



September 7, 2017

## FOUNDATION INVESTIGATION REPORT

### HIGHWAY 17 CONISTON CPR OVERHEAD TEMPORARY DETOUR STRUCTURE, SITE NO. 46-123 SUDBURY DISTRICT, TOWNSHIP OF DRYDEN AGREEMENT NO. 5015-E-0045 - WORK ORDER 1

**Submitted to:**

Jason Wright, P.Eng.  
AECOM Canada Ltd.  
189 Wyld Street, Suite 103  
North Bay, ON P1B 1Z2



**GEOCRES NO.: 41I-352**

**Report Number: 1651997-WO1-3**

**Distribution:**

1-E-Copy - AECOM Canada Ltd.  
1 E-Copy - Ministry of Transportation, Ontario, Project Manager  
1 E-Copy - Ministry of Transportation, Ontario, Foundations  
1 E-Copy - Golder Associates Ltd.

REPORT





## Table of Contents

### **PART A – FOUNDATION INVESTIGATION REPORT**

<b>1.0 INTRODUCTION.....</b>	<b>1</b>
<b>2.0 SITE DESCRIPTION AND BACKGROUND INFORMATION.....</b>	<b>1</b>
2.1 Previous Investigations.....	1
<b>3.0 INVESTIGATION PROCEDURE .....</b>	<b>3</b>
<b>4.0 SUBSURFACE CONDITIONS.....</b>	<b>4</b>
4.1 Regional Geology .....	4
4.2 Subsoil Conditions .....	4
4.3 Bedrock/Refusal .....	6
4.4 Groundwater Conditions .....	7
<b>5.0 CLOSURE.....</b>	<b>8</b>

### **SITE PHOTOGRAPHS**

#### **DRAWINGS**

Drawing 1	Borehole Locations and Soil Strata
Drawing 2	Soil Strata

<b>APPENDIX A</b>	<b>Borehole Records – GEOCON 1975</b>
Record of Boreholes	1 to 8

<b>APPENDIX B</b>	<b>Borehole Records – Golder 2016</b>
Record of Boreholes	BH1 to BH4

#### **APPENDIX C Current Investigation – Borehole Records**

Lists of Abbreviations and Symbols	
Lithological and Geotechnical Rock Description Terminology	
Records of Boreholes	C17-1 to C17-9
Records of DCPTs	C17-8D1, C17-8D2, C17-D91, C17-D2
Record of Drillholes	C17-1 to C17-4 and C17-7

#### **APPENDIX D Current Investigation – Geotechnical Laboratory Test Results**

Figure D1	Grain Size Distribution – Sand to Sand and Gravel (Fill)
Figure D2	Grain Size Distribution – Clayey Silt (Fill)
Figure D3	Plasticity Chart – Clayey Silt (Fill)
Figure D4	Grain Size Distribution – Clayey Silt to Clay
Figure D5	Plasticity Chart – Clayey Silt to Clay
Figure D6	Consolidation Test Summary – Borehole C17-3, Sample 7
Figure D7	Consolidation Test Summary – Adjacent to Borehole C17-4, Sample 1
Figure D8	Grain Size Distribution – Sandy Silt to Silt and Sand to Sand
Figure D9	Plasticity Chart – Silt
Figure D10	Grain Size Distribution – Silty Sand and Gravel to Sand and Gravel (TILL)
Figure D11	Bedrock Core Photographs



## **1.0 INTRODUCTION**

Golder Associates Ltd. (Golder) has been retained by AECOM Canada Ltd. (AECOM) on behalf of the Ministry of Transportation, Ontario (MTO), to provide foundation engineering services for a temporary modular bridge (TMB) and detour embankment widening associated with the rehabilitation of the Canadian Pacific Railway (CPR) Overhead structure located on Highway 17 in Coniston, Ontario, approximately 2.8 km west of the Highway 17-Highway 537 junction in the Sudbury Area. This work has been carried out under the Retainer Assignment Agreement # 5015-E-0045 – Work Order #1. The highway and structural engineering aspects of the project are being carried out under separate contract between Morrison Hershfield (MH) and MTO.

