

March 30, 2017

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

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

Attention: Laura Prentice- A/SeniorProject Manager

Subject: Lot Development and Foundation Design Assessment
Whistle Bend Subdivision Phase 3D & 3E 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 3D and 3E 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 in order to minimize potential for damage caused by seasonal frost heave.

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

3.0 PHASE 3D AND 3E SITE CONDITIONS

3.1 Location and Development To Date

Phases 3D surrounds Olive May Way south of Leota Street and west of Goddard Way. Phase 3E runs along the Keno Way corridor between Olive May Way and Casca Boulevard (refer to Figure 1 – 3D & 3E, attached).

Proposed development in 3D includes multi-family housing throughout the entire phase, while proposed development in 3E will be commercial with a large centrally located public service lot located northwest of the Continuing Care Facility.

The area where these two phases are located are currently undeveloped but have been previously utilized for the following:

- During predesign, this area was investigated as a potential non-frost-susceptible borrow area. Throughout the highest point of the aeolian feature (drumlin) 8.7 m of sand was noted overlying glaciolacustrine silt (refer to Borehole log W14101171-BH15, attached). This material was subsequently used for pregrading and subgrade construction during Phases 1 & 2 construction;
- Also during Phases 1 & 2 construction, significant stockpiles of organic and fine-grained soils were created in the area located directly north of the Continuing Care Facility site;
- The establishment of a large lay-down area to support subsequent phases of construction (currently being utilized by Castle Rock Enterprises for pipe and equipment storage) was constructed; and
- Most recently, the area was utilized by Norcope Enterprises for stockpiling sub-cut material from the Continuing Care Facility foundation excavation.

3.2 General Soil Conditions

3.2.1 Phase 3D

Soil conditions throughout much of Phase 3D (the eastern portion of the area, including lots 436 to 438 along the south side of Olive May Way and much of lots 430 to 433 are underlain by shallow, frost susceptible, glaciolacustrine silt soils. Medium to fine grained sand can be expected on either side of Mascot Street on lots 434 and 435 where current testpits encountered between 2.0 m (testpit TP07) and 1.4 m (testpit TP08) of sand. The transition appears to be in the vicinity where Olive May Way begins heading in a northerly direction. (refer to the attached log for testpit TP06). However, the Associated Engineering Surface Works Site Grading Plan (Drawing Number 2183-03-C-4302) suggests that much of the sand in this area will be removed during site grading.

3.2.2 Phase 3E

Soil conditions throughout the Keno Way corridor in Phase 3E (between Olive May Way and west to Casca Boulevard) will be predominantly frost susceptible glaciolacustrine silt (there may be some pockets of fill encountered throughout). Throughout the west end of Phase 3E (in the vicinity of lots 456 to 459 where testpit TP03 was excavated), sand was encountered between 0.4 and 1.6 m. The Associated Engineering Surface Works Site Grading Plan (Drawing Number 2183-03-C-4303) suggests that fill will be placed in this area during site grading.

3.3 Groundwater

Detailed geotechnical evaluations were completed for the Continuing Care Facility (initial work by Tetra Tech including a borehole drilling program and a Cone Penetration Testing (CPT) program. CPT testing is a very useful method of delineating discrete lenses of varying fine-grained soil types, assessing potentially liquefiable soils and can predict possible seepage zones. CPT results of this testing suggested that seepage may occur at a depth of around 4.5 m, however; groundwater monitoring wells installed below 4.5 m were dry during the monitoring period in advance of construction. Based on this information, groundwater is not expected to be encountered during the construction of conventional shallow foundation systems in Phases 3D and 3E.

4.0 SITE GRADING AND DRAINAGE RECOMMENDATIONS

Review of the Surface Works Overland Drainage Plan (Drawing Number 2183-03-C-4301) prepared by Associated Engineering confirms that site grading will ensure positive drainage throughout Phases 3D and 3E. For Phase 3D,

surface water will be collected along Olive May Way, Goddard Way, Leota Street, Mascot Street and Casca Boulevard and directed towards the bio swale located east of Sybil Circle. For Phase 3E, the path is much more direct, travelling east along Keno Way to the bio swale located adjacent to the north end of Phase 3A.

After site grading is complete, there will be minimal potential for surface water and roof runoff disposal by infiltration into any remaining surficial sand soils. Therefore, rock pits constructed on individual lots for storm water management will not likely be feasible. Discharge over hardscape, onto paved roadways and into the storm sewer system should be considered to direct flow towards the bio swale system.

As well, final site grading around all commercial and residential structures must direct water (roof run-off and surface water) away from the foundation elements to minimize potential for seasonal 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. After site grading is complete, there will not likely be areas of free draining material encountered throughout Phases 3D and 3E, therefore; there will not be opportunity to waive the requirements in this standard.

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 moisture conditioned and 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 not likely be areas of free draining material encountered throughout Phase 3D and 3E, therefore; there will not be opportunity to waive the requirements in this standard.

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 the following recommendations are adhered to, perimeter foundation insulation should 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.

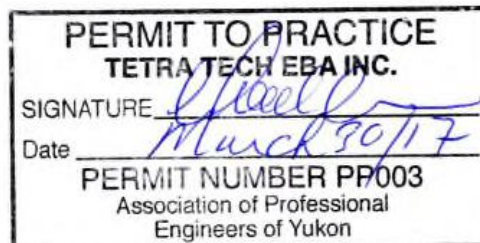
Respectively Submitted,
Tetra Tech Canada Inc.

