

May 11, 2018

Associated Engineering (B.C.) Ltd.
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ISSUED FOR USE
FILE: ENG.WARC03380-01
Via Email: bartschs@ae.ca

Attention: Mr. Steven Bartsch. P.Eng. – Area Manager, Yukon & NWT

Subject: Geotechnical Evaluation – Phase 5
Whistle Bend Subdivision – Whitehorse, Yukon

1.0 INTRODUCTION

Tetra Tech Canada Inc. (Tetra Tech) was retained by Associated Engineering (B.C.) Ltd. (AE) to collect additional geotechnical information for Phase 5 of the Whistle Bend Subdivision.

This report summarizes the work completed and the conditions encountered, along with presenting recommendations to support final design.

2.0 GEOTECHNICAL INFORMATION FROM PREVIOUS EVALUATIONS

Prior to the current evaluation work, other geotechnical evaluations had been completed throughout the Phase 5 area of the Whistle Bend Subdivision, including:

- Project No W14101171 - 2008: Two boreholes were drilled to 6 m on and north of the old CBC tower site as part of the AECOM Predesign Geotechnical Evaluation;
- Project No W14101372.002 – 2010: A testpit was excavated at the intersection of Casca Boulevard and Leota Street along the south side of Phase 5;
- Project No W14101545.001 - 2011: A testpit was excavated close to what is now Witch Hazel Drive as part of the Morrison Hershfield Soil Infiltration study; and,
- Project No W23101141: - 2008: a deep borehole (60 m) was drilled along Leota Drive on the south side of Phase 5 for a Geothermal Assessment project completed for the City of Whitehorse.

The historic and recent testhole logs used for this geotechnical evaluation are presented in Appendix A of this report.

3.0 CURRENT SITE ASSESSMENT

On April 22, 2018, ten boreholes were drilled throughout the east half of Phase 5. Due to soft, wet conditions, access throughout the west half of the study area was limited so evaluation has been based on historic data collected during the completion of the projects listed in Section 2.0 and conditions noted along the sidewalls of the storm drainage swale excavated along the west side of the site.

All boreholes were drilled to a termination depth of 6.0 m with a truck mounted CME 75 drill rig contracted from Don Jeck Services of Whitehorse, Yukon. The drill rig was equipped with solid flight augers. Tetra Tech's site representative was Mr. Myles Plaunt, CET of Tetra Tech's Whitehorse office.

Disturbed grab samples were collected at regular intervals throughout the depth of each of the boreholes drilled. Samples were returned to the Whitehorse laboratory for visual classification purposes only.

Upon completion, all boreholes were backfilled to grade to ensure safe site conditions and UTM coordinate locations of the boreholes were recorded using a hand-held GPS unit.

The location of the current and previously completed testholes used for this evaluation are all presented on Figure 1, attached and as mentioned above, the detailed testhole logs are presented in Appendix A.

4.0 SITE DESCRIPTION & GEOTECHNICAL CONDITIONS

4.1 Surface Conditions & Terrain

At the time of the current field investigation, the area was cleared but not stripped or grubbed.

In general, the far northeast corner and the two edges bordering the Ta'an selection sit at a higher elevation than the remainder of the site. It is understood that the preliminary grading plans suggest that there will be significant volumes of fill placed during development.

4.2 Subsurface Conditions

4.2.1 Soil Conditions

As was expected, the area is underlain by glaciolacustrine silt. And very little good quality sand was noted overlying the silts. During the drilling program, attention was given to areas that defined micro terrain units since they tend to suggest the presence of glaciofluvial or eolian sand. Boreholes BH05, BH08, BH10 and BH11 were all drilled where significant thicknesses of surficial sand could be recovered for use as pipe bedding or structural fill.

Along with the four boreholes mentioned, significant thicknesses of sand was noted at the far north end of the drainage swale.

4.2.2 Groundwater

No groundwater has been noted in any of the current or historical testholes advanced throughout the study area.

4.2.3 Seasonal Frost and Permafrost

On April 22, 2018, the top 0.2 to 0.4 m was thawed but below this depth seasonal frost was still noted to depths of 2.0 m or better.

Permafrost was not encountered (or anticipated) at this location.

4.2.4 Bedrock

Bedrock has not been encountered in any of the deep boreholes drilled throughout the Whistle Bend Subdivision area.

5.0 RECOMMENDATIONS

5.1 Challenges Related To Deep Utility Construction

As expected the biggest challenge related to deep utility construction will be material reuse. Although the moisture content of the majority of the glaciolacustrine silt samples collected during the April 22, 2018 field investigation were acceptable, there were depths where moistures in excess of 30% were noted (refer to the current borehole logs where transitions between moist, which would be acceptable as backfill, and wet, which will possibly prove problematic if not dried out in advance of reuse). If the moisture content of the soils in the spoil piles is more than +3% above optimum moisture, the contractor should be prepared to disturb the spoil piles in an attempt to reduce the moisture content and make it suitable for use as backfill below 1.7 m in the deep utility trenches.

Soft, wet soil conditions at invert elevations may necessitate the use of bedding stone under and around pipes.

5.2 Underground Utilities Construction

The excavation of deep utility trenches must conform to Yukon *Occupational Health and Safety Regulations* guidelines. The fine-grained soils at depth throughout Phase 5 should not be prone to sloughing, therefore, trench side slopes cut to 0.75:1.0 (horizontal:vertical) should ensure safe, compliant, working conditions. If areas of instability are encountered, the contractor should relax the trench sideslopes as required.

All material excavated from the utility line trenches can be considered for backfill at depth. However, as mentioned above, material reuse will be dependent upon moisture content.

Deep utility line backfill should be placed in 200 mm thick lifts and compacted to 95% of Standard Proctor Maximum Dry Density (SPMDD) for material placed below 1.0 m from grade and 98% of SPMDD for backfill placed in the final 1.0 m from grade.

It is recommended that a Class "B" pipe bedding configuration (commonly used on YG and City of Whitehorse projects with 150 mm of bedding under the pipe, beside the pipe and 300 mm above the pipe) be specified for this project. When compacted to at least 95% of SPMDD, this bedding configuration will ensure proper support and protection of the utility lines during backfill.

Bedding may be imported bedding sand in dry areas, or bedding stone in areas where wet and unstable conditions are encountered below invert elevations.

Imported bedding sand and stone should conform to the gradation specifications presented in Table 1.

