TETRA TECH

April 11, 2017

ISSUED FOR USE
FILE: W14103567-18.004
Via Email: laura.prentice@gov.yk.ca

Government of Yukon
Department of Community Services
Land Development Branch
Box 2703
Whitehorse, YT Y1A 2C6

Attention: Laura Prentice- A/SeniorProject Manager

Subject: Lot Development and Foundation Design Assessment
Whistle Bend Subdivision Phase 3C Design Bulletin, Whitehorse, YT

1.0 INTRODUCTION

Tetra Tech Canada Inc. (Tetra Tech) was retained by the Government of Yukon (YG), Department of Community Services to provide geotechnical recommendations pertaining to foundation design for Phase 3C of the Whistle Bend Subdivision, Whitehorse, YT. This work follows Tetra Tech's proposal dated September 2, 2016.

2.0 SCOPE OF SERVICE

The scope of services includes the following:

- Describing site and soil conditions that may affect surface and subsurface drainage;
- Outlining appropriate methods of controlling surface water flow and disposal;
- Assessing potential for water problems to occur along with the provision of recommendations for prevention and mitigation of drainage problems; and,
- Providing foundation insulation recommendations for use during residential and commercial construction.

Appropriate sections and clauses in CAN/CSA S406-92, NBCC, and City of Whitehorse Servicing Standards Manual specifications shall be referenced.

3.0 PHASE 3C SITE CONDITIONS

3.1 Location and Development To Date

Phase 3C extends south inside the Casca Boulevard right-of-way. It extends south to Leotta Street for the area west of Goodard Way and the eastern boundary is the bio swale that runs north of Keno Way.

Proposed development throughout Phase 3C includes lots for multi-family housing, tri-plex and quad-plex structures; single family dwellings and a public service lot located along the east side of Goodard Way.

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The Phase 3C area is currently undeveloped. Clearing has been completed but stripping and grubbing will be completed in advance of pregrading, deep utility installation and roadway construction throughout 2017.

3.2 Phase 3C General Soil Conditions

Significant thicknesses of medium and/or medium to fine grained sand was noted during the December 2016 and March 2017 testpitting programs throughout the central and western portion of Sybill Circle in Phase 3C.

Shallow glaciolacustrine silt was encountered along the east portion of the site (lots east of Goodard Way and Olive May Way, including the lots on the south side of Sybill Circle next to the bio swale.

The logs for all testholes advanced throughout Phase 3C are attached to this letter report.

3.3 Groundwater

Deep boreholes were drilled in the vicinity of Phase 3C during the final design stages of Phase 1 and 2. Three boreholes (W14101372-BH01 at the water recirculation pump house site on Casca Boulevard; W14101372-BH02 at the sewage lift station site on Keno Way; and W14101500-BH01 which was drilled along the Porter Creek Sewage Lagoon access road (this is on the west side of the Phase 4 area)), were all drilled to a termination depth of 10 m. Groundwater was not noted in the three boreholes and subsequent monitoring or construction has suggested that groundwater should not affect conventional shallow foundation construction.

4.0 SITE GRADING AND DRAINAGE RECOMMENDATIONS

Review of the Associated Engineering Surface Works Pregrading Plan for Phase 3C (Drawing Number 2183-03-C-0004) confirms that once site grading is complete (assuming all fill placed is select sand to ensure non-frost susceptible conditions for foundation construction), the following site conditions will exist:

- Near surface glaciolacustrine silt will be encountered throughout lots 408 to 420 along Olive May Way; lot 538 (institutional) and lot 542 (park) along Goodard Way; and lots 346 (PUL) and single family lots 474 to 482 (possibly lots 483 and 529 as well);
- Much of multi-family lots 533 and 534, as well the entire lot 506 will be underlain by sand; and,
- Single family lots 484 to 528 at the north portion of Phase 3C will be underlain by sand once pregrading has been completed.

After site grading is complete, there will be potential for surface water and roof runoff disposal by infiltration into the surficial sand soils throughout the north and west portions of Phase 3C. However, potential for rock pit construction throughout the lots underlain by shallow glaciolacustrine silt will be minimal to non-existent; therefore, storm and surface water discharge on these lots should be directed over hardscape, onto paved roadways and into the storm sewer/bio swale system.

As well, it is important that all final site grading around commercial and residential structures direct water (roof run-off and surface water) away from the foundation elements to minimize potential for frost heave damage.

5.0 FOUNDATION RECOMMENDATIONS

According to the City of Whitehorse Building Advisory October 25, 2010, *Drainage Standards for Building Foundations*, any new building constructed in Whitehorse with below grade foundations must adhere to prescribed standards for drainage. The relevant standards referenced in the City of Whitehorse document include the following:

- Permanent Wood Foundations, as outlined in CAN/CSA S-406-92, Construction of Preserved Wood Foundations and identified in the 2005 edition of the National Building Code of Canada (NBCC 2005).
- Concrete Foundations, as described in NBCC 2005, Section 9.14, which identifies minimum requirements for foundation drainage, drainage tile and associated piping, granular drainage layers, drainage disposal, and control of surface runoff.

