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Project No. 18106595 Rev. 2

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ADDENDUM NO. 1 – GEOTECHNICAL INVESTIGATION
PROPOSED SITE REDEVELOPMENT
WESTGATE MALL PHASE 1
OTTAWA, ONTARIO

1.0 INTRODUCTION

This letter serves as an addendum to, and provides additional information and clarifications to, Golder Associates Ltd.'s (Golder's) geotechnical report numbered 18106595-1000, titled "*Geotechnical Investigation report, Proposed Site Redevelopment, Westgate Mall Phase 1, Ottawa, Ontario*", dated November 2018. In this regard, this letter should be read in conjunction with the contents of the original geotechnical report including the "Important Information and Limitations" document included as part of that report.

2.0 DESCRIPTION OF PROJECT AND SITE

Currently, the site is occupied by the Westgate Mall which is an "L" shaped commercial retail building located on the north and west sides of the property and a stand-alone restaurant building located at the south east corner of the site.

At this time, only Phase 1 of the redevelopment plans, which consists of a single building to be located in the southeast corner of the site (as shown on Figure 1), is being considered for construction. The Phase 1 development area is currently occupied by a parking lot and a single-storey restaurant.

The plans and information provided by RioCan indicate that the Phase 1 building will consist of a 24 storey tower and 4 storey podium with two levels of underground parking as well as an asphalt surfaced parking. The building will be approximately rectangular in shape. The ground floor of the podium will be rectangular in shape. Levels 2 to 4 of the podium will be a smaller "L" shaped structure on top of the ground floor. The tower will be approximately rectangular in shape and will sit on top of the larger "L" shaped podium.

3.0 FIELDWORK PROCEDURE

An additional fieldwork investigation was carried out in order to better delineate the bedrock surface in support of the detailed design.

The additional fieldwork for this investigation was carried out between April 29 and May 8, 2019. During that time, a total of 9 boreholes (numbered 19-01A to 19-08, inclusive) were advanced at the approximate locations shown on the attached Site Plan (Figure 1). The boreholes were advanced using a truck-mounted hollow-stem auger drill rig supplied and operated by Marathon Drilling, Ontario. The boreholes were advanced to depths ranging from between about 10.7 and 17.7 metres below the existing ground surface. Practical refusal to auger advancement was encountered in all boreholes except borehole 19-01A. The remaining boreholes were then extended into the bedrock using rotary diamond drilling techniques while retrieving NQ sized core. Within these boreholes, the drilled lengths in the bedrock were between 1.5 and 3.3 metres.

Standard penetration tests were carried out within the overburden at regular intervals of depth. Samples of the soils encountered were recovered using 35 millimetre inside diameter split-spoon sampling equipment. Grab samples of the existing pavement structure were also collected from selected boreholes.

The fieldwork was supervised by technicians from our staff who located the boreholes, directed the drilling and in-situ testing operations, logged the boreholes and samples, and took custody of the soil and bedrock samples retrieved. On completion of the drilling operations, the soil and bedrock samples were transported to our laboratory for further examination by the project engineer.

The borehole locations were selected in consultation with RioCan, marked in the field, and subsequently surveyed by Golder Associates personnel. The borehole coordinates and ground surface elevations were measured using a Trimble R8 GPS survey unit. The geodetic reference system used for the survey is the North American datum of 1983 (NAD83). The borehole coordinates are based on the Modified Transverse Mercator (MTM Zone 9) coordinate system. The elevations are referenced to Geodetic datum (CGVD28).

4.0 SUBSURFACE CONDITIONS

4.1 General

Information on the subsurface conditions is presented as follows:

- Record of Borehole and Drillhole Sheets from the current investigation are provided in Appendix A.
- Results of Hydraulic Conductivity Testing are provided in Appendix B.
- Core Photos are provided in Appendix C.

In general, the subsurface stratigraphy within the area of the investigation consists of surficial fill materials (including fill associated with the parking lot pavement structure) overlying silty clay which is generally underlain by glacial till over limestone bedrock.

The Record of Borehole sheets describe the subsurface conditions at the borehole locations only.
The stratigraphic boundaries shown on the borehole records are inferred from non-continuous sampling in some cases, observations of drilling progress as well as results of Standard Penetration Tests (SPTs) and, therefore, represent transitions between soil types rather than exact planes of geological change. Furthermore, subsurface soil, bedrock and groundwater conditions will vary between and beyond the borehole locations.

The following sections provides a more detailed description of each soil layer encountered in the boreholes from the current investigation only.

4.2 Pavement Structure / Fill

Asphaltic concrete was encountered at all the boreholes; the thickness of the asphaltic concrete (Pavement structure), where encountered, is provided in the table below.

Fill was encountered in each of the boreholes. The upper portion of the fill generally consists of granular pavement structure comprised predominantly of variable amounts of sand, silt, and gravel. In some of the boreholes, the lower portion of the fill consists of grey brown to black silty clay. The presence of organic matter was observed in the silty clay fill in boreholes 19-01A, 19-02, 19-04, and 19-08. The depth to the bottom of the fill at each of the borehole locations is also provided in the table below.

Borehole No.	Asphalt Thickness (mm)	Depth to Bottom of Fill Material(1) (m)
19-01A	150	1.5
19-02	90	3.1
19-03	200	3.1
19-04	90	2.7
19-05	150	3.1
19-06	150	3.1
19-07	150	1.5
19-08	80	1.5

(1) Depth measured from the existing ground surface at time of the investigation.

SPT “N” values measured within the fill ranged from 4 to 41 blows per 0.3 metres of penetration, indicating a variable, very loose to dense state of packing.

4.3 Silty Clay to Clay

At all of the borehole locations, the pavement structure and fill are underlain by a deposit of sensitive marine silty clay from the previous Champlain Sea that covered most of the Ottawa area.

The upper portion of the deposit in boreholes 19-01A, 19-07, and 19-08 is generally brown to grey brown in colour (i.e., weathered) and extends to a depth of about 3.1 metres below existing ground surface. SPT ‘N’ values measured within the weathered curst range from between about 4 and 14 blows per 0.3 metres of penetration were obtained within the weathered crust portion of the silty clay deposit.

Below the weathered crust in boreholes 19-01A, 19-07, and 19-08, and below the fill at the remaining boreholes, the silty clay is grey in colour. The unweathered silty clay deposit extends to depths ranging from between about 3.7 and 4.6 metres below the existing ground surface.

4.4 Glacial Till

At all of the boreholes, a deposit of glacial till was encountered beneath the silty clay and extends to depths of between about 7.6 and 15.7 metres below ground surface. The glacial till typically consists of a heterogeneous mixture of gravel, cobbles, and boulders in a matrix of sand and silt with a trace to some clay.

Standard Penetration tests carried out within the glacial till gave SPT ‘N’ values ranging from between about 3 blows per 0.3 metres of penetration to greater than 104 blows per 0.3 metres of penetration indicating a variable, very loose to very dense state of packing; however, the higher blow counts may be indicative of the presence of boulders and cobbles in the till rather than the state of packing. The lower blow counts have likely been affected by the drilling technique (i.e., hollow stem augers below the water table).

4.5 Bedrock

Boreholes 19-01B to 19-08 were extended through the glacial till deposit into the underlying bedrock using rotary diamond drilling techniques. The depths and elevations to bedrock surface are summarized below:

Borehole No.	Ground Surface Elevation (masl)	Depth to Bedrock (m)	Elevation of Bedrock (masl)
19-01B	74.55	15.66	58.89
19-02	74.60	14.07	60.53
19-03	74.67	14.95	59.72
19-04	74.62	12.14	62.48
19-05	74.75	12.32	62.43
19-06	74.57	8.71	65.86
19-07	74.81	9.56	65.25
19-08	74.90	7.57	67.33

Recovered bedrock cores from these locations consist of fresh, thinly to medium bedded, grey, fine grained limestone bedrock with shale partings and occasional nodular sections.

The Total Core Recovery (TCR) of the cored bedrock ranged between 90 and 100 percent and the Rock Quality Designation (RQD) ranged from about 35 to 100 percent, indicating a poor to excellent quality rock.

4.6 Groundwater Conditions

A monitoring well was installed in borehole 19-08. The groundwater level was measured on May 28, 2019. The following table summarizes the measured groundwater level and hydraulic conductivities in the following table:

Borehole	Geological Material Well Installed In	Groundwater Depth on May 28, 2019 (mbgs)	Groundwater Elevation on May 28, 2019 (m)	Hydraulic Conductivity on May 28, 2019 (cm/s)
19-08	Bedrock	4.47	70.43	$2x10^{-3}$

It should be noted that groundwater levels are expected to fluctuate seasonally. Higher groundwater levels are expected during wet periods of the year, such as spring.

5.0 DISCUSSION AND RECOMMENDATIONS

5.1 Caisson Foundations

As an alternative to driven pile foundations noted in the geotechnical report, the proposed buildings can be supported on caisson foundations socketed into the limestone bedrock. The use of liners or casings will be required in order to advance the caissons through the overburden with minimal loss of ground. The casings should be extended so that they are “seated” a minimum of 500 mm into the bedrock.

Casing installation through the glacial till containing cobbles and boulders will be difficult. Churn drilling and possibly rock coring techniques will be required to advance the caissons through the glacial till.

5.1.1 Axial Geotechnical Resistance

Due to the relatively high water table and the difficulty in socketing liners into the bedrock to completely cut off the water infiltrations, it may not be feasible to dewater and clean the base of the caisson and, as such, end-bearing support may not be developed. The axial geotechnical resistance for rock socketed caissons is therefore recommended to be based primarily on the side-wall (shaft) resistance of the rock socket rather than end-bearing.

Rock-socketed caissons should be designed based on the side-wall (shaft) resistance of the rock socket and a factored geotechnical resistance at ULS of 2,000 kPa, provided that the caisson socket is within competent bedrock (i.e., RQD greater than 75 percent). This value assumes that the side wall of the socket will be cleaned of any cuttings or smeared material.

Due to the relatively high water table and the potential difficulty in socketing a liner into the bedrock, it may not be possible to dewater and adequately clean the base of the caisson and, as such, end-bearing support should not be used. Also, due to the highwater table, the placement of concrete should be done by using tremie method during caisson construction. The concrete for each caisson must be poured continuously to avoid formation of clod joints within the caissons.

To provide full fixity, the caissons should be provided with a minimum socket length equal to 2 times the caisson diameter. The structural engineer should check that the shear strength of the concrete is adequate to support these loads.

SLS resistances do not apply to caissons founded within the limestone bedrock, because the SLS resistance for 25 mm of settlement is greater than the factored axial geotechnical resistance at ULS.

To reduce damage to the rock between two adjacent caissons during construction, it is recommended to maintain a minimum distance of 2 times diameters edge to edge, or minimum 2 metres, whichever is greater, between the caissons.

Post-construction inspection including Cross Sonic Logging (CSL) should be carried out on all installed caissons in accordance with ASTM D6760. The testing should be carried out no sooner than 3 calendar days subsequent to concrete placement, but within 45 days after concrete placement.

Caissons construction must be monitored by a qualified geotechnical engineer or his/her representative at all time.