Table 1: Recommended Pipe Bedding Materials Specifications

BEDDING SAND		25 mm BEDDING STONE	
Particle Size (mm)	% Passing by Mass	Particle Size (mm)	% Passing by Mass
10.000	100	25.000	100
5.000	80 – 100	20.000	70 - 100
2.000	55 – 100	12.500	55 – 100
0.630	25 – 65	10.00	30 – 80
0.250	10 – 40	5.000	0 – 40
0.080	2 – 15	2.000	0 – 10

Note: Gradation Limits From City of Whitehorse Servicing Standards Manual

5.3 Seasonal Frost Penetration

Based on the installation depths of the utility line piping, there will likely be some installation within the estimated depth of seasonal frost penetration. However, it is assumed that the civil consultant (Associated Engineering) has addressed this concern and the final design has appropriate mitigative measures.

5.4 Soil Corrosivity

5.4.1 Factors Contributing To Soil Corrosivity

Soil corrosivity and pipe corrosion are not considered to be directly measurable; however, research suggests that the main factors contributing to soil corrosivity include:

- Aeration – since well aerated soils generally have lower water retention properties (grain size) and better evaporation rates, loamy and sandy soils are desirable around ductile iron pipes and fittings. However, typical construction methods (the compaction process), will affect the aeration potential;
- pH – The acidity of a soil can lead to extreme corrosion rates and pitting. When pH levels are below 4.5 (very acidic) or above 9.1 (strongly alkaline), high corrosion loss rates can be expected;
- Moisture Content and Resistivity – Since water is one of the components necessary for electrochemical corrosion (along with oxygen and metal), the moisture content of the soil is probably the most important factor in assessing potential. Increased moisture contents will result in lower resistivity in soil and therefore increasing potential for corrosion. Interesting to note, however, research suggests that once the soil is saturated, the additional moisture has no increased effect on resistivity; and
- Temperature – Soils at or below freezing will have increased resistivity for a given moisture content and if this happens rapidly (which would be the case in the Yukon), the increase in resistivity corresponds to decreases in the corrosive potential of the soil.

5.4.2 Soil Corrosivity Testing

To assess potential for corrosivity, an analytical lab can perform a suite of tests that includes:

- Physical tests including Conductivity, percent of Moisture, pH, Redox Potential, and Resistivity;
- Leachable Anions and Nutrient testing including Chloride and Sulphide testing; and

- Anion and Nutrient testing including Sulphate testing.

5.4.3 Interpretation Of Corrosivity Results

Although soil corrosivity is not a directly measurable soil parameter, there are systems and methods that attempt to predict potential and the resulting corrosion of metallic pipe and fittings based on soil properties. Two of the more widely used methods are the American Waste Water Association (AWWA) 10 point scoring method that bases potential on the weighted aggregation of 5 soil properties. A second method that is used is the Spicklemire (2002) 25 point scoring method which is similar to the AWWA method but has additional factors. For the purpose of this exercise, the AWWA method will be used to assess potential. The five soil parameters used to calculate the weighted aggregation includes resistivity, pH, redox potential, sulphides and moisture content. If the total is greater than 10 points, protective measures such as cathodic protection of cast iron alloys is warranted.

As part of the Whistle Bend Phase 3D and 3E a composite sample of soil from various depths was submitted for testing. As mentioned in an April 26, 2018 email, the results were assessed using the AWWA 10-point scoring method and the total was between 2 and 3. Since this is well below the threshold of 10, no concerns are anticipated.

5.5 Pavement Structure

As with previous phases throughout the It is assumed that pavement structure design for Phase 5 will include 75 mm of asphalt; 150 mm of 20 mm crushed basecourse; 200 mm of 50 mm crushed sub-base; 500 mm of pit run sub-base and 800 mm of select sand for residential streets and for collectors, 100 mm of asphalt, along with the same thicknesses of the granular components will be used for design.

5.5.1 Roadway Construction Recommendations

All imported granular materials (crushed basecourse, crushed sub-base and pit run sub-base) must meet the gradation limits presented in Table 2. If non-compliant materials are proposed, a sample can be submitted to Tetra Tech for testing and an opinion regarding suitability for use can be supplied.

Table 2: Imported Gravel Gradation Specifications

20 mm CRUSHED BASECOURSE AGGREGATE		80 mm PIT RUN SUB-BASE AGGREGATE		50 mm CRUSHED SUB-BASE AGGREGATE	
Particle Size (mm)	% Passing by Mass	Particle Size (mm)	% Passing by Mass	Particle Size (mm)	% Passing by Mass
20.000	100	80.000	100	50.000	100
12.500	64 – 100	25.000	55 - 100	25.000	55 - 100
5.000	36 – 72	12.500	42 - 84	12.500	42 - 84
2.500		5.000	26 - 65	5.000	26 - 65
1.250	12 – 42	1.250	11 - 47	2.500	
0.315	4 – 22	0.315	3 - 30	1.250	11 - 47
0.080	3 - 6	0.080	0 - 8	0.315	3 - 30
				0.080	0 - 8

Note: Gradation Limits From City of Whitehorse Servicing Standards Manual

All sub-base materials must be placed in lifts not exceeding 200 mm in thickness and the contractor should be prepared to moisture condition each lift to facilitate compaction. The crushed 20 mm basecourse aggregate can be placed in a single lift and final tight-blading and recompaction should be performed immediately prior to paving.

If soft areas are encountered during roadway reconstruction, additional subcut may be required (down to a dry, stable surface). When the subcut areas are being backfilled, all materials placed within the final meter must be compacted to at least 98% of SPMDD. For material placed below 1.0 m from finished grade, 95% of SPMDD is considered acceptable. All granular material placed as subcut backfill will have to be moisture conditioned to facilitate compaction.

5.5.1 Granular Structure Under Sidewalks

The typical Tetra Tech granular structure recommendation for paved surfaces and exterior concrete has always been 1.7 m of non-frost susceptible material. This recommendation was not followed during the design and construction of Phases 1 and 2 and this practice was carried forward during the construction of Phases 3 and 4.

Current information from Associated Engineering suggests that there are sections of sidewalk throughout Phase 3A (where there is less surficial sand cover than throughout Phases 1 and 2) that are experiencing frost heave damage and possible damage from construction traffic.

Therefore, to minimize the risk of damage along sections of separate walkway routes, construction should be over 1.7 m of non-frost susceptible soil. Anything less becomes a risk management issue.

5.6 Concrete

All concrete should be cast onto a clean, level, compacted, granular surfaces. It is important that no loose and/or disturbed material be allowed to remain on the bearing surface. Bearing surfaces should consist of 20 mm crushed basecourse gravel which has been moisture conditioned and compacted to at least 98% SPMDD.

