



To:	YTG – Community Services – Land Dev.	Date:	March 29, 2019
Attention:	Kaori Torigai	Memo No.:	001
From:	Myles Plaunt, C.E.T.	File:	ENG.WARC03386-29
Subject:	Permafrost Assessment Hamilton Boulevard – Whitehorse, Yukon		

1.0 INTRODUCTION

Tetra Tech Canada Inc. (Tetra Tech) has been retained to complete an assessment of the permafrost conditions along the toe of the Hamilton Boulevard embankment (both sides) along the area where significant permafrost degradation has resulted in ongoing maintenance issues.

Previously completed projects by Tetra Tech include:

- 2013 – Geotechnical Evaluation – Hamilton Boulevard Sta 4+755 (Tetra Tech Project W14103046-01). Four boreholes were drilled through the embankment fill and underlying permafrost soils to delineate the area of concern. A thermistor was installed along the north bound shoulder lane (in borehole W14103046-BH03) to measure ground temperatures for determining when the permafrost soils had thawed.
- 2013 to 2018 – Monitoring of the ground temperatures at the W14103046-BH03 location was performed monthly throughout 2013 and January 2014. Monthly monitoring was again performed throughout 2015 and it appeared that ground temperatures at depth were above 0 degrees celcius. A final set of readings was collected in May, 2018 and presented under project number ENG.WARC03386-09.
- Concurrent to monitoring ground temperatures, the subject section of the Hamilton Boulevard extension was also surveyed to assess when settlement had ceased, suggesting that reconstruction could commence.

2.0 CURRENT CONDITIONS AND FIELD INVESTIGATION PROGRAM

It appears that the permafrost that was noted during the 2013 investigation has thawed from beneath the roadway embankment. Since the roadway elevations have also been consistent, it can be assumed that the ice rich silt noted below the peat layer has melted out and the peat has also thawed and compressed to its current state.

What was not determined was what the conditions are outside the constructed embankment along both sides of Hamilton Boulevard. To assess whether there is ice rich permafrost soils along the toe of the constructed embankment, a borehole was drilled to 6 m on both sides utilizing a Terra Sonic drill rig contracted from Midnight Sun Drilling. This drill rig allows for continuous sampling which is ideal for delineating sections of frozen soil and more importantly, visible ice that may contribute to instability when thawed. Thermistor cables were installed, and initial ground temperature readings were collected in both boreholes.

The locations of the two boreholes are presented on Figure 1, attached, along with the borehole logs detailing the geotechnical conditions encountered.

3.0 ASSESSMENT OF CURRENT PERMAFROST

This project was initiated to assess whether or not the soils supporting the toe of the roadway embankment were ice rich (which means that the reconstructed embankment could eventually have horizontal tension cracks which would lead to long term maintenance issues. Based on the conditions noted at the two current borehole locations it appears that:

- No permafrost soils were noted in BH02 along toe of the sideslope on the west side of Hamilton Boulevard.
- BH01 was drilled along the east side toe in an area where there is standing water for much of the year. This was a greater concern as the water and surficial soils could have contributed to insulating the underlying permafrost (which would still eventually melt out). In this borehole, a thin lens of frozen peat was noted but there was no visible ice in the section of sample observed.
- This office can only comment on the conditions noted at the borehole locations. However, if the Government of Yukon and the City of Whitehorse are satisfied that based on the ongoing ground temperature monitoring in Borehole W14103046-BH03; the results of current surveys suggesting that settlement has reached acceptable levels; and the data collected for this current assessment, reconstruction can be considered.

4.0 LIMITATIONS OF REPORT

This report and its contents are intended for the sole use of Government of Yukon 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 Government of Yukon, 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 or Contractual Terms and Conditions executed by both parties.