The prescriptive measures are based on CSA and NBC specifications as summarized in the following sections.

5.1 Permanent (Preserved) Wood Foundation Recommendations

If the use of permanent (preserved) wood foundations (PWF) is desired, a granular drainage layer should be installed beneath all footings and basement slabs, in accordance with CAN-CSA S406, because of the impervious glaciolacustrine underlying material. There are areas of free draining and non-free draining material throughout Phase 3C, therefore; there will be opportunity to waive the requirements in this standard as long as there is inspection and proper documentation by a geotechnical consultant qualified to perform visual soil classification.

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. It is common to use bedding stone that is produced to satisfy the City of Whitehorse 25 mm Bedding Stone Specification. However, if alternative granular materials are being considered, testing can confirm suitability for use.

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 site soils can be used as backfill around foundations and in service trenches. All backfill materials should be compacted to at least 95% of Standard Proctor Maximum Dry Density.

5.2 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. As mentioned above, there will be areas of free draining and non-free draining material encountered throughout Phase 3C, therefore; there will be opportunity to waive the requirements in this standard as long as there is inspection and proper documentation by a geotechnical consultant qualified to perform visual soil classification.

Concrete footing and foundation wall systems 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).

6.0 FROST PENETRATION AND FROST HEAVE POTENTIAL

As mentioned above, the underlying glaciolacustrine silt is considered frost-susceptible. If there is less than 2.5 m of non-frost susceptible soil cover protecting the foundation, the following recommendations should be adhered to in order to provide sufficient protection from frost heave damage.

6.1 Foundation Insulation Recommendations

Current local codes now dictate the use of insulation around all foundations. However, the insulation thickness and distance out from the foundation elements are often considered to be insufficient when dealing with fine grained soils. Tetra Tech recommends insulating foundations constructed on frost susceptible soils to mitigate potential for seasonal frost-heave damage.

Typical insulation recommendations are shown on Figure 2, attached. Two foundation scenarios are presented including strip footings to support residential structures and a pad and pedestal configuration for foundations supporting entrance overhangs or rear decks.

It should be noted that the designs presented in Figure 2 is based on a foundation depth of 1.2 m. If different footing burial depths are being considered, Tetra Tech should be contacted to revise their insulation recommendations accordingly.

6.2 Foundation Construction On Frost Susceptible Soils

For frost heave to occur, three elements must be present, including:

- Cold temperatures that result in foundation soils that are below freezing;
- Frost susceptible soils such as the glaciolacustrine silts that have been noted throughout Phases 3D and 3E; and,
- Soil moisture contents that are high enough to support the formation of ice lenses.

Since it is impossible to control winter temperatures and it isn't practical to sub-excavate 2.5 m of fine grained soil under most structures, the soil moisture content becomes the single element that can be controlled by ensuring adequate perimeter insulation and control of surface water and roof runoff away from all foundation elements.

During foundation construction, it is critical that footings not be constructed on or over frozen ground and once the foundation is constructed, the underlying frost susceptible soils must be protected and not allowed to freeze.

7.0 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. Tetra Tech's General Conditions are provided in Appendix A of this report.

8.0 CLOSURE

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

Respectively Submitted,
Tetra Tech Canada Inc.

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Attachments: Figure 1 – 3C: Site Plan Showing Existing Borehole and Testpit Locations
Figure 2: Foundation Insulation Details
Appendix A: Testhole Logs Specific To Phase 3C
Appendix B: Tetra Tech's General Conditions

FIGURES

W14101372-TP17
545 (GREENBELT)
W14101171-BH13
W14101372-BH01
W14101500-BH02
TP15
TP11
TP14
TP13
TP10
TP12
W14101372-TP16
546 (GREENBELT)
534
533
347 (PUL)
348 (PUL)
542 (PARK)
TP08
TP09
547 (GREENBELT)
W14101372-TP03
200 (GREENBELT)
PHASE 3C LIMITS
538 (INSTITUTIONAL)
544 (GREENBELT)
GREENBELT
W14101372-TP18
W14101372-TP19
TP07
W14101171-BH14
355 (PUL)
W14101171-BH15
548 (GREENBELT)
201 (Greenbelt)
W14101545.001-TP02
CASCA BOULEVARD
TP06
539 (PARKING)
535 (PUL)
540 (PARKING)
TP05
TP04
W14101545.001-TP03
W14101372-BH02
TP01
541 (PARK)
W14101372-TP12
W14101372-TP20
KENO WAY
TP03
TP02
W14101372-TP15
W14103526-TP03
LOT 413 (GREENBELT)
W14101171-BH11