Tetra Tech recommends that all concrete be designed, mixed, placed, and tested in accordance with the most recent edition of the Canadian Standards Association (CSA) Standard CAN/CSA-A23.1 and A23.2. According to these standards, concrete should be designed to at least satisfy the minimum durability requirements as defined by the exposure class.

The exposure class of the concrete is dependent on the presence or lack of chlorides, sulphates, freezing and thawing conditions, and the soil saturation. Based on the aforementioned conditions, the governing exposure class for all exterior concrete curb & gutter and sidewalks is C-2 which corresponds to a minimum compressive strength of 32 MPa and has 5% to 8% entrained air.

If shoulder season (early spring or late fall) construction is considered, Tetra Tech should be contacted and given the opportunity to review the contractor's cold weather concrete placement procedures.

6.0 FOUNDATION RECOMMENDATIONS

A Building Advisory was issued by The City of Whitehorse, Planning and Development on October 25, 2010. This advisory relates to *Drainage Standards for Building Foundations*. The requirements for drain rock, perimeter drainage systems and sump construction presented in the advisory will have to be followed for all foundations. The prescriptive measures are based on CSA and NBC specifications as summarized in the following sections.

6.1 Preserved Wood Foundation Recommendations

If the use of preserved wood foundations (PWF) is desired, a granular drainage layer will be required beneath all footings and basement slabs, in accordance with CAN-CSA S406, because of the impervious glaciolacustrine underlying material. If areas of free draining material are encountered it may be possible to remove the requirement for a gravel drainage layer (a geotechnical engineer should be consulted).

The granular drainage layer should be constructed using a clean crushed stone or screened drain rock material of maximum particle size 40 mm and having less than 10% sand (passing the 5 mm sieve). This layer shall be at least 125 mm thick and shall extend beyond the footing plate a minimum of 300 mm. The granular drainage layer shall drain to a sump which, in turn, shall drain to a point of final disposal beyond the building's footprint.

In accordance with CAN-CSA S406, the use of perimeter drainage tile or pipe is not recommended with PWF.

All backfill material placed within 600 mm of the foundation walls shall be free of deleterious debris, frozen materials, and boulders larger than 150 mm in diameter.

Existing soils can be used as backfill in service trenches so long as no cobbles are placed within one lift of any pipe installation and all backfill materials are compacted to at least 95% of SPMD.

6.2 Concrete Foundation Recommendations

If the use of concrete foundations is desired, the drainage tile and pipe, granular drainage layers, drainage disposal and surface drainage specifications as per NBC 2005, Section 9.14 "Drainage" must be followed.

Full depth concrete foundations with concrete footings are required to have perimeter drainage tile which terminates in a sump pit. A sump pit is to be installed to assist in the removal of water from the foundation area (should water accumulation in the sump pit warrant it).

6.3 Foundations On Free Draining Soils

The prescriptive measures described above may not apply if adequate thicknesses of free draining soil exists below foundation elements. If underlying soils meet the conditions of "free draining" soils (as verified by geotechnical engineering staff capable of soil classification), the drainage layer and sump can be omitted. Since there will be significant site grading throughout Phase 5, it is difficult to predict whether there will be areas with adequate thicknesses of free draining soil so site specific assessments will be required to determine actual conditions.

7.0 FROST PENETRATION AND FROST HEAVE POTENTIAL

The underlying glaciolacustrine silt is considered to be very frost-susceptible. If the following recommendations are adhered to, the insulation should provide sufficient protection to the foundation from frost heave.

7.1 Insulation Recommendations – Heated and Unheated Structures

Tetra Tech recommends insulating foundations to mitigate potential for seasonal frost-heave damage. General foundation insulation recommendations are presented on Figure 2. If different footing burial depths or insulation configurations are desired, Tetra Tech would be pleased to revise their insulation recommendations accordingly.

8.0 CONSTRUCTION TESTING AND MONITORING

All recommendations presented herein are site-specific and based on the assumption that there will be an adequate level of monitoring during construction. An adequate level of construction monitoring also provides opportunity to verify that the recommendations based on geotechnical data obtained from the testholes used for this evaluation is applicable to the entire site. Appropriate quality assurance and quality control (QA/QC) testing should be undertaken during construction to confirm that construction is completed in accordance with the recommendations provided in this report. For this project, appropriate QA/QC inspection and testing is considered to include:

- Laboratory testing on samples of proposed fill materials to confirm compliance to specified gradation requirements (by sieve analysis) and compaction (proctor moisture density testing) requirements;
- Compaction, concrete and asphalt testing during construction to ensure that project objectives are met; and,
- Geotechnical inspections of foundation excavations.

9.0 LIMITATIONS OF REPORT

This report and its contents are intended for the sole use of Associated Engineering (B.C.) Ltd. and their agents. Tetra Tech Canada Inc. (operating as 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 Associated Engineering (B.C.) Ltd., 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 B. We trust this document meets your present requirements. If you have any questions or comments, please contact the undersigned.