Myles Plaunt, CET
Senior Engineering Technologist, Arctic Region
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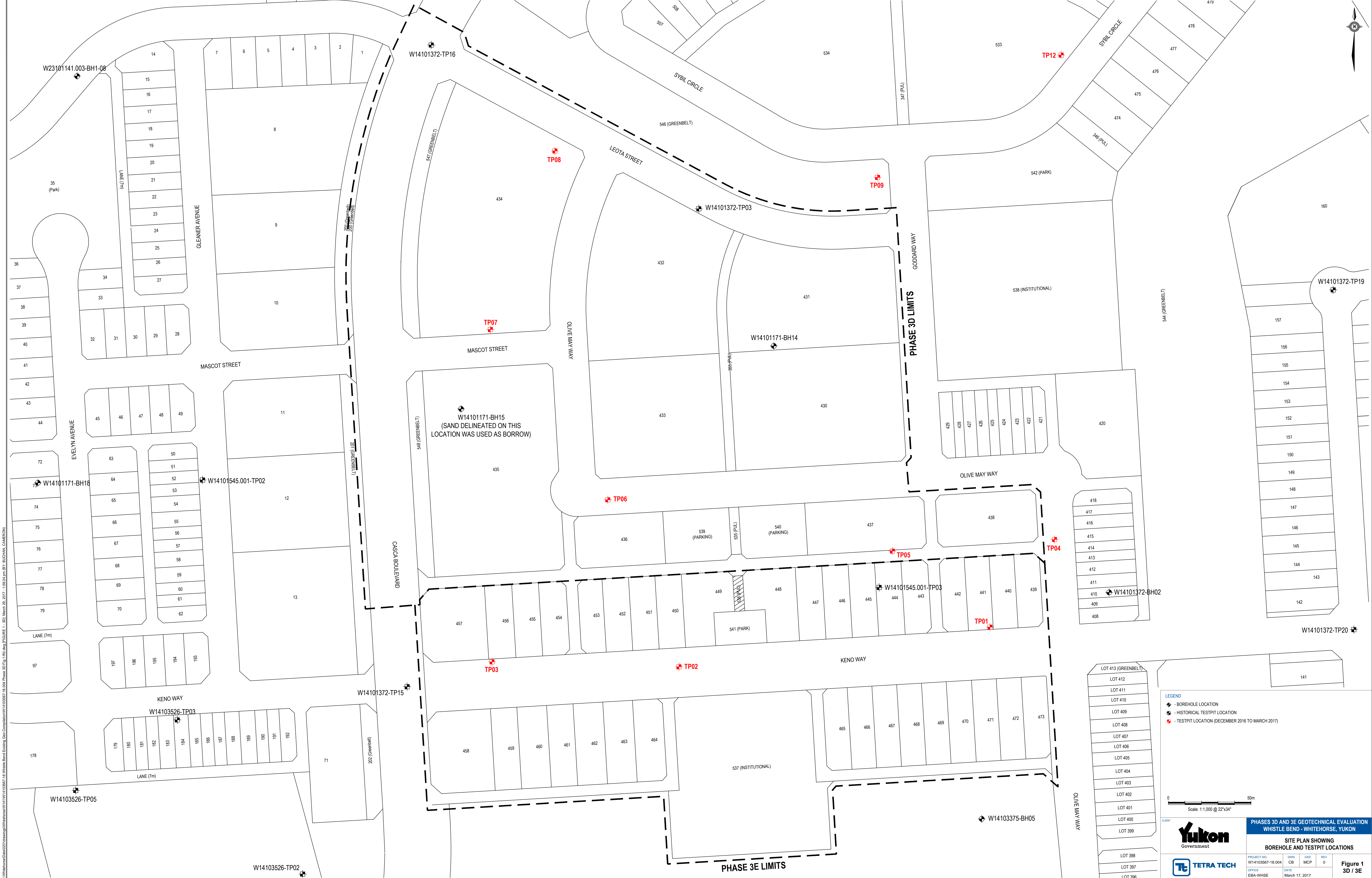
Chad Cowan, P.Eng.
Geotechnical Manager – Yukon, Arctic Region
Direct Line: 867.668.9214
Chad.Cowan@tetrattech.com

- Attachments: Figure 1 – 3D & 3E: Site Plan Showing Existing Borehole and Testpit Locations
Figure 2: Foundation Insulation Details
Appendix A: Borehole Logs Specific to Phases 3D and 3E
Appendix B: Tetra Tech's General Conditions



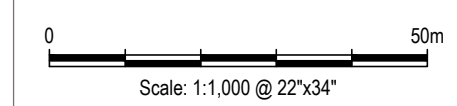
FIGURES

-
- Figure 1 Site Plan Showing Phase 3D and Phase 3E Borehole and Testpit Locations
Figure 2 Foundation Insulation Details



C:\Whitehorse\Borehole\2017\Drawings\Whiteseal\W14103526-TP02.dwg [FIGURE 1 - 3D] March 29, 2017 - 1:59:24 pm (BY: BUCHAN, CAMERON)