LEGEND

- BOREHOLE LOCATION
- MONITORING WELL LOCATION
- HISTORICAL TESTPIT LOCATION
- TESTPIT LOCATION (DECEMBER 2016 TO MARCH 2017)

0 50m

Scale: 1:1,250 @ 22"x34"

CLIENT

Yukon Government

PHASE 3C GEOTECHNICAL EVALUATION
WHISTLE BEND - WHITEHORSE, YUKON

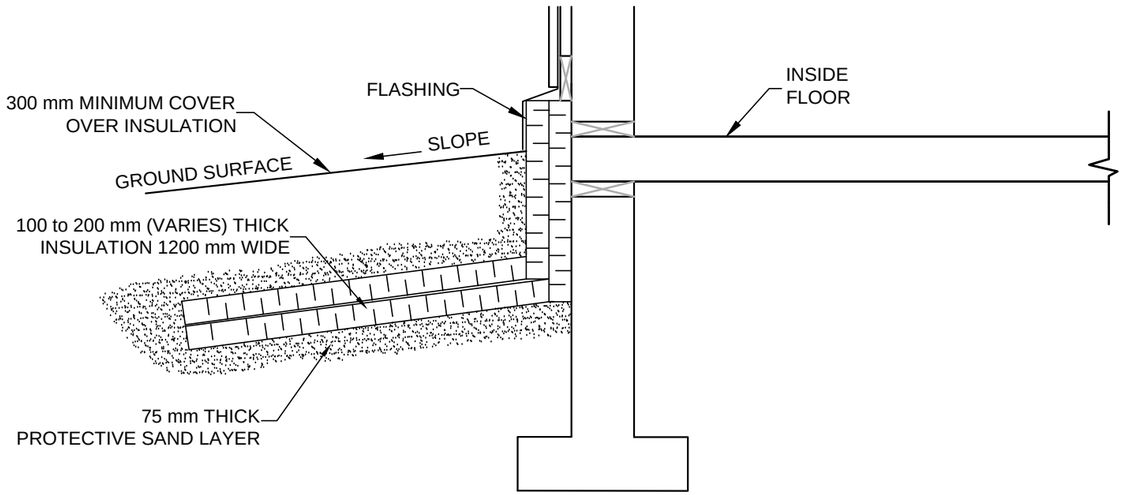
SITE PLAN SHOWING
BOREHOLE AND TESTPIT LOCATIONS

TETRA TECH

PROJECT NO.	DWN	CKD	REV
W14103567-18.004	CB	MCP	0

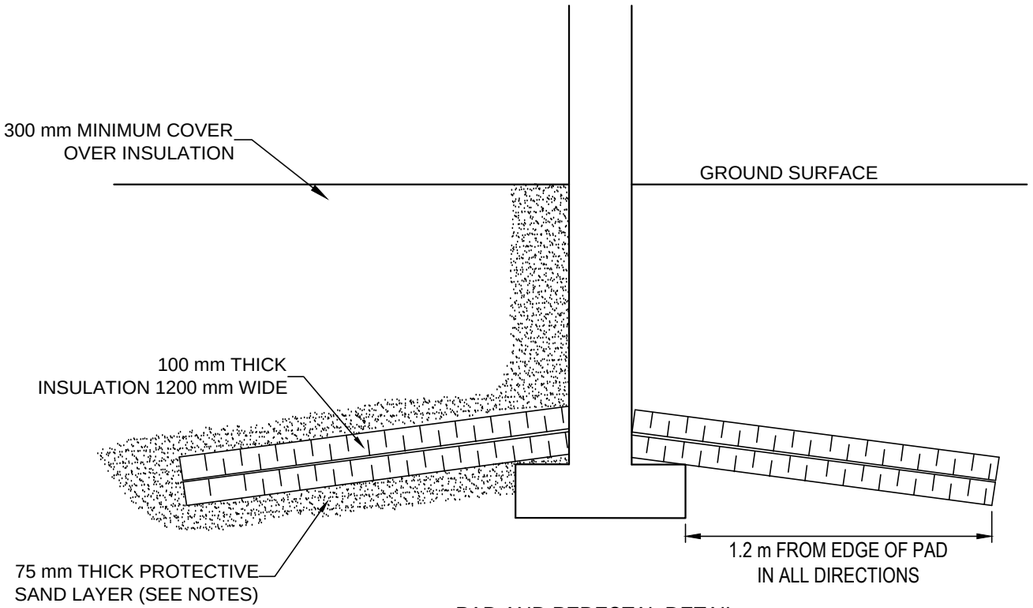
OFFICE	DATE
EBA-WHSE	March 17, 2017

Figure 1 - 3C



SECTION - STRIP FOOTING

N.T.S.



PAD AND PEDESTAL DETAIL

N.T.S.

PLAN

N.T.S.