Respectfully submitted,
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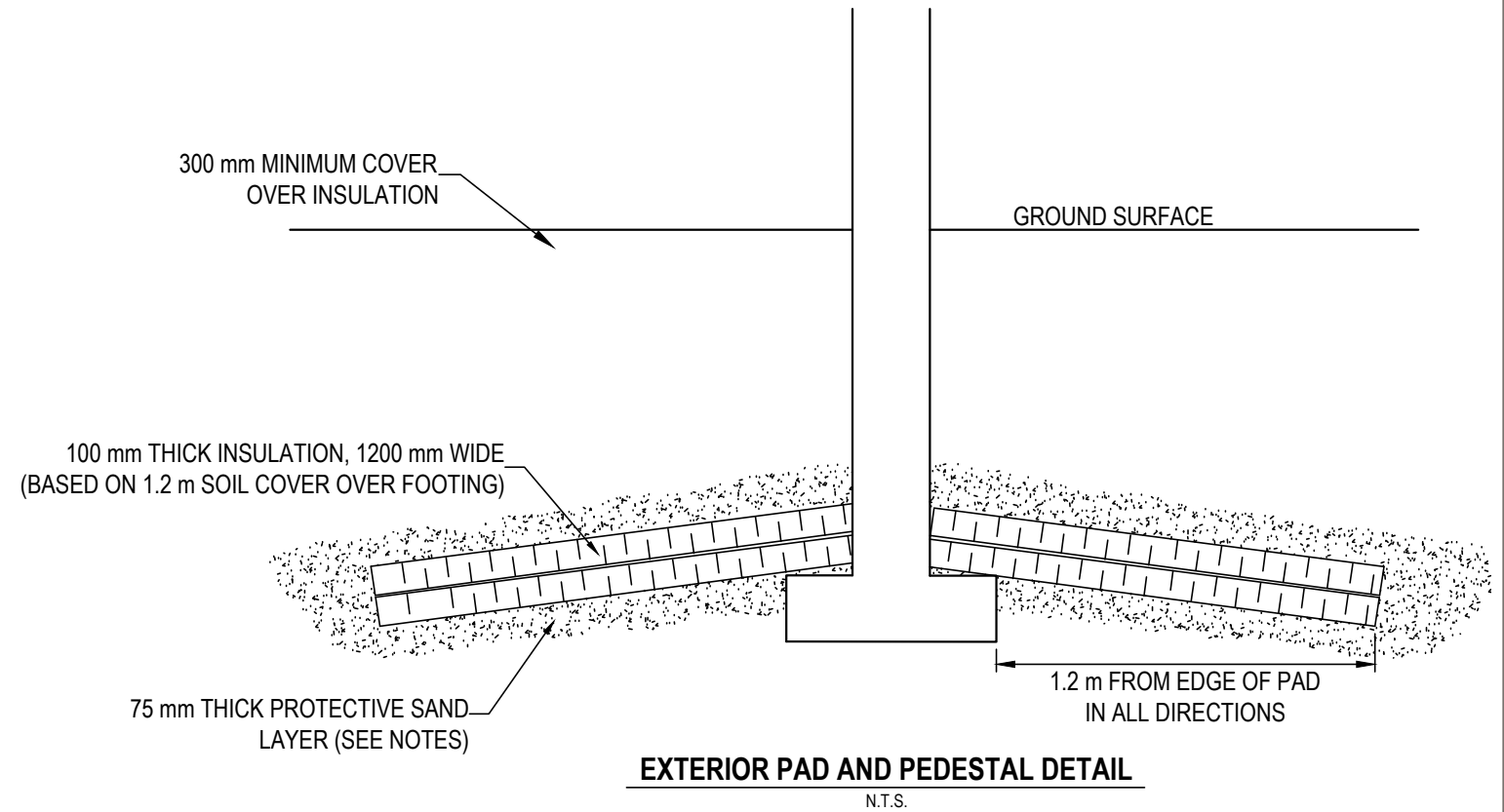
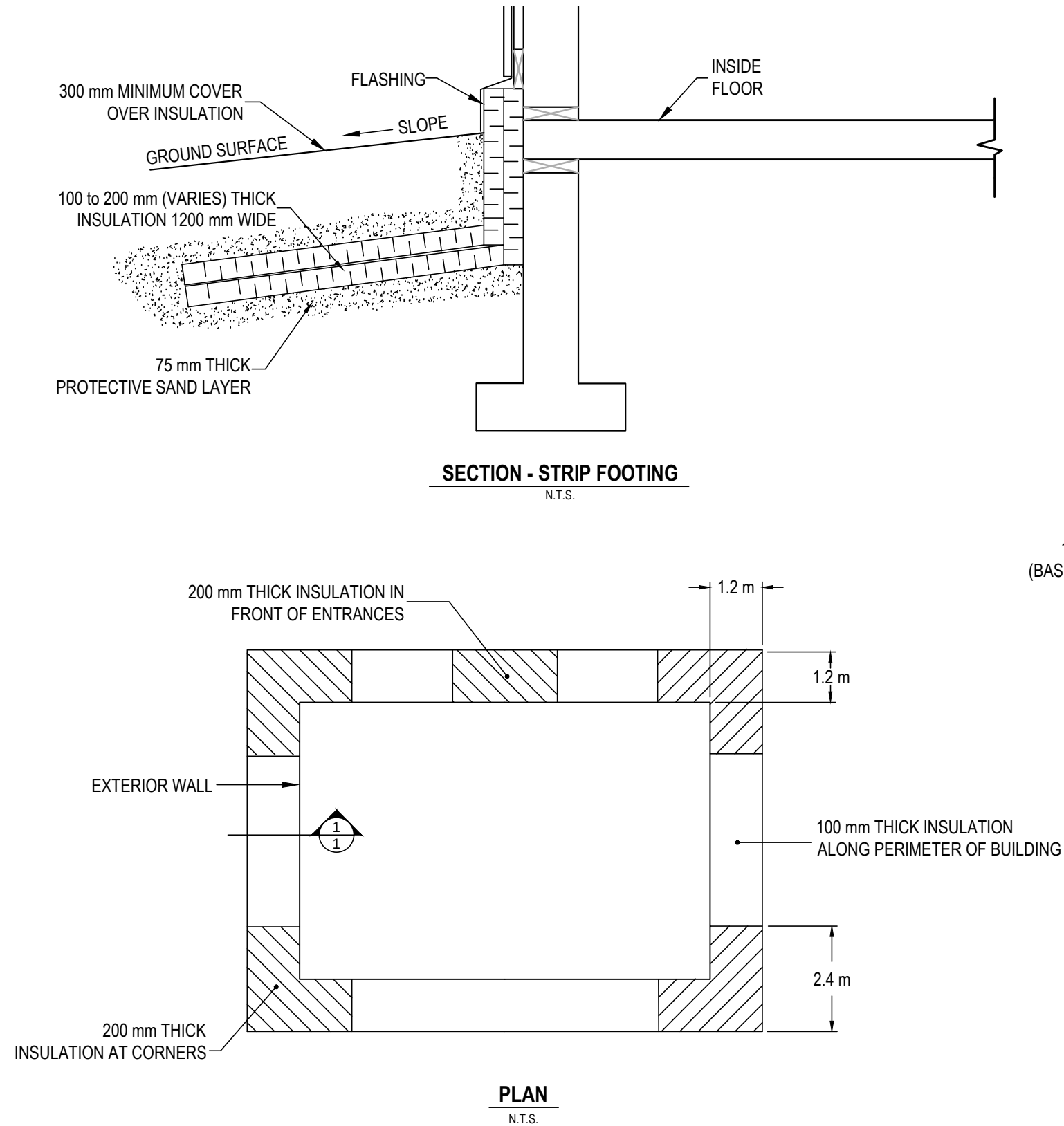


FIGURES

- Figure 1 Site Plan Showing Current & Historical Testhole Locations
Figure 2 Commercial and Residential Foundation Insulation Details



Q:\Whitehorse\Drawings\Whitehorse\ENG-WARC03380-01 Whistle Bend 2018 Geotech Services\ENG-WARC03380-01 Phase 5 Fig.2-R0.dwg [FIGURE 2] May 07, 2018 - 9:02:23 am (BY: BUCHAN, CAMERON)



NOTES :