5.2 Dewatering Area of Influence

Two levels of underground garage parking would extend about 9 metres below the existing ground surface. Accordingly, excavation to these depths will be through surficial fill and into the underlying native silty clay and glacial till, and into the bedrock in the eastern half of the site (i.e., in the vicinity of boreholes 18-02, 19-06 and 19-08). Measurements taken during the current investigation suggest that the groundwater level is generally at about 4-5 metres depth below ground surface, and within the glacial till deposit. The excavation will therefore be below the measured groundwater level, acknowledging that higher groundwater levels could exist during wet periods of the year.

The radius of influence for the excavation for steady-state flow was estimated to be approximately 40 metres from the excavation in locations where bedrock is encountered. In the western portion of the site where the bedrock is not anticipated to be encountered in the excavation, the radius of influence is estimated to be approximately 15 metres, based on the hydraulic conductivity of the glacial till ($6x10^{-7}$ m/s) and the anticipated depth of groundwater lowering.

The potential groundwater inflow to the excavation was calculated assuming radial flow in a confined aquifer. To account for potentially seasonally-higher water levels, the initial groundwater elevation was assumed to be 70.9 metres (i.e., 0.5 metres higher that the groundwater level measured at borehole 18-09) and it was assumed that the excavation would be dewatered to a depth of 9 metres (elevation 65.7 metres). The analytical solution was applied using the highest hydraulic conductivity values estimated for the bedrock ($2x10^{-5}$ m/s).
The steady-state (long term average) dewatering rate for the excavation is estimated to be approximately 200,000 L/day. Initial groundwater flows may be greater (up to 1,000,000 L/day), depending upon how the excavation and dewatering proceeds.

5.3 Permanent Drainage

The measured groundwater depth at the site is variable, but it is generally considered to be between about 2 to 5 metres below existing site grades. To manage the long term groundwater levels and the interaction with the proposed development, a drainage system diverting collected groundwater inflow to the sewer system is recommended. The volumes of water anticipated to be diverted to the municipal sewer system can be taken as the steady-state dewatering rate noted in Section 5.2 above.

The subfloor drainage system (i.e., below the lowest garage level) may consist of a network of robust sub-drain pipes conveying collected groundwater to a sump or sumps from which the groundwater can be pumped to a municipal sewer. The drainage system would consist of interconnected perforated drain pipes (bedded and backfilled with free draining granular soils) installed around the perimeter and within the building footprint.
The capacity of the subfloor drainage system should be modified during construction as required based on the estimated steady state groundwater inflow rates provided above. As a minimum, the subdrains should be spaced no greater than 6 metres apart, at a depth of at least 0.5 metres below the basement floor slab, and they should be bedded and backfilled with at least 150 millimetres of clear stone surround that is fully wrapped in geotextile.

Drainage, such as a composite synthetic drainage system or equivalent, should be provided to the exterior walls. The composite drain must withstand the design horizontal earth pressures used for basement wall design and should be connected to the basement level underslab drainage system. The drainage system collector pipes should drain to a sump for collection and discharge to a sewer.

6.0 CLOSURE

We trust that this report is sufficient for your present requirements. If you have any questions concerning this report, please feel free to contact the undersigned.

Yours truly,

Golder Associates Ltd.

LICENSED PROFESSIONAL ENGINEER
SG
S. L. GHADBANE
100184126
Aug 9/19
PROVINCE OF ONTARIO

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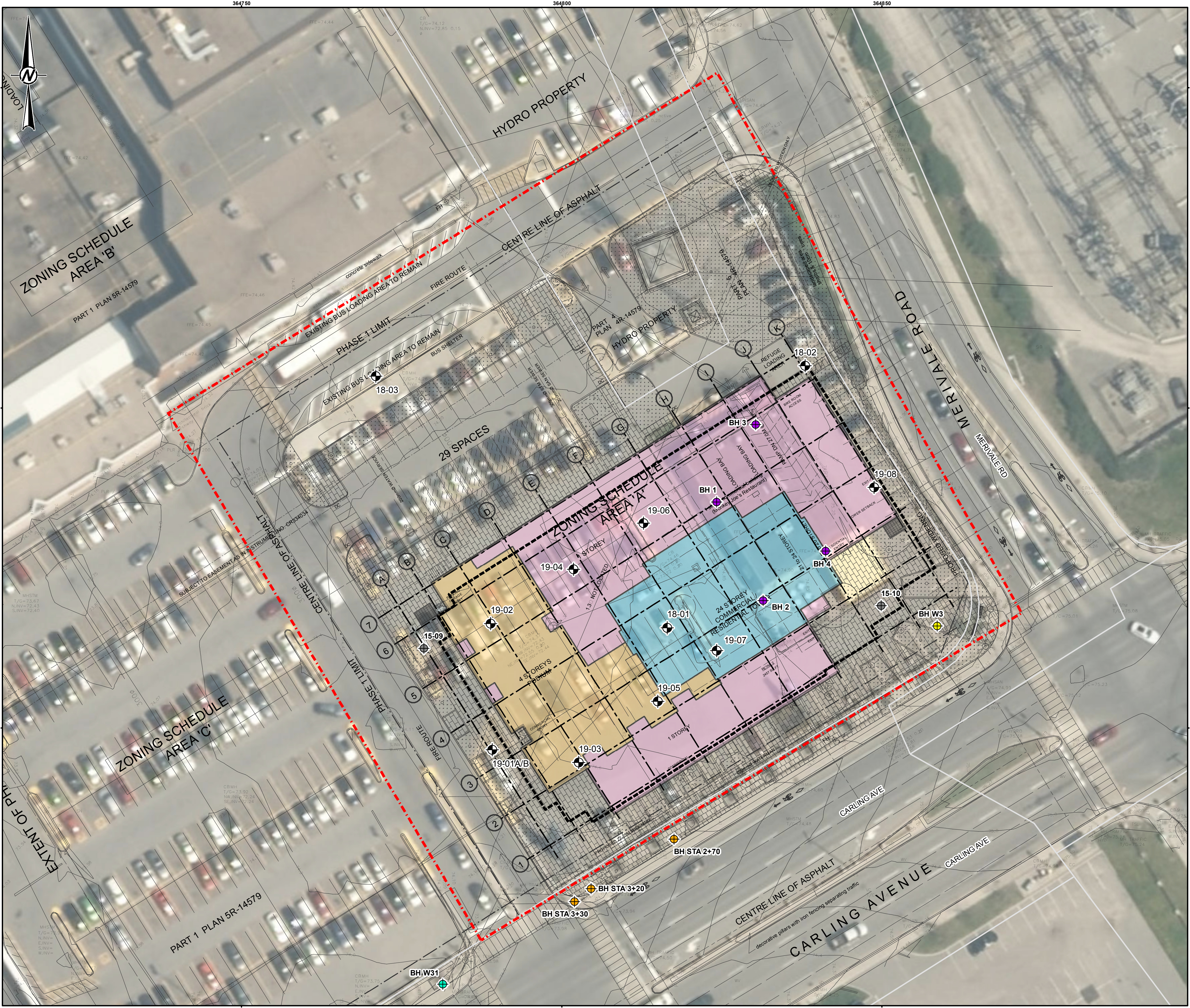
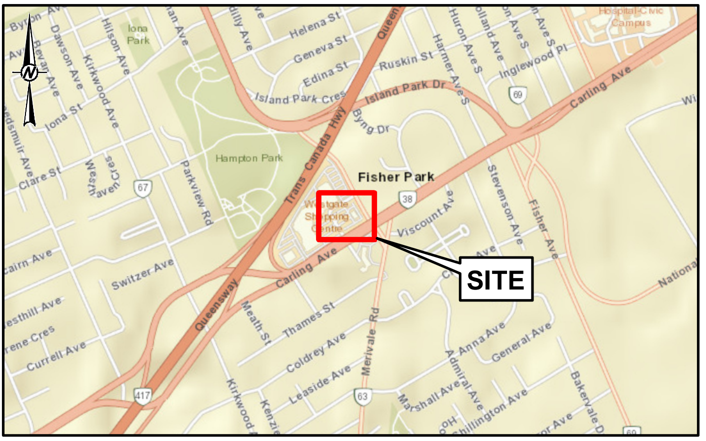
Senior Geotechnical Engineer

AKP/SG/NRL/mvrd
https://golderassociates.sharepoint.com/sites/30869g/deliverables/geotechnical report/addendum 1/18106595-001-l-rev2-addendum no 1-0908_19.docx

Attachments:	Figure 1	-	Site Plan
	Appendix A	-	List of Abbreviations and Symbols Lithological and Geotechnical Rock Description Terminology Record of Borehole and Drillhole Sheets
	Appendix B	-	Results of Hydraulic Conductivity Testing
	Appendix C	-	Core Photos



KEY MAP



SCALE 1:25,000

LEGEND

⊕	BOREHOLE LOCATION, CURRENT INVESTIGATION
⊕	APPROXIMATE BOREHOLE LOCATION, PREVIOUS INVESTIGATION (1522569)
⊕	APPROXIMATE BOREHOLE LOCATION, PREVIOUS INVESTIGATION (782032)
⊕	APPROXIMATE BOREHOLE LOCATION, PREVIOUS INVESTIGATION (762168)
⊕	APPROXIMATE BOREHOLE LOCATION, PREVIOUS INVESTIGATION (752031)
⊕	APPROXIMATE BOREHOLE LOCATION, PREVIOUS INVESTIGATION (70794)
▭	PHASE I SITE
▭	PROPOSED PHASE I BUILDING FOOTPRINT

PROPOSED BUILDING FOOTPRINT

🟪	1 STOREY
🟨	4 STOREY PODIUM
🟦	24 STOREY COMMERCIAL/RESIDENTIAL TOWER

NOTE(S)

1. ALL LOCATIONS ARE APPROXIMATE

REFERENCE(S)

1. LAND INFORMATION ONTARIO (LIO) DATA PRODUCED BY GOLDER ASSOCIATES LTD. UNDER LICENCE FROM ONTARIO MINISTRY OF NATURAL RESOURCES, © QUEENS PRINTER 2016
2. SERVICE LAYER CREDITS: SOURCES: ESRI, HERE, DELORME, USGS, INTERMAP, INCREMENT P CORP., NRCAN, ESRI JAPAN, METI, ESRI CHINA (HONG KONG), ESRI (THAILAND), MAPMYINDIA, © OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY
3. PROJECTION: TRANSVERSE MERCATOR, DATUM: NAD 83, COORDINATE SYSTEM: MTM ZONE 9, VERTICAL DATUM: CGVD28

0 5 10 20

1:600 METRES

CLIENT
RIOCAN MANAGEMENT INC.

PROJECT
DETAILED DESIGN GEOTECHNICAL INVESTIGATION PROPOSED SITE REDEVELOPMENT, PHASE I WESTGATE MALL SITE, OTTAWA, ONTARIO

TITLE
SITE PLAN

CONSULTANT
GOLDER

YYYY-MM-DD	2019-06-07
DESIGNED	SG
PREPARED	BR
REVIEWED	SG
APPROVED	NRL

PROJECT NO.	CONTROL	REV	FIGURE
18106595	0005	0	1

Path: N:\Active\Spatial_IM\RioCan_Management_Inc\Westgate\99_PROJ\18106595_RioCAN_DetDesGeoTInv\40_PROD\0005_BG_Geotech\18106595-0005-BG-0001.mxd

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM:
25mm
0

APPENDIX A

List of Abbreviations and Symbols
Lithological and Geotechnical Rock Description Terminology
Record of Borehole and Drillhole Sheets

LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY

WEATHERINGS STATE

Fresh: no visible sign of rock material weathering.