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

Yukon Government

TETRA TECH

PHASE 3 GEOTECHNICAL EVALUATION
WHISTLE BEND - WHITEHORSE, YUKON

FOUNDATION INSULATION DETAILS

PROJECT NO.	DWN	CKD	REV
W14103567-18.004	CB	MCP	0

OFFICE	DATE
EBA-WHSE	January 25, 2016

Figure 2

APPENDIX A
PHASE 3C TESTHOLE LOGS

TERMS USED ON BOREHOLE LOGS

TERMS DESCRIBING CONSISTENCY OR CONDITION

COARSE GRAINED SOILS (major portion retained on 0.075mm sieve): Includes (1) clean gravels and sands, and (2) silty or clayey gravels and sands. Condition is rated according to relative density, as inferred from laboratory or in situ tests.

DESCRIPTIVE TERM	RELATIVE DENSITY	N (blows per 0.3m)
Very Loose	0 TO 20%	0 to 4
Loose	20 TO 40%	4 to 10
Compact	40 TO 75%	10 to 30
Dense	75 TO 90%	30 to 50
Very Dense	90 TO 100%	greater than 50

The number of blows, N, on a 51mm O.D. split spoon sampler of a 63.5kg weight falling 0.76m, required to drive the sampler a distance of 0.3m from 0.15m to 0.45m.

FINE GRAINED SOILS (major portion passing 0.075mm sieve): Includes (1) inorganic and organic silts and clays, (2) gravelly, sandy, or silty clays, and (3) clayey silts. Consistency is rated according to shearing strength, as estimated from laboratory or in situ tests.

DESCRIPTIVE TERM	UNCONFINED COMPRESSIVE STRENGTH (KPA)
Very Soft	Less than 25
Soft	25 to 50
Firm	50 to 100
Stiff	100 to 200
Very Stiff	200 to 400
Hard	Greater than 400

NOTE: Slickensided and fissured clays may have lower unconfined compressive strengths than shown above, because of planes of weakness or cracks in the soil.

GENERAL DESCRIPTIVE TERMS

Slickensided - having inclined planes of weakness that are slick and glossy in appearance.
Fissured - containing shrinkage cracks, frequently filled with fine sand or silt; usually more or less vertical.
Laminated - composed of thin layers of varying colour and texture.
Interbedded - composed of alternate layers of different soil types.
Calcareous - containing appreciable quantities of calcium carbonate.;
Well graded - having wide range in grain sizes and substantial amounts of intermediate particle sizes.
Poorly graded - predominantly of one grain size, or having a range of sizes with some intermediate size missing.

MODIFIED UNIFIED SOIL CLASSIFICATION

MAJOR DIVISION			GROUP SYMBOL	TYPICAL DESCRIPTION
COARSE - GRAINED SOILS More than 50% retained on No. 75 µm sieve*	GRAVELS 50% or more of coarse fraction retained on No. 4 sieve	CLEAN GRAVELS	GW	Well-graded gravels and gravel-sand mixtures, little or no fines
			GP	Poorly-graded gravels and gravel-sand mixtures, little or no fines
		GRAVELS WITH FINES	GM	Silty gravels, gravel-sand-silt mixtures
			GC	Clayey gravels, gravel-sand-clay mixtures
	SANDS More than 50% of coarse fraction passes No. 4 sieve	CLEAN SANDS	SW	Well-graded sands and gravelly sands, little or no fines
			SP	Poorly-graded sands and gravelly sands, little or no fines
		SANDS WITH FINES	SM	Silty sands, sand-silt mixtures
			SC	Clayey sands, sand-clay mixtures
FINE-GRAINED SOILS (by behavior) 50% or more passes 75 µm sieve*	SILTS	Liquid limit <50	ML	Inorganic silts, very fine sands, rock flour, silty or clayey fine sands of slight plasticity
		Liquid limit >50	MH	Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts
	CLAYS Above "A" line on plasticity chart negligible organic content	Liquid limit <30	CL	Inorganic clays of low plasticity, gravelly clays, sandy clays, silty clays, lean clays
		Liquid limit 30-50	CI	Inorganic clay of medium plasticity, silty clays
		Liquid limit >50	CH	Inorganic clay of high plasticity, fat clays
	ORGANIC SILTS AND CLAYS	Liquid limit <50	OL	Organic silts and organic silty clays of low plasticity
		Liquid limit >50	OH	Organic clays of medium to high plasticity
HIGHLY ORGANIC SOILS			PT	Peat, muck and other highly organic soils