- THE INSULATION (DOW CHEMICAL HI SERIES STYROFOAM OR POLYURETHANE OR APPROVED EQUIVALENT) SHOULD BE MOISTURE RESISTANT AND SUITABLE FOR BURIAL UNDER VEHICULAR TRAFFIC AREAS.
- A MINIMUM BEDDING THICKNESS OF 75 mm OF FINE TO MEDIUM GRAINED SAND SHOULD BE PLACED ABOVE AND BELOW THE INSULATION FOR PROTECTION.
- THIS PLAN IS NOT TO SCALE

CLIENT



**2018 GEOTECHNICAL SERVICES
WHISTLE BEND - WHITEHORSE, YUKON**

**COMMERCIAL AND RESIDENTIAL
FOUNDATION INSULATION DETAILS**

PROJECT NO. ENG.WARC03380-01	DWN CB	CKD MCP	REV 0
OFFICE EBA-WHSE	DATE May 7, 2018		

Figure 2

APPENDIX A

TESTHOLE LOGS USED FOR THIS EVALUATION



**Associated
Engineering**

GLOBAL PERSPECTIVE.
LOCAL FOCUS.

Borehole No: BH18-05

Project: 2018 Geotechnical Services

Project No: ENG.WARC03380-01

Location: Phase 5 - Whistle Bend Subdivision

Whitehorse, Yukon

UTM: 493942 E; 6738888 N; Z 8

Depth (m)	Method	Soil Description	Ground Ice Description	Sample Type	Moisture Content (%)	Plastic Limit	Moisture Content	Liquid Limit	Depth (ft)
0		ORGANIC ROOT MAT - moist, black, (100 mm thick) SAND - trace to some silt, brown, fine to medium sand	Unfrozen			20	40	80	0
			Seasonally frozen						1
1									2
									3
2		- damp	Unfrozen						4
									5
3		SILT (GLACIOLACUSTRINE) - some clay, damp, firm (est.), olive grey							6
									7
4									8
									9
5									10
									11
6		END OF BOREHOLE (6.0 metres)							12
									13
7									14
									15
7.5									16



TETRA TECH

Contractor: DonJeck Services

Completion Depth: 6 m

Drilling Rig Type: Truck Mounted CME 75

Start Date: 2018 April 22

Logged By: MCP

Completion Date: 2018 April 22

Reviewed By: CC

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**Associated
Engineering**

GLOBAL PERSPECTIVE.
LOCAL FOCUS.

Borehole No: BH18-06

Project: 2018 Geotechnical Services

Project No: ENG.WARC03380-01

Location: Phase 5 - Whistle Bend Subdivision

Whitehorse, Yukon

UTM: 493803 E; 6738905 N; Z 8

Depth (m)	Method	Soil Description	Ground Ice Description	Sample Type	Moisture Content (%)	Plastic Limit	Moisture Content	Liquid Limit	Depth (ft)
0		ORGANIC ROOT MAT - wet, black, (150 mm thick)	Unfrozen			20	40	80	0
		SILT (GLACIOLACUSTRINE) - some sand at upper interface, some clay, light olive grey, fine sand	Seasonally frozen						1
									2
									3
1									4
									5
		- damp to moist	Unfrozen						6
2									7
									8
									9
3									10
									11
									12
4									13
									14
									15
5									16
									17
									18
6		END OF BOREHOLE (6.0 metres)							19
									20
									21
7									22
									23
7.5									24



TETRA TECH

Contractor: DonJeck Services

Completion Depth: 6 m

Drilling Rig Type: Truck Mounted CME 75

Start Date: 2018 April 22

Logged By: MCP

Completion Date: 2018 April 22

Reviewed By: CC

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**Associated
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GLOBAL PERSPECTIVE.
LOCAL FOCUS.

Borehole No: BH18-07

Project: 2018 Geotechnical Services

Project No: ENG.WARC03380-01

Location: Phase 5 - Whistle Bend Subdivision

Whitehorse, Yukon

UTM: 493812 E; 6738764 N; Z 8

Depth (m)	Method	Soil Description	Ground Ice Description	Sample Type	Moisture Content (%)	Plastic Limit	Moisture Content	Liquid Limit	Depth (ft)
0		ORGANIC ROOT MAT - wet, black, (100 mm thick) SILT - some sand, brown, fine sand	Unfrozen Seasonally frozen			20	40	80	0
1		SAND - silty, brown, fine sand							1
2		SILT (GLACIOLACUSTRINE) - some clay, mottled grey with brown at upper interface - olive grey							2
3		- moist	Unfrozen						3
4		- 200 mm thick sand lens - silty, damp, fine sand							4
5									5
6		END OF BOREHOLE (6.0 metres)							6
7									7
7.5									7.5



TETRA TECH

Contractor: DonJeck Services

Completion Depth: 6 m

Drilling Rig Type: Truck Mounted CME 75

Start Date: 2018 April 22

Logged By: MCP

Completion Date: 2018 April 22

Reviewed By: CC

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**Associated
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GLOBAL PERSPECTIVE.
LOCAL FOCUS.

Borehole No: BH18-08

Project: 2018 Geotechnical Services

Project No: ENG.WARC03380-01

Location: Phase 5 - Whistle Bend Subdivision

Whitehorse, Yukon

UTM: 493978 E; 6738733 N; Z 8

Depth (m)	Method	Soil Description	Ground Ice Description	Sample Type	Moisture Content (%)	Plastic Limit	Moisture Content	Liquid Limit	Depth (ft)
0		ORGANIC ROOT MAT AND SURFICIAL SILT - moist, black and brown, (200 mm thick)	Unfrozen			20	40	80	0
		SAND - trace silt, brownish grey, fine to medium sand	Seasonally frozen						1
1									2
		- damp	Unfrozen						3
2									4
									5
3									6
									7
4									8
									9
5									10
									11
6									12
									13
7									14
									15
7.5									16
									17
									18
									19
									20
									21
									22
									23
									24



TETRA TECH

Contractor: DonJeck Services

Completion Depth: 6 m

Drilling Rig Type: Truck Mounted CME 75

Start Date: 2018 April 22

Logged By: MCP

Completion Date: 2018 April 22

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**Associated
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GLOBAL PERSPECTIVE.
LOCAL FOCUS.