The purpose of this investigation is to establish the subsurface conditions at the locations of the foundation element of the temporary modular bridge and along the proposed detour embankment widening, adjacent to the Coniston CPR Overhead by methods of borehole drilling, in situ testing and laboratory testing of selected soil samples.

## **2.0 SITE DESCRIPTION AND BACKGROUND INFORMATION**

We understand that the existing CPR Overhead is to be rehabilitated which requires a temporary detour (i.e. widening of the existing approach embankments) and a temporary modular bridge (TMB). We understand that a three-span TMB will be located about 4 m to the north of the existing bridge and the existing approach embankments will require widening along the north side slope.

The existing west approach embankment is about 10 m high and may have been constructed of a combination of granular fill layers and cohesive fill layers. Based on information presented in the previous bridge General Arrangement (GA) drawings and previous borehole information we understand that the east approach embankment is comprised of rock fill. Northeast of the existing east abutment there is a visible bedrock outcrop and the rock is dipping to the west (towards the rail tracks) and is 9 m high at the abutment front slope. Blast rock fill is visually noted along the north side of the east approach embankment.

In general, the topography in the area of the Overhead structure consists of rolling terrain, including densely treed areas, bedrock outcrops, and low-lying swamps containing organic soils and areas of standing water and various types of vegetation. The CPR right-of-way appears to be aligned within a natural valley between bedrock outcrops. The railway tracks are aligned in a northeast-southwest direction, while the Overhead structure and Highway 17 are aligned in an east-west direction, skewed to the track alignment. The existing ground surface along the proposed detour and TMB alignment varies greatly as the centreline of the detour is positioned approximately along the mid-slope of the north side of the existing Highway 17 approach embankments and due to the exposed sloping bedrock noted above. Select site photographs are attached following the text of this report.

### **2.1 Previous Investigations**

Previous foundation investigations for the existing bridge at the site carried out in 1975 indicates that the native material at the site consists of deposits of varved silty clay to clayey silt underlain by a deposit of silty sand to gravelly sandy silt, which is in turn underlain by bedrock. The details of this subsurface investigation are presented in:

- Geocon Ltd., 1977. Foundation Investigation Report for CPR Overhead at Coniston W.P. 158-74-01, Site 46-123, Hwy. 17, District 17, Sudbury. Ministry of Transportation and Communications, Ontario. Geocres No. 411-140.

The locations of these boreholes have been converted from previous station and offset to approximate coordinates in MTM NAD83 (Zone12) along with the ground surface elevations as follows:



## FOUNDATION REPORT - HIGHWAY 17 CONISTON CPR OVERHEAD DETOUR, ASSIGNMENT NO. 5015-E-0045

Borehole	Location (MTM NAD 83, Zone12)		Ground Surface Elevation (m)
	Northing	Easting	
1	5149839.2	318797.0	262.1
2	5149851.8	318825.8	252.6
3	5149838.1	318849.8	262.4
4	5149837.4	318866.3	262.6
5	5149832.3	318785.0	262.1
6	5149832.5	318797.7	262.2
7	5149819.1	318822.0	253.8
8	5149830.3	318856.5	262.5

In 2016, Golder conducted a foundation investigation to support retaining walls adjacent to the tracks.

- Golder Associates Ltd., 2016. Foundation Investigation Report for RSS Walls at the Coniston CPR Overhead 2.8 km West of Highway 537/17 Junction, Site # 46-123, Sudbury Area, Assignment No. 15, Agreement No. 5013-E-0034, W.P. 5165-10-01. Geocres No. 41J-342

In summary, these boreholes encountered a 0.7 m to 1.5 m thick layer of gravelly silt sand to sand and gravel fill from ground surface in places underlain by layers of organic clay and/or sandy silt between about 0.2 to 0.8 m thick; in turn underlain by a deposit of varved clayey silt to clay between 4.6 m and 5.8 m thick, which is in places underlain by a 0.7 m thick and potentially up to 4.2 m thick deposits of silt and sand.