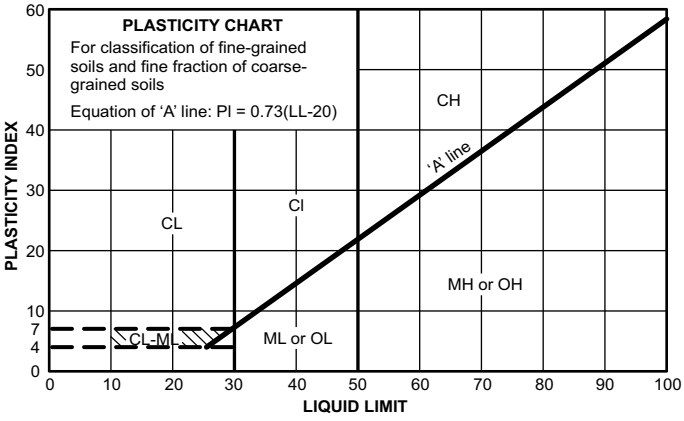
LABORATORY CLASSIFICATION CRITERIA

Classification on basis of percentage of fines
GW, GP, SW, SP
GM, GC, SM, SC
Borderline classification requiring use of dual symbols

$C_U = D_{60} / D_{10}$ Greater than 4 $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3	
Not meeting both criteria for GW	
Atterberg limits plot below 'A' line or plasticity index less than 4	Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols
Atterberg limits plot above 'A' line and plasticity index greater than 7	

Less than 5% pass 75 µm sieve
More than 12% pass 75 µm sieve
5% to 12% pass 75 µm sieve

$C_U = D_{60} / D_{10}$ Greater than 6 $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3	
Not meeting both criteria for SW	
Atterberg limits plot above 'A' line and plasticity index less than 4	Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols
Atterberg limits plot above 'A' line and plasticity index greater than 7	



* Based on the material passing the 75 mm sieve

† ASTM Designation D 2487, for identification procedure see D 2488 USC as modified by PFRA

GROUND ICE DESCRIPTION

ICE NOT VISIBLE

GROUP SYMBOL	SYMBOL	SUBGROUP DESCRIPTION	
N	Nf	Poorly-bonded or friable	
	Nbn	No excess ice, well-bonded	
	Nbe	Excess ice, well-bonded	

VISIBLE ICE LESS THAN 50% BY VOLUME

GROUP SYMBOL	SYMBOL	SUBGROUP DESCRIPTION	
V	Vx	Individual ice crystals or inclusions	
	Vc	Ice coatings on particles	
	Vr	Random or irregularly oriented ice formations	
	Vs	Stratified or distinctly oriented ice formations	

VISIBLE ICE GREATER THAN 50% BY VOLUME

ICE	ICE + Soil Type	Ice with soil inclusions	
	ICE	Ice without soil inclusions (greater than 25 mm thick	

NOTES:

1. Dual symbols are used to indicate borderline or mixed ice classifications.
2. Visual estimates of ice contents indicated on borehole logs ± 5%
3. This system of ground ice description has been modified from NRC Technical Memo 79, Guide to the Field Description of Permafrost for Engineering Purposes.

LEGEND: Soil ☐ Ice ■

Government of Yukon - Community Services

Testpit No: **TP04**

Project: Geotechnical Evaluation Services	Project No: W14103567-18.004
Location: Whistle Bend Subdivision - Phase 3	Ground Elev: 676.5 m
Whitehorse, Yukon	UTM: 494362 E; 6738086 N; Z 8

Depth (m)	Method	Soil Description	Ground Ice Description	Moisture Content (%)	Plastic Limit / Moisture Content / Liquid Limit (20 40 60 80)	Elevation (m)
0	Excavated	ORGANICS - black, (150 mm thick)	Seasonally frozen			676
		SILT (GLACIOLACUSTRINE) - trace to some clay, olive brown				
1		- moist	Unfrozen			675
		END OF TESTPIT (1.5 metres)				
2						674
3						

TETRA TECH

Contractor: Arctic Backhoe Services	Completion Depth: 1.5 m
Drilling Rig Type: CAT Rubber Tired Backhoe	Start Date: 2016 December 05
Logged By: MCP	Completion Date: 2016 December 05
Reviewed By: CPC	Page 1 of 1

Government of Yukon - Community Services

Testpit No: **TP09**

Project: Geotechnical Evaluation Services	Project No: W14103567-18.004
Location: Whistle Bend Subdivision - Phase 3	Ground Elev: 677 m
Whitehorse, Yukon	UTM: 494255 E; 6738305 N; Z 8

Depth (m)	Method	Soil Description	Ground Ice Description	Moisture Content (%)	Plastic Limit / Moisture Content / Liquid Limit (20 40 60 80)	Elevation (m)
0	Excavated	ORGANICS - thin veneer left after stripping, black, (50 mm thick)	Seasonally frozen			677
		SILT (GLACIOLACUSTRINE) - trace to some clay, olive brown				
		- moist	Unfrozen			
1						676
		END OF TESTPIT (1.5 metres)				
2						675
3						674