Borehole No: BH18-09

Project: 2018 Geotechnical Services

Project No: ENG.WARC03380-01

Location: Phase 5 - Whistle Bend Subdivision

Whitehorse, Yukon

UTM: 493933 E; 6738618 N; Z 8

Depth (m)	Method	Soil Description	Ground Ice Description	Sample Type	Moisture Content (%)	Plastic Limit	Moisture Content	Liquid Limit	Depth (ft)
0		ORGANIC ROOT MAT - moist to wet, black, (200 mm thick)	Unfrozen			20	40	80	0
		SILT (GLACIOLACUSTRINE) - some clay, olive grey	Seasonally frozen						1
1									2
									3
2		- damp	Unfrozen						4
									5
3		- moist							6
									7
4									8
									9
5									10
									11
6		END OF BOREHOLE (6.0 metres)							12
									13
7									14
									15
7.5									16



TETRA TECH

Contractor: DonJeck Services

Completion Depth: 6 m

Drilling Rig Type: Truck Mounted CME 75

Start Date: 2018 April 22

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**Associated
Engineering**

GLOBAL PERSPECTIVE.
LOCAL FOCUS.

Borehole No: BH18-10

Project: 2018 Geotechnical Services

Project No: ENG.WARC03380-01

Location: Phase 5 - Whistle Bend Subdivision

Whitehorse, Yukon

UTM: 494103 E; 6738655 N; Z 8

Depth (m)	Method	Soil Description	Ground Ice Description	Sample Type	Moisture Content (%)	Plastic Limit	Moisture Content	Liquid Limit	Depth (ft)
0		ORGANIC ROOT MAT - moist, black, (100 mm thick) SAND - trace to some silt, brown to brownish grey, fine to medium sand	Unfrozen			20	40	80	0
			Seasonally frozen						1
1									2
									3
2			Unfrozen						4
									5
3		SILT (GLACIOLACUSTRINE) - some clay, damp to moist, olive grey							6
									7
4									8
									9
5		- moisture content increasing							10
									11
6		END OF BOREHOLE (6.0 metres)							12
									13
7									14
									15
7.5									16



TETRA TECH

Contractor: DonJeck Services

Completion Depth: 6 m

Drilling Rig Type: Truck Mounted CME 75

Start Date: 2018 April 22

Logged By: MCP

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**Associated
Engineering**

GLOBAL PERSPECTIVE.
LOCAL FOCUS.

Borehole No: BH18-11

Project: 2018 Geotechnical Services

Project No: ENG.WARC03380-01

Location: Phase 5 - Whistle Bend Subdivision

Whitehorse, Yukon

UTM: 494191 E; 6738675 N; Z 8

Depth (m)	Method	Soil Description	Ground Ice Description	Sample Type	Moisture Content (%)	Plastic Limit	Moisture Content	Liquid Limit	Depth (ft)
0		ORGANIC ROOT MAT AND SURFICIAL SILT - moist, black with brown, (150 mm thick)	Unfrozen			20	40	80	0
		SAND - trace to some silt, brown to brownish grey, fine sand	Seasonally frozen						1
1									2
									3
2		- damp	Unfrozen						4
									5
3		SILT (GLACIOLACUSTRINE) - some clay, damp to moist, olive grey							6
									7
4									8
									9
5		- moist to wet							10
									11
6		END OF BOREHOLE (6.0 metres)							12
									13
7									14
									15
7.5									16



TETRA TECH

Contractor: DonJeck Services

Completion Depth: 6 m

Drilling Rig Type: Truck Mounted CME 75

Start Date: 2018 April 22

Logged By: MCP

Completion Date: 2018 April 22

Reviewed By: CC

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**Associated
Engineering**

GLOBAL PERSPECTIVE.
LOCAL FOCUS.

Borehole No: BH18-12

Project: 2018 Geotechnical Services

Project No: ENG.WARC03380-01

Location: Phase 5 - Whistle Bend Subdivision

Whitehorse, Yukon

UTM: 494263 E; 6738638 N; Z 8

Depth (m)	Method	Soil Description	Ground Ice Description	Sample Type	Moisture Content (%)	Plastic Limit	Moisture Content	Liquid Limit	Depth (ft)
0						20	40	80	0
		ORGANIC ROOT MAT AND SURFICIAL SILT - moist to wet, black with brown, (150 mm thick)	Unfrozen						
		SAND - trace to some silt, brown to brownish grey, fine to medium sand	Seasonally frozen						1
1									2
									3
									4
		SILT (GLACIOLACUSTRINE) - some clay, olive grey							5
		- moist to wet	Unfrozen						6
2									7
									8
									9
3									10
									11
									12
4									13
									14
									15
5									16
									17
									18
6									19
		END OF BOREHOLE (6.0 metres)							20
									21
7									22
									23
7.5									24



TETRA TECH

Contractor: DonJeck Services

Completion Depth: 6 m

Drilling Rig Type: Truck Mounted CME 75

Start Date: 2018 April 22

Logged By: MCP

Completion Date: 2018 April 22

Reviewed By: CC

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**Associated
Engineering**

GLOBAL PERSPECTIVE.
LOCAL FOCUS.

Borehole No: BH18-13

Project: 2018 Geotechnical Services

Project No: ENG.WARC03380-01

Location: Phase 5 - Whistle Bend Subdivision

Whitehorse, Yukon

UTM: 494074 E; 6738555 N; Z 8

Depth (m)	Method	Soil Description	Ground Ice Description	Sample Type	Moisture Content (%)	Plastic Limit	Moisture Content	Liquid Limit	Depth (ft)
0						20	40	80	0
		ORGANIC ROOT MAT AND SURFICIAL SILT - moist to wet, black with brown, (150 mm thick)	Unfrozen						
		SAND - some silt to silty, brown	Seasonally frozen						1
		SILT (GLACIOLACUSTRINE) - some clay, light to medium olive grey							2
1									3
		- moist	Unfrozen						4
2									5
		- moist to wet							6
3									7
		- moist							8
4									9
		- wet							10
5									11
									12
6		END OF BOREHOLE (6.0 metres)							13
									14
7									15
									16
7.5									17



TETRA TECH

Contractor: DonJeck Services

Completion Depth: 6 m

Drilling Rig Type: Truck Mounted CME 75

Start Date: 2018 April 22

Logged By: MCP

Completion Date: 2018 April 22

Reviewed By: CC

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**Associated
Engineering**

GLOBAL PERSPECTIVE.
LOCAL FOCUS.