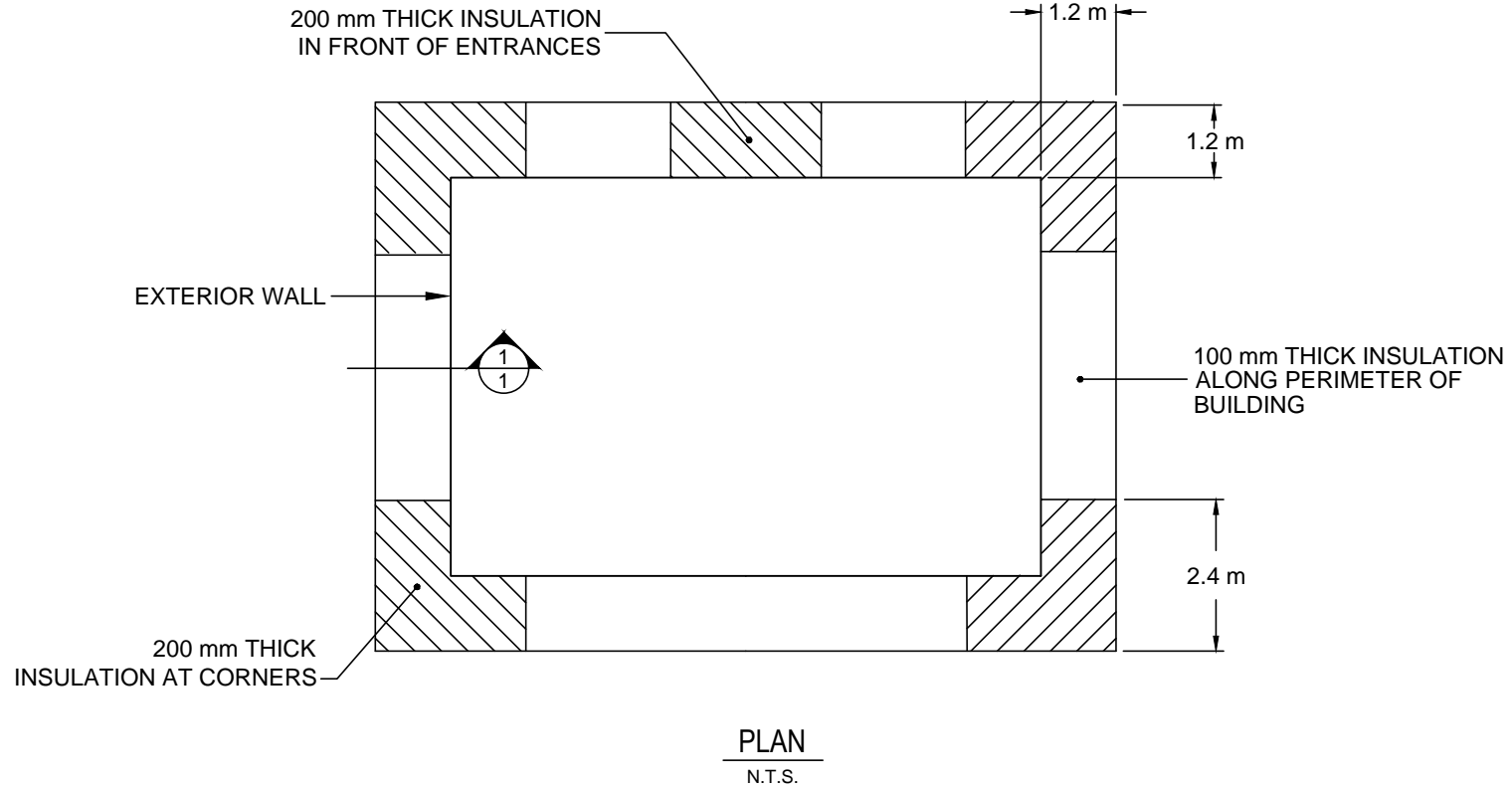
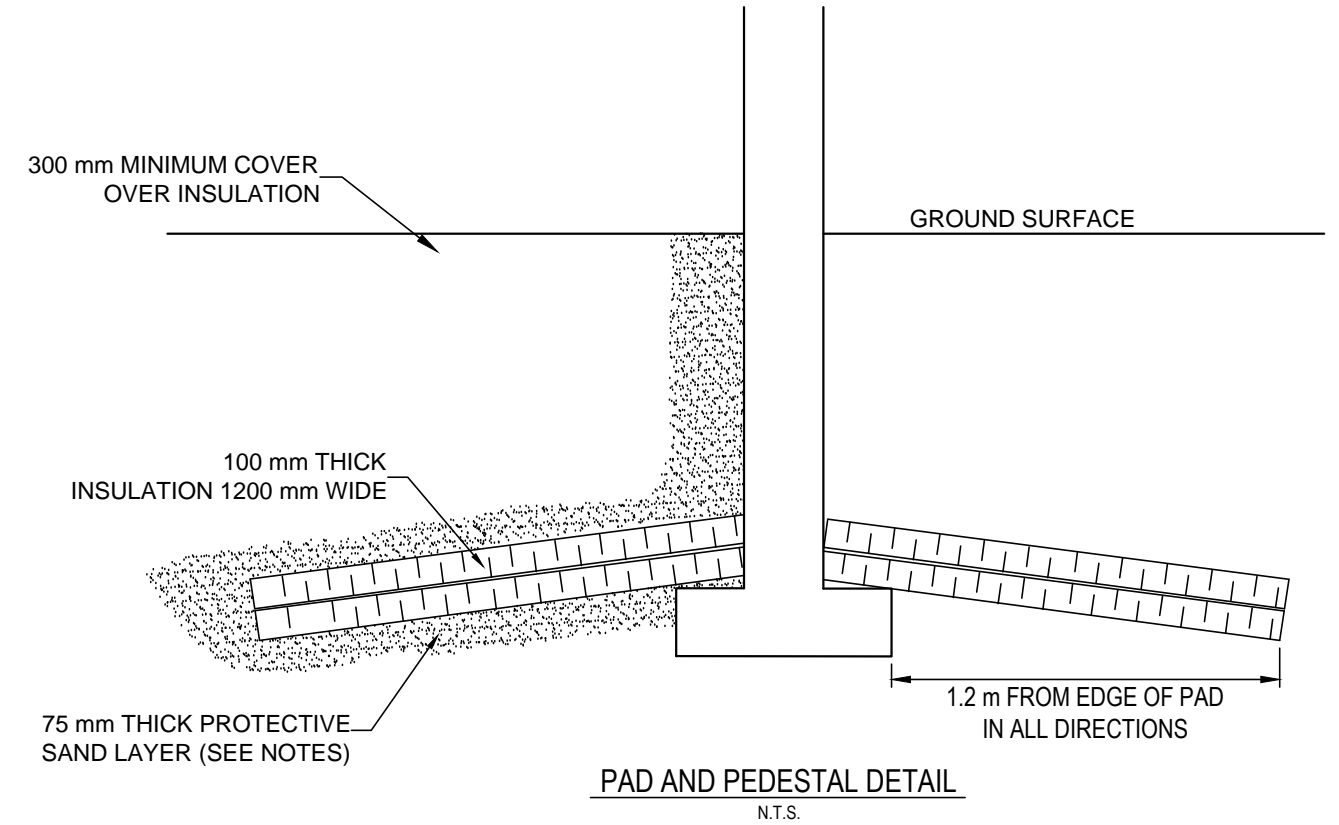
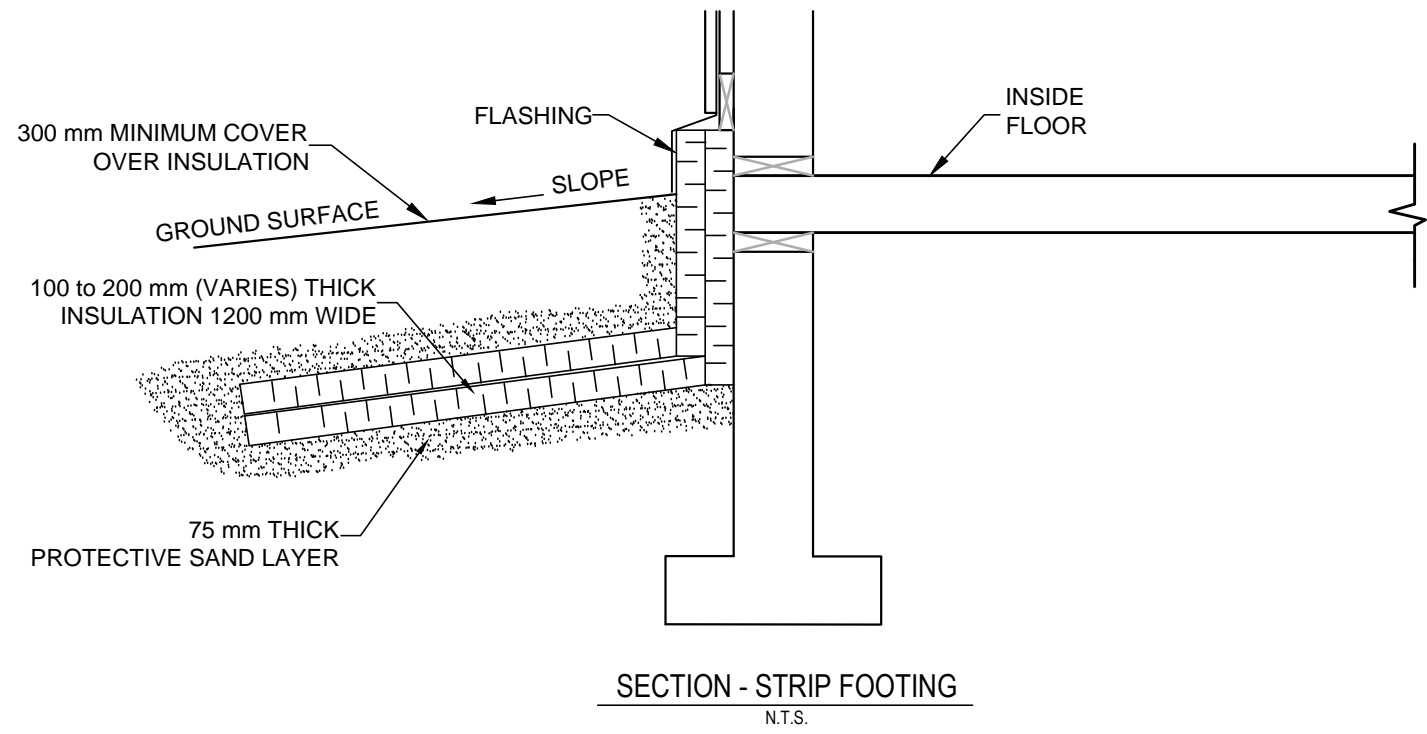
- LEGEND**
- ◆ - BOREHOLE LOCATION
 - ◆ - HISTORICAL TESTPIT LOCATION
 - ◆ - TESTPIT LOCATION (DECEMBER 2016 TO MARCH 2017)



