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MEMORANDUM

Date: September 2, 2026

To: Mr. Derek Hnatiuk
Township of Strong
P.O.Box 1120
Sundridge, ON
P0A 1Z0

From: Jeremy Longhurst; Jackson Mercer, P.Eng.; George Liang, Ph.D., P. Eng.

RE: Geotechnical Investigation for the Culvert Washout and Flood Damage
at Pool Lake Culvert in Sundridge, Ontario

Dear Mr. Hnatiuk,

This memorandum documents TULLOCH's findings from the geotechnical rock probe investigation performed on June 4th, 2026, for the Pool Lake Culvert Washout Replacement Project along South Lake Bernard Road in Sundridge, Ontario. This letter will outline the observations and findings made during the site investigation and provide recommendations pertaining to the foundation construction of the proposed culvert replacement. Statements and recommendations contained herein are based on visual and tactile observation of the rock probe cuttings around the Pool Lake Culvert washout area on the west side of South Bernard Lake Road. Attached to this memorandum are site photographs taken from the rock probe investigation and rock probe logs roughly identifying inferred subsurface conditions based on exposed rock probe cuttings.

1. BACKGROUND INFORMATION

During the flooding event experienced in April 2026, the Pool Lake Culvert that connects Pool Lake to Bernard Lake, which spans under South Lake Bernard Road, was washed out due to the excess volume of flowing water, critically damaging the road and cutting off north/south vehicle access to the residential property located north of the culvert. The temporary culvert reinstallation to allow normal traffic flow and emergency vehicle services to the area began on May 6th, 2026. The temporary reinstallation measures included the reinstatement of one length of the existing culvert and granular road fill to the existing road surface elevation. During the temporary construction of the reinstatement measures, the Township, under TULLOCH's observation, advanced a series of shallow test pits to a depth of approximately 0.60 m below the streambed

elevation to determine if shallow bedrock was present within the culvert footprint. Bedrock was not encountered during this investigation, and deeper investigation measures were recommended to determine the depth to bedrock for suitable foundation design.

Given the above recommendations, a rock probe investigation with the use of a high impact energy hydraulic percussion rock drill was proposed to assess subsurface conditions and depth to bedrock.

2. REGIONAL GEOLOGY

Based on review of the Bedrock Geology, Quaternary Geology and the Surficial Geology of Southern Ontario mapping as published by the Ontario Geological Society (OGS), the site surficial geology is comprised of glaciolacustrine deposits consisting of sand, gravel, silt and clay. It is bound on either side of the Pool Lake Culvert by shallow Precambrian bedrock drift complexes exposed at ground surface or covered by discontinuous, thin layers of overburden drift.

Bedrock underlying the project site consists of felsic igneous rocks consisting of tonalite, granodiorite, monzonite, granite, and syenite derived gneisses (OGS 2011). Generally, the bank of Pool Lake was covered with small to medium sized vegetation as it tapered toward the culvert location. The topography in the area also transitioned from higher elevation to the south of the culvert location along South Lake Bernard Road, reaching its lowest topological elevation at the culvert location, and then steeply rising higher again north of the culvert. A site photograph log of the geotechnical investigation and some selected photos of the temporary culvert replacement is attached to this document.

3. FIELD OBSERVATIONS

TULLOCH attended site on June 4th, 2026, to observe the drilling of a total of seven (7) rock probes, denoted as RP-26-01 to -07, throughout the project site. Table 3-1 below summarizes the rock probe information obtained during the investigation.

Table 3-1: Summary of Rock Probe Information

Rock Probe No.	Location ¹		Depth to Inferred Bedrock Surface (mbgs) ²	Maximum Depth (mbgs) ²
	Easting (m)	Northing (m)		
RP-26-01	626 684	5 063 569	N/E ³	9.1
RP-26-02	626 683	5 063 574	N/E ³	9.1
RP-26-03	626 682	5 063 579	N/E ³	9.1
RP-26-04	626 680	5 063 589	N/E ³	9.1
RP-26-05	626 680	5 063 594	5.79	9.1
RP-26-06	626 680	5 063 597	5.18	9.1

Rock Probe No.	Location ¹		Depth to Inferred Bedrock Surface (mbgs) ²	Maximum Depth (mbgs) ²
	Easting (m)	Northing (m)		
RP-26-07	626 681	5 063 584	N/E ³	9.1

Note(s): ¹ Coordinates in UTM NAD83 Zone 17T. ² Meters below ground surface (mbgs). ³ N/E = Not Encountered

Rock Probes were advanced using a Furukawa Rock Drill (FRD) USA HCR900ESV rock drill provided by Rock Breakers (2007) Inc., subcontracted by HLD Construction. Borehole advancement was conducted with high impact energy hydraulic percussion rock drill techniques. All boreholes were positioned along South Lake Bernard Road by a TULLOCH geotechnical representative who oversaw the drilling operations. No soil or rock samples could be obtained due to the type of drill equipment used, and therefore, visual and audible observations were made to infer the subsurface conditions.

The following observations were made during the drilling operations:

- Seven (7) rock probes were advanced to approximately 9.14 meters below ground surface (mbgs) on the south bound lane of South Lake Bernard Road around the existing culvert washout location. Three (3) were advanced to the south of the temporary culvert replacement, and four (4) were advanced to the north to profile the depth from ground surface to bedrock.
- Visual observations of the drill cuttings indicated the encountered soils included sandy gravel to gravelly sand road fill at ground surface overlaying silty sand to non-plastic silt deposits.
- Boulders sized particles were encountered in RP-26-02 and RP-26-04 at depths of approximately 1.37 mbgs and 7.01 mbgs, respectively. The boulders were inferred to range in size from approximately 0.5 to 0.9 m diameter.
- Bedrock was encountered in RP-26-05 and -06 at 5.79 mbgs and 5.18 mbgs respectively. From the observations made during the investigation, the bedrock surface is inferred to slope upward to the north from the culvert. This observation is also consistent with steep change in topography along South Lake Bernard Road as it travels north of the culvert location.
- Groundwater was encountered during rock probe advancement, as indicated by saturated soil cuttings expelled during advancement.
 - Due to the nature of the investigation, the groundwater depth could not be accurately determined. However, given the close proximity to Pool Lake, the groundwater level is anticipated to be close to ground surface.
 - It should be noted that groundwater levels are subject to seasonal fluctuations, with high levels occurring during wet weather conditions in the spring and fall, and

lower levels during dry weather conditions. As such, additional precautions should be taken for groundwater management.