The locations of these boreholes in MTM NAD83 (Zone12) coordinates and ground surface elevations referenced to Geodetic datum are as follows:

Borehole	Location (MTM NAD 83, Zone12)		Ground Surface Elevation (m)
	Northing	Easting	
BH1	5149845.7	318819.3	253.9
BH2	5149825.5	318800.2	254.1
BH3	5149846.5	318844.3	254.0
BH4	5149824.0	318881.4	254.4

The locations of the 1975 and 2016 Foundations Investigations are shown on Drawing 1. The pertinent subsurface information from the 1975 and 2016 Foundations Investigations is presented in Appendices A and B, respectively.



### **3.0 INVESTIGATION PROCEDURE**

The current investigation for the detour and TMB was carried out between April 18 and May 1, 2017, during which time a total of nine boreholes (C17-1 to C17-9) and four dynamic cone penetration tests (DCPT) were advanced at the locations shown on Drawing 1. The Record of Borehole and Drillhole sheets are presented in Appendix C.

The field investigation was carried out using a buggy-mounted CME 55 drill rig and portable Hilti core drilling equipment supplied and operated by Landcore Drilling Ltd. of Chelmsford, Ontario. Boreholes C17-1 and C17-2, were advanced using a 50 mm inside diameter core barrel advanced by a Hilti coring machine. Boreholes C17-3 to C17-9 were advanced using 108 mm inside diameter hollow stem augers with NW casing and wash boring techniques (where required). In general, soil samples were obtained at depth intervals of 0.75 m and 1.5 m, using a 50 mm O.D. split-spoon sampler driven by an automatic hammer, carried out in accordance with Standard Penetration Test (SPT) procedures (ASTM D1586). Samples of the cohesive soils were obtained using 76 mm O.D. thin walled Shelby Tubes (ASTM D1587). Field vane shear tests were completed within cohesive deposits in accordance with ASTM D2573, using MTO Standard 'N' size vanes. All boreholes were backfilled with bentonite and cuttings upon completion in accordance with Ontario Regulation 903 Wells (as amended).

The boreholes were sampled to depths between 2.3 m and 17.3 m below ground surface. In addition, dynamic cone penetration tests (DCPTs) were advanced 10 m west and 10 m east of Boreholes C17-8 and C17-9 along the existing embankment toe of slope to depths between 0.2 m and 2.7 m below ground surface for delineation of refusal/bedrock surface.

The groundwater conditions were observed in the open boreholes during and immediately following the drilling operations and a standpipe piezometer was installed in Borehole 17-4 to permit monitoring of the groundwater level. The piezometer consists of a 38 mm diameter polyvinyl chloride (PVC) pipe, with a slotted screen sealed within a sand filter pack at a selected depth interval within the borehole. Above the sand filter pack and piezometer screen, the annulus surrounding the piezometer pipe was backfilled with bentonite pellets and/or bentonite grout to ground surface. The piezometer installation details and water level readings are indicated on the borehole records contained in Appendix A. All other boreholes were backfilled upon completion in accordance with Ontario Regulation 903 (Wells, as amended).

The fieldwork was supervised by a member of our engineering and technical staff, who observed the drilling, sampling and in situ testing operations, logged the boreholes, and examined and took custody of the soil and bedrock samples. The samples were identified in the field, placed in appropriate containers, labelled and transported to our Sudbury Geotechnical Laboratory where the samples underwent further visual examination and laboratory testing. All of the laboratory tests were carried out to MTO and/or ASTM Standards, as appropriate. Classification testing (water content, grain size distribution and Atterberg limits) was carried out on selected samples. In addition two one-dimensional consolidation (oedometer) testes were carried out on selected soil samples. Unconfined compression strength (UCS) tests were carried out on selected bedrock core samples. The results of the laboratory testing on samples from the boreholes are presented on the Record of Borehole and Drillhole sheets and are included in Appendix D.