PHASES 3D AND 3E GEOTECHNICAL EVALUATION WHISTLE BEND - WHITEHORSE, YUKON			
SITE PLAN SHOWING BOREHOLE AND TESTPIT LOCATIONS			
PROJECT NO. W14103526-18.004	DRN CB	CHK MCP	REV 0
OFFICE EBA-WHSE	DATE March 17, 2017	Figure 1 3D / 3E	

- LOT 413 (GREENBELT)
- LOT 412
- LOT 411
- LOT 410
- LOT 409
- LOT 408
- LOT 407
- LOT 406
- LOT 405
- LOT 404
- LOT 403
- LOT 402
- LOT 401
- LOT 400
- LOT 399
- LOT 398
- LOT 397
- LOT 396

Q:\Whitehorse\Drawings\Whitehorse\14103567-18 Whistle Bend Existing Geo Compilation\W14103567-18.004 Phase 3A Fig. 1-R0.dwg [FIGURE 2] March 29, 2017 - 1:57:59 pm (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



**PHASE 3 GEOTECHNICAL EVALUATION
WHISTLE BEND - WHITEHORSE, YUKON**

FOUNDATION INSULATION DETAILS



PROJECT NO. W14103567-18.004	DWN CB	CKD MCP	REV 0
OFFICE EBA-WHSE	DATE January 25, 2016		

Figure 2

APPENDIX A

PHASE 3D AND PHASE 3E TESTHOLE LOGS

**Government of Yukon -
Community Services**

Testpit No: TP01

Project: Geotechnical Evaluation Services

Project No: W14103567-18.004

Location: Whistle Bend Subdivision - Phase 3

Ground Elev: 676 m

Whitehorse, Yukon

UTM: 494323 E; 6738033 N; Z 8

Depth (m)	Method	Soil Description	Ground Ice Description	Moisture Content (%)	Elevation (m)
0	Excavated	SAND (FILL) - some silt to silty, uniformly graded, brown, fine sand, (150 mm thick)	Seasonally frozen		676
		ORGANIC ROOT MAT - black, (50 mm thick)			
		SILT (GLACIOLACUSTRINE) - trace to some clay, olive grey and brown			
		- moist	Unfrozen		
1					675
2		END OF TESTPIT (1.5 metres)			674
3					673



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

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**Government of Yukon -
Community Services**

Testpit No: TP02

Project: Geotechnical Evaluation Services

Project No: W14103567-18.004

Location: Whistle Bend Subdivision - Phase 3

Ground Elev: 677.5 m

Whitehorse, Yukon

UTM: 494135 E; 6738009 N; Z 8

Depth (m)	Method	Soil Description	Ground Ice Description	Moisture Content (%)	Elevation (m)
0	Excavated	SILT (FILL) - reworked by construction traffic, some sand, trace gravel, trace clay, olive brown	Seasonally frozen		677
			Unfrozen		
1		SAND - some silt, uniformly graded, moist, brown, fine sand			
		SILT (GLACIOLACUSTRINE) - trace to some clay, moist, olive brown			
2		END OF TESTPIT (1.7 metres)			675
3					



Contractor: Arctic Backhoe Services

Completion Depth: 1.7 m

Drilling Rig Type: CAT Rubber Tired Backhoe

Start Date: 2016 December 05

Logged By: MCP

Completion Date: 2016 December 05

Reviewed By: CPC

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**Government of Yukon -
Community Services**

Testpit No: TP03

Project: Geotechnical Evaluation Services

Project No: W14103567-18.004

Location: Whistle Bend Subdivision - Phase 3

Ground Elev: 678 m

Whitehorse, Yukon

UTM: 494022 E; 5738012 N; Z 8

Depth (m)	Method	Soil Description	Ground Ice Description	Moisture Content (%)	Elevation (m)
0	Excavated	SILT (FILL) - some fine sand, olive brown - trace organics in silt matrix	Seasonally frozen		678
		SAND - some silt, uniformly graded, brown, fine sand - damp	Unfrozen		
1		SILT (GLACIOLACUSTRINE) - trace to some clay, moist, olive brown			
2		END OF TESTPIT (2.0 metres)			
3					675



Contractor: Arctic Backhoe Services

Completion Depth: 2 m

Drilling Rig Type: CAT Rubber Tired Backhoe

Start Date: 2016 December 05

Logged By: MCP

Completion Date: 2016 December 05

Reviewed By: CPC

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**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 (%)	Elevation (m)
0	Excavated	ORGANICS - black, (150 mm thick)	Seasonally frozen		676
		SILT (GLACIOLACUSTRINE) - trace to some clay, olive brown			
		- moist	Unfrozen		
1					
		END OF TESTPIT (1.5 metres)			675
2					
3					674



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

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**Government of Yukon -
Community Services**

Testpit No: TP05

Project: Geotechnical Evaluation Services

Project No: W14103567-18.004

Location: Whistle Bend Subdivision - Phase 3

Ground Elev: 676.5 m

Whitehorse, Yukon

UTM: 494264 E; 6738079 N; Z 8

Depth (m)	Method	Soil Description	Ground Ice Description	Moisture Content (%)	Elevation (m)
0	Excavated	ORGANICS - black, (150 mm thick)	Seasonally frozen		676
		SAND - some silt, uniformly graded, brown			
		- damp SILT (GLACIOLACUSTRINE) - trace to some clay, moist, olive brown	Unfrozen		
1					
		END OF TESTPIT (1.2 metres)			675
2					
3					674