4. GEOTECHNICAL RECOMMENDATIONS

4.1. Precast Concrete Closed-Bottom Box Culvert

It is our understanding that the temporary culvert will be replaced by a new 2.4 m high, 1.5 m wide, 14.4 m long closed-bottom precast concrete culvert with a minimum embedment of 2.1 m below the top of road elevation. Based on the available geotechnical data and site conditions observed during the investigation, the following construction sequences are recommended for the base preparation of the precast concrete culvert.

- Excavate the existing subsurface materials to the bottom side of the culvert plus an allowance for the backfill materials. Remove any loose sedimentation and/or soft compressible organic materials and any disturbed silty sand to silt subgrade deposits from the base of the excavation, as required.
- From review of the available rock probe data, it is anticipated that the base of the excavation will be within the saturated silt deposit (likely below the ground water table).
 - As such, a 600 mm thick layer of 300 mm minus diameter rockfill is proposed to be placed throughout the base of the proposed culvert in the stripped sandy silty to silt deposits to build a firm foundation platform, as excessive vibratory compaction effort is likely to cause disturbance or liquefaction of the saturated silty sand to silt deposits.
 - In addition, to protect the easily disturbed subgrade deposits against potential erosion by water flow, a heavy non-woven geotextile such as a Layfield LP 10, or approved equivalent, should be placed on the surface of the excavated subgrade material before placing rockfill without compaction.
- After placing the rockfill stabilized base, place the heavy non-woven geotextile and a geogrid layer on the rockfill such as a Tensor TX140, or approved equivalent.
- Place 500 mm Granular “B” or equivalent material compacted under the full-time inspection of a geotechnical engineer, or their representative, using at least six (6) to eight (8) static passes by a vibratory smooth steel drum roller.
 - The number of passes may be refined based on the site-specific conditions at the discretion of the geotechnical engineer during construction to ensure adequate compaction while minimizing disturbance to the sensitive underlying subgrade material.

- Following written approval of the rockfill and geosynthetic placement by the geotechnical engineer, place the closed bottom culvert on top of the compacted Granular “B” bedding layer and backfill using Granular “A” around the side walls of the culvert to the final designed elevation of road.
- Backfill along the sides and the top of the precast culvert structure should consist of free-draining, non-frost susceptible granular materials such as OPSS Granular A (OPSS 1010).
 - All granular backfill materials should be placed in thin lifts, not to exceed 300 mm in uncompacted thickness. Lifts should be compacted to 98% of the material’s SPMDD and 100% SPMDD within 1.0 m below the top of road elevation.
 - The use of heavy compaction equipment should be avoided immediately adjacent to and above the culvert. At no time should the fill levels on either side of the structure differ by more than 300 mm to avoid applying unbalanced loads on the structure, which could cause lateral displacement (dislodging) and/or damage.
 - The excavated native soils should not be reused as structural backfill materials, due to their fine grained and frost susceptible nature. However, the existing fill may be reused as road subbase fill, provided it is free of organics or other deleterious materials. A suitable frost taper is required for the common fill placed within the frost penetration depth.
- The Silty Sand to Silt deposit encountered at the site, is highly erodible and scour prone. Depending on flow velocities, erosion and scour protection should be provided along the slopes and sides of the culvert base and the bank of Pool Lake. The erosion/scour protection should be designed by a Hydraulic Engineer.
 - To minimize flow in the bedding and backfill layers, seepage collars comprising of either 60 MIL Geomembrane or low permeable clayey fill at the upstream end of the culvert should be provided.
- The underlying soils on this site are considered to be frost susceptible due to the high fine particle content observed during the investigation. The estimated frost penetration depth at the site is 1.8 m; as such, all foundations should be situated at least 1.8 m below ground surface to provide adequate insulation against frost heaving.
 - Frost tapers should be implemented for backfilling behind the culvert foundation where differential frost heaving will not be acceptable, as recommended in the applicable OPSD (e.g., OPSD 3101.150).
 - If construction is undertaken during the winter months, foundation subgrade must be protected from freezing.

Table 4-1 lists the recommended design bearing capacities for the closed-bottom culvert.

Table 4-1: Bearing Capacity for Culvert Box Foundation

Min. Bearing Depth (m)	SLS (kPa)	Factored ULS (kPa)
2.1	100	150

Based on a preliminary assessment, the long-term settlement of the proposed culvert is estimated to be less than 25 mm, which can be accommodated by cambering the road over the culvert. A relatively uniform loading pressure under the base of the culvert is anticipated, and as such, the differential settlement should be negligible.

4.2. Lateral Earth Pressure

The lateral earth pressures acting against the precast concrete box culvert should be calculated according to the Canadian Highway Bridge Design Code (CHBDC 2014 CAN/CSA-S6-14). The general equation for calculating lateral earth pressure is:

$$P = k (\gamma h + q) \quad \text{Equation 1}$$

Where:

P = lateral earth pressure in kPa acting at depth;

k = earth pressure coefficient;

γ = bulk unit weight in kN/m³;

h = depth to point of interest in m;

q = surcharge near wall in kPa.

Longitudinal drains and weep holes should be installed to provide positive drainage of the granular backfill, as required by the design engineer. Unless drainage provisions are made or remain functional over the design life of the structure, hydrostatic pressure will have to be added to the lateral pressure. In accordance with Clause 6.12.3 of the CHBDC (S6-14), a minimum earth pressure of 12 kPa should be assumed to act on abutments, culvert walls and wing walls at the surface to account for compaction induced earth pressures. The properties listed in Table 4-2 can be used during the design for the backfill materials.

Table 4-2: Recommended Lateral Earth Pressure Parameters

Material	Unit Weight (kN/m ³)	Effective Friction Angle (°)	Coefficient of Lateral Earth Pressure ¹	
			K' _a	K' _o
Granular A	22	38	0.24	0.38

Material	Unit Weight (kN/m ³)	Effective Friction Angle (°)	Coefficient of Lateral Earth Pressure ¹	
			K' _a	K' _o
Granular B, Type I	21	34	0.28	0.44
Granular B, Type II	21	36	0.26	0.41

Note(s): ¹ K'_a = coefficient of active earth pressure on a laterally unrestrained (non-rigid) structure; K'_o = coefficient of earth pressure at rest for soil loading on a laterally restrained structure.