The approximate locations of the boreholes were determined based on preliminary drawings provided to Golder during the planning phase by MH as foundation element locations were not known at that time and confirmed with AECOM/MTO prior to drilling. The as-drilled locations and elevations of the boreholes were surveyed using a Trimble Geo7 GPS survey unit. A summary of the borehole locations (northing and easting coordinates given relative to NAD83 MTM Zone 12, as well as latitude and longitude) and Geodetic elevations are provided on the borehole records and together with the drilling depths are summarized below.





## FOUNDATION REPORT - HIGHWAY 17 CONISTON CPR OVERHEAD DETOUR, ASSIGNMENT NO. 5015-E-0045

Borehole	Location (MTM NAD 83, Zone12)		Location (WGS84)		Ground Surface Elevation (m)	Borehole/ DCPT Depth (m)
	Northing	Easting	Latitude	Longitude		
C17-1	5149846.8	318881.4	46.488138	-80.816580	260.2	3.0*
C17-2	5149856.2	318871.2	46.488223	-80.816713	254.0	3.0*
C17-3	5149852.7	318815.9	46.488192	-80.817433	253.5	11.7*
C17-4	5149860.2	318800.5	46.488260	-80.817633	253.5	11.9*
C17-5	5149839.0	318787.1	46.488070	-80.817809	262.6	17.3
C17-6	5149865.0	318776.1	46.488304	-80.817951	253.1	10.7
C17-7	5149841.5	318720.8	46.488094	-80.818672	261.7	9.2*
C17-8	5149860.2	318720.0	46.488262	-80.818682	255.9	0.3
C17-8D1	5149860.2	318710.0	46.488262	-80.818812	256.2	0.2
C17-8D2	5149860.2	318730.0	46.488262	-80.818552	255.0	1.0
C17-9	5149857.5	318671.9	46.488239	-80.819309	257.1	2.3
C17-9D1	5149857.5	318661.9	46.488239	-80.819439	257.1	2.7
C17-9D2	5149857.5	318681.9	46.488238	-80.819178	257.1	2.1

\*Includes between 1.0 and 3.1 m of bedrock core length.

The relevant borehole logs from this investigation used to supplement the current investigation are provided in Appendix C.

## 4.0 SUBSURFACE CONDITIONS

The detailed subsurface soil and groundwater conditions encountered in the boreholes and the results of in situ and laboratory testing are provided on the Record of Borehole sheets contained in Appendix C. The results of geotechnical laboratory testing are contained in Appendix D. The results of the in situ tests (i.e., SPT 'N'-values and field vanes) as presented on the Record of Borehole sheets and in Section 4 are uncorrected. The stratigraphic boundaries shown on the Record of Borehole sheets and on the interpreted stratigraphic profiles on Drawings 1 and 2 are inferred from non-continuous sampling and, therefore, represent transitions between soil types rather than exact planes of geological change. The subsoil conditions will vary between and beyond the borehole locations.

### 4.1 Regional Geology

The site is located within a glaciolacustrine plain, with low relief and a suspected high water table<sup>1</sup>. The published information indicated the site borders on areas characterized by bedrock knobs generally covered by a thin veneer (1 to 3 m in thickness) of bouldery sandy glacial till, with low relief and undulating topography<sup>1</sup>.

### 4.2 Subsoil Conditions

In general, the subsoil conditions encountered at the borehole locations consist of embankment fill or a surface layer of topsoil, underlain by a native deposit of clayey silt to clay, which is underlain by a granular deposit ranging in composition from silt to sand in turn underlain by a till deposit comprised of gravelly silty sand to sand and gravel overlying bedrock. Generally, the stratigraphy noted in the current investigation is consistent with the previous investigations. A more detailed description of the soil deposits and groundwater conditions encountered in the boreholes is provided below.