TETRA TECH

Contractor: Arctic Backhoe Services

Completion Depth: 1.2 m

Drilling Rig Type: CAT Rubber Tired Backhoe

Start Date: 2016 December 05

Logged By: MCP

Completion Date: 2016 December 05

Reviewed By: CPC

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**Government of Yukon -
Community Services**

Testpit No: TP06

Project: Geotechnical Evaluation Services

Project No: W14103567-18.004

Location: Whistle Bend Subdivision - Phase 3

Ground Elev: 677 m

Whitehorse, Yukon

UTM: 494092 E; 6738110 N; Z 8

Depth (m)	Method	Soil Description	Ground Ice Description	Moisture Content (%)	Elevation (m)
0	Excavated	SILT (FILL) - trace to some clay, trace fine sand (from construction traffic), olive brown	Seasonally frozen		677
		- wet	Unfrozen		
1		SAND - some silt, uniformly graded, moist at interface with surficial silt, brown			
		- damp			
2		SILT (GLACIOLACUSTRINE) - trace to some clay, moist, olive brown END OF TESTPIT (1.6 metres) Note: Excavated where Norcope's Continuing Care subcut stockpile was located.			675
3					674



Contractor: Arctic Backhoe Services

Completion Depth: 1.6 m

Drilling Rig Type: CAT Rubber Tired Backhoe

Start Date: 2016 December 05

Logged By: MCP

Completion Date: 2016 December 05

Reviewed By: CPC

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**Government of Yukon -
Community Services**

Testpit No: TP07

Project: Geotechnical Evaluation Services

Project No: W14103567-18.004

Location: Whistle Bend Subdivision - Phase 3

Ground Elev: 678.5 m

Whitehorse, Yukon

UTM: 494021 E; 6738213 N; Z 8

Depth (m)	Method	Soil Description	Ground Ice Description	Moisture Content (%)	Elevation (m)
0		ORGANICS - very thin veneer, black, (50 mm thick) SILT - sandy, brown, fine sand	Seasonally frozen		
		SAND - some silt, becoming trace silt with depth, brown - damp	Unfrozen		678
1	Excavated				677
2					676
		END OF TESTPIT (2.5 metres)			676
3					



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

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**Government of Yukon -
Community Services**

Testpit No: TP08

Project: Geotechnical Evaluation Services

Project No: W14103567-18.004

Location: Whistle Bend Subdivision - Phase 3

Ground Elev: 678.5 m

Whitehorse, Yukon

UTM: 494060 E; 6738321 N; Z 8

Depth (m)	Method	Soil Description	Ground Ice Description	Moisture Content (%)	Elevation (m)
0		SILT AND SAND - brown, fine sand	Seasonally frozen		678
1	Excavated	SAND - some silt, damp, brown, fine to medium sand	Unfrozen		677
2		SILT (LACUSTRINE) - trace to some clay, moist, olive brown			676
3		END OF TESTPIT (2.5 metres)			676



Contractor: Arctic Backhoe Services

Completion Depth: 2.5 m

Drilling Rig Type: CAT Rubber Tired Backhoe

Start Date: 2016 December 05

Logged By: MCP

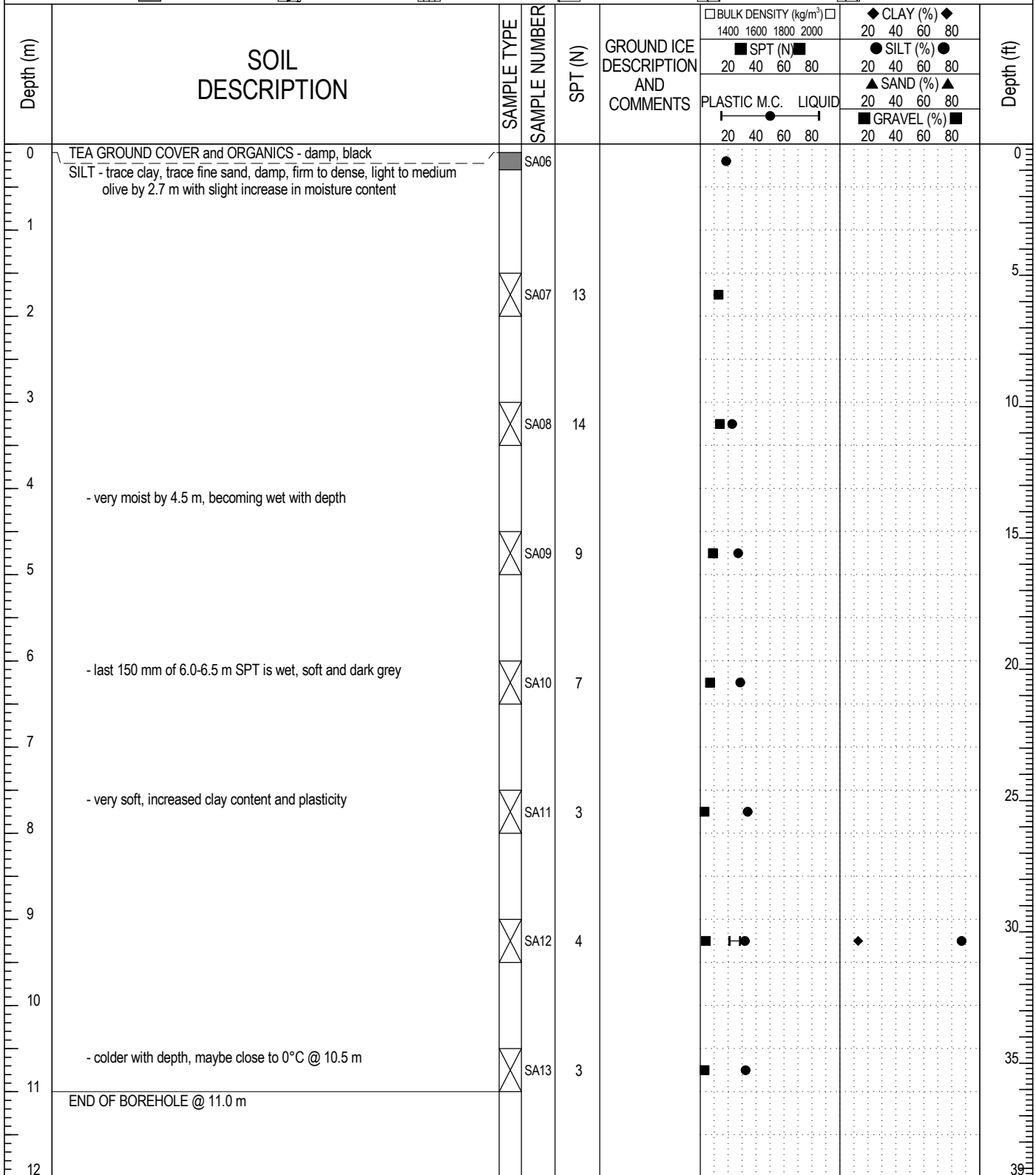
Completion Date: 2016 December 05

Reviewed By: CPC

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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		