The above earth pressure coefficients assume a horizontal backfill condition, vertical back-face of the retaining structure and smooth soil-wall interface only. If the design includes a sloping ground surface in front of the retaining structure, a backfill inclination, or an inclined back-face of the retaining wall, the earth-pressure coefficients will require modification. TULLOCH should be contacted to provide appropriate coefficients for these conditions.

4.3. Temporary Excavations and Groundwater Control

Open excavations for the construction of the proposed culvert replacement must be carried out in a manner that complies with the Occupational Health and Safety Act (OHSA), Ontario Regulation 213/91. Table 4-3 summarizes the generalized material types encountered during the investigation that are anticipated to be encountered and the associated OHSA soil types for excavation requirements.

Table 4-3: OHSA Excavation Soil Type Summary

Material Type	OHSA Soil Type
Existing Fills and Native Soils above the Water Table	3
Native Soils below the Water Table	4

Figures 4-1 to 4-3 illustrate the requirements for temporary cut slopes according to OHSA standards relevant to the crossing location, which are summarized below. A qualified geotechnical engineer should be retained to inspect the conditions during construction to confirm the soil classification and excavation type required to comply with safety regulations.

- Type 1 and 2 soils may have a vertical excavation from the base of the cut to a maximum height of 1.2 m, after which the excavation walls must be sloped at a gradient not steeper than 1H:1V (see Figure 4-1);
- Type 3 soils must be sloped at a minimum gradient of 1H:1V from the bottom to the crest of the excavation (Figure 4-2)

- Type 4 soils must be sloped at a minimum gradient of 3H:1V from the bottom to the crest of the excavation (Figure 4-3)

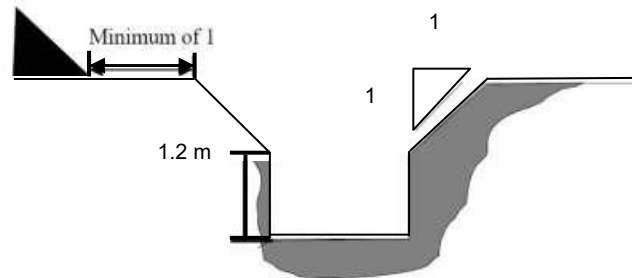


Figure 4-1: Typical Section for Type 1 and 2 Soil Excavation

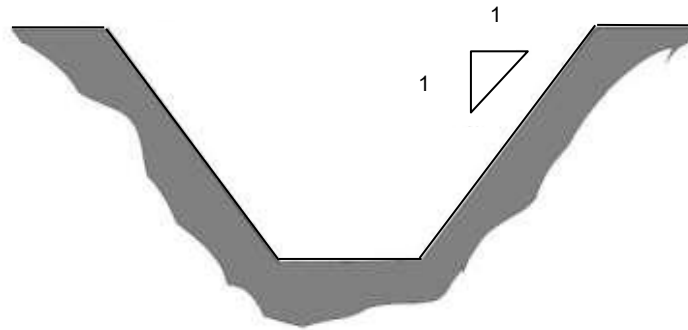


Figure 4-2: Typical Section for Type 3 Soil Excavation



Figure 4-3: Typical Section for Type 4 Soil

As summarized in Table 4-3, the encountered fills materials and native soils on site would be classified as Type 3 soils above the groundwater table and Type 4 soils below the groundwater table. Any organic soils, if encountered, would be defined as Type 4 soil throughout the excavation. Temporary excavations for Type 3 and Type 4 soils should be stable with an unsupported slope angle of 1H:1V and 3H:1V, respectively. Excavation safety and the stability of temporary construction slopes and lateral support systems are the contractor's responsibility.

As the native materials are of a glacial origin, there is the possibility of encountering boulders and cobbles during excavation that were not identified in the geotechnical investigation. Therefore, heavy equipment may be required, and the contractor undertaking the work should supply equipment capable of removing such material. However, it is anticipated that typical heavy civil earth moving equipment will be sufficient for excavations on site.

The contractor should take care not to leave the subgrade soils exposed to the environment, as the cohesive soils will be easily weathered and could become disturbed. Additionally, the installation and removal of sheet piling to hydraulically isolate the construction with vibratory equipment should be avoided during construction, as the vibratory effort will likely cause significant disturbance or liquefaction of the sensitive in-situ soil deposits.

Excavated material should not exceed what can be backfilled within the same working day. The subgrade works should always be maintained in the dry, and it is the contractor's responsibility to maintain site dewatering for construction. The subgrade materials shall not be allowed to freeze, nor shall frozen material be placed as backfill. To protect the soil, structural fill or a concrete mud mat should be placed shortly after the subgrade material has been exposed.

Backfill placement should be completed as discussed under the review of a geotechnical engineer or their representative, and adequate time should be allowed to complete the necessary laboratory gradation and standard proctor testing in advance of backfill operations. Depending on the subgrade conditions, static rolling of fill may be required at the discretion of the geotechnical engineer.

Based on the water level measurements obtained during the time of the investigation, it is anticipated that the groundwater table will be encountered to perform the construction work discussed in this memorandum. Where encountered, excavations that extend below the groundwater table may require control measures. The native soils encountered on site are considered to have medium to high permeability; therefore, sump and pump techniques may be enough to dewater shallow excavations that do not extend significantly below the groundwater table (i.e., less than approximately 0.5 m). However, well points or other active groundwater control techniques or a groundwater cut-off (e.g., sheet pile retaining structure) system will need to be installed to dewater the site if deeper excavations below the water table are attempted.

The actual dewatering methods should be established at the contractor's discretion within the context of a performance specification for the project. It should be noted that, under the Ontario Water Resources Act, the Water Taking and Transfer Regulation 387/04, for the purpose of construction site dewatering, an Environmental Activity Sector Registry (EASR) registration is

required if the dewatering discharge is greater than 50,000 L/day but less than or equal to 400,000 L/day. If water taking is greater than 400,000 L/day a Permit to Take Water (PTTW) is required from the Ministry of the Environment, Conservation and Parks. Reference is also given to OPSS 517 and 518, which pertain to construction dewatering. At this site, an EASR registration will be required if active dewatering is implemented, and a PTTW may need to be pursued depending on the groundwater control method selected and the excavation configurations.