TETRA TECH

Contractor: Arctic Backhoe Services	Completion Depth: 1.5 m
Drilling Rig Type: CAT Rubber Tired Backhoe	Start Date: 2016 December 05
Logged By: MCP	Completion Date: 2016 December 05
Reviewed By: CPC	Page 1 of 1

Government of Yukon - Community Services

Testpit No: **TP10**

Project: Geotechnical Evaluation Services	Project No: W14103567-18.004
Location: Whistle Bend Subdivision - Phase 3	Ground Elev: 677.5 m
Whitehorse, Yukon	UTM: 494105 E; 6738422 N; Z 8

Depth (m)	Method	Soil Description	Ground Ice Description	Moisture Content (%)	Plastic Limit / Moisture Content / Liquid Limit (20 40 60 80)	Elevation (m)
0	Excavated	ORGANICS - thin veneer left after stripping, black, (50 mm thick)	Seasonally frozen			677
		SILT - sandy, uniformly graded, brown, fine sand				
		SAND - some silt, becoming trace silt with depth, damp, brown, fine to medium sand	Unfrozen			
1						676
2						675
3						

TETRA TECH

Contractor: Arctic Backhoe Services	Completion Depth: 3 m
Drilling Rig Type: CAT Rubber Tired Backhoe	Start Date: 2016 December 05
Logged By: MCP	Completion Date: 2016 December 05
Reviewed By: CPC	Page 1 of 2

Government of Yukon - Community Services

Testpit No: **TP11**

Project: Geotechnical Evaluation Services	Project No: W14103567-18.004
Location: Whistle Bend Subdivision - Phase 3	Ground Elev: 679 m
Whitehorse, Yukon	UTM: 474273 E; 6738470 N; Z 8

Depth (m)	Method	Soil Description	Ground Ice Description	Moisture Content (%)	Plastic Limit / Moisture Content / Liquid Limit (20 40 60 80)	Elevation (m)
0						679
	Excavated	SAND - silty, uniformly graded, brown, fine sand	Seasonally frozen			
		- trace to some silt, damp	Unfrozen			
1						678
2						677
		END OF TESTPIT (2.5 metres)				
3						676

TETRA TECH

Contractor: Arctic Backhoe Services	Completion Depth: 2.5 m
Drilling Rig Type: CAT Rubber Tired Backhoe	Start Date: 2016 December 05
Logged By: MCP	Completion Date: 2016 December 05
Reviewed By: CPC	Page 1 of 1

Government of Yukon - Community Services

Testpit No: **TP12**

Project: Geotechnical Evaluation Services	Project No: W14103567-18.004
Location: Whistle Bend Subdivision - Phase 3	Ground Elev: 678.5 m
Whitehorse, Yukon	UTM: 494366 E; 6738379 N; Z 8

Depth (m)	Method	Soil Description	Ground Ice Description	Moisture Content (%)	Plastic Limit / Moisture Content / Liquid Limit (20 40 60 80)	Elevation (m)
0		ORGANICS - thin veneer left after stripping, black, (50 mm thick)	Seasonally frozen			678
		SAND - some silt to silty, brown, fine sand				
		- damp	Unfrozen			
1	Excavated	- cleaner, fine to medium sand				677
2						
		END OF TESTPIT (2.5 metres)				676
3						

TETRA TECH

Contractor: Arctic Backhoe Services	Completion Depth: 2.5 m
Drilling Rig Type: CAT Rubber Tired Backhoe	Start Date: 2016 December 05
Logged By: MCP	Completion Date: 2016 December 05
Reviewed By: CPC	Page 1 of 1

Government of Yukon - Community Services

Testpit No: **TP13**

Project: Geotechnical Evaluation Services	Project No: W14103567-18.004
Location: Whistle Bend Subdivision - Phase 3C	Ground Elev: 680 m
Whitehorse, Yukon	UTM: 494310 E; 6738435 N; Z 8

Depth (m)	Method	Soil Description	Ground Ice Description	Moisture Content (%)	Plastic Limit / Moisture Content / Liquid Limit (20 40 60 80)	Elevation (m)
0		SAND - some silt to silty, uniformly graded, light brown, fine sand	Seasonally frozen			680
1		- trace of silt				679
2	Excavator	- sloughing badly below 2.00 metres	Unfrozen			678
3						677
4						676
		SILT (GLACIOLACUSTRINE) - trace to some clay, moist, olive brown				
5		END OF TESTPIT (5.00 metres)				675
6						674
7						673
7.5						

TETRA TECH

Contractor: Castle Rock Ent.	Completion Depth: 5 m
Drilling Rig Type: Linkbelt 330 Tracked	Start Date: 2017 March 15
Logged By: MCP	Completion Date: 2017 March 15
Reviewed By: CPC	Page 1 of 1