Borehole No: BH18-14

Project: 2018 Geotechnical Services

Project No: ENG.WARC03380-01

Location: Phase 5 - Whistle Bend Subdivision

Whitehorse, Yukon

UTM: 493927 E; 6738562 N; Z 8

Depth (m)	Method	Soil Description	Ground Ice Description	Sample Type	Moisture Content (%)	Plastic Limit	Moisture Content	Liquid Limit	Depth (ft)
0						20	40	80	0
		ORGANIC ROOT MAT AND SURFICIAL SILT - moist to wet, black with brown, (300 mm thick)	Unfrozen						
		SAND - silty, dark brown to brown	Seasonally frozen						1
		SILT (GLACIOLACUSTRINE) - some clay, light olive grey							2
1									3
									4
									5
		- damp	Unfrozen						6
2									7
									8
									9
3									10
									11
									12
4									13
									14
									15
5									16
									17
									18
6									19
		END OF BOREHOLE (6.0 metres)							20
									21
7									22
									23
7.5									24



TETRA TECH

Contractor: DonJeck Services

Completion Depth: 6 m

Drilling Rig Type: Truck Mounted CME 75

Start Date: 2018 April 22

Logged By: MCP

Completion Date: 2018 April 22

Reviewed By: CC

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**Associated
Engineering**

GLOBAL PERSPECTIVE.
LOCAL FOCUS.

Borehole No: EXP18-15

Project: 2018 Geotechnical Services

Project No: ENG.WARC03380-01

Location: Phase 5 - Whistle Bend Subdivision

Whitehorse, Yukon

UTM: 493710 E; 6738900 N; Z 8

Depth (m)	Method	Soil Description	Ground Ice Description	Moisture Content (%)	Plastic Limit	Moisture Content	Liquid Limit	Depth (ft)
0		ORGANIC ROOT MAT AND SURFICIAL SILT - wet, black with brown, (300 mm thick)	Unfrozen		20	40	80	0
		SAND - trace to some silt, damp, brownish grey, fine to medium sand	Face of exposure thawed					1
1								2
								3
2								4
								5
3								6
								7
4								8
								9
5								10
								11
6								12
								13
7								14
								15
7.5								16
								17
								18
								19
								20
								21
								22
								23
								24

SILT (GLACIOLACUSTRINE) - some clay, moist to wet, olive grey

END OF EXPOSURE (5.8 metres)
Note: Exposure logged is located along large drainage swale constructed on west edge of phase 5 at north end.



TETRA TECH

Contractor: DonJeck Services

Completion Depth: 5.8 m

Drilling Rig Type: Truck Mounted CME 75

Start Date: 2018 April 22

Logged By: MCP

Completion Date: 2018 April 22

Reviewed By: CC

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**Associated
Engineering**

GLOBAL PERSPECTIVE.
LOCAL FOCUS.

Borehole No: EXP18-16

Project: 2018 Geotechnical Services

Project No: ENG.WARC03380-01

Location: Phase 5 - Whistle Bend Subdivision

Whitehorse, Yukon

UTM: 493650 E; 6738660 N; Z 8

Depth (m)	Method	Soil Description	Ground Ice Description	Moisture Content (%)	Plastic Limit	Moisture Content	Liquid Limit	Depth (ft)
0					20	40	80	0
		ORGANIC ROOT MAT AND SURFICIAL SILT - wet, black with brown, (150 mm thick)	Unfrozen					
		SAND - some silt, damp, brown, fine to medium sand	Face of exposure thawed					1
		SILT (GLACIOLACUSTRINE) - some clay, moist to wet, olive grey						2
1								3
								4
								5
2								6
								7
								8
								9
3								10
								11
								12
4								13
								14
								15
5		END OF EXPOSURE (4.5 metres) Note: Exposure logged along large drainage swale immediately north of Witch Hazel Drive.						16
								17
								18
6								19
								20
								21
7								22
								23
7.5								24



TETRA TECH

Contractor: DonJeck Services

Completion Depth: 4.5 m

Drilling Rig Type: Truck Mounted CME 75

Start Date: 2018 April 22

Logged By: MCP

Completion Date: 2018 April 22

Reviewed By: CC

Page 1 of 1

Geotechnical Evaluation		AECOM		BOREHOLE NO: BH16			
Whistle Bend Subdivision		Drilling Method: NODWELL Mounted CME 75		PROJECT: W14101171			
Whitehorse, YT		100 m North of CBC Tower Clearing					
SAMPLE TYPE DISTURBED NO RECOVERY SPT A-CASING SHELBY TUBE CORE							
BACKFILL TYPE BENTONITE PEA GRAVEL SLOUGH GROUT DRILL CUTTINGS SAND							
Depth (m)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	GROUND ICE DESCRIPTION AND COMMENTS	☐ BULK DENSITY (kg/m ³) ☐ 1400 1600 1800 2000	☒ CLAY (%) ☒ 20 40 60 80	Depth (ft)
					☒ SPT (N) ☐ 20 40 60 80	☒ SILT (%) ☒ 20 40 60 80	
					PLASTIC M.C. LIQUID ☐ 20 40 60 80	☒ SAND (%) ☒ 20 40 60 80	
						☒ GRAVEL (%) ☒ 20 40 60 80	
0	ORGANIC ROOT MATERIAL - seasonally frozen, organic brown SAND - some silt to silty, damp below seasonal frost, dark brown - becomes clean and medium to fine grained, dry to damp, medium greyish brown		1				0
1							
2	SILT - some clay, trace fine sand, damp, firm, light olive		2				5
3							
4			3				10
5	- moisture content increases with depth, still firm						
6			4				15
7							
8	- some mottling in soil at 4.5 m		5				20
9							
10	END OF BOREHOLE @ 6.0 m						25
							30
							33



Geotechnical Evaluation		AECOM		BOREHOLE NO: BH17	
Whistle Bend Subdivision		Drilling Method: NODWELL Mounted CME 75		PROJECT: W14101171	
Whitehorse, YT		South End of CBC Tower			
SAMPLE TYPE DISTURBED NO RECOVERY SPT A-CASING SHELBY TUBE CORE					
BACKFILL TYPE BENTONITE PEA GRAVEL SLOUGH GROUT DRILL CUTTINGS SAND					
Depth (m)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	GROUND ICE DESCRIPTION AND COMMENTS	BULK DENSITY (kg/m³) CLAY (%) SILT (%) SAND (%) GRAVEL (%)
					SPT (N) PLASTIC M.C. LIQUID
0	ORGANIC ROOT MATERIAL - seasonally frozen, black and brown SAND - some silt, trace organics, damp below seasonal frost, brown - becomes SAND - trace silt, medium to fine grained, damp, greyish brown SILT - some clay, trace fine sand, damp, firm, medium olive brown		1		1400 1600 1800 2000 20 40 60 80 20 40 60 80 20 40 60 80 20 40 60 80
1			2		
2	- moisture content increasing with depth, becoming softer				
3			3		
4	- sandy, silt lens from 4.1 to 4.3 m		4		
5					
6	END OF BOREHOLE @ 6.0 m		5		
7					
8					
9					
10					