Seasonal variations in the water table should be expected, with higher levels occurring during wet weather conditions in the spring and fall and lower levels occurring during normal dry weather conditions. It is recommended that foundation work be undertaken during dry months when water flows and elevations are minimized. All surface water flow should be diverted away from excavations.

5. CLOSURE

This geotechnical memorandum has been prepared by TULLOCH for the exclusive use of the Township of Strong and their authorized agents for the proposed Pool Lake Culvert Replacement Project. Within the limitations of scope, schedule and budget, our services have been executed in accordance with generally accepted practices in the field of geotechnical engineering for the above-noted project. Classification and identification of soils and geologic units have been based upon commonly accepted methods employed in professional geotechnical practice. No warranty or other conditions, expressed or implied, should be understood. Please refer to the attached Notice to Reader, which forms an integral part of this report.

We trust that the information in this memorandum will be sufficient to allow the Township of Strong to proceed with the project. Should further elaboration be required for any portion of this project, we would be pleased to assist.

Sincerely,



Jeremy Longhurst,
Engineering Technician



Reviewed By:
Jackson Mercer, P. Eng.
Geotechnical Engineer



Attachment(s): Site Location Plan, Terminology, Photo Log, Rock Probe Logs, Notice to Reader

KEY AND SITE LOCATION PLAN AND FIGURES



PROJECT LOCATION

COORDINATES		
BOREHOLE ID	EASTING	NORTHING
RP-26-01	626 684	5 063 569
RP-26-02	626 683	5 063 574
RP-26-03	626 682	5 063 579
RP-26-04	626 680	5 063 589
RP-26-05	626 680	5 063 594
RP-26-06	626 680	5 063 597
RP-26-07	626 681	5 063 584

NOTES:

1. COORDINATES ARE IN UTM ZONE 17T (NAD83 CSRS).

LEGEND:

RP-26-01  ROCK PROBE LOCATION

ROCK PROBE LOCATION PLAN



					DRAWING: ROCK PROBE LOCATION PLAN	PROJECT: POOL LAKE CULVERT REPLACEMENT SOUTH BERNARD ROAD SOUTH SUNDRIDGE, ONTARIO	DRAWN BY:	CHECKED BY:	PROJECT No. :			
							C. MANN	J. MERCER	26-0997		DRAWING No. 26-0997-001	REVISION No. 0
								APPROVED BY:				
								G. LIANG				
0	2026-06-26	CM	ISSUED FOR REPORT					SCALE:	DATE:			
No.	DATE	BY	ISSUES / REVISIONS					AS NOTED	2026-06-26			

TERMINOLOGY

ABBREVIATIONS, TERMINOLOGY AND PRINCIPAL SYMBOLS USED IN REPORT AND BOREHOLE LOGS

BOREHOLES AND TEST PIT LOGS

Soils

AS	Auger/Grab Sample	w	Water Content
SS	Split Spoon	wP	Plastic Limit
SH	Shelby Tube	wL	Liquid Limit
PISTON	Thin-walled Piston	VANE	Field Vane
WS	Washed Sample	OR	Organic Content
SC	Soil Core	GR	Gravel
BS	Block Sample	SA	Sand
WH	Weight of Rods & Hammer	SI	Silt
WR	Weight of Rods	CL	Clay

Bedrock

TCR	Total Core Recover	VN	Vein
SCR	Solid Core Recovery	CO	Contact
FI	Fracture Frequency Index	KV	Karstic Void
HQ	Rock Core (63.5 mm dia.)	MB	Mechanical Break
NQ	Rock Core (47.6 mm dia.)	PL	Planar
BQ	Rock Core (36.5 mm dia.)	CU	Curved
JN	Joint	UN	Undulating
FLT	Fault	IR	Irregular
SH	Shear	SM	Smooth
SK	Slickensided	SR	Slightly Rough
BD	Bedding	R	Rough
FO	Foliation	VR	Very rough

IN SITU SOIL TESTING

Standard Penetration Test (SPT) "N" value is the number of blows required to drive a 51 mm OD split barrel sampler into the soil a distance of 300 mm with a 63.5kg weight free falling a distance of 760 mm after an initial penetration of 150 mm has been achieved.

Dynamic Cone Penetration Test (DCPT) is the number of blows required to drive a cone with a 60-degree apex attached to "A" size drill rods continuously into the soil for each 300 mm penetration with a 63.5 kg weight free falling a distance of 760 mm.

Cone Penetration Test (CPT) is an electronic cone point with a 10 cm base area with a 60-degree apex pushed through the soil at a penetration rate of 2cm/s.

Field Vane Test (FVT) consists of a vane blade, a set of rods and torque measuring apparatus used to determine the undrained shear strength of cohesive soils.

SOIL DESCRIPTIONS

The soil descriptions and classifications are based on an expanded Unified Soil Classification System (USCS). The USCS classifies soils on the basis of engineering properties. The system divides soils into three major categories: coarse grained, fine grained and highly organic soils. The soil is then subdivided based on either gradation or plasticity characteristics. The classification excludes particles larger than 75 mm. To aid in quantifying material amounts by weight within the respective grain size fractions, the following terms have been included to expand the USCS:

Soil Classification		Terminology	Proportion
Clay	<0.002 mm	"trace", sand, etc.	1% to 10%
Silt	0.002 to 0.06 mm	"some"	10% to 20%
Sand	0.075 to 4.75 mm	Sandy, Gravelly, etc.	20% to 35%
Gravel	4.751 to 75 mm	"and" SAND, SILT, (non-cohesive)	>35%
Cobbles	75 to 300 mm	"with" SAND, SILT, (cohesive)	>35%
Boulders	>300 mm		

Notes:

1. Soil properties, such as strength, gradation, plasticity, structure, etc., dictate the soils engineering behaviour over the grain size fractions;
2. With the exception of soil samples tested for grain size distribution or plasticity, all soil sample classifications are based on visual and tactile observations and, therefore, constitute an approximate description.

