

The embedment material should be moisture treated and compacted to a minimum 95% of MPMDD (ASTM D1557) at $\pm 2\%$ of the optimum moisture content where the water main alignment does not underlie the new road alignment. Where the water main does underlie the new road alignment (e.g., the north tie in), the embedment material should be moisture treated and compacted to 100% of MPMDD (ASTM D1557) at $\pm 2\%$ of the optimum moisture content within 300 mm of subgrade elevation.

Backfilling should be done symmetrically and the material within 450 mm directly above the crown of the pipe culvert should be laid and compacted as one lift. For a culvert with crown within 300 mm of subgrade, installation methods should be approved by the Ministry Representative.

4.3 Trench and Utility Excavations

Tetra Tech assumes that the replacement water main will be constructed using open-cut trenches with sloped excavation sidewalls. This is considered technically feasible for excavations, which are less than 6 m deep. All work conducted in and around a trench and utility excavations must be carried out in accordance with requirements specified by the WorkSafe BC Occupational Health & Safety Regulations.

The soils may not be suitable for using the minimum requirements outlined by WorkSafe BC, therefore, a professional engineer retained by the contractor should provide site-specific recommendations.

If the proposed water main construction is subject to the road lanes remaining open to traffic, then the use of metal shoring cages should be considered. The shoring cages and the loads acting on the shoring cages should be specified by the contractor's geotechnical engineer.

4.4 Excavation Seepage

As noted in Section 3.3, the groundwater level is anticipated to be deep and is not expected to be encountered during construction. However, the groundwater level in this area may experience temporary perched water conditions due to seasonal fluctuations, surface water infiltration, and/or snow melt. Depending on the construction schedule and weather conditions during construction, groundwater seepage may be observed within the excavation.

Tetra Tech recommends surface grading during construction to divert surface water runoff away from the trench. Additionally, if groundwater seepage is observed in excavations, the excavation sideslopes may need to be flattened to maintain stability. The safe angle for trench slopes should be assessed and confirmed on site by the contractor's geotechnical engineer.

4.5 Reuse of Materials

During site preparation, volumes of excavated native material will be available. Soils, which are excavated during construction which have of a fines content greater than 5% are likely to be moisture-sensitive and are generally not suitable for re-use as backfill within, and immediately adjacent to, a roadway. However, with appropriate moisture conditioning it would be suitable as built Type D fill that could be included under the road in other parts of the project.

Tetra Tech recommends any excavated granular material intended for re-use should be tested and results used to verify whether the material is in conformance to the materials specified in Section 4.1 and/or Section 4.2.

4.6 Material Stockpiling

Tetra Tech recommends that any excavated granular material should be stockpiled and reviewed by the Ministry Representative for potential re-use as backfill. Any poor quality excavated materials (i.e., organic soils, fine-grained soils, and/or high fines content soils) should be disposed of off-site. Additionally, the minimum distance that the toe of the material stockpiles be offset from the edge of open excavations should be equal to the depth of the excavation (i.e., 1V:1H from the bottom of the trench).

The stockpiles should be handling in accordance with relevant environmental considerations as per Section 165 of BCMoTI (2016) to prevent the material from becoming saturated. To minimise material segregation, stockpiles should be formed into long flat stockpiles with gradual slopes. Cone type stockpiles should be avoided where possible.

5.0 ADDITIONAL GEOTECHNICAL WORK

We anticipate that the additional work required to develop the project may include:

- Tetra Tech as the Engineer of Record should complete geotechnical field reviews during construction in order to verify that the subsurface soil and groundwater conditions are consistent with our assumptions and to verify that our recommendations are being followed. Our geotechnical field reviews would include:
 - Review excavation subgrade and advice of the necessary sub-excavation and replacement prior to water main construction.
 - Visually review backfill materials for conformance to our specifications.
 - Provide laboratory support for field review through Proctor testing and grain-size analysis testing.
 - Facilitate design changes to account for any unforeseen conditions.
- Tetra Tech understands that auxiliary water main structures, such as underground valve chambers, are not required for the project, therefore, geotechnical recommendations relating to these structures have not been provided in this memo. Tetra Tech can provide geotechnical recommendations for auxiliary structures including site preparation, temporary excavations, backfill and drainage, bearing capacity and settlement, and lateral earth pressures on request should they be required for the final design.

6.0 LIMITATIONS OF REPORT

This report and its contents are intended for the sole use of the British Columbia Ministry of Transportation and Infrastructure and their agents. Tetra Tech Canada Inc. (Tetra Tech) does not accept any responsibility for the accuracy of any of the data, the analysis, or the recommendations contained or referenced in the report when the report is used or relied upon by any Party other than the British Columbia Ministry of Transportation and Infrastructure, or for any Project other than the proposed development at the subject site. Any such unauthorized use of this report is at the sole risk of the user. Use of this document is subject to the Limitations on the Use of this Document attached in the Appendix A and with those outlined in Consulting Services Contract 256CS1118.

7.0 CLOSURE

We trust this technical memo meets your present requirements. If you have any questions or comments, please contact the undersigned.

Respectfully submitted,
Tetra Tech Canada Inc.