Faintly weathered: weathering limited to the surface of major discontinuities.

Slightly weathered: penetrative weathering developed on open discontinuity surfaces but only slight weathering of rock material.

Moderately weathered: weathering extends throughout the rock mass but the rock material is not friable.

Highly weathered: weathering extends throughout rock mass and the rock material is partly friable.

Completely weathered: rock is wholly decomposed and in a friable condition but the rock and structure are preserved.

BEDDING THICKNESS

Description	Bedding Plane Spacing
Very thickly bedded	Greater than 2 m
Thickly bedded	0.6 m to 2 m
Medium bedded	0.2 m to 0.6 m
Thinly bedded	60 mm to 0.2 m
Very thinly bedded	20 mm to 60 mm
Laminated	6 mm to 20 mm
Thinly laminated	Less than 6 mm

JOINT OR 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

GRAIN SIZE

Term	Size*
Very Coarse Grained	Greater than 60 mm
Coarse Grained	2 mm to 60 mm
Medium Grained	60 microns to 2 mm
Fine Grained	2 microns to 60 microns
Very Fine Grained	Less than 2 microns

Note: * Grains greater than 60 microns diameter are visible to the naked eye.

CORE CONDITION

Total Core Recovery (TCR)

The percentage of solid drill core recovered regardless of quality or length, measured relative to the length of the total core run.

Solid Core Recovery (SCR)

The percentage of solid drill core, regardless of length, recovered at full diameter, measured relative to the length of the total core run.

Rock Quality Designation (RQD)

The percentage of solid drill core, greater than 100 mm length, as measured along the centerline axis of the core, relative to the length of the total core run. RQD varies from 0% for completely broken core to 100% for core in solid segments.

DISCONTINUITY DATA

Fracture Index

A count of the number of naturally occuring discontinuities (physical separations) in the rock core. Mechanically induced breaks caused by drilling are not included.

Dip with Respect to Core Axis

The angle of the discontinuity relative to the axis (length) of the core. In a vertical borehole a discontinuity with a 90^{o} angle is horizontal.

Description and Notes

An abbreviation description of the discontinuities, whether naturally occurring separations such as fractures, bedding planes and foliation planes and mechanically separated bedding or foliation surfaces. Additional information concerning the nature of fracture surfaces and infillings are also noted.

Abbreviations

JN	Joint
FLT	Fault
SH	Shear
VN	Vein
FR	Fracture
SY	Stylolite
BD	Bedding
FO	Foliation
CO	Contact
AXJ	Axial Joint
KV	Karstic Void
MB	Mechanical Break

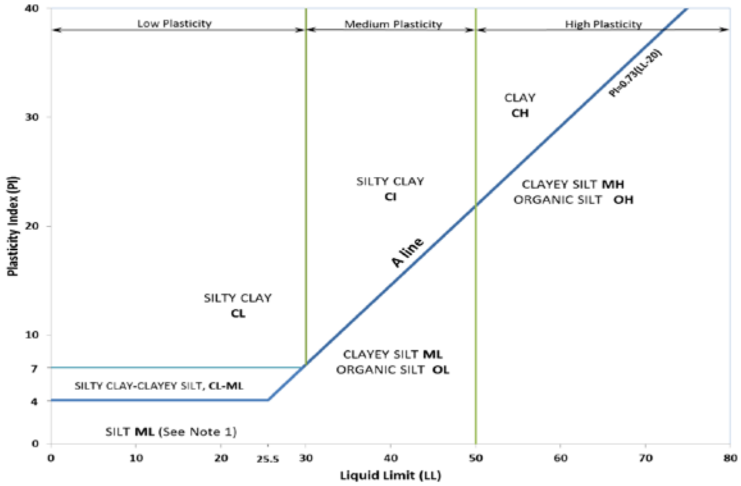
PL	Planar
CU	Curved
UN	Undulating
IR	Irregular
K	Slickensided
PO	Polished
SM	Smooth
SR	Slightly Rough
RO	Rough
VR	Very Rough

METHOD OF SOIL CLASSIFICATION

The Golder Associates Ltd. Soil Classification System is based on the Unified Soil Classification System (USCS)

Organic or Inorganic	Soil Group	Type of Soil		Gradation or Plasticity	$Cu = \frac{D_{60}}{D_{10}}$	$Cc = \frac{(D_{30})^2}{D_{10} x D_{60}}$	Organic Content	USCS Group Symbol	Group Name
INORGANIC (Organic Content ≤30% by mass)	COARSE-GRAINED SOILS (>50% by mass is larger than 0.075 mm)	GRAVELS (>50% by mass of coarse fraction is larger than 4.75 mm)	Gravels with ≤12% fines (by mass)	Poorly Graded	<4	≤1 or ≥3	≤30%	GP	GRAVEL
				Well Graded	≥4	1 to 3		GW	GRAVEL
			Gravels with >12% fines (by mass)	Below A Line	n/a			GM	SILTY GRAVEL
				Above A Line	n/a			GC	CLAYEY GRAVEL
		SANDS (≥50% by mass of coarse fraction is smaller than 4.75 mm)	Sands with ≤12% fines (by mass)	Poorly Graded	<6	≤1 or ≥3		SP	SAND
				Well Graded	≥6	1 to 3		SW	SAND
			Sands with >12% fines (by mass)	Below A Line	n/a			SM	SILTY SAND
				Above A Line	n/a			SC	CLAYEY SAND

Organic or Inorganic	Soil Group	Type of Soil	Laboratory Tests	Field Indicators					Organic Content	USCS Group Symbol	Primary Name
				Dilatancy	Dry Strength	Shine Test	Thread Diameter	Toughness (of 3 mm thread)			
INORGANIC (Organic Content ≤30% by mass)	FINE-GRAINED SOILS (≥50% by mass is smaller than 0.075 mm)	SILTS (Non-Plastic or PI and LL plot below A-Line on Plasticity Chart below)	Liquid Limit <50	Rapid	None	None	>6 mm	N/A (can't roll 3 mm thread)	<5%	ML	SILT
				Slow	None to Low	Dull	3mm to 6 mm	None to low	<5%	ML	CLAYEY SILT
				Slow to very slow	Low to medium	Dull to slight	3mm to 6 mm	Low	5% to 30%	OL	ORGANIC SILT
			Liquid Limit ≥50	Slow to very slow	Low to medium	Slight	3mm to 6 mm	Low to medium	<5%	MH	CLAYEY SILT
				None	Medium to high	Dull to slight	1 mm to 3 mm	Medium to high	5% to 30%	OH	ORGANIC SILT
		CLAYS (PI and LL plot above A-Line on Plasticity Chart below)	Liquid Limit <30	None	Low to medium	Slight to shiny	~ 3 mm	Low to medium	0% to 30% **(see Note 2)**	CL	SILTY CLAY
			Liquid Limit 30 to 50	None	Medium to high	Slight to shiny	1 mm to 3 mm	Medium		CI	SILTY CLAY
			Liquid Limit ≥50	None	High	Shiny	<1 mm	High		CH	CLAY
HIGHLY ORGANIC SOILS (Organic Content >30% by mass)		Peat and mineral soil mixtures							30% to 75%	PT	SILTY PEAT, SANDY PEAT
		Predominantly peat, may contain some mineral soil, fibrous or amorphous peat							75% to 100%		PEAT



Note 1 – Fine grained materials with PI and LL that plot in this area are named (ML) SILT with slight plasticity. Fine-grained materials which are non-plastic (i.e. a PL cannot be measured) are named SILT.

Note 2 – For soils with <5% organic content, include the descriptor "trace organics" for soils with between 5% and 30% organic content include the prefix "organic" before the Primary name.

Dual Symbol — A dual symbol is two symbols separated by a hyphen, for example, GP-GM, SW-SC and CL-ML.

For non-cohesive soils, the dual symbols must be used when the soil has between 5% and 12% fines (i.e. to identify transitional material between "clean" and "dirty" sand or gravel.

For cohesive soils, the dual symbol must be used when the liquid limit and plasticity index values plot in the CL-ML area of the plasticity chart (see Plasticity Chart at left).

Borderline Symbol — A borderline symbol is two symbols separated by a slash, for example, CL/CI, GM/SM, CL/ML.

A borderline symbol should be used to indicate that the soil has been identified as having properties that are on the transition between similar materials. In addition, a borderline symbol may be used to indicate a range of similar soil types within a stratum.

ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES AND TEST PITS

PARTICLE SIZES OF CONSTITUENTS

Soil Constituent	Particle Size Description	Millimetres	Inches (US Std. Sieve Size)
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)

MODIFIERS FOR SECONDARY AND MINOR CONSTITUENTS

Percentage by Mass	Modifier
>35	Use 'and' to combine major constituents (*i.e.,* SAND and GRAVEL)
> 12 to 35	Primary soil name prefixed with "gravelly, sandy, SILTY, CLAYEY" as applicable
> 5 to 12	some
≤ 5	trace

PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:
The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) required to drive a 50 mm (2 in.) split-spoon sampler for a distance of 300 mm (12 in.). Values reported are as recorded in the field and are uncorrected.

Cone Penetration Test (CPT)
An electronic cone penetrometer with a 60° conical tip and a project end area of 10 cm^2 pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance (q_t), porewater pressure (u) and sleeve frictions are recorded electronically at 25 mm penetration intervals.

Dynamic Cone Penetration Resistance (DCPT); N_d:
The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) to drive uncased a 50 mm (2 in.) diameter, 60° cone attached to "A" size drill rods for a distance of 300 mm (12 in.).

PH:	Sampler advanced by hydraulic pressure
PM:	Sampler advanced by manual pressure
WH:	Sampler advanced by static weight of hammer
WR:	Sampler advanced by weight of sampler and rod

SAMPLES

AS	Auger sample
BS	Block sample
CS	Chunk sample
DD	Diamond Drilling
DO or DP	Seamless open ended, driven or pushed tube sampler – note size
DS	Denison type sample
GS	Grab Sample
MC	Modified California Samples
MS	Modified Shelby (for frozen soil)
RC	Rock core
SC	Soil core
SS	Split spoon sampler – note size
ST	Slotted tube
TO	Thin-walled, open – note size (Shelby tube)
TP	Thin-walled, piston – note size (Shelby tube)
WS	Wash sample

SOIL TESTS

w	water content
PL , w_p	plastic limit
LL , w_L	liquid limit
C	consolidation (oedometer) test
CHEM	chemical analysis (refer to text)
CID	consolidated isotropically drained triaxial test[1]
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement[1]
D_R	relative density (specific gravity, Gs)
DS	direct shear test
GS	specific gravity
M	sieve analysis for particle size
MH	combined sieve and hydrometer (H) analysis
MPC	Modified Proctor compaction test
SPC	Standard Proctor compaction test
OC	organic content test
SO_4	concentration of water-soluble sulphates
UC	unconfined compression test
UU	unconsolidated undrained triaxial test
V (FV)	field vane (LV-laboratory vane test)
γ	unit weight

1. Tests anisotropically consolidated prior to shear are shown as CAD, CAU.

NON-COHESIVE (COHESIONLESS) SOILS

Compactness[2]

Term	SPT 'N' (blows/0.3m)[1]
Very Loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	>50

1. SPT 'N' in accordance with ASTM D1586, uncorrected for the effects of overburden pressure.
2. Definition of compactness terms are based on SPT 'N' ranges as provided in Terzaghi, Peck and Mesri (1996). Many factors affect the recorded SPT 'N' value, including hammer efficiency (which may be greater than 60% in automatic trip hammers), overburden pressure, groundwater conditions, and grainsize. As such, the recorded SPT 'N' value(s) should be considered only an approximate guide to the soil compactness. These factors need to be considered when evaluating the results, and the stated compactness terms should not be relied upon for design or construction.