The following table outlines the qualitative terms used to describe the relative density condition of cohesionless soils related to the SPT "N" value:

Cohesionless Soils

Compactness	SPT "N" Value (blows/30cm)
Very Loose	0 to 4
Loose	5 to 10
Compact	11 to 30
Dense	31 to 50
Very Dense	>50

The following table outlines the qualitative terms used to describe the consistency of cohesive soils related to undrained shear strength and SPT "N" value:

Cohesive Soils

Consistency	Undrained Shear Strength (kPa)	SPT "N" Value (blows/30 cm)
Very Soft	<12.5	< 2
Soft	12.5 to 25	2 to 4
Firm	25 to 50	5 to 8
Stiff	50 to 100	9 to 15
Very Stiff	100 to 200	16 to 30
Hard	> 200	>30

Note: Utilizing the SPT "N" value to correlate the consistency and undrained shear strength of cohesive soils is very approximate and needs to be used with caution.

Particle Sizes

Constituent	Description	Size (mm)	Size (in)
BOULDERS	Not Applicable	>300	>12
COBBLES	Not Applicable	75 to 300	3 to 12
GRAVEL	Coarse Fine	19 to 75 4.75 to 19	0.75 to 3 (4) to 0.75
SAND	Coarse Medium Fine	2.00 to 4.75 0.425 to 2.00 0.075 to 0.425	(10) to (4) (40) to (10) (200) to (40)
SILT/CLAY	Classified by Plasticity	< 0.075	< (200)

Note: Brackets () indicate US Standard Sieve Size Number

ROCK CORING

Rock Quality Designation (RQD) is an indirect measure of the number of fractures within a rock mass, Deere et al. (1967). It is the sum of sound pieces of rock core equal to or greater than 100 mm recovered from the core run, divided by the total length of the core run, expressed as a percentage. If the core section is broken during coring or handling, the pieces are fitted together and, if 100 mm or greater included in the total sum.

Intact Rock Strength

Intact Strength (MPa)	Description
< 1	Extremely low strength
1 to 5	Very low strength
5 to 25	Low strength
25 to 50	Medium strength
50 to 100	High strength
100 to 250	Very high strength
>250	Extremely high strength

Rock Mass Quality

RQD Classification	RQD Value (%)
Very Poor Quality	<25
Poor Quality	25 to 50
Fair Quality	50 to 75
Good Quality	75 to 90
Excellent Quality	90 to 100

Rock Mass Weathering

Term	Description
Unweathered (Fresh)	No visible sign of material weathering and slight discoloration on major discontinuity surfaces.
Slightly Weathered	Discoloration indicates the weathering of rock material and discontinuity of surfaces. All of the rock material may be discoloured by weathering and may be somewhat weaker than its fresh condition.
Moderately Weathered	Less than half the rock material is decomposed and/or disintegrates to soil. Fresh or discoloured rock is present either as a continuous framework of as core stones.
Highly Weathered	More than half the rock material is decomposed and/or disintegrated to soil. Fresh or discoloured rock is present either as a discontinuous framework or as core stones.
Completely Weathered	All rock material is decomposed and/or disintegrated to soil. The original mass structure is largely intact.
Residual Soil	All rock material is converted to soil. The mass structure and material fabric are destroyed. There is a large change in volume, but the soil has not been significantly transported.

Joint and Foliation Spacing

Description	Spacing
Very Wide	Greater than 3 m
Wide	1 m to 3 m
Moderately Close	0.3 m to 1 m
Close	50 mm to 300 mm
Very Close	Less than 50 mm

Bedding Thickness

Description	Spacing
Very thick	Greater than 2 m
Thick	0.6 m to 2 m
Medium	0.2 m to 0.6 m
Thin	60 mm to 0.2 m
Very thin	20 mm to 60 mm
Laminated	6 to 20 mm
Thinly Laminated	Less than 6 mm

SYMBOLS

General

w_N	Natural water content within the soil sample
γ	Unit weight
γ'	Effective unit weight
γ_D	Dry unit weight
γ_{SAT}	Saturated unit weight
ρ	Density
ρ_s	Density of solid particles
ρ_w	Density of water
ρ_D	Dry density
ρ_{SAT}	Saturated density
e	Void ratio
n	Porosity
S	Degree of saturation
E_{50}	Fifty percent secant modulus

Consistency

w_L	Liquid Limit
w_P	Plastic Limit
I_P	Plasticity Index
w_S	Shrinkage Limit
I_L	Liquidity Index
I_C	Consistency Index
e_{max}	Void ratio in loosest state
e_{min}	Void ratio in densest state
I_D	Density Index (formerly relative density)

Shear Strength

S_u	Undrained shear strength parameter (total stress)
c'	Effective cohesion intercept
ϕ'	Effective friction angle
τ_P	Peak shear strength
τ_R	Residual shear strength
δ	Angle of interface friction
μ	Coefficient of friction = $\tan \phi'$

Consolidation

C_c	Compression index (normally consolidated range)
C_r	Recompression index (over consolidated range)
m_v	Coefficient of volume change
c_v	Coefficient of consolidation
T_v	Time factor (vertical direction)
U	Degree of consolidation
σ'_v	Effective overburden pressure
OCR	Overconsolidation ratio

PHOTOGRAPH LOG



Photo 1: General Site Conditions During Investigation.



Photo 2: General Site Conditions During Investigation.

CLIENT

Township of Strong

PROJECT

Pool Lake Culvert Replacement - Geotechnical Rock Probe Investigation

CONSULTANT



YYYY-MM-DD 2026-06-26

PREPARED JL

REVIEWED JM

APPROVED GL

TITLE

RP-26-01
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FIGURE
1



Photo 3: General Site Conditions During Investigation.