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APPENDIX A

TETRA TECH'S LIMITATIONS OF USE OF THIS DOCUMENT

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DESIGN REPORT

1.1 USE OF DOCUMENT AND OWNERSHIP

This document pertains to a specific site, a specific development, and a specific scope of work. The document may include plans, drawings, profiles and other supporting documents that collectively constitute the document (the "Professional Document").

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Where TETRA TECH submits electronic file and/or hard copy versions of the Professional Document or any drawings or other project-related documents and deliverables (collectively termed TETRA TECH's "Instruments of Professional Service"), only the signed and/or sealed versions shall be considered final. The original signed and/or sealed electronic file and/or hard copy version archived by TETRA TECH shall be deemed to be the original. TETRA TECH will archive a protected digital copy of the original signed and/or sealed version for a period of 10 years.

Both electronic file and/or hard copy versions of TETRA TECH's Instruments of Professional Service shall not, under any circumstances, be altered by any party except TETRA TECH. TETRA TECH's Instruments of Professional Service will be used only and exactly as submitted by TETRA TECH.

Electronic files submitted by TETRA TECH have been prepared and submitted using specific software and hardware systems. TETRA TECH makes no representation about the compatibility of these files with the Client's current or future software and hardware systems.

1.3 STANDARD OF CARE

Services performed by TETRA TECH for the Professional Document have been conducted in accordance with the Contract, in a manner consistent with the level of skill ordinarily exercised by members of the profession currently practicing under similar conditions in the jurisdiction in which the services are provided. Professional judgment has been applied in developing the conclusions and/or recommendations provided in this Professional Document. No warranty or guarantee, express or implied, is made concerning the test results, comments, recommendations, or any other portion of the Professional Document.

If any error or omission is detected by the Client or an Authorized Party, the error or omission must be immediately brought to the attention of TETRA TECH.

1.4 DISCLOSURE OF INFORMATION BY CLIENT

The Client acknowledges that it has fully cooperated with TETRA TECH with respect to the provision of all available information on the past, present, and proposed conditions on the site, including historical information respecting the use of the site. The Client further acknowledges that in order for TETRA TECH to properly provide the services contracted for in the Contract, TETRA TECH has relied upon the Client with respect to both the full disclosure and accuracy of any such information.

1.5 INFORMATION PROVIDED TO TETRA TECH BY OTHERS

During the performance of the work and the preparation of this Professional Document, TETRA TECH may have relied on information provided by third parties other than the Client.

While TETRA TECH endeavours to verify the accuracy of such information, TETRA TECH accepts no responsibility for the accuracy or the reliability of such information even where inaccurate or unreliable information impacts any recommendations, design or other deliverables and causes the Client or an Authorized Party loss or damage.

1.6 GENERAL LIMITATIONS OF DOCUMENT

This Professional Document is based solely on the conditions presented and the data available to TETRA TECH at the time the data were collected in the field or gathered from available databases.

The Client, and any Authorized Party, acknowledges that the Professional Document is based on limited data and that the conclusions, opinions, and recommendations contained in the Professional Document are the result of the application of professional judgment to such limited data.

The Professional Document is not applicable to any other sites, nor should it be relied upon for types of development other than those to which it refers. Any variation from the site conditions present, or variation in assumed conditions which might form the basis of design or recommendations as outlined in this report, at or on the development proposed as of the date of the Professional Document requires a supplementary exploration, investigation, and assessment.

TETRA TECH is neither qualified to, nor is it making, any recommendations with respect to the purchase, sale, investment or development of the property, the decisions on which are the sole responsibility of the Client.

1.7 ENVIRONMENTAL AND REGULATORY ISSUES

Unless so stipulated in the Design Report, TETRA TECH was not retained to explore, address or consider, and has not explored, addressed or considered any environmental or regulatory issues associated with the project specific design.

1.8 CALCULATIONS AND DESIGNS

TETRA TECH may have undertaken design calculations and prepared project specific designs in accordance with terms of reference that were previously set out in consultation with, and agreement of, TETRA TECH's client. These designs have been prepared to a standard that is consistent with current industry practice. Notwithstanding, if any error or omission is detected by TETRA TECH's Client or any party that is authorized to use the Design Report, the error or omission should be immediately drawn to the attention of TETRA TECH.

1.9 GEOTECHNICAL CONDITIONS

A Geotechnical Report is commonly the basis upon which the specific project design has been completed. It is incumbent upon TETRA TECH's Client, and any other authorized party, to be knowledgeable of

the level of risk that has been incorporated into the project design, in consideration of the level of the geotechnical information that was reasonably acquired to facilitate completion of the design.

If a Geotechnical Report was prepared for the project by TETRA TECH, it may be included in the Design Report as appropriate. The Geotechnical Report contains Limitations that should be read in conjunction with these Limitations for the Design Report.

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This report has been prepared based on the applicable codes, standards, guidelines or best practice as identified in the report. Some mandated codes, standards and guidelines (such as ASTM, AASHTO Bridge Design/Construction Codes, Canadian Highway Bridge Design Code, National/Provincial Building Codes) are routinely updated and corrections made. TETRA TECH cannot predict nor be held liable for any such future changes, amendments, errors or omissions in these documents that may have a bearing on the assessment, design or analyses included in this report.