5.0 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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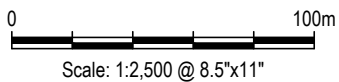
Attachments: 2019 Site Plan and Borehole Logs
Limitations on the Use of this Document – Geotechnical

PERMIT TO PRACTICE TETRA TECH CANADA INC.	
SIGNATURE	
Date	Mar 29/19
PERMIT NUMBER PP003 Association of Professional Engineers of Yukon	



LEGEND:

-  - BOREHOLE LOCATION
-  - GROUND TEMPERATURE CABLE LOCATION



CLIENT



PERMAFROST ASSESSMENT
HAMILTON BOULEVARD - WHITEHORSE, YUKON

SITE PLAN SHOWING BOREHOLE LOCATIONS



PROJECT NO. ENG.WARC03386-29	DWN CB	CKD MCP	REV 0
OFFICE EBA-WHSE	DATE March 29, 2019		

Figure 1

YTG - Community Services

Borehole No: BH01

Project: Hamilton Blvd. Permafrost Assessment

Project No: ENG.WARC03386-29

Location: Hamilton Boulevard

Whitehorse, Yukon

UTM: 494748 E; 6728970 N; Z 8

Depth (m)	Method	Soil Description	Ground Ice Description	Sample Type	Temperature (°C)	Moisture Content (%)	Thermistor	Depth (ft)
0		SILT - ice on surface, trace sand, trace organics, wet when thawed, grey	Seasonally frozen					0
1		SILT (TILL) - sandy, gravelly, wet, dark grey	Unfrozen		0.9			3
3		PEAT - fibrous, black	Permafrost - Nbe		2.1			10
3		SILT (TILL) - gravelly, some sand, cobbles throughout, moist becoming damp with depth, dense to very dense, dark grey	Unfrozen		2.7			15
6		END OF BOREHOLE (6.0 metres) Notes: Thermistor conduit installed on March 8, 2019 Thermistor cable installed on March 28, 2019 Samples collected for visual classification purposes			3			20



Contractor:

Completion Depth: 6 m

Drilling Rig Type: Terra sonic

Start Date: 2019 March 8

Logged By: MCP

Completion Date: 2019 March 8

Reviewed By:

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YTG - Community Services

Borehole No: BH02

Project: Hamilton Blvd. Permafrost Assessment

Project No: ENG.WARC03386-29

Location: Hamilton Boulevard

Whitehorse, Yukon

UTM: 494671 E; 6728972 N; Z 8

Depth (m)	Method	Soil Description	Ground Ice Description	Sample Type	Temperature (°C)	Moisture Content (%)	Thermistor	Depth (ft)
0		ORGANICS - moss covered, black	Seasonally frozen					0
0.5		- very wet SILT - trace sand, trace organics, wet, soft, mottled brown with grey, fine sand	Unfrozen					1
1		SAND AND SILT (TILL) - gravelly, very wet, loose, olive brown						2
2		- sandier and coarser, wet			2.3			3
3	Sonic	- very wet to 5.0 metres			2			4
4								5
5								6
6		SILT (TILL) - gravelly, some sand, cobbles throughout, moist, dense, dark grey			1.5			7
6		END OF BOREHOLE (6.0 metres) Notes: Thermistor conduit installed on March 8, 2019 Thermistor cable installed on March 28, 2019 Samples collected for visual classification purposes			0.7			8
7								9
7.5								10



Contractor:

Completion Depth: 6 m

Drilling Rig Type: Terra sonic

Start Date: 2019 March 8

Logged By: MCP

Completion Date: 2019 March 8

Reviewed By:

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GEOTECHNICAL

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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.

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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.

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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 document, 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 stipulated in the report, TETRA TECH has not been retained to explore, address or consider and has not explored, addressed or considered any environmental or regulatory issues associated with development on the subject site.

1.8 NATURE AND EXACTNESS OF SOIL AND ROCK DESCRIPTIONS

Classification and identification of soils and rocks are based upon commonly accepted systems, methods and standards employed in professional geotechnical practice. This report contains descriptions of the systems and methods used. Where deviations from the system or method prevail, they are specifically mentioned.