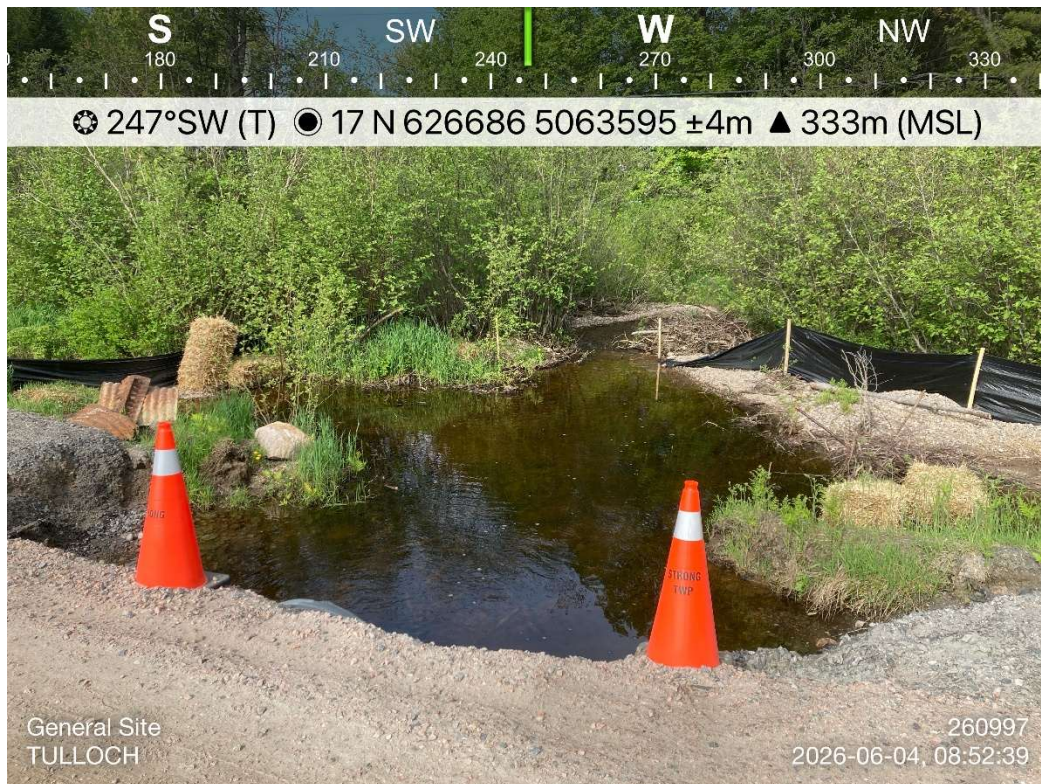


Photo 4: General Site Conditions During Investigation.

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FIGURE
2



Photo 5: General Site Conditions During Investigation.



Photo 6: General Site Conditions During Investigation.

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FIGURE
3



Photo 7: General Site Conditions During Investigation.

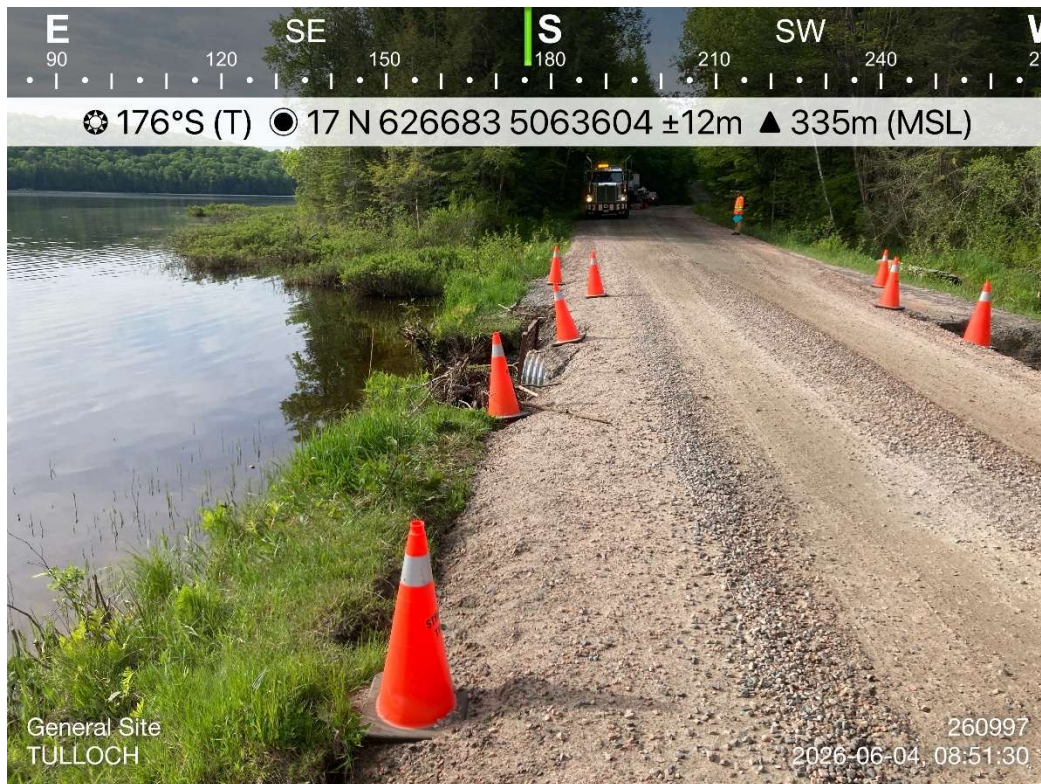


Photo 8: General Site Conditions During Investigation.