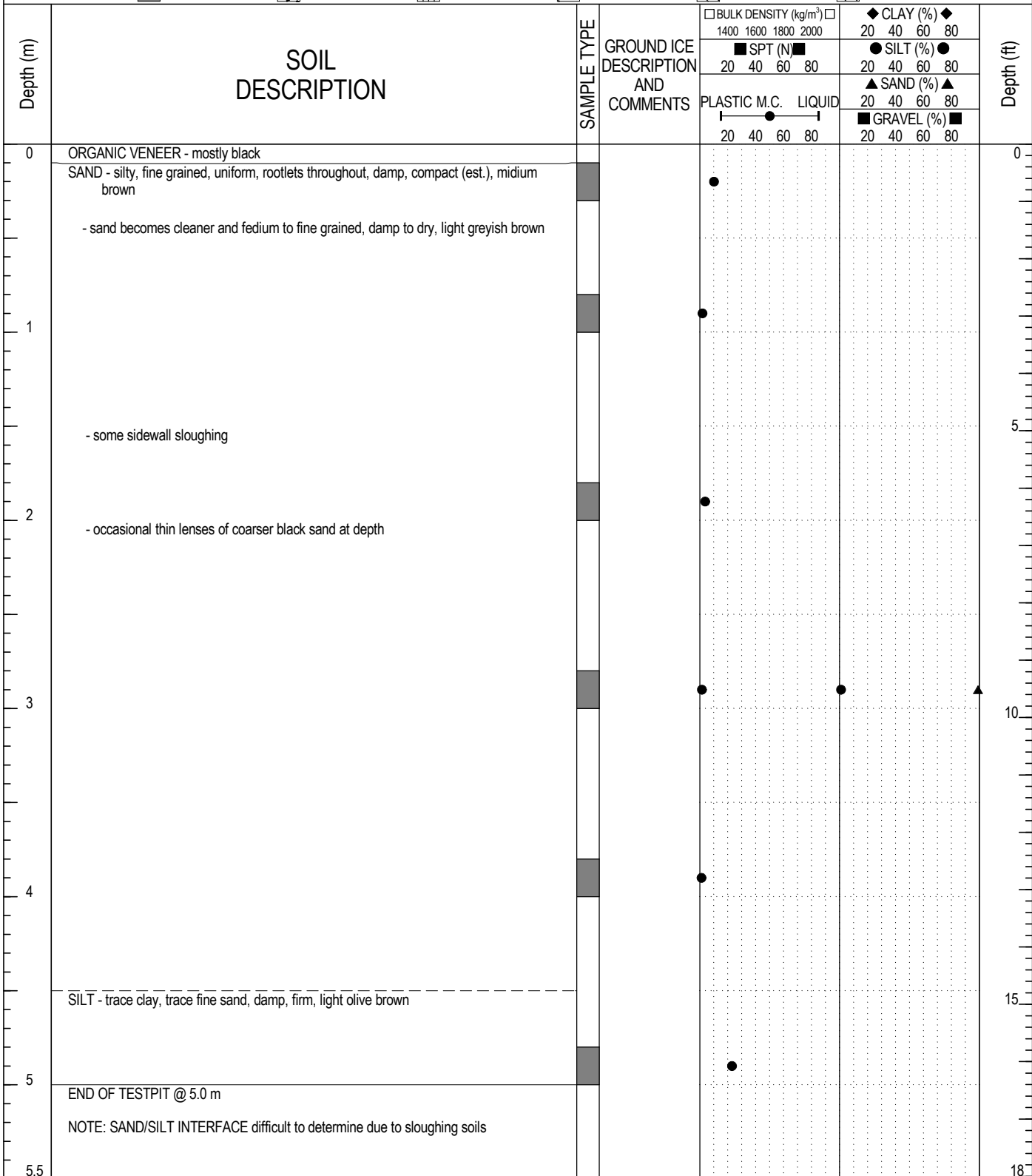
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BACKFILL TYPE	<input type="checkbox"/> BENTONITE	<input type="checkbox"/> PEA GRAVEL	<input type="checkbox"/> SLOUGH	<input type="checkbox"/> GROUT	<input type="checkbox"/> DRILL CUTTINGS	<input type="checkbox"/> SAND




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: TP03
Detailed Geotechnical Design	EXCAVATOR: Hitachi FX200LC Tracked Excavator	PROJECT: W14101372.002
Sewer Force Main Route, Whitehorse, YT		

SAMPLE TYPE	<input checked="" type="checkbox"/> DISTURBED	<input type="checkbox"/> NO RECOVERY	<input type="checkbox"/> SPT	<input type="checkbox"/> A-CASING	<input type="checkbox"/> SHELBY TUBE	<input type="checkbox"/> CORE
BACKFILL TYPE	<input checked="" type="checkbox"/> BENTONITE	<input type="checkbox"/> PEA GRAVEL	<input type="checkbox"/> SLOUGH	<input type="checkbox"/> GROUT	<input type="checkbox"/> DRILL CUTTINGS	<input type="checkbox"/> SAND



	LOGGED BY: MCP	COMPLETION DEPTH: 5m
	REVIEWED BY: CPC	COMPLETE: 10/09/09
	DRAWING NO:	Page 1 of 1

Whistle Bend Subdivision	CLIENT: Associated Engineering	TESTPIT NO: TP15
Detailed Geotechnical Design	EXCAVATOR: Komatsu Rubber Tired Backhoe	PROJECT: W14101372.002
Casca & Phases I and II, Whitehorse, YT		

SAMPLE TYPE	<input type="checkbox"/> DISTURBED	<input type="checkbox"/> NO RECOVERY	<input type="checkbox"/> SPT	<input type="checkbox"/> A-CASING	<input type="checkbox"/> SHELBY TUBE	<input type="checkbox"/> CORE
BACKFILL TYPE	<input type="checkbox"/> BENTONITE	<input type="checkbox"/> PEA GRAVEL	<input type="checkbox"/> SLOUGH	<input type="checkbox"/> GROUT	<input type="checkbox"/> DRILL CUTTINGS	<input type="checkbox"/> SAND