<sup>1</sup> Garnet, J.F., 1980. Sudbury Area (NTS 41i/SE) District of Nipissing, Parry Sound and Sudbury; Ontario Geologic Society, Northern Ontario Engineering Geology Terrain Study 100.



## FOUNDATION REPORT - HIGHWAY 17 CONISTON CPR OVERHEAD DETOUR, ASSIGNMENT NO. 5015-E-0045

Deposit/Layer Description	Boreholes	Deposit Thickness (m)	Deposit Surface Elevation (m)	N Values (blows)	Laboratory Testing
				Field Vane Results (kPa)	
				Consistency or Relative Density	
<b>Asphalt</b>	C17-5, C17-7	0.10	262.6, 261.7	n/a	n/a
<b>Concrete<sup>1</sup></b>	C17-5	0.25	262.5	n/a	n/a
<b>Sandy/Silty Topsoil and/or Peat</b>	C17-3, C17-4, C17-6, C17-8, C17-9	0.1 – 0.2	257.1 – 253.1	n/a	n/a
<b>(FILL) Sand and Gravel, Sand, Silty Sand, Sandy Silt<sup>2</sup>, trace organics, brown; moist to wet,</b>	C17-3 to C17-7 and C17-9	0.6 – 4.0 0.9 (lower fill in C17-5)	262.2 – 253.0	N = 6 - 57; 67/0.16	w = 7% – 10% 3 – M (Fig. D1) 1 – MH (Fig. D1)
				n/a	
				<b>Loose to very dense</b>	
<b>(FILL) Clayey Silt, some to with sand, some gravel; brown; moist to wet</b>	C17-4, C17-5, C17-7	0.9 – 4.9	258.3 – 252.8	N = 4 - 57	w = 18% – 20% 2 – MH (Fig. D2) 2 – AL (Fig. D3) w <sub>L</sub> = 26% – 30% w <sub>p</sub> = 17% I <sub>p</sub> = 9% – 13%
				n/a	
				<b>Firm to hard</b>	
<b>Clayey Silt to Clay, trace sand, trace gravel, varved; brown to grey; wet</b>	C17-3 to C17-6	4.7 – 7.8	252.4 – 251.5	N = WH – 14	w = 28% – 47% 9 – MH (Fig. D4) 13 – AL (Fig. D5) w <sub>L</sub> = 26% – 54% w <sub>p</sub> = 19% – 24% I <sub>p</sub> = 6% – 31% 2 – Oedometer (Fig. B6 and B7)
				S <sub>u</sub> = 24 – >100 S = 4 - 9	
				<b>Soft to very stiff</b>	
<b>Sandy Silt, Silt and Sand, Silt, Sand<sup>2</sup>, trace gravel, trace clay; grey; wet</b>	C17-3, C17-4, C17-6, C17-9	0.4 – 2.6	256.0 – 243.8	N = 1 – 36	w = 14% – 31% 4 – MH (Fig. D8) 1 – AL (Fig. DB9) including 1-AL(N.P.) w <sub>L</sub> = 18% w <sub>p</sub> = 15% I <sub>p</sub> = 3%
				n/a	
				<b>Very loose to dense</b>	
<b>TILL - Sand and Gravel to Gravelly Silty Sand<sup>2</sup>, trace clay; dark brown to grey; wet</b>	C17-5, C17-7 to C17-9	0.2 - 2.6	256.1 – 246.4	N = 16 – 74; 10/0.2	w = 6% – 18% 3 – MH (Fig. D10)
				n/a	
				<b>Compact to very dense</b>	