Government of Yukon - Community Services

Testpit No: **TP14**

Project: Geotechnical Evaluation Services	Project No: W14103567-18.004
Location: Whistle Bend Subdivision - Phase 3C	Ground Elev: 677.5 m
Whitehorse, Yukon	UTM: 494420 E; 6738450 N; Z 8

Depth (m)	Method	Soil Description	Ground Ice Description	Moisture Content (%)	Plastic Limit / Moisture Content / Liquid Limit (20 40 60 80)	Elevation (m)
0	Excavator	SAND - some silt to silty, uniformly graded, light brown, fine sand	Seasonally frozen			677
1		SILT (GLACIOLACUSTRINE) - trace to some clay, olive brown				
		END OF TESTPIT (1.20 metres)				676
2						675
3						674
4						673
5						672
6						671
7						670
7.5						

TETRA TECH

Contractor: Castle Rock Ent.	Completion Depth: 1.2 m
Drilling Rig Type: Linkbelt 330 Tracked	Start Date: 2017 March 15
Logged By: MCP	Completion Date: 2017 March 15
Reviewed By: CPC	Page 1 of 1

Government of Yukon - Community Services

Testpit No: **TP15**

Project: Geotechnical Evaluation Services	Project No: W14103567-18.004
Location: Whistle Bend Subdivision - Phase 3C	
Whitehorse, Yukon	UTM: 494180 E; 6738510 N; Z 8

Depth (m)	Method	Soil Description	Ground Ice Description	Moisture Content (%)	Plastic Limit / Moisture Content / Liquid Limit (20 40 60 80)	Depth (ft)
0		SAND - some silt to silty, uniformly graded, light brown, fine sand	Seasonally frozen			0
		- cleaner, medium brown, medium sand				1
1						2
						3
						4
						5
						6
2	Excavator	- sloughing badly below 2.00 metres	Unfrozen			7
						8
						9
3						10
						11
		SILT (GLACIOLACUSTRINE) - trace to some clay, moist, olive brown				12
						13
4		END OF TESTPIT (4.00 metres)				14
						15
						16
5						17
						18
						19
6						20
						21
						22
7						23
7.5						24

TETRA TECH

Contractor: Castle Rock Ent.	Completion Depth: 4 m
Drilling Rig Type: Linkbelt 330 Tracked	Start Date: 2017 March 15
Logged By: MCP	Completion Date: 2017 March 15
Reviewed By: CPC	Page 1 of 1

Geotechnical Evaluation	AECOM	BOREHOLE NO: BH13
Whistle Bend Subdivision	Drilling Method: NODWELL Mounted CME 75	PROJECT: W14101171
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	SAMPLE NUMBER	GROUND ICE DESCRIPTION AND COMMENTS	BULK DENSITY (kg/m³) 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 MATERIAL - seasonally frozen, brown and black						0
	SAND - silty, trace organics at upper interface, fine grained, uniform, damp below seasonal frost, medium brown		1		●		
	- sand becomes slightly coarser, trace silt, dry to damp, medium greyish brown						
1			2		●	● ▲	5
	- trace to some gravel from 1.5 to 2.5 m						
2							
	SILT - some clay, trace fine sand, damp, firm, light olive		3		●		
3	- moisture content increases with depth, firm, becomes dark olive						10
4			4		●		15
5	- easy drilling throughout depth of borehole						
			5		●		
6	END OF BOREHOLE @ 6.0 m						20
7							25
8							
9							30
10							33

TETRA TECH EBA

LOGGED BY: MCP	COMPLETION DEPTH: 6m
REVIEWED BY:	COMPLETE: 08/12/10
DRAWING NO:	Page 1 of 1

Whistle Bend Subdivision	CLIENT: Associated Engineering	BOREHOLE NO: BH01
Detailed Geotechnical Design	DRILL: Nodwell Mounted CME 75	PROJECT: W14101372.002
Pumphouse, 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	SAMPLE NUMBER	SPT (N)	GROUND ICE DESCRIPTION AND COMMENTS	Depth (ft)
0	TEA GROUND COVER and ORGANIC ROOT MAT - damp, medium brown		SA01			0
	SAND - silty, fine grained, uniform, damp, loose, medium brown					
1	SILT - some fine sand, trace clay, damp, stiff, light olive					5
	- smooth drilling		SA02	19		
2						
3	- thin lens of moist soil @ 3.0 m		SA03	18		10
4						
5			SA04	15		15
	- moisture content increases below 5.5 m, firm, darker olive in colour					
6			SA05	10		20
	END OF BOREHOLE @ 6.5 m					
7						25
8						
9						30
10						
11						35
12						39