Field Moisture Condition

Term	Description
Dry	Soil flows freely through fingers.
Moist	Soils are darker than in the dry condition and may feel cool.
Wet	As moist, but with free water forming on hands when handled.

COHESIVE SOILS

Consistency

Term	Undrained Shear Strength (kPa)	SPT 'N'[1,2] (blows/0.3m)
Very Soft	<12	0 to 2
Soft	12 to 25	2 to 4
Firm	25 to 50	4 to 8
Stiff	50 to 100	8 to 15
Very Stiff	100 to 200	15 to 30
Hard	>200	>30

1. SPT 'N' in accordance with ASTM D1586, uncorrected for overburden pressure effects; approximate only.
2. SPT 'N' values should be considered ONLY an approximate guide to consistency; for sensitive clays (e.g., Champlain Sea clays), the N-value approximation for consistency terms does NOT apply. Rely on direct measurement of undrained shear strength or other manual observations.

Water Content

Term	Description
w < PL	Material is estimated to be drier than the Plastic Limit.
w ~ PL	Material is estimated to be close to the Plastic Limit.
w > PL	Material is estimated to be wetter than the Plastic Limit.

LIST OF SYMBOLS

Unless otherwise stated, the symbols employed in the report are as follows:

I. GENERAL

π	3.1416
ln x	natural logarithm of x
$\log_{10}$	x or log x, logarithm of x to base 10
g	acceleration due to gravity
t	time

II. STRESS AND STRAIN

γ	shear strain
Δ	change in, e.g. in stress: $\Delta\,\sigma$
ε	linear strain
ε_v	volumetric strain
η	coefficient of viscosity
υ	Poisson's ratio
σ	total stress
σ'	effective stress ($\sigma' = \sigma - u$)
σ'_{vo}	initial effective overburden stress
$\sigma_1, \sigma_2, \sigma_3$	principal stress (major, intermediate, minor)
σ_{oct}	mean stress or octahedral stress $= (\sigma_1 + \sigma_2 + \sigma_3)/3$
τ	shear stress
u	porewater pressure
E	modulus of deformation
G	shear modulus of deformation
K	bulk modulus of compressibility

III. SOIL PROPERTIES

(a) Index Properties

$\rho(\gamma)$	bulk density (bulk unit weight)*
$\rho_d(\gamma_d)$	dry density (dry unit weight)
$\rho_w(\gamma_w)$	density (unit weight) of water
$\rho_s(\gamma_s)$	density (unit weight) of solid particles
γ'	unit weight of submerged soil ($\gamma' = \gamma - \gamma_w$)
D_R	relative density (specific gravity) of solid particles ($D_R = \rho_s / \rho_w$) (formerly G_s)
e	void ratio
n	porosity
S	degree of saturation

* Density symbol is ρ. Unit weight symbol is γ where $\gamma = \rho g$ (i.e. mass density multiplied by acceleration due to gravity)

(a) Index Properties (continued)

w	water content
w_l or LL	liquid limit
w_p or PL	plastic limit
I_p or PI	plasticity index = $(w_l – w_p)$
NP	non-plastic
w_s	shrinkage limit
I_L	liquidity index = $(w – w_p) / I_p$
I_C	consistency index = $(w_l – w) / I_p$
e_{max}	void ratio in loosest state
e_{min}	void ratio in densest state
I_D	density index = $(e_{max} – e) / (e_{max} - e_{min})$ (formerly relative density)

(b) Hydraulic Properties

h	hydraulic head or potential
q	rate of flow
v	velocity of flow
i	hydraulic gradient
k	hydraulic conductivity (coefficient of permeability)
j	seepage force per unit volume

(c) Consolidation (one-dimensional)

C_c	compression index (normally consolidated range)
C_r	recompression index (over-consolidated range)
C_s	swelling index
C_α	secondary compression index
m_v	coefficient of volume change
c_v	coefficient of consolidation (vertical direction)
c_h	coefficient of consolidation (horizontal direction)
T_v	time factor (vertical direction)
U	degree of consolidation
σ'_p	pre-consolidation stress
OCR	over-consolidation ratio = σ'_p / σ'_{vo}

(d) Shear Strength

τ_p, τ_r	peak and residual shear strength
ϕ'	effective angle of internal friction
δ	angle of interface friction
μ	coefficient of friction = $\tan \delta$
c'	effective cohesion
c_u, s_u	undrained shear strength ($\phi = 0$ analysis)
p	mean total stress $(\sigma_1 + \sigma_3)/2$
p′	mean effective stress $(\sigma'_1 + \sigma'_3)/2$
q	$(\sigma_1 - \sigma_3)/2$ or $(\sigma'_1 - \sigma'_3)/2$
q_u	compressive strength $(\sigma_1 - \sigma_3)$
S_t	sensitivity

Notes: 1 $\tau = c' + \sigma' \tan \phi'$

2 shear strength = (compressive strength)/2

PROJECT: 18106595-1100

RECORD OF BOREHOLE: 19-01A

SHEET 1 OF 2

LOCATION: N 5027696.6 ;E 364789.2

BORING DATE: April 29, 2019

DATUM: CGVD28

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80

SHEAR STRENGTH Cu, kPa: nat V. + Q - ● rem V. ⊕ U - ○ : 20 40 60 80

HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT: Wp ⊢—○W—⊣ Wl : 20 40 60 80

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.30m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		74.55					
0	Power Auger 200 mm Diam. (Hollow Stem)	ASPHALTIC CONCRETE	■	0.00					
		FILL - (SM/GM) SILTY SAND and GRAVEL; brown; non-cohesive, moist, compact	▨	0.15	1	SS	27		
1									
		(CL/CI) SILTY CLAY; dark grey, contains organic matter (rootlets) (WEATHERED CRUST); cohesive, w>PL, very stiff to stiff	▨	73.02 1.53					
2					2	SS	12		
3		(CI/CH) SILTY CLAY to CLAY; grey, contains organic matter; cohesive, w>PL, stiff	▨	71.50 3.05	3	SS	2		
4									
		(ML) gravelly sandy SILT, some low-plasticity fines; grey, contains cobbles (GLACIAL TILL); non-cohesive, wet, compact to loose	▨	69.97 4.58					
5					4	SS	30		
6									
					5	SS	6		
7									
8					6	SS	10		
9									
					7	SS	8		
10									

CONTINUED NEXT PAGE

DEPTH SCALE

1 : 50

GOLDER

LOGGED: RA

CHECKED: SG

PROJECT: 18106595-1100

RECORD OF BOREHOLE: 19-01A

SHEET 2 OF 2

LOCATION: N 5027696.6 ;E 364789.2

BORING DATE: April 29, 2019

DATUM: CGVD28

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) WATER CONTENT PERCENT Wp ⊢—○W—⊣ Wl (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		--- CONTINUED FROM PREVIOUS PAGE ---									
10	Power Auger 200 mm Diam. (Hollow Stem)	(ML) gravelly sandy SILT, some low-plasticity fines; grey, contains cobbles (GLACIAL TILL); non-cohesive, wet, compact to loose		63.87 10.68							
11		(SM) gravelly SILTY SAND; grey, contains cobbles and fragments of shale (GLACIAL TILL); non-cohesive, wet, very dense to compact			8	SS	>50				
12				61.74 12.81	9	SS	28				
13		End of borehole									
14											
15											
16											
17											
18											
19											
20											

DEPTH SCALE

1 : 50

GOLDER

LOGGED: RA

CHECKED: SG

MIS-BHS 001 18106595.GPJ GAL-MIS.GDT 7/8/19 ZS

PROJECT: 18106595-1100

RECORD OF BOREHOLE: 19-01B

SHEET 1 OF 3

LOCATION: N 5027696.6 ;E 364789.2

BORING DATE: April 30, 2019

DATUM: CGVD28

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80); SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}); WATER CONTENT PERCENT Wp ⊢—○W—⊣ Wl (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		74.55							
0	Power Auger 200 mm Diam. (Hollow Stem)	For soil stratigraphy refer to RECORD OF BOREHOLE 19-01A		0.00							
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											

CONTINUED NEXT PAGE

DEPTH SCALE

1 : 50

GOLDER

LOGGED: RA

CHECKED: SG

PROJECT: 18106595-1100

RECORD OF BOREHOLE: 19-01B

SHEET 2 OF 3

LOCATION: N 5027696.6 ;E 364789.2

BORING DATE: April 30, 2019

DATUM: CGVD28

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m 20 40 60 80 SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3} WATER CONTENT PERCENT Wp ⊢—○W—⊣ Wl 20 40 60 80	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		--- CONTINUED FROM PREVIOUS PAGE ---									
10	Power Auger 200 mm Diam. (Hollow Stem)	For soil stratigraphy refer to RECORD OF BOREHOLE 19-01A									
11											
12											
13				60.82							
14		(SP/GP) SAND and GRAVEL, some non-plastic fines; grey, contains cobbles (GLACIAL TILL); non-cohesive, wet, very loose		13.73	1	SS	3				
15					2	SS	>50				
				58.89							
		Borehole continued on RECORD OF DRILLHOLE 19-01B		15.66							
16											
17											
18											
19											
20											

MIS-BHS 001 18106595.GPJ GAL-MIS.GDT 7/8/19 ZS

DEPTH SCALE
1 : 50

GOLDER

LOGGED: RA
CHECKED: SG

PROJECT: 18106595-1100

RECORD OF DRILLHOLE: 19-01B

SHEET 3 OF 3

LOCATION: N 5027696.6 ;E 364789.2

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: April 30, 2019

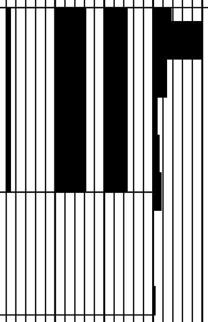
DRILL RIG: CME 55

DRILLING CONTRACTOR: Marathon Drilling

DATUM: CGVD28

JN - Joint	BD - Bedding	PL - Planar	PO - Polished	BR - Broken Rock
FLT - Fault	FO - Foliation	CU - Curved	K - Slickensided	**NOTE:** For additional abbreviations refer to list of abbreviations & symbols.
SHR - Shear	CO - Contact	UN - Undulating	SM - Smooth	
VN - Vein	OR - Orthogonal	ST - Stepped	Ro - Rough	
CJ - Conjugate	CL - Cleavage	IR - Irregular	MB - Mechanical Break	