## FOUNDATION REPORT - HIGHWAY 17 CONISTON CPR OVERHEAD DETOUR, ASSIGNMENT NO. 5015-E-0045

### Where:

N = SPT 'N'-value; number of blows for 0.3 m of penetration  
 $s_u$  = Undrained Shear Strength from in situ field 'N'-vane (kPa)  
 S = calculated sensitivity  
 w = Natural Moisture Content (%)  
 MH = Combined Sieve and Hydrometer analysis  
 M = Sieve analysis for particle size  
 AL = Atterberg Limits Test  
 $w_p$  = Plastic Limit (%)  
 $w_l$  = Liquid Limit (%)  
 $I_p$  = Plasticity Index (%)  
 NP = Non-Plastic test result

### Notes:

- Concrete encountered in Borehole C17-5 is likely part of the concrete approach slab.
- Cobbles were encountered in Boreholes C17-3, C17-5 within the native sandy silt to silt and in the sand and gravel to gravelly silty sand deposits up 110 mm in diameter. Cobbles were also encountered within the embankment fill and within the gravelly silty sand Till deposit in Borehole C17-7.

Laboratory consolidation (oedometer) tests were carried out on two Shelby Tube samples of the clayey silt to clay deposit, obtained from Shelby tube samples in Boreholes C17-3 and in a separate borehole drilled adjacent to Borehole C17-4. The preconsolidation stress was estimated from the void ratio versus logarithmic pressure plot and from the total work versus pressure plot. A bulk unit weight of 18.0 kN/m<sup>3</sup> and 18.7 kN/m<sup>3</sup> and a specific gravity of 2.77 were measured on the consolidation test samples. The detailed results of the oedometer tests are shown on Figures D6 and D7 in Appendix D, and the test results are summarized below:

Borehole/ Sample No.	Sample Depth / Elevation	$\sigma_{vo}'$ (kPa)	$\sigma_p'$ (kPa)	$\sigma_p' - \sigma_{vo}'$ (kPa)	OCR	$e_o$	$C_c$	$C_r$	$c_v^*$ (cm <sup>2</sup> /s)
C17-3/ Sample 7	5.5 m/ 248.0 m	65	140	75	2.2	0.96	0.19	0.02	$6.3 \times 10^{-3}$
Adjacent to C17-4/ Sample 1	5.5 m/ 248.0 m	70	190	120	2.7	1.09	0.16	0.03	$2.7 \times 10^{-3}$

\*For the consolidation stress range 130 kPa to 250 kPa

where:  $\sigma_{vo}'$  is the effective overburden stress in kPa  
 $\sigma_p'$  is the preconsolidation stress in kPa  
 OCR is the overconsolidation ratio  
 $e_o$  is the initial void ratio  
 $C_c$  is the compression index  
 $C_r$  is the recompression index  
 $c_v$  is the coefficient of consolidation in cm<sup>2</sup>/s

### 4.3 Bedrock/Refusal

On the northeast end of the existing bridge, an exposed bedrock knob is present dipping westerly towards the rail right-of-way. Another bedrock knob is present approximately 20 m north of Borehole 17-8 located beyond the toe of the embankment slope.

Based on the results of the DCPTs, previous geotechnical investigations at the site, and published geological information, the DCPTs are considered to have achieved "refusal" on the inferred bedrock surface. Further, boreholes where bedrock was not cored were terminated on "refusal" conditions on the inferred bedrock surface as indicated by auger refusal, refusal to further casing advancement and/or split-spoon refusal. Bedrock was cored in Boreholes C17-1 to C17-4 and C17-7 and the depth/elevation of the actual/inferred bedrock surface is presented below.