BULK DENSITY (kg/m³) 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

TETRA TECH EBA

LOGGED BY: MCP	COMPLETION DEPTH: 6.5m
REVIEWED BY: CPC	COMPLETE: 10/07/19
DRAWING NO:	Page 1 of 1

Whistle Bend Subdivision	CLIENT: Associated Engineering	BOREHOLE NO: BH02
Detailed Geotechnical Design	DRILL: Nodwell Mounted CME 75	PROJECT: W14101372.002
Sanitary Lift Station, 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	SAMPLE NUMBER	SPT (N)	GROUND ICE DESCRIPTION AND COMMENTS	BULK DENSITY (kg/m³) 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	TEA GROUND COVER and ORGANICS - damp, black							0
	SILT - trace clay, trace fine sand, damp, firm to dense, light to medium olive by 2.7 m with slight increase in moisture content		SA06					
1								5
2			SA07	13				
3			SA08	14				10
4	- very moist by 4.5 m, becoming wet with depth							
5			SA09	9				15
6	- last 150 mm of 6.0-6.5 m SPT is wet, soft and dark grey		SA10	7				20
7								
8	- very soft, increased clay content and plasticity		SA11	3				25
9			SA12	4				30
10								
11	- colder with depth, maybe close to 0°C @ 10.5 m		SA13	3				35
	END OF BOREHOLE @ 11.0 m							
12								39

TETRA TECH EBA

LOGGED BY: MCP	COMPLETION DEPTH: 11m
REVIEWED BY: CPC	COMPLETE: 10/07/19
DRAWING NO:	Page 1 of 1

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/m³) 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					5
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

TETRA TECH EBA

LOGGED BY: MCP	COMPLETION DEPTH: 2m
REVIEWED BY: CPC	COMPLETE: 10/10/18
DRAWING NO:	Page 1 of 1

Whistle Bend Subdivision	CLIENT: Associated Engineering	TESTPIT NO: TP17
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/m³) 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 - silty to some silt to 0.5 m, becomes cleaner with trace silt below 0.5 m, damp, medium to dark brown at 0.5 m					
1						
						5
	SILT (GLACIOLACUSTRINE) - trace clay, trace fine sand, damp to moist, medium olive					
2	END OF TESTPIT @ 2.0 m NOTE: Testpit excavated near north end of Casca Blvd					
3						10

TETRA TECH EBA

LOGGED BY: MCP	COMPLETION DEPTH: 2m
REVIEWED BY: CPC	COMPLETE: 10/10/18
DRAWING NO:	Page 1 of 1

APPENDIX B
TETRA TECH'S GENERAL CONDITIONS

GENERAL CONDITIONS

GEOTECHNICAL REPORT – YUKON GOVERNMENT

This report incorporates and is subject to these “General Conditions”.

1.1 USE OF REPORT AND OWNERSHIP

This geotechnical report pertains to a specific site, a specific development and a specific scope of work. It is not applicable to any other sites nor should it be relied upon for types of development other than that to which it refers. Any variation from the site or development would necessitate a supplementary geotechnical assessment.

This report and the recommendations contained in it are intended for the sole use of TETRA TECH’s Client, the Yukon Government. TETRA TECH does not accept any responsibility for the accuracy of any of the data, the analyses or the recommendations contained or referenced in the report when the report is used or relied upon by any party other than TETRA TECH’s Client unless otherwise authorized in writing by TETRA TECH. Any unauthorized use of the report is at the sole risk of the user.

1.2 ALTERNATE REPORT FORMAT

Where TETRA TECH submits both electronic file and hard copy versions of reports, drawings and 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 and legally binding. The original signed and/or sealed version archived by TETRA TECH shall be deemed to be the original for the Project.

Both electronic file and hard copy versions of TETRA TECH’s instruments of professional service shall not, under any circumstances, no matter who owns or uses them, 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 ENVIRONMENTAL AND REGULATORY ISSUES

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

1.4 NATURE AND EXACTNESS OF SOIL AND ROCK DESCRIPTIONS

Classification and identification of soils and rocks are based upon commonly accepted systems and methods 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.

1.5 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.

1.6 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 historic 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 investigation and review may be necessary.

1.7 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.

1.8 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.

1.9 INFLUENCE OF CONSTRUCTION ACTIVITY

There is a direct correlation between construction activity and 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 are known.

1.10 OBSERVATIONS DURING CONSTRUCTION

Because of the nature of geological deposits, the judgmental nature of geotechnical engineering, as well as 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.

1.11 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 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.

1.12 BEARING CAPACITY

Design bearing capacities, loads and allowable stresses 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 assumed. Sufficient observations should be made by qualified geotechnical personnel during construction to assure that the soil and/or rock conditions assumed in this report in fact exist at the site.

1.13 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.

1.14 INFORMATION PROVIDED TO TETRA TECH BY OTHERS

During the performance of the work and the preparation of the report, TETRA TECH may rely on information provided by persons other than the Client. While TETRA TECH endeavours to verify the accuracy of such information when instructed to do so by the Client, TETRA TECH accepts no responsibility for the accuracy or the reliability of such information which may affect the report.