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	FLUSH COLOUR % RETURN	RECOVERY TOTAL CORE % 80 60 40 20	RECOVERY SOLID CORE % 80 60 40 20	R.Q.D. % 80 60 40 20	FRACT. INDEX PER 0.25 m 5 10 15 20	DIP w.r.t. CORE AXIS 0 30 60 90	DISCONTINUITY DATA TYPE AND SURFACE DESCRIPTION	Jcon	Jr	Ja	HYDRAULIC CONDUCTIVITY K, cm/sec 10^{-6} 10^{-5} 10^{-4} 10^{-3}	Diametral Point Load Index (MPa) 2 4 6	RMC -Q' AVG.
		BEDROCK SURFACE		58.89														
16 17	Rotary Drill NQ Core	Slightly weathered to fresh, grey, fine grained LIMESTONE, with shale interbeds		15.66 56.86	1 2													
18 19 20 21 22 23 24 25		End of Drillhole		17.69														



DEPTH SCALE

1 : 50

GOLDER

LOGGED: RA

CHECKED: SG

MIS-RCK 004 18106595.GPJ GAL-MISS.GDT 7/8/19 ZS

PROJECT: 18106595-1100

RECORD OF BOREHOLE: 19-02

SHEET 1 OF 3

LOCATION: N 5027716.3 ;E 364788.9

BORING DATE: May 9, 2019

DATUM: CGVD28

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m 20 40 60 80; SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3}; WATER CONTENT PERCENT Wp ⊢ ○W ⊣ Wl 20 40 60 80	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE	74.60							
0	Power Auger 200 mm Diam.	ASPHALTIC CONCRETE	0.00							
		FILL - (SW) gravelly SAND; brown (PAVEMENT STRUCTURE)	0.15							
		FILL - (CI/CL) SILTY CLAY, some gravel and sand; grey brown, contains organic matter and wood pieces; cohesive, w~PL								
2				1	SS	10				
3		(CI/CL) SILTY CLAY; grey; cohesive, w>PL, very stiff	71.55 3.05	2	SS	5				
4		(SM/ML) gravelly SAND and SILT; grey brown to grey, contains cobbles, boulders and shale fragments (GLACIAL TILL); non-cohesive, moist to wet, compact to very dense	70.03 4.57	3	SS	30				
6				4	SS	32				
7	Wash Boring NW Casing									
10		*CONTINUED NEXT PAGE*								

DEPTH SCALE

1 : 50

GOLDER

LOGGED: CRG

CHECKED: SG

PROJECT: 18106595-1100

RECORD OF BOREHOLE: 19-02

SHEET 2 OF 3

LOCATION: N 5027716.3 ;E 364788.9

BORING DATE: May 9, 2019

DATUM: CGVD28

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m 20 40 60 80; SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3}; WATER CONTENT PERCENT Wp ⊢—○W—⊣ Wl 20 40 60 80	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		--- CONTINUED FROM PREVIOUS PAGE ---									
10	Wash Boring NW Casing	(SM/ML) gravelly SAND and SILT; grey brown to grey, contains cobbles, boulders and shale fragments (GLACIAL TILL); non-cohesive, moist to wet, compact to very dense									
					5	SS	>50				
11											
12											
13											
14				60.53 14.07							
		Borehole continued on RECORD OF DRILLHOLE 19-02									
15											
16											
17											
18											
19											
20											

DEPTH SCALE

1 : 50

GOLDER

LOGGED: CRG

CHECKED: SG

PROJECT: 18106595-1100

RECORD OF DRILLHOLE: 19-02

SHEET 3 OF 3

LOCATION: N 5027716.3 ;E 364788.9

DRILLING DATE: May 9, 2019

DATUM: CGVD28

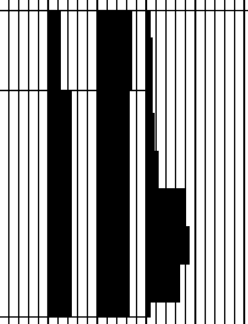
DRILL RIG:

INCLINATION: -90° AZIMUTH: ---

DRILLING CONTRACTOR: Marathon Drilling

JN - Joint	BD - Bedding	PL - Planar	PO - Polished	BR - Broken Rock
FLT - Fault	FO - Foliation	CU - Curved	K - Slickensided	**NOTE:** For additional abbreviations refer to list of abbreviations & symbols.
SHR - Shear	CO - Contact	UN - Undulating	SM - Smooth	
VN - Vein	OR - Orthogonal	ST - Stepped	Ro - Rough	
CJ - Conjugate	CL - Cleavage	IR - Irregular	MB - Mechanical Break	

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	COLOUR % RETURN FLUSH	RECOVERY TOTAL CORE % 80 60 40 20	RECOVERY SOLID CORE % 80 60 40 20	R.Q.D. % 80 60 40 20	FRACT. INDEX PER 0.25 m 5 10 15 20	DIP w.r.t. CORE AXIS 0 30 60 90	DISCONTINUITY DATA TYPE AND SURFACE DESCRIPTION	Jcon	Jr	Ja	HYDRAULIC CONDUCTIVITY K, cm/sec 10^{-6} 10^{-5} 10^{-4} 10^{-3}	Diametral Point Load Index (MPa) 2 4 6	RMC -Q' AVG.
		BEDROCK SURFACE		60.53														
15 16	Rotary Drill NQ Core	Slightly weathered to fresh, fine grained, grey LIMESTONE, with interbeds of shale		14.07	1	80												
					2	80												
				58.50 16.10														
17 18 19 20 21 22 23 24		End of Drillhole																



DEPTH SCALE

1 : 50

GOLDER

LOGGED: CRG

CHECKED: SG

PROJECT: 18106595-1100

RECORD OF BOREHOLE: 19-03

SHEET 1 OF 3

LOCATION: N 5027694.6 ;E 364802.6

BORING DATE: April 30-May 1, 2019

DATUM: CGVD28

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80); SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}); WATER CONTENT PERCENT Wp ⊢—○W—⊣ Wl (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE	74.67							
0	Wash Boring NW Casing	ASPHALTIC CONCRETE	0.00							
		FILL - (SM/GM) SILTY SAND and GRAVEL; brown; non-cohesive, wet, compact	74.47 0.20	1	SS	29				
1				2	SS	14				
2				3	SS	10				
		FILL - (CL/CI) SILTY CLAY, some sand and gravel; grey brown; cohesive, w>PL	72.23 2.44	4	SS	4				
3		(CL/CI) SILTY CLAY; grey; cohesive, w>PL, stiff	71.62 3.05	5	SS	2				
4		(ML) gravelly sandy SILT, some low plasticity fines; grey, contains cobbles (GLACIAL TILL); non-cohesive, wet, compact	70.70 3.97	6	SS	21				
5				7	SS	16				
6				8	SS	23				
		(SM/GM) SILTY SAND and GRAVEL; grey, contains cobbles and boulders (GLACIAL TILL); non-cohesive, wet, compact to very dense	68.37 6.30	9	SS	24				
7				10	SS	>50				
8				11	SS	>50				
				12	SS	>50				
9				13	SS	>50				
10										

CONTINUED NEXT PAGE

DEPTH SCALE

1 : 50

GOLDER

LOGGED: RA

CHECKED: SG

PROJECT: 18106595-1100

RECORD OF BOREHOLE: 19-03

SHEET 2 OF 3

LOCATION: N 5027694.6 ;E 364802.6

BORING DATE: April 30-May 1, 2019

DATUM: CGVD28

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m 20 40 60 80; SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3}; WATER CONTENT PERCENT Wp ⊢—○W—⊣ Wl 20 40 60 80	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		--- CONTINUED FROM PREVIOUS PAGE ---									
10	Wash Boring NW Casing	(SM/GM) SILTY SAND and GRAVEL; grey, contains cobbles and boulders (GLACIAL TILL); non-cohesive, wet, compact to very dense			14	SS	59				
11					15	SS	>50				
12											
13					16	SS	>50				
14					17	SS	>50				
15		Borehole continued on RECORD OF DRILLHOLE 19-03		59.72 14.95							
16											
17											
18											
19											
20											

DEPTH SCALE

1 : 50

GOLDER

LOGGED: RA

CHECKED: SG

PROJECT: 18106595-1100

RECORD OF DRILLHOLE: 19-03

SHEET 3 OF 3

LOCATION: N 5027694.6 ;E 364802.6

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: April 30-May 1, 2019

DRILL RIG: CME 55

DRILLING CONTRACTOR: Marathon Drilling

DATUM: CGVD28

JN - Joint
FLT - Fault
SHR- Shear
VN - Vein
CJ - Conjugate

BD- Bedding
FO- Foliation
CO- Contact
OR- Orthogonal
CL - Cleavage

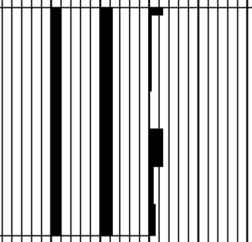
PL - Planar
CU- Curved
UN- Undulating
ST - Stepped
IR - Irregular

PO- Polished
K - Slickensided
SM- Smooth
Ro - Rough
MB- Mechanical Break

BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	FLUSH COLOUR % RETURN	RECOVERY TOTAL CORE % 80 60 40 20	RECOVERY SOLID CORE % 80 60 40 20	R.Q.D. % 80 60 40 20	FRACT. INDEX PER 0.25 m 5 10 15 20	DIP w.r.t. CORE AXIS 0 30 60 90	DISCONTINUITY DATA TYPE AND SURFACE DESCRIPTION	Jcon	Jr	Ja	HYDRAULIC CONDUCTIVITY K, cm/sec 10^{-6} 10^{-5} 10^{-4} 10^{-3}	Diametral Point Load Index (MPa) 2 4 6	RMC -Q' AVG.
		BEDROCK SURFACE		59.72 14.95														
15 16	Rotary Dill NQ Core	Slightly weathered to fresh, fine grained, grey to black LIMESTONE, with interbeds of shale			1													
17 18 19 20 21 22 23 24		End of Drillhole		58.20 16.47														



DEPTH SCALE
1 : 50

LOGGED: RA
CHECKED: SG

PROJECT: 18106595-1100

RECORD OF BOREHOLE: 19-04

SHEET 1 OF 3

LOCATION: N 5027724.8 ;E 364801.8

BORING DATE: May 10, 2019

DATUM: CGVD28

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.30m
		GROUND SURFACE	74.62			
0	Power Auger 200 mm Diam. (Hollow Stem)	ASPHALTIC CONCRETE	0.00			
		FILL - (CL) sandy SILTY CLAY, some gravel to gravelly; grey brown, contains pockets of sand, cobbles, boulders and wood pieces; cohesive, w>PL to w>PL	0.09			
1				1	SS	13
				2	SS	22
2						
				3	SS	18
		(CI/CL) SILTY CLAY; grey, contains organic matter (rootlets); cohesive, w>PL, stiff to firm	71.88 2.74			
3						
				4	SS	3
4				5	SS	>50
		(SM/ML) gravelly SAND and SILT; grey, contains cobbles and boulders (GLACIAL TILL); non-cohesive, wet, compact to very dense	70.51 4.11			
	Wash Boring NW Casing					
5						
6						
7						
				6	SS	>50
8						
9						
10						