## FOUNDATION REPORT - HIGHWAY 17 CONISTON CPR OVERHEAD DETOUR, ASSIGNMENT NO. 5015-E-0045

Borehole No.	Depth to Bedrock/Refusal (below ground surface at borehole location) (m)	Bedrock Surface/DCPT Refusal Elevation (m)	Refusal Condition (m)
C17-1	Ground Surface	260.2	3.0 m bedrock core length
C17-2	Ground Surface	254.0	3.0 m bedrock core length
C17-3	8.6	244.9	3.1 m bedrock core length
C17-4	8.9	244.6	3.0 m bedrock core length
C17-5	17.3	245.3	Casing and split-spoon refusal
C17-6	10.7	242.4	Auger and split-spoon refusal
C17-7	8.2	253.5	1.0 m bedrock core length
C17-8	0.3	255.6	Auger and split-spoon refusal
C17-8D1	0.2	256.0	Hammer bouncing
C17-8D2	1.0	254.0	Hammer bouncing
C17-9	2.3	254.8	Auger and split-spoon refusal
C17-9D1	2.7	254.4	Hammer bouncing
C17-9D2	2.1	255.0	Hammer bouncing

The retrieved bedrock core from Boreholes C17-1 to C17-3 and C17-7 is described as slightly weathered to fresh, very fine grained, grey arkosic greywacke. In Borehole C17-4, the bedrock is described as very fine grained, grey to pink meta quartzite. More detailed descriptions of the bedrock cores are presented on the Record of Drillhole sheets in Appendix C. Photographs of the bedrock core samples are shown on Figure D11 in Appendix D. The bedrock properties, as encountered in the boreholes, are summarized below.

Borehole No.	Total Core Recovery (TCR)	Rock Quality Designation (RQD)	Quality Classification (Table 3.10 of CFEM 2006 <sup>2</sup> )	UCS (MPa)	Strength Classification (Table 3.5 of CFEM 2006 <sup>3</sup> )
C17-1	75% - 100%	18% - 67%	Very Poor to Fair	91	(R4) Strong
C17-2	100%	22% - 69%	Very Poor to Fair	142	(R5) Very Strong
C17-3	93% - 100%	45% - 81%	Poor to Good	87	(R4) Strong
C17-4	100%	81% - 100%	Good to Excellent	151	(R5) Very Strong
C17-7	100%	0%	Very Poor	-	-

### 4.4 Groundwater Conditions

Unstabilized groundwater levels measured in the open boreholes upon completion of drilling are summarized below. It should be noted that the introduction of drilling water to advance NW casing in the boreholes may impact the measured groundwater levels. Water levels may vary depending on the time of year and precipitation events.

<sup>2</sup> Canadian Geological Society, 2006. Canadian Foundation Engineering Manual, 4<sup>th</sup> Edition.



## FOUNDATION REPORT - HIGHWAY 17 CONISTON CPR OVERHEAD DETOUR, ASSIGNMENT NO. 5015-E-0045

Borehole	Ground Surface Elevation (m)	Depth to Groundwater (mbgs)	Groundwater Elevation (m)
C17-3	253.5	2.1	251.4
C17-4 (Piezometer)	253.5	1.6 (April 27, 2017 and July 4, 2017)	251.9
C17-5	262.6	6.9	255.7
C17-6	253.1	5.9	247.2
C17-7	261.7	6.6	255.1
C17-9	257.1	1.8	255.3

### 5.0 CLOSURE

This Foundation Investigation Report was prepared by Mr. Tibor Berecz, and the technical aspects were reviewed by Ms. Sarah E.M. Poot, P.Eng. a senior geotechnical engineer and Associate of Golder. Mr. Jorge M.A. Costa, P.Eng., a Senior Consultant with Golder and Designated MTO Foundations Contact for Golder, conducted an independent quality control review of this report.



## Report Signature Page

GOLDER ASSOCIATES LTD.