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FIGURE
4

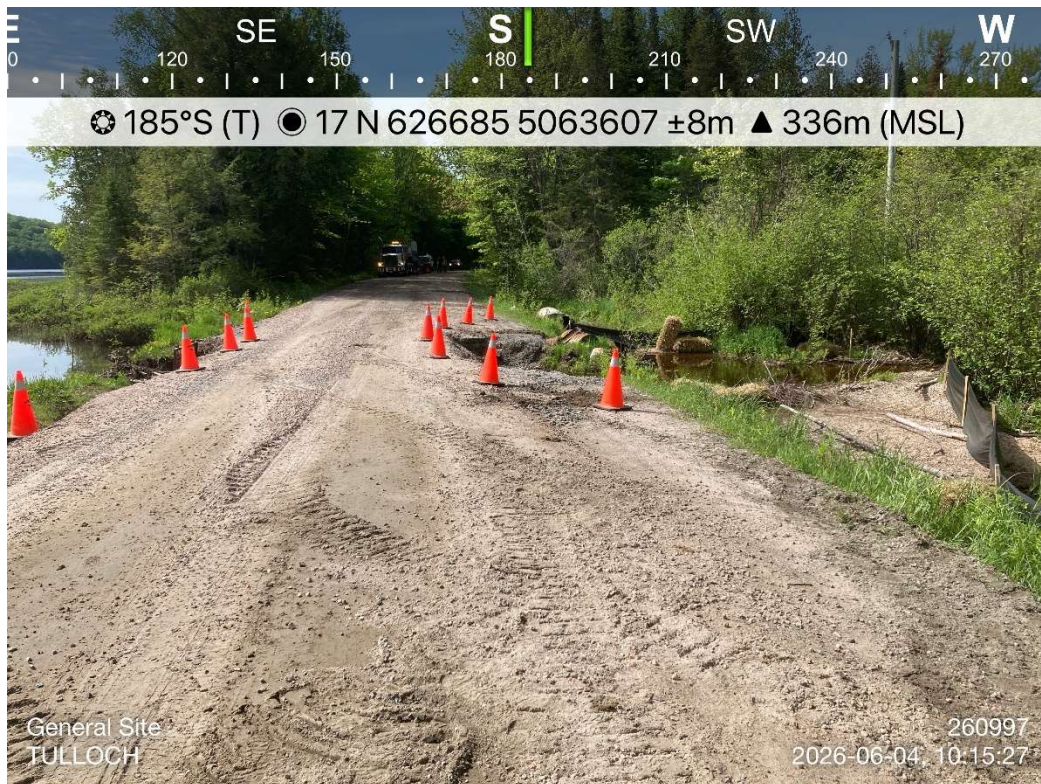


Photo 9: General Site Conditions During Investigation.



Photo 10: General Site Conditions During Investigation.

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FIGURE
5



Photo 11: RP-26-01 After Advancement.



Photo 12: RP-26-01 Backfilled and Completed

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FIGURE
6



Photo 13: RP-26-02 Advancement.



Photo 14: RP-26-02 Backfilled and Completed

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FIGURE
7



Photo 15: RP-26-03 Advancement.



Photo 16: RP-26-03 Backfilled and Completed

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FIGURE
8



Photo 17: RP-26-04 Advancement.



Photo 18: RP-26-04 Backfilled and Completed

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FIGURE
9



Photo 19: RP-26-05 Advancement.



Photo 20: RP-26-05 Backfilled and Completed

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FIGURE
10



Photo 21: RP-26-06 Advancement.



Photo 22: RP-26-06 Backfilled and Completed

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FIGURE
11



Photo 23: RP-26-07 Advancement.



Photo 24: RP-26-07 Backfilled and Completed

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FIGURE
12

ROCK PROBE LOGS



RECORD OF BOREHOLE No RP-26-02

1 OF 1

METRIC

JOB NUMBER 260997 LOCATION North Bound Lane, South Lake Bernard Road South, Sundridge, ON ORIGINATED BY JL

CLIENT Township of Strong DATUM Ground Surface BOREHOLE TYPE Percussion Rock Drill COMPILED BY JL

DRILLER Rock Breakers (2007) Inc. DATE 2026.06.04 NORTHING 5063574 EASTING 626683 CHECKED BY JM

SOIL PROFILE			SAMPLES				GROUND WATER CONDITIONS	DEPTH (M)	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	RECOVERY RATIO (%)			SHEAR STRENGTH kPa					W _p	W	W _L	
								20	40	60	80	100					
0.00	FILL - (SW) Gravelly SAND, fine to coarse sand and gravel, trace to some non-plastic fines, grey to dark brown, non-cohesive, moist to wet																
1.37	BOULDER																
1.83	(ML) SILT, non-plastic, trace fine sand, grey, wet																
4.57	BOULDER																
5.49	(ML) SILT, non-plastic, trace fine sand, grey, wet																
9.14	END OF ROCK PROBE LOG - TARGET DEPTH ACHIEVED Notes: - Rock probe terminated at 9.14 mbgs upon completion. - No soil or rock samples could be obtained due to the type of drill equipment used. - Lithology estimated based on visual and audible observations made to infer the subsurface conditions. - Bedrock not encountered. - Rock probe backfilled with cuttings.																

200 + : Numbers refer to Field Vane Over Limit + 3, X 3: Numbers refer to Sensitivity O 3% STRAIN AT FAILURE

2. SOIL REPORT+REC. (DEPTH) 260997 PROJECT FILE.GPJ ONTARIO MTO.GDT 26-7-30



RECORD OF BOREHOLE No RP-26-04

1 OF 1

METRIC

JOB NUMBER 260997 LOCATION North Bound Lane, South Lake Bernard Road South, Sundridge, ON ORIGINATED BY JL
CLIENT Township of Strong DATUM Ground Surface BOREHOLE TYPE Percussion Rock Drill COMPILED BY JL
DRILLER Rock Breakers (2007) Inc. DATE 2026.06.04 NORTHING 5063589 EASTING 626680 CHECKED BY JM

SOIL PROFILE			SAMPLES				GROUND WATER CONDITIONS	DEPTH (M)	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	RECOVERY RATIO (%)			SHEAR STRENGTH kPa ○ POCKET PEN + FIELD VANE ● QUICK TRIAXIAL × LAB VANE								
0.00	FILL - (SW) Gravelly SAND, fine to coarse sand and gravel, trace to some non-plastic fines, grey to dark brown, non-cohesive, moist to wet																
1.83	(SM) SILTY SAND, fine to coarse grained, grey to brown, non-cohesive, moist																
4.57	(ML) SILT, non-plastic, trace fine sand, grey, wet																
7.01	BOULDER																
7.62	(ML) SILT, non-plastic, trace fine sand, grey, wet																
9.14	END OF ROCK PROBE LOG - TARGET DEPTH ACHIEVED Notes: - Rock probe terminated at 9.14 mbgs upon completion. - No soil or rock samples could be obtained due to the type of drill equipment used. - Lithology estimated based on visual and audible observations made to infer the subsurface conditions. - Bedrock not encountered. - Rock probe backfilled with cuttings.																