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m	HYDRAULIC CONDUCTIVITY, k, cm/s	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
20 40 60 80	10^{-6} 10^{-5} 10^{-4} 10^{-3}		
SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○	WATER CONTENT PERCENT Wp ⊢—○W—⊣ Wl		
20 40 60 80	20 40 60 80		

CONTINUED NEXT PAGE

DEPTH SCALE
1 : 50

GOLDER

LOGGED: CRG
CHECKED: SG

PROJECT: 18106595-1100

RECORD OF BOREHOLE: 19-04

SHEET 2 OF 3

LOCATION: N 5027724.8 ;E 364801.8

BORING DATE: May 10, 2019

DATUM: CGVD28

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE			SAMPLES			DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m 20 40 60 80 SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3} WATER CONTENT PERCENT Wp ⊢—○W—⊣ Wl 20 40 60 80	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.30m				
		--- CONTINUED FROM PREVIOUS PAGE ---									
10	Wash Boring NW Casing	(SM/ML) gravelly SAND and SILT; grey, contains cobbles and boulders (GLACIAL TILL); non-cohesive, wet, compact to very dense									
11											
12				62.48 12.14							
		Borehole continued on RECORD OF DRILLHOLE 19-04									
13											
14											
15											
16											
17											
18											
19											
20											

DEPTH SCALE

1 : 50

GOLDER

LOGGED: CRG

CHECKED: SG

MIS-BHS 001 18106595.GPJ GAL-MIS.GDT 7/8/19 ZS

PROJECT: 18106595-1100

RECORD OF DRILLHOLE: 19-04

SHEET 3 OF 3

LOCATION: N 5027724.8 ;E 364801.8

DRILLING DATE: May 10, 2019

DATUM: CGVD28

INCLINATION: -90° AZIMUTH: ---

DRILL RIG:

DRILLING CONTRACTOR: Marathon Drilling

JN - Joint
FLT - Fault
SHR- Shear
VN - Vein
CJ - Conjugate

BD- Bedding
FO- Foliation
CO- Contact
OR- Orthogonal
CL - Cleavage

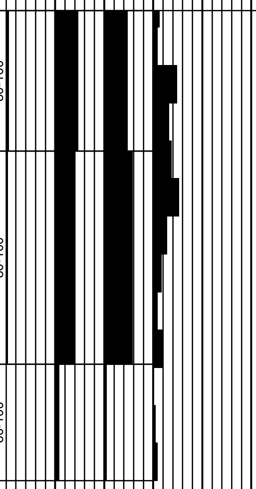
PL - Planar
CU- Curved
UN- Undulating
ST - Stepped
IR - Irregular

PO- Polished
K - Slickensided
SM- Smooth
Ro - Rough
MB- Mechanical Break

BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	ELEV. DEPTH (m)	RUN No.	FLUSH COLOUR % RETURN
		BEDROCK SURFACE	62.48		
	Rotary Drill NQ Core	Weathered to fresh, grey to black, interbedded LIMESTONE, with interbeds of shale	12.14	1	80-100
13					
				2	80-100
14					
				3	80-100
15			59.37 15.25		
		End of Drillhole			
16					
17					
18					
19					
20					
21					
22					



DISCONTINUITY DATA: DIP w.r.t. CORE AXIS (0 30 60 90); TYPE AND SURFACE DESCRIPTION; Jcon Jr Ja

HYDRAULIC CONDUCTIVITY K, cm/sec (10^{-6} 10^{-5} 10^{-4} 10^{-3})

Diametral Point Load Index (MPa) 2 4 6

RMC -Q' AVG.

DEPTH SCALE

1 : 50

GOLDER

LOGGED: CRG

CHECKED: SG

PROJECT: 18106595-1100

RECORD OF BOREHOLE: 19-05

SHEET 1 OF 3

LOCATION: N 5027704.2 ;E 364815.0

BORING DATE: May 2, 2019

DATUM: CGVD28

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80

SHEAR STRENGTH Cu, kPa: nat V. + Q - ● rem V. ⊕ U - ○ : 20 40 60 80

HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT: Wp ⊢—○W—⊣ Wl : 20 40 60 80

ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.30m
		GROUND SURFACE	74.75			
0	Wash Boring NW Casing	ASPHALTIC CONCRETE	0.00			
		FILL - (GM) SILTY SAND and GRAVEL; brown, contains oxidation staining; non-cohesive, wet, compact	0.15	1	SS	30
1						
		FILL - (CL) SILTY CLAY, trace to some sand and gravel; grey; cohesive, w>PL	73.23 1.52	2	SS	21
2						
3		(CI/CH) SILTY CLAY, some gravel; grey; cohesive, w>PL, firm to stiff	71.70 3.05	3	SS	2
4						
		(SM/GM) SILTY SAND and GRAVEL; grey, contains cobbles (GLACIAL TILL); non-cohesive, wet, compact to very dense	70.17 4.58	4	SS	>50
5						
6				5	SS	47
7						
				6	SS	48
8						
9				7	SS	19
10						

CONTINUED NEXT PAGE

DEPTH SCALE
1 : 50

LOGGED: RA
CHECKED: SG

PROJECT: 18106595-1100

RECORD OF BOREHOLE: 19-05

SHEET 2 OF 3

LOCATION: N 5027704.2 ;E 364815.0

BORING DATE: May 2, 2019

DATUM: CGVD28

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80); SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}); WATER CONTENT PERCENT Wp ⊢—○W—⊣ Wl (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		--- CONTINUED FROM PREVIOUS PAGE ---									
10	Wash Boring NW Casing	(SM/GM) SILTY SAND and GRAVEL; grey, contains cobbles (GLACIAL TILL); non-cohesive, wet, compact to very dense									
11					8	SS	46				
12				62.43 12.32	9	SS	>50				
		Borehole continued on RECORD OF DRILLHOLE 19-05									
13											
14											
15											
16											
17											
18											
19											
20											

DEPTH SCALE

1 : 50

GOLDER

LOGGED: RA

CHECKED: SG

PROJECT: 18106595-1100

RECORD OF DRILLHOLE: 19-05

SHEET 3 OF 3

LOCATION: N 5027704.2 ;E 364815.0

DRILLING DATE: May 2, 2019

DATUM: CGVD28

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 55

DRILLING CONTRACTOR: Marathon Drilling

JN - Joint
FLT - Fault
SHR- Shear
VN - Vein
CJ - Conjugate

BD- Bedding
FO- Foliation
CO- Contact
OR- Orthogonal
CL - Cleavage

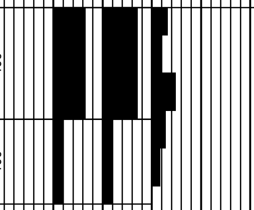
PL - Planar
CU- Curved
UN- Undulating
ST - Stepped
IR - Irregular

PO- Polished
K - Slickensided
SM- Smooth
Ro - Rough
MB- Mechanical Break

BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	COLOUR % RETURN FLUSH	RECOVERY TOTAL CORE % 80 60 40 20	RECOVERY SOLID CORE % 80 60 40 20	R.Q.D. % 80 60 40 20	FRACT. INDEX PER 0.25 m 5 10 15 20	DIP w.r.t. CORE AXIS 0 30 60 90	DISCONTINUITY DATA TYPE AND SURFACE DESCRIPTION	Jcon	Jr	Ja	HYDRAULIC CONDUCTIVITY K, cm/sec 10^{-6} 10^{-5} 10^{-4} 10^{-3}	Diametral Point Load Index (MPa) 2 4 6	RMC -Q' AVG.
		BEDROCK SURFACE		62.43														
13	Rotary Drill NQ Core	Highly weathered to fresh, grey to black LIMESTONE, with shale bedded		12.32	1	100												
					2	100												
				61.13 13.62														
		End of Drillhole																
14																		
15																		
16																		
17																		
18																		
19																		
20																		
21																		
22																		



MIS-RCK 004 18106595.GPJ GAL-MISS.GDT 7/8/19 ZS

DEPTH SCALE

1 : 50

GOLDER

LOGGED: RA

CHECKED: SG

RECORD OF BOREHOLE: 19-06

PROJECT: 18106595-1100

SHEET 1 OF 2

LOCATION: N 5027732.0 ;E 364812.8

BORING DATE: May 7, 2019

DATUM: CGVD28

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80

SHEAR STRENGTH Cu, kPa: nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80

HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT: Wp ⊢—○W—⊣ Wl 20 40 60 80

ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION

BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.30m
	GROUND SURFACE	74.57			
Wash Boring NW Casing	ASPHALTIC CONCRETE	0.00			
	FILL - (SM) gravelly SILTY SAND; dark brown; non-cohesive,	0.15			
	FILL - (SP) SAND, trace gravel, some non-plastic fines; brown to dark brown, thin to thick laminations of silty clay; non-cohesive, moist, wet	74.11 0.46	1	SS	34
	FILL - (SM) gravelly SILTY SAND, some low-plasticity fines; dark brown to brown; non-cohesive, moist to wet, compact	73.05 1.52	2	SS	11
	(CI/CH) SILTY CLAY to CLAY; trace sand; grey brown, contains laminations of silty sand; w>PL, stiff to very stiff	71.52 3.05	3	SS	2
	(SM) SAND and SILT, trace gravel; grey, contains cobbles (GLACIAL TILL); non-cohesive, wet very dense	70.00 4.57	4	SS	>50
	(SM) gravelly SILTY SAND; grey, contains cobbles (GLACIAL TILL); non-cohesive, wet, very dense	68.47 6.10	5	SS	64
			6	SS	52
	Borehole continued on RECORD OF DRILLHOLE 19-06	65.86 8.71			

DEPTH SCALE

1 : 50

GOLDER

LOGGED: RI

CHECKED: SG

PROJECT: 18106595-1100

RECORD OF DRILLHOLE: 19-06

SHEET 2 OF 2

LOCATION: N 5027732.0 ;E 364812.8

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: May 7, 2019

DRILL RIG: CME 55

DRILLING CONTRACTOR: Marathon Drilling

DATUM: CGVD28

JN - Joint
FLT - Fault
SHR- Shear
VN - Vein
CJ - Conjugate

BD- Bedding
FO- Foliation
CO- Contact
OR- Orthogonal
CL - Cleavage

PL - Planar
CU- Curved
UN- Undulating
ST - Stepped
IR - Irregular

PO- Polished
K - Slickensided
SM- Smooth
Ro - Rough
MB- Mechanical Break

BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	FLUSH COLOUR % RETURN	RECOVERY TOTAL CORE % 80 60 40 20	RECOVERY SOLID CORE % 80 60 40 20	R.Q.D. % 80 60 40 20	FRACT. INDEX PER 0.25 m 5 10 15 20	DISCONTINUITY DATA DIP w.r.t. CORE AXIS 0 30 60 90	DISCONTINUITY DATA TYPE AND SURFACE DESCRIPTION	Jcon	Jr	Ja	HYDRAULIC CONDUCTIVITY K, cm/sec 10^{-6} 10^{-5} 10^{-4} 10^{-3}	Diametral Point Load Index (MPa) 2 4 6	RMC -Q' AVG.
		BEDROCK SURFACE		65.86														
9	Rotary Drill NQ Core	Fresh, thinly to medium bedded, light to medium grey LIMESTONE, with interbeds of shale		8.71	1	100												
10				63.85 10.72	2	100												
		End of Drillhole																
11																		
12																		
13																		
14																		
15																		
16																		
17																		
18																		