Whistle Bend Subdivision		CLIENT: Associated Engineering		TESTPIT NO: TP16		
Detailed Geotechnical Design		EXCAVATOR: Komatsu Rubber Tired Backhoe		PROJECT: W14101372.002		
Casca & Phases I and II, Whitehorse, YT						
SAMPLE TYPE ☒ DISTURBED ☐ NO RECOVERY ☒ SPT ☐ A-CASING ☐ SHELBY TUBE ☐ CORE						
BACKFILL TYPE ☒ BENTONITE ☐ PEA GRAVEL ☐ SLOUGH ☐ GROUT ☐ DRILL CUTTINGS ☐ SAND						
Depth (m)	SOIL DESCRIPTION	SAMPLE TYPE	GROUND ICE DESCRIPTION AND COMMENTS	☐ BULK DENSITY (kg/m ³) ☐ 1400 1600 1800 2000 ☒ SPT (N) ☐ 20 40 60 80 PLASTIC M.C. LIQUID 20 40 60 80	☒ CLAY (%) ☐ 20 40 60 80 ☐ SILT (%) ☐ 20 40 60 80 ☐ SAND (%) ☐ 20 40 60 80 ☐ GRAVEL (%) ☐ 20 40 60 80	Depth (ft)
0	ORGANIC ROOT MAT - seasonally frozen, black					0
	SAND - some silt to silty to 0.8 m, cleaner with trace of silt from 0.8 m to 1.2 m, seasonally frozen to 0.3 m, medium brown					
1						
	SILT (GLACIOLACUSTRINE) - trace clay, trace fine sand, damp to moist, medium olive					
2	END OF TESTPIT @ 2.0 m					
	NOTE: Testpit excavated at intersection of Casca Blvd (north leg) at the sanitary force main crossing					
3						10

LOGGED BY: MCP

REVIEWED BY: CPC

DRAWING NO:

COMPLETION DEPTH: 2m

COMPLETE: 10/10/18

Page 1 of 1

Whistle Bend Infiltration Testing		CLIENT: Morrison Hershfield Ltd.		TESTPIT NO: TP01					
Whistle Bend Subdivision		EXCAVATOR: Komatsu 420 Rubber Tire Backhoe		PROJECT: W14101545.001					
Whitehorse, YT				ELEVATION: 674 m					
SAMPLE TYPE DISTURBED NO RECOVERY SPT A-CASING SHELBY TUBE CORE									
BACKFILL TYPE BENTONITE PEA GRAVEL SLOUGH GROUT DRILL CUTTINGS SAND									
Depth (m)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	GROUND ICE DESCRIPTION AND COMMENTS	☐ BULK DENSITY (kg/m³) ☐ 1400 1600 1800 2000		☒ CLAY (%) ☒ 20 40 60 80		Elevation (m)
					☒ SPT (N) ☒ 20 40 60 80		☒ SILT (%) ☒ 20 40 60 80		
					PLASTIC M.C. LIQUID 20 40 60 80		☒ SAND (%) ☒ 20 40 60 80 ☒ GRAVEL (%) ☒ 20 40 60 80		
0	ORGANIC COVER			FROZEN TO 0.2 m					674.0
	SILT - some sand, trace clay, non plastic, olive brown, some organic inclusions - becomes dry, firm			UNFROZEN					
	- organics end								
1									673.0
			SA01						
2	- becomes trace clay, trace sand								672.0
3	END OF TESTPIT @ 3.0 m (Machine Extent)								671.0
			SA02						
4									670.0



GEOLOGIC LOG

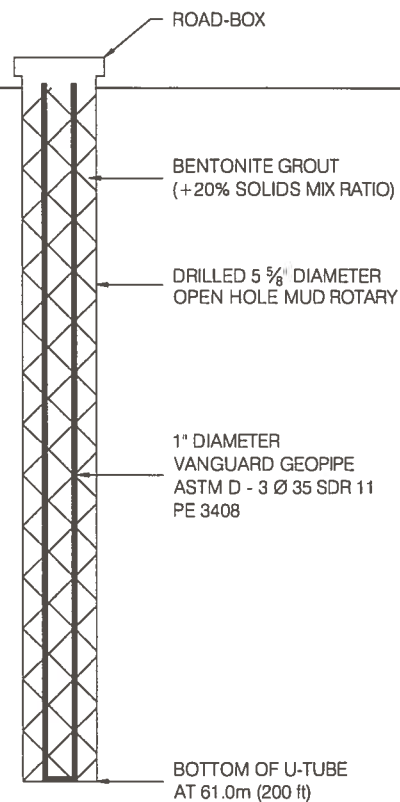
BOREHOLE NO.

BH1-08

PURPOSE OF HOLE: Test Ground Heat Exchanger
 DRILLING METHOD: MUD Rotary
 START DRILLING: August 25, 2008
 FINISH DRILLING: August 27, 2008
 CONTRACTOR: Geotech Drilling Ltd.

LOCATION: See Figure 1
 EASTING: 493688
 NORTHING: 6738267
 ZONE: 8
 GROUND ELEV (m - asl): 675 (approx)

Lithology		Comments	U-Tube Construction Details
Depth (m)			
0m			ROAD-BOX
	SILTY SAND	1.54m (5 ft)	Brown, some gravel
	SILT/CLAY	7.62m (25 ft)	Light grey, no inclusions
10m			
20m			
30m			
40m			
50m			
60m	SILT CLAY	61.0m (200 ft)	Greenish grey, no inclusions
	END OF HOLE		
70m			
80m			



ISSUED FOR
REVIEW

CLIENT



District Heating and Waste Heat Collection Feasibility Study
for the Whistle Bend Development, Whitehorse, Yukon

BH1-08 Borehole Log & U-Tube Construction Details

EBA Engineering
Consultants Ltd.



PROJECT NO.
W23101141.003
OFFICE
EBA-KELOWNA

DWN
LM
CKD
KSJ
REV
-
DATE
January 20, 2009

Figure 2

APPENDIX B

TETRA TECH'S LIMITATIONS ON THE USE OF THIS DOCUMENT

LIMITATIONS ON USE OF THIS DOCUMENT

GEOTECHNICAL – YUKON GOVERNMENT

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").

The Professional Document is intended for the sole use of TETRA TECH's Client (**Yukon Government**) as specifically identified in the TETRA TECH Services Agreement or other Contractual Agreement entered into with the Client (either of which is termed the "Contract" herein). TETRA TECH does not accept any responsibility for the accuracy of any of the data, analyses, recommendations or other contents of the Professional Document when it is used or relied upon by any party other than the Client, unless authorized in writing by TETRA TECH.

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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.

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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 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.