Classification and identification of geological units are judgmental in nature as to both type and condition. TETRA TECH does not warrant conditions represented herein as exact, but infers accuracy only to the extent that is common in practice.

Where subsurface conditions encountered during development are different from those described in this report, qualified geotechnical personnel should revisit the site and review recommendations in light of the actual conditions encountered.

1.9 LOGS OF TESTHOLES

The testhole logs are a compilation of conditions and classification of soils and rocks as obtained from field observations and laboratory testing of selected samples. Soil and rock zones have been interpreted. Change from one geological zone to the other, indicated on the logs as a distinct line, can be, in fact, transitional. The extent of transition is interpretive. Any circumstance which requires precise definition of soil or rock zone transition elevations may require further investigation and review.

1.10 STRATIGRAPHIC AND GEOLOGICAL INFORMATION

The stratigraphic and geological information indicated on drawings contained in this report are inferred from logs of test holes and/or soil/rock exposures. Stratigraphy is known only at the locations of the test hole or exposure. Actual geology and stratigraphy between test holes and/or exposures may vary from that shown on these drawings. Natural variations in geological conditions are inherent and are a function of the historical environment. TETRA TECH does not represent the conditions illustrated as exact but recognizes that variations will exist. Where knowledge of more precise locations of geological units is necessary, additional exploration and review may be necessary.

1.11 PROTECTION OF EXPOSED GROUND

Excavation and construction operations expose geological materials to climatic elements (freeze/thaw, wet/dry) and/or mechanical disturbance which can cause severe deterioration. Unless otherwise specifically indicated in this report, the walls and floors of excavations must be protected from the elements, particularly moisture, desiccation, frost action and construction traffic.

1.12 SUPPORT OF ADJACENT GROUND AND STRUCTURES

Unless otherwise specifically advised, support of ground and structures adjacent to the anticipated construction and preservation of adjacent ground and structures from the adverse impact of construction activity is required.

1.13 INFLUENCE OF CONSTRUCTION ACTIVITY

Construction activity can impact structural performance of adjacent buildings and other installations. The influence of all anticipated construction activities should be considered by the contractor, owner, architect and prime engineer in consultation with a geotechnical engineer when the final design and construction techniques, and construction sequence are known.

1.14 OBSERVATIONS DURING CONSTRUCTION

Because of the nature of geological deposits, the judgmental nature of geotechnical engineering, and the potential of adverse circumstances arising from construction activity, observations during site preparation, excavation and construction should be carried out by a geotechnical engineer. These observations may then serve as the basis for confirmation and/or alteration of geotechnical recommendations or design guidelines presented herein.

1.15 DRAINAGE SYSTEMS

Where temporary or permanent drainage systems are installed within or around a structure, the systems which will be installed must protect the structure from loss of ground due to internal erosion and must be designed so as to assure continued satisfactory performance of the drains. Specific design detail of such systems should be developed or reviewed by the geotechnical engineer. Unless otherwise specified, it is a condition of this report that effective temporary and permanent drainage systems are required and that they must be considered in relation to project purpose and function.

1.16 DESIGN PARAMETERS

Bearing capacities for Limit States or Allowable Stress Design, strength/stiffness properties and similar geotechnical design parameters quoted in this report relate to a specific soil or rock type and condition. Construction activity and environmental circumstances can materially change the condition of soil or rock. The elevation at which a soil or rock type occurs is variable. It is a requirement of this report that structural elements be founded in and/or upon geological materials of the type and in the condition used in this report. Sufficient observations should be made by qualified geotechnical personnel during construction to assure that the soil and/or rock conditions considered in this report in fact exist at the site.

1.17 SAMPLES

TETRA TECH will retain all soil and rock samples for 30 days after this report is issued. Further storage or transfer of samples can be made at the Client's expense upon written request, otherwise samples will be discarded.

1.18 APPLICABLE CODES, STANDARDS, GUIDELINES & BEST PRACTICE

This document 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.