DEPTH SCALE

1 : 50

GOLDER

LOGGED: RI

CHECKED: SG

PROJECT: 18106595-1100

RECORD OF BOREHOLE: 19-07

SHEET 1 OF 2

LOCATION: N 5027712.1 ;E 364824.2

BORING DATE: May 3, 2019

DATUM: CGVD28

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80

SHEAR STRENGTH Cu, kPa: nat V. + Q - ● rem V. ⊕ U - ○; 20 40 60 80

HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT: Wp ⊢—○W—⊣ Wl; 20 40 60 80

ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION

BORING METHOD: Wash Boring, NW Casing

SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLE NUMBER	TYPE	BLOWS/0.30m
GROUND SURFACE	74.81			
ASPHALTIC CONCRETE	0.00			
FILL - (SM) gravelly SILTY SAND; dark brown; non-cohesive, wet, dense	0.15	1	SS	41
(CI/CH) SILTY CLAY to CLAY; grey brown (WEATHERED CRUST); cohesive, w>PL, very stiff	73.28 1.53	2	SS	11
(CI/CH) SILTY CLAY to CLAY; grey; cohesive, w>PL, stiff to firm	71.76 3.05	3	SS	1
(SM/GM) SILTY SAND and GRAVEL; grey, contains cobbles (GLACIAL TILL); non-cohesive, wet, very dense	71.15 3.66	4	SS	62
		5	SS	43
		6	SS	60
		7	SS	>50
Borehole continued on RECORD OF DRILLHOLE 19-07	65.25 9.56			

DEPTH SCALE METRES: 0 1 2 3 4 5 6 7 8 9 10

DEPTH SCALE

1 : 50

GOLDER

LOGGED: RA

CHECKED: SG

PROJECT: 18106595-1100

RECORD OF DRILLHOLE: 19-07

SHEET 2 OF 2

LOCATION: N 5027712.1 ;E 364824.2

DRILLING DATE: May 3, 2019

DATUM: CGVD28

DRILL RIG: CME 55

INCLINATION: -90° AZIMUTH: ---

DRILLING CONTRACTOR: Marathon Drilling

JN - Joint
FLT - Fault
SHR- Shear
VN - Vein
CJ - Conjugate

BD- Bedding
FO- Foliation
CO- Contact
OR- Orthogonal
CL - Cleavage

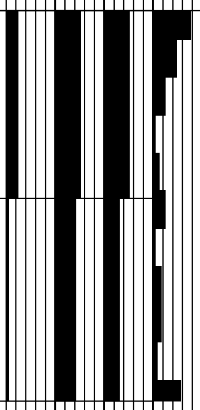
PL - Planar
CU- Curved
UN- Undulating
ST - Stepped
IR - Irregular

PO- Polished
K - Slickensided
SM- Smooth
Ro - Rough
MB- Mechanical Break

BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	COLOUR % RETURN FLUSH	RECOVERY TOTAL CORE % 80 60 40 20	RECOVERY SOLID CORE % 80 60 40 20	R.Q.D. % 80 60 40 20	FRACT. INDEX PER 0.25 m 5 10 15 20	DISCONTINUITY DATA DIP w.r.t. CORE AXIS 0 30 60 90	DISCONTINUITY DATA TYPE AND SURFACE DESCRIPTION	Jcon	Jr	Ja	HYDRAULIC CONDUCTIVITY K, cm/sec 10^{-6} 10^{-5} 10^{-4} 10^{-3}	Diametral Point Load Index (MPa) 2 4 6	RMC -Q' AVG.
		BEDROCK SURFACE		65.25														
10 11 12	Rotary Drill NQ Core	Slightly weathered to fresh, fine grained, grey LIMESTONE, with shale partings		9.56	1 2													
				62.67 12.14														
		End of Drillhole																
13 14 15 16 17 18 19																		



DEPTH SCALE
1 : 50

GOLDER

LOGGED: RA
CHECKED: SG

PROJECT: 18106595-1100

RECORD OF BOREHOLE: 19-08

SHEET 1 OF 2

LOCATION: N 5027737.6 ;E 364848.8

BORING DATE: May 8, 2019

DATUM: CGVD28

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80

SHEAR STRENGTH Cu, kPa: nat V. + Q - ● rem V. ⊕ U - ○; 20 40 60 80

HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT: Wp ⊢—○W—⊣ Wl; 20 40 60 80

BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.30m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
	GROUND SURFACE	74.90					
Power Auger 200 mm Diam. (Hollow Stem)	ASPHALTIC CONCRETE	0.00					Flush Mount Casing Silica Sand
	FILL - (SW) gravelly SAND, angular; grey (PAVEMENT STRUCTURE)	0.08					
	FILL - (CL/CI) SILTY CLAY, some sand, trace to some gravel; grey, contains organic matter; cohesive, w>PL	0.20	1	SS	9		
			2	SS	11		
	(CI/CH) SILTY CLAY to CLAY, trace to some sand; grey brown, contains laminations of silty sand (WEATHERED CRUST); cohesive, w>PL, very stiff	73.38 1.52	3	SS	14		
			4	SS	4		
	(CI/CH) SILTY CLAY to CLAY; grey, contains laminations of gravelly sand; cohesive, w>PL, stiff	71.85 3.05	5	SS	2		
	(SM/ML) SAND and SILT, trace to some gravel; grey, contains cobbles (GLACIAL TILL); non-cohesive, moist, very dense	71.24 3.66	6	SS	>104		Bentonite Seal
			7	SS	>50		∇
	(SM) SILTY SAND, trace to some gravel; grey, contains cobbles (GLACIAL TILL); non-cohesive, wet, dense	69.56 5.34	8	SS	41		
	(SW) gravelly SAND, some non-plastic fines; grey, contains cobbles (GLACIAL TILL); non-cohesive, wet, compact to very dense	68.80 6.10	9	SS	21		Bentonite Seal
			10	SS	>80		
	Cobbles, gravel, possible broken up bedrock	67.79 7.11	R1	RC	DD		Cave
	Borehole continued on RECORD OF DRILLHOLE 19-08	67.33 7.57					

DEPTH SCALE

1 : 50

GOLDER

LOGGED: RI

CHECKED: SG

PROJECT: 18106595-1100

RECORD OF DRILLHOLE: 19-08

SHEET 2 OF 2

LOCATION: N 5027737.6 ;E 364848.8

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: May 8, 2019

DRILL RIG: CME 55

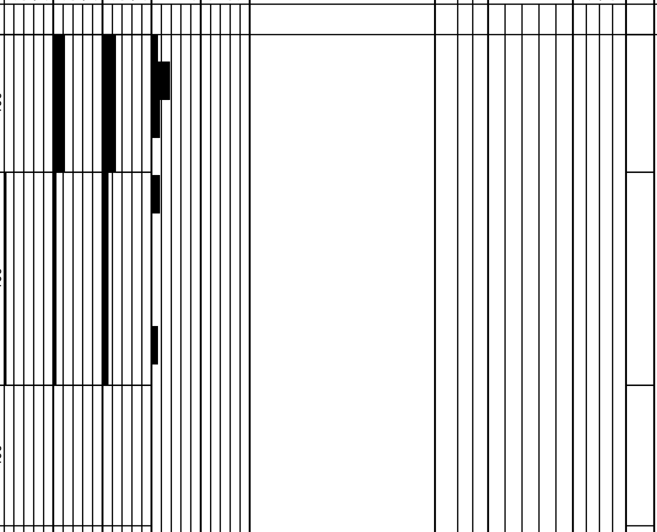
DRILLING CONTRACTOR: Marathon Drilling

DATUM: CGVD28

JN - Joint	BD - Bedding	PL - Planar	PO - Polished	BR - Broken Rock
FLT - Fault	FO - Foliation	CU - Curved	K - Slickensided	**NOTE:** For additional abbreviations refer to list of abbreviations & symbols.
SHR - Shear	CO - Contact	UN - Undulating	SM - Smooth	
VN - Vein	OR - Orthogonal	ST - Stepped	Ro - Rough	
CJ - Conjugate	CL - Cleavage	IR - Irregular	MB - Mechanical Break	

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)	RUN No.	COLOUR / % RETURN FLUSH
		BEDROCK SURFACE		67.33		
	Rotary Drill NQ Core	Fresh, thin to medium bedded, light to medium grey LIMESTONE, with interbeds of shale		7.57		
8					2	100
9					3	100
10					4	100
				64.08 10.82		
		End of Drillhole				
11						
12						
13						
14						
15						
16						
17						

RECOVERY: TOTAL CORE % (80 60 40 20); SOLID CORE % (80 60 40 20) | R.Q.D. % (80 60 40 20) | FRACT. INDEX PER 0.25 m (5 10 15 20) | DISCONTINUITY DATA: DIP w.r.t. CORE AXIS (0 30 60 90); TYPE AND SURFACE DESCRIPTION; Jcon; Jr; Ja | HYDRAULIC CONDUCTIVITY K, cm/sec (10^{-6} 10^{-5} 10^{-4} 10^{-3}) | Diametral Point Load Index (MPa) (2 4 6) | RMC -Q' AVG.