2. SOIL REPORT+REC. (DEPTH) 260997 PROJECT FILE GPJ ONTARIO MTO.GDT 26-7-30

200 + : Numbers refer to Field Vane Over Limit + 3, × 3: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE



RECORD OF BOREHOLE No RP-26-05

1 OF 1

METRIC

JOB NUMBER 260997 LOCATION North Bound Lane, South Lake Bernard Road South, Sundridge, ON ORIGINATED BY JL

CLIENT Township of Strong DATUM Ground Surface BOREHOLE TYPE Percussion Rock Drill COMPILED BY JL

DRILLER Rock Breakers (2007) Inc. DATE 2026.06.04 NORTHING 5063594 EASTING 626679 CHECKED BY JM

SOIL PROFILE			SAMPLES				GROUND WATER CONDITIONS	DEPTH (M)	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	RECOVERY RATIO (%)			SHEAR STRENGTH kPa								
								20	40	60	80	100					
0.00	FILL - (SW) Gravelly SAND, fine to coarse sand and gravel, trace to some non-plastic fines, grey to dark brown, non-cohesive, moist to wet																
1.83	(SM) SILTY SAND, fine to coarse grained, brown, non-cohesive, moist																
5.79	BEDROCK																
9.14	END OF ROCK PROBE LOG - TARGET DEPTH ACHIEVED Notes: - Rock probe terminated at 9.14 mbgs upon completion. - No soil or rock samples could be obtained due to the type of drill equipment used. - Lithology estimated based on visual and audible observations made to infer the subsurface conditions. - Bedrock encountered at 5.79 mbgs. - Rock probe backfilled with cuttings.																

2. SOIL REPORT+REC. (DEPTH) 260997 PROJECT FILE GPJ ONTARIO MTO.GDT 26-7-30

200 + : Numbers refer to Field Vane Over Limit + 3, X 3: Numbers refer to Sensitivity O 3% STRAIN AT FAILURE



RECORD OF BOREHOLE No RP-26-06

1 OF 1

METRIC

JOB NUMBER 260997 LOCATION North Bound Lane, South Lake Bernard Road South, Sundridge, ON ORIGINATED BY JL

CLIENT Township of Strong DATUM Ground Surface BOREHOLE TYPE Percussion Rock Drill COMPILED BY JL

DRILLER Rock Breakers (2007) Inc. DATE 2026.06.04 NORTHING 5063597 EASTING 626679 CHECKED BY JM

SOIL PROFILE			SAMPLES				GROUND WATER CONDITIONS	DEPTH (M)	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	RECOVERY RATIO (%)			SHEAR STRENGTH kPa								
								20	40	60	80	100					
0.00	FILL - (SW) Gravelly SAND, fine to coarse sand and gravel, trace to some non-plastic fines, grey to dark brown, non-cohesive, moist to wet																
1.83	(SM) SILTY SAND, fine to coarse grained, brown, non-cohesive, moist																
5.18	BEDROCK																
9.14	END OF ROCK PROBE LOG - BEDROCK ENCOUNTERED Notes: - Rock probe terminated at 9.14 mbgs upon completion. - No soil or rock samples could be obtained due to the type of drill equipment used. - Lithology estimated based on visual and audible observations made to infer the subsurface conditions. - Bedrock encountered at 5.18 mbgs. - Rock probe backfilled with cuttings.																

2. SOIL REPORT+REC. (DEPTH) 260997 PROJECT FILE GPJ ONTARIO MTO.GDT 26-7-30

200 + : Numbers refer to Field Vane Over Limit + 3, X 3: Numbers refer to Sensitivity O 3% STRAIN AT FAILURE

NOTICE TO READER

NOTICE TO READER

This Memorandum has been prepared by TULLOCH Engineering Inc. ('TULLOCH') for the sole and exclusive use of Township of Strong (the 'Client') to support design for the Pool Lake Culvert Replacement (the 'Development') located at the Pool Lake culvert just south of 1202 South Bernard Lake Road (the 'Site'). The Memorandum shall not be used for any other purpose, or provided to, relied upon or used by any third party without the express written consent of TULLOCH.

A limited number of rock probes were advanced at the Site; and as such, the information collected and presented herein applies to the rock probe locations only. The subsurface conditions between rock probes can change and accordingly any use of the data contained in this Memorandum should take into consideration the nature of the materials and potential variation between rock probes.

This Memorandum contains opinions, conclusions and recommendations made by TULLOCH using professional judgment and reasonable care for the purpose of foundation design for the Development. Use of or reliance on this memorandum by the Client is subject to the following conditions:

- a) the memorandum being read in the context of and subject to the terms of the Engineering Services Agreement for the Work, including any methodologies, procedures, techniques, assumptions and other relevant terms or conditions specified or agreed therein;
- b) the memorandum being read in its entirety. TULLOCH is not responsible for the use of portions of the memorandum without reference to the entire memorandum;
- c) the conditions of the site may change over time or may have already changed due to natural forces or human intervention, and TULLOCH takes no responsibility for the impact that such changes may have on the accuracy or validity of the observations, conclusions and recommendations set out in this memorandum;
- d) the classification of soils and rocks in this memorandum is based on commonly accepted methods. However, the classification of geologic materials and the boundaries between subsurface layers involves judgement. Boundaries between different soils layers may also be transitional rather than abrupt. TULLOCH does not warrant or guarantee the exactness of these descriptions and boundaries.
- e) the subsurface conditions must be verified by a qualified geotechnical engineer during construction to ensure that the rock probe data presented herein is representative of the actual site conditions so that the design recommendations contained herein remain valid; and
- f) the memorandum is based on information made available to TULLOCH by the Client or by certain third parties; and unless stated otherwise in the Agreement, TULLOCH has not verified the accuracy, completeness or validity of such information, makes no representation regarding its accuracy and hereby disclaims any liability in connection therewith.

This Memorandum has been prepared with the degree of care, skill and diligence normally provided by engineers in the performance of comparable services for projects of similar nature. The scope of this memorandum includes foundation engineering design only and it specifically excludes investigation, detection, prevention and assessment of the presence of subsurface contaminants. No conclusions or inferences should be drawn regarding contamination at the site including but not limited to molds, fungi, spores, bacteria, viruses, soil gases such as Radon, PCBs, petroleum hydrocarbons, inorganic and volatile organic compounds, polycyclic aromatic hydrocarbons and or any by products thereof.