Depth (m)	SOIL DESCRIPTION	SAMPLE TYPE	GROUND ICE DESCRIPTION AND COMMENTS	BULK DENSITY (kg/m ³)		CLAY (%)		SILT (%)		SAND (%)		Depth (ft)
				1400	1600	1800	2000	20	40	60	80	
0	ORGANIC ROOT MAT - seasonally frozen, black											0
	SAND - some silt to silty between 0.2 and 1.0 m, cleaner with trace of silt from 1.0 m to silt interface at 2.0 m, seasonally frozen to 0.3 m, medium brown at surface to dark brown below 1.0 m											
1												
2												
	END OF TESTPIT @ 2.3 m											
	NOTE: Testpit excavated at intersection of Casca Blvd (north leg) and Keno											
3												10



LOGGED BY: MCP	COMPLETION DEPTH: 2.3m
REVIEWED BY: CPC	COMPLETE: 10/10/18
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	<input type="checkbox"/> DISTURBED	<input type="checkbox"/> NO RECOVERY	<input type="checkbox"/> SPT	<input type="checkbox"/> A-CASING	<input type="checkbox"/> SHELBY TUBE	<input type="checkbox"/> CORE
BACKFILL TYPE	<input type="checkbox"/> BENTONITE	<input type="checkbox"/> PEA GRAVEL	<input type="checkbox"/> SLOUGH	<input type="checkbox"/> GROUT	<input type="checkbox"/> DRILL CUTTINGS	<input type="checkbox"/> SAND

Depth (m)	SOIL DESCRIPTION	SAMPLE TYPE	GROUND ICE DESCRIPTION AND COMMENTS	BULK DENSITY (kg/m ³)		CLAY (%)		SILT (%)		SAND (%)		Depth (ft)
				1400	1600	1800	2000	20	40	60	80	
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	COMPLETION DEPTH: 2m
REVIEWED BY: CPC	COMPLETE: 10/10/18
DRAWING NO:	Page 1 of 1

Whistle Bend Infiltration Testing		CLIENT: Morrison Hershfield Ltd.		TESTPIT NO: TP03									
Whistle Bend Subdivision		EXCAVATOR: Komatsu 420 Rubber Tire Backhoe		PROJECT: W14101545.001									
Whitehorse, YT				ELEVATION: 677.6 m									
SAMPLE TYPE		<input type="checkbox"/> DISTURBED	<input type="checkbox"/> NO RECOVERY	<input type="checkbox"/> SPT	<input type="checkbox"/> A-CASING								
BACKFILL TYPE		<input type="checkbox"/> BENTONITE	<input type="checkbox"/> PEA GRAVEL	<input type="checkbox"/> SLOUGH	<input type="checkbox"/> GROUT								
		<input type="checkbox"/> SHELBY TUBE	<input type="checkbox"/> CORE	<input type="checkbox"/> DRILL CUTTINGS	<input type="checkbox"/> SAND								
Depth (m)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	GROUND ICE DESCRIPTION AND COMMENTS	BULK DENSITY (kg/m ³)		CLAY (%)		SILT (%)		SAND (%)		Elevation (m)
					1400	1600	1800	2000	20	40	60	80	
						SPT (N)		PLASTIC M.C.		LIQUID			
						20	40	60	80	20	40	60	80
						GRAVEL (%)							
						20	40	60	80	20	40	60	80
0	ORGANIC COVER			FROZEN TO 0.5 m									
	SAND - trace silt, poorly graded, fine to medium sand, light brown												
	- dry, loose			UNFROZEN									677.0
1													
			SA01										676.0
2	SILT - trace clay, moist, firm, non plastic, olive brown												675.0
3	END OF TESTPIT @ 3.0 m (Machine Extent)		SA02										674.0
4													