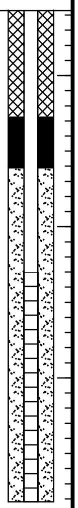
Bentonite Seal

Cave

Bentonite Seal

Silica Sand

38 mm Diam, PVC #10Slot Screen



WL in Screen at Elev. 70.43 m on May 28, 2019

DEPTH SCALE

1 : 50

GOLDER

LOGGED: RI

CHECKED: SG

APPENDIX B

Results of Hydraulic Conductivity Testing

HVORSLEV SLUG TEST ANALYSIS
FALLING HEAD TEST 19-08

INTERVAL (metres below ground surface)

Top of Interval =	**9.30**
Bottom of Interval =	**10.82**

$$K = \frac{r_c^2}{2L_e} \ln\left[\frac{L_e}{2R_e} + \sqrt{1+\left(\frac{L_e}{2R_e}\right)^2}\right]\left[\frac{\ln\left(\frac{h_1}{h_2}\right)}{(t_2 - t_1)}\right]$$

where K = (m/sec)

where:

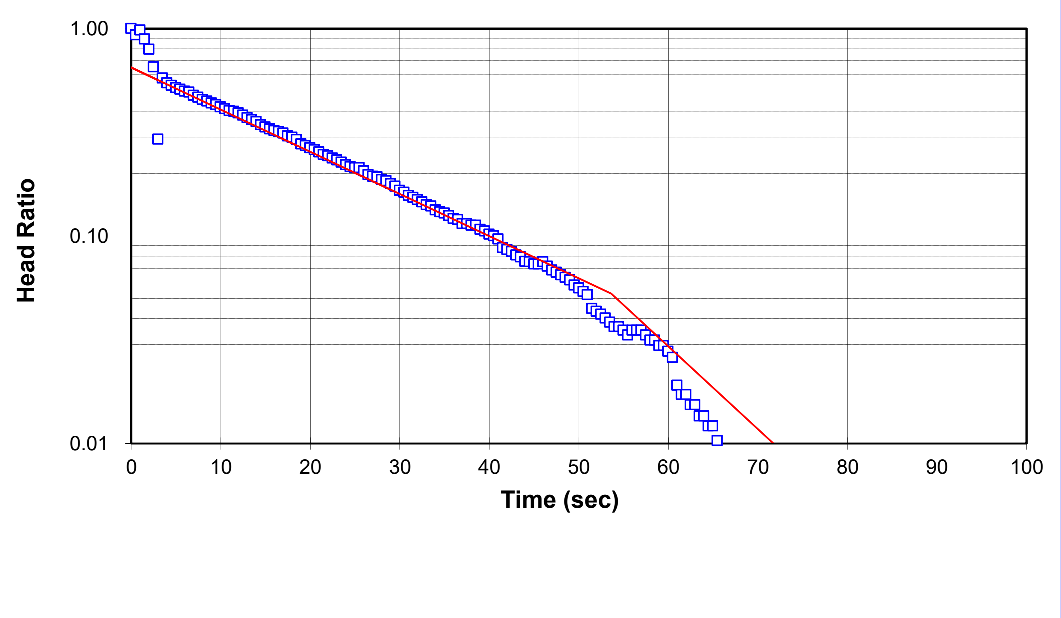
r_c = casing radius (metres)
R_e = filter pack radius (metres)
L_e = length of screened interval (metres)
t = time (seconds)
h_t = head at time t (metres)

INPUT PARAMETERS

r_c =	1.9E-02
R_e =	3.8E-02
L_e =	1.5
t_1 =	0
t_2 =	40
h_1/h_0 =	0.65
h_2/h_0 =	0.10

RESULTS

K=	2E-05	m/sec
K=	2E-03	cm/sec



Project Name: RioCan/Westgate Mall
Project No.:
Test Date: 5/30/2019

Analysis By: CAMC
Checked By: 0
Analysis Date: 6/6/2019

Golder Associates Ltd.

APPENDIX C

Core Photos

BH 19-01B DRY

15.66 m to 17.69 m

15.66 m START OF RUN

17.69 m END OF BOREHOLE

GOLDER

Geotechnical Investigation

Westgate Mall Phase 1 Development

Ottawa, Ontario

Project No.	18106595
Drawn:	APK
Date:	06/06/2019
Checked:	SG
Review:	SG

FIGURE C1

BH 19-01B WET

15.66 m to 17.69 m

15.66 m START OF RUN

17.69 m END OF BOREHOLE

Geotechnical Investigation

Westgate Mall Phase 1 Development

Ottawa, Ontario

GOLDER

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FIGURE C2

BH 19-02 DRY
14.07 m to 16.10 m

14.07 m START OF RUN

16.10 m END OF BOREHOLE

GOLDER

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FIGURE C3

BH 19-02 WET

14.07 m to 16.10 m


14.07 m START OF RUN

16.10 m END OF BOREHOLE

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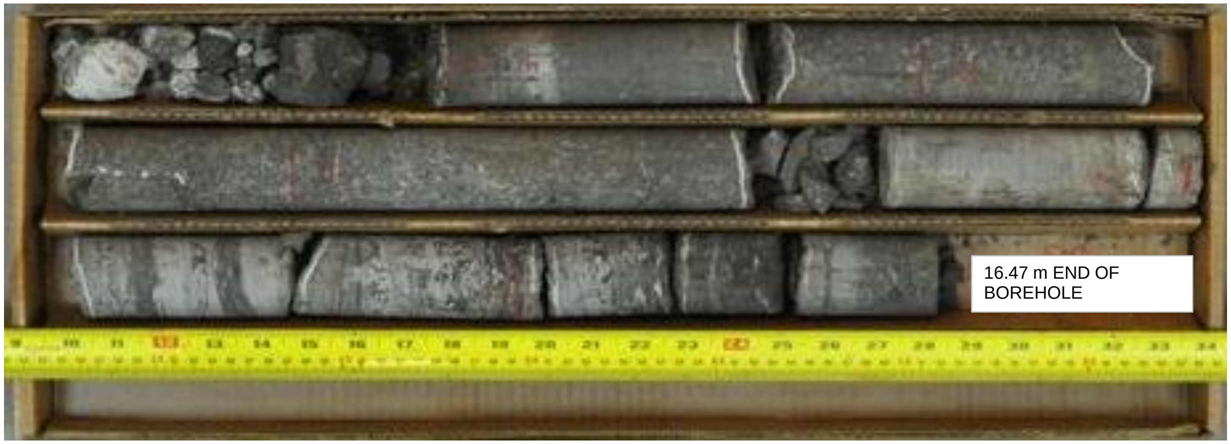
FIGURE C4

BH 19-03 DRY

14.95 m to 16.47 m

14.95 m START OF RUN



16.47 m END OF BOREHOLE

GOLDER

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Date:	06/06/2019
Checked:	SG
Review:	SG

FIGURE C5

BH 19-03 WET

14.95 m to 16.47 m

14.95 m START OF RUN

16.47 m END OF BOREHOLE

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Review:	SG

FIGURE C6

BH 19-04 DRY

12.14 m to 15.25 m

Boulders

12.14 m TOP OF BEDROCK

15.25 m END OF BOREHOLE

GOLDER

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Date:	06/06/2019
Checked:	SG
Review:	SG

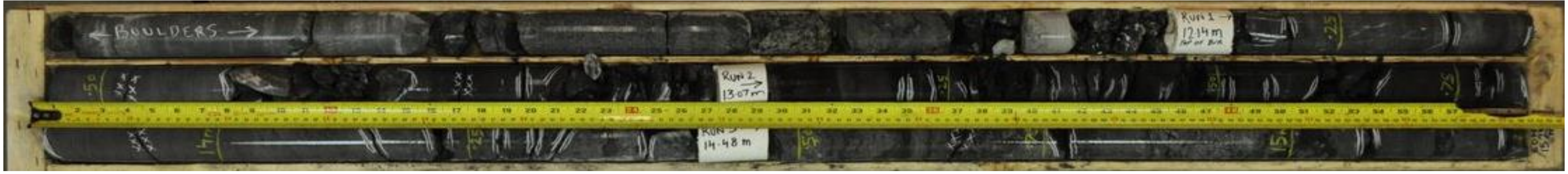
FIGURE C7

BH 19-04 WET

12.14 m to 15.25 m

Boulders

12.14 m TOP OF BEDROCK



15.25 m END OF

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Date: 06/06/2019
Checked: SG
Review: SG

FIGURE C8

BH 19-05 DRY

12.32 m to 13.62 m

12.32 m START OF RUN

13.62 m END OF

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Review:	SG

FIGURE C9

BH 19-05 DRY

12.32 m to 13.62 m

12.32 m START OF RUN

13.62 m END OF

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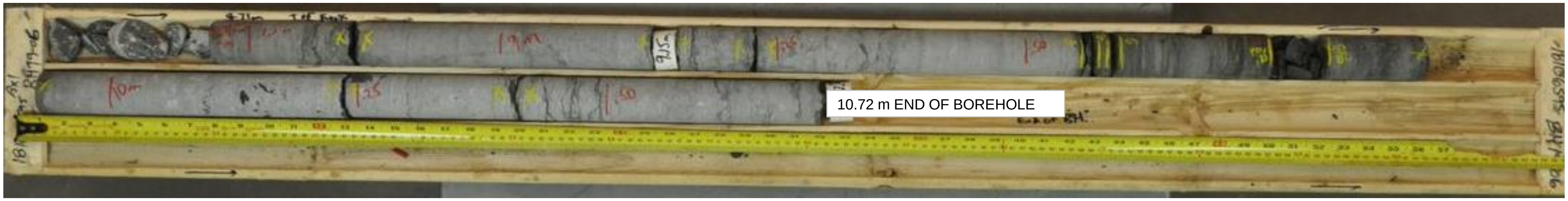
Date:	06/06/2019
Checked:	SG
Review:	SG

FIGURE C10

BH 19-06 DRY

8.71 m to 10.72 m



8.71 m START OF RUN

10.72 m END OF BOREHOLE

GOLDER

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Ottawa, Ontario

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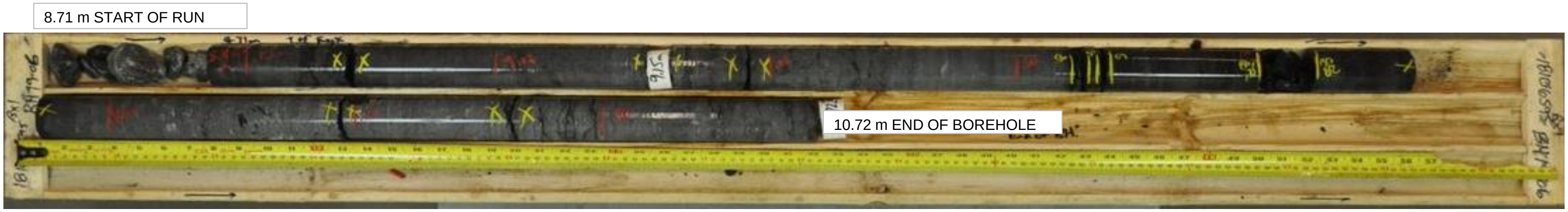
Drawn:	APK
Date:	06/06/2019
Checked:	SG
Review:	SG

FIGURE C11

BH 19-06 WET

8.71 m to 10.72 m



GOLDER

Geotechnical Investigation

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Date:	06/06/2019
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Review:	SG

FIGURE C12

BH 19-07 DRY

9.56 m to 12.14 m

9.56 m START OF RUN

12.14 m END OF BOREHOLE

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Date:	06/06/2019
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Review:	SG

FIGURE C13

BH 19-07 WET

9.56 m to 12.14 m

9.56 m START OF RUN

12.14 m END OF BOREHOLE

GOLDER

Geotechnical Investigation

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Ottawa, Ontario

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Drawn:	APK
Date:	06/06/2019
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Review:	SG

FIGURE C14

BH 19-08 WET

7.57 m to 10.82 m

7.57 m START OF RUN

10.82 m END OF BOREHOLE

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Date:	06/06/2019
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Review:	SG

FIGURE C15

BH 19-08 WET

7.57 m to 10.82 m

7.57 m START OF RUN

10.82 m END OF BOREHOLE

GOLDER

Geotechnical Investigation

Westgate Mall Phase 1 Development

Ottawa, Ontario

Project No.	18106595
Drawn:	APK
Date:	06/06/2019
Checked:	SG
Review:	SG

FIGURE C16