Adam Core, P.Eng.  
Geotechnical Engineer



Sarah E.M. Poot, P.Eng.  
Associate, Senior Geotechnical Engineer



Jorge M.A. Costa, P.Eng.  
Designated MTO Foundations Contact, Senior Consultant

TB/AC/SEMP/JMAC/kp/nh

Golder, Golder Associates and the GA globe design are trademarks of Golder Associates Corporation.

n:\active\2016\3 proj\1651997 aecom\_5015-e-0045\_ne retainer\wo#1 - shadow, culvert, cpr\5 reporting\3 coniston cpr\final\1651997 rep coniston cpr tmb and detour fir 07sept2017 final.docx

## Site Photographs



North Side of Hwy 17 Overhead Looking East Across CPR Tracks



North Side of Hwy 17 Overhead Looking West Across CPR Tracks

Project No.	1651997-WO1
Date:	September, 2017

**Golder Associates Ltd.**

Inputted by:	TB
Checked by:	SP



## Site Photographs



Looking North at South side of Hwy 17 Overhead

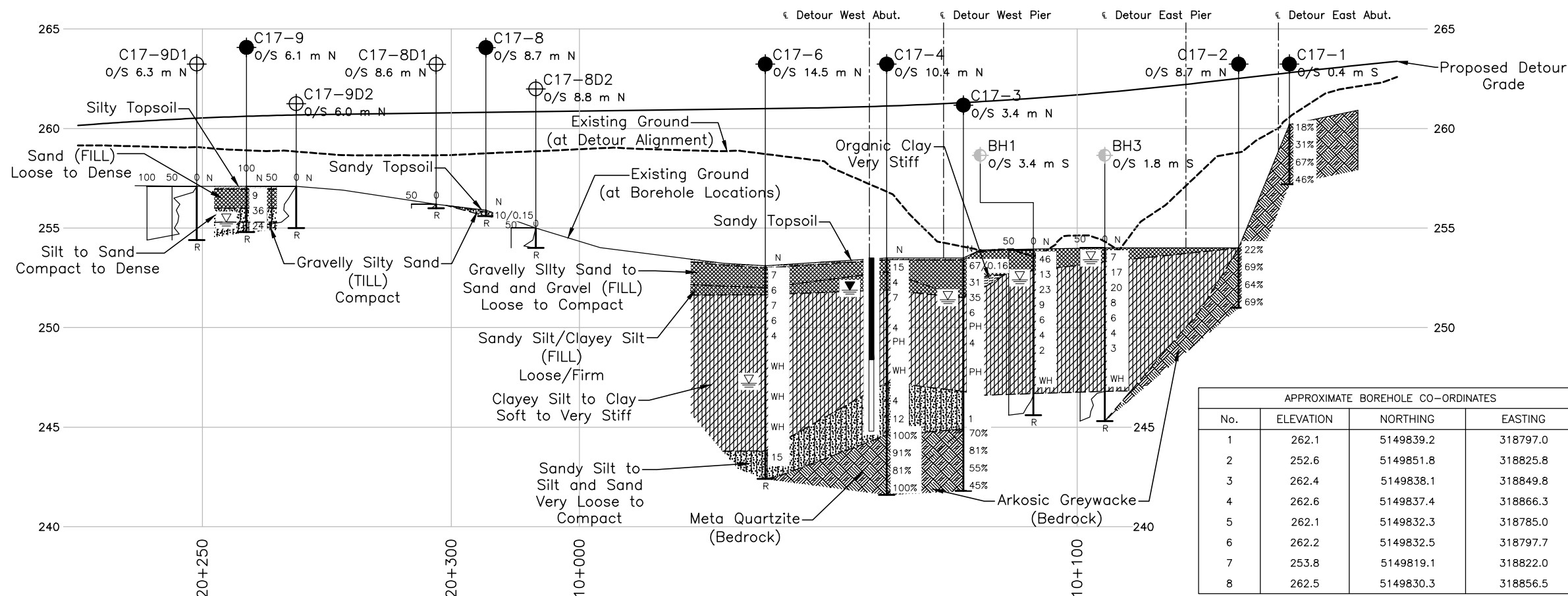