LOGGED BY: IM

COMPLETION DEPTH: 3m

REVIEWED BY: CPC

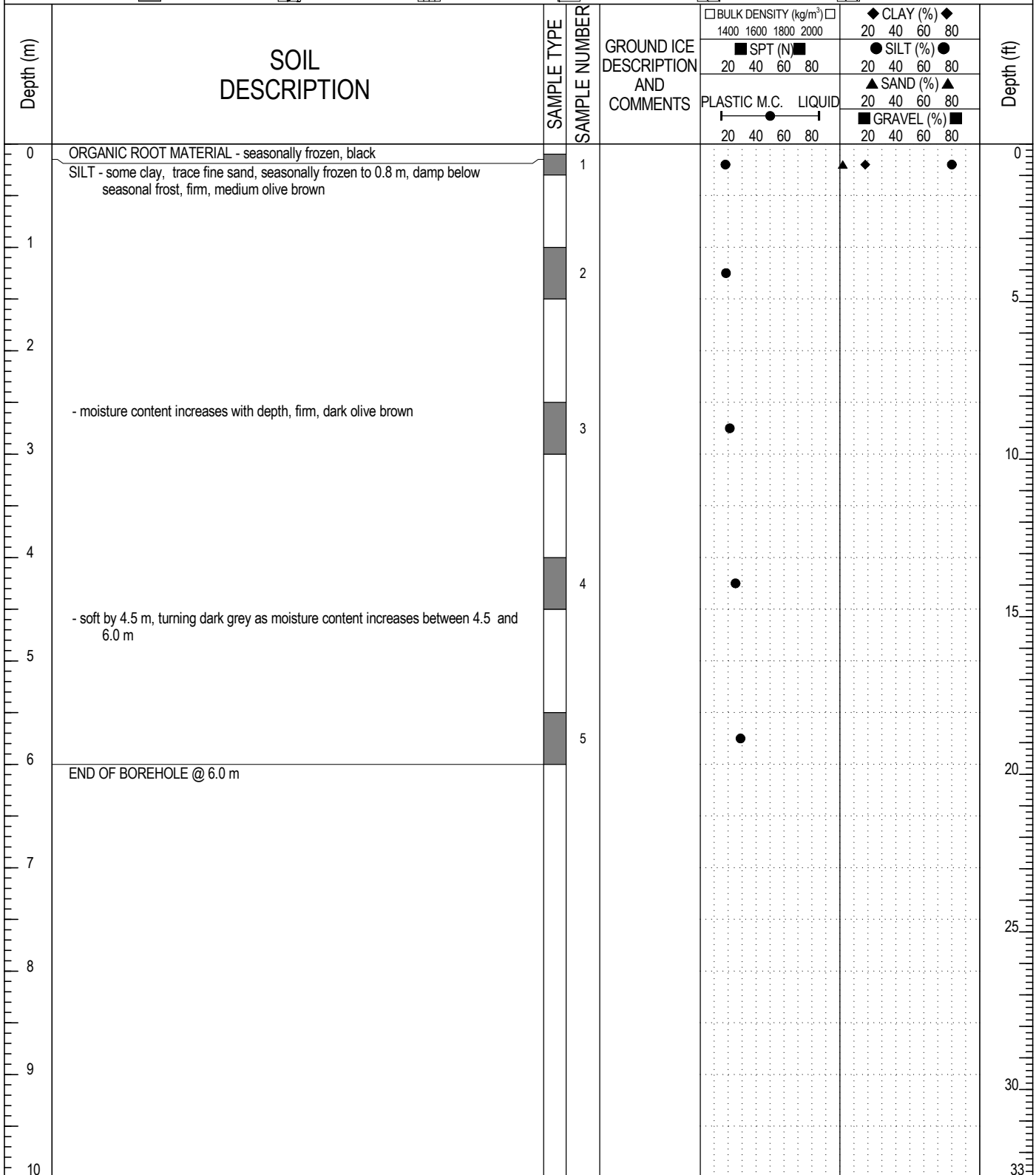
COMPLETE: 11/11/29


DRAWING NO: Figure 1

Page 1 of 1

Geotechnical Evaluation	AECOM	BOREHOLE NO: BH14
Whistle Bend Subdivision	Drilling Method: NODWELL Mounted CME 75	PROJECT: W14101171
Whitehorse, YT		

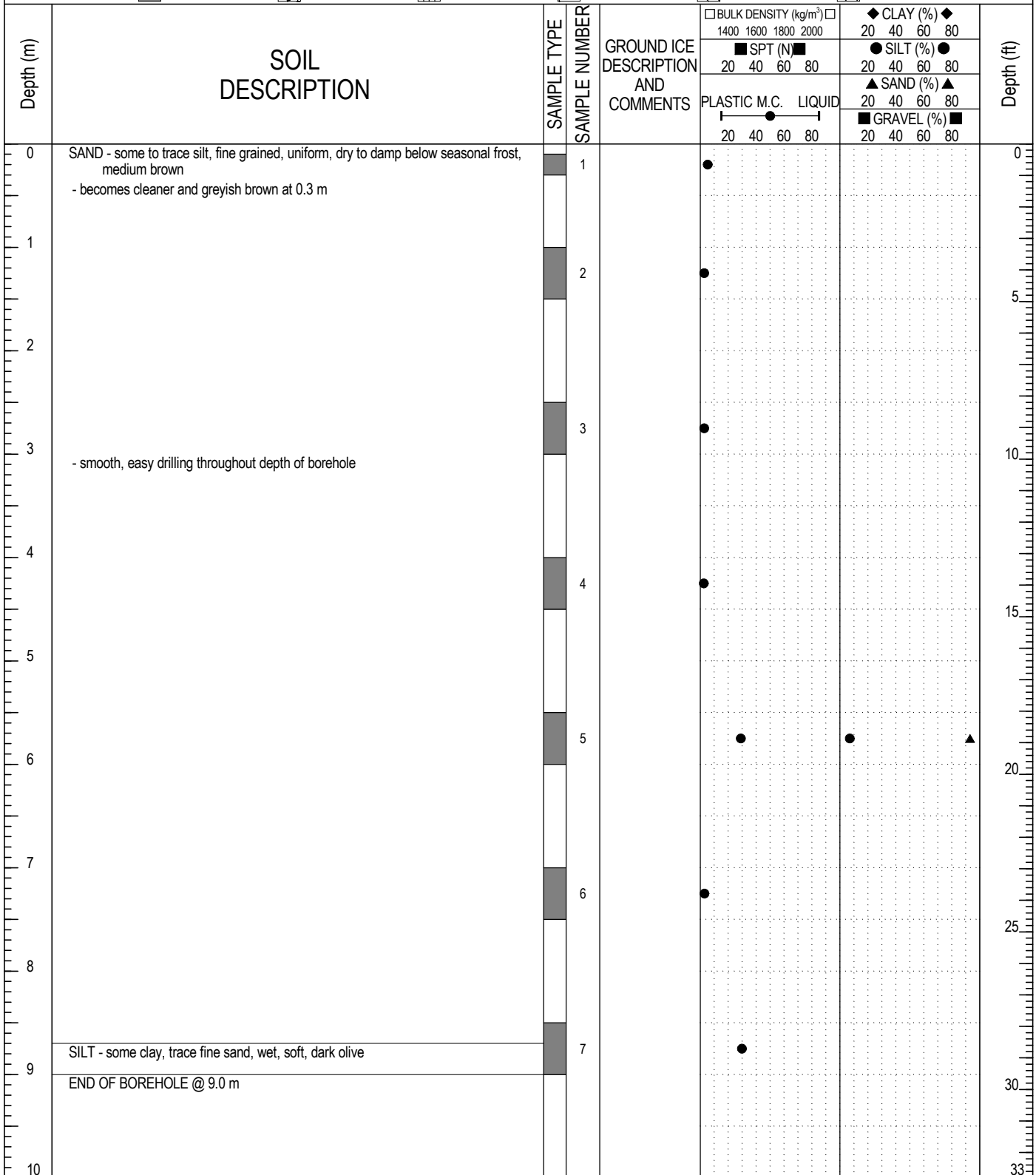
SAMPLE TYPE	<input type="checkbox"/> DISTURBED	<input type="checkbox"/> NO RECOVERY	<input type="checkbox"/> SPT	<input type="checkbox"/> A-CASING	<input type="checkbox"/> SHELBY TUBE	<input type="checkbox"/> CORE
BACKFILL TYPE	<input type="checkbox"/> BENTONITE	<input type="checkbox"/> PEA GRAVEL	<input type="checkbox"/> SLOUGH	<input type="checkbox"/> GROUT	<input type="checkbox"/> DRILL CUTTINGS	<input type="checkbox"/> SAND




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

Geotechnical Evaluation	AECOM	BOREHOLE NO: BH15
Whistle Bend Subdivision	Drilling Method: NODWELL Mounted CME 75	PROJECT: W14101171
Whitehorse, YT	Drilled on Dune	

SAMPLE TYPE	<input type="checkbox"/> DISTURBED	<input type="checkbox"/> NO RECOVERY	<input type="checkbox"/> SPT	<input type="checkbox"/> A-CASING	<input type="checkbox"/> SHELBY TUBE	<input type="checkbox"/> CORE
BACKFILL TYPE	<input type="checkbox"/> BENTONITE	<input type="checkbox"/> PEA GRAVEL	<input type="checkbox"/> SLOUGH	<input type="checkbox"/> GROUT	<input type="checkbox"/> DRILL CUTTINGS	<input type="checkbox"/> SAND



	LOGGED BY: MCP	COMPLETION DEPTH: 9m
	REVIEWED BY:	COMPLETE: 08/12/10
	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.

This report is subject to copyright and shall not be reproduced either wholly or in part without the prior, written permission of the Yukon Government, the Client, or TETRA TECH. It is acknowledged that the Yukon Government, the Client, may reproduce the report freely for internal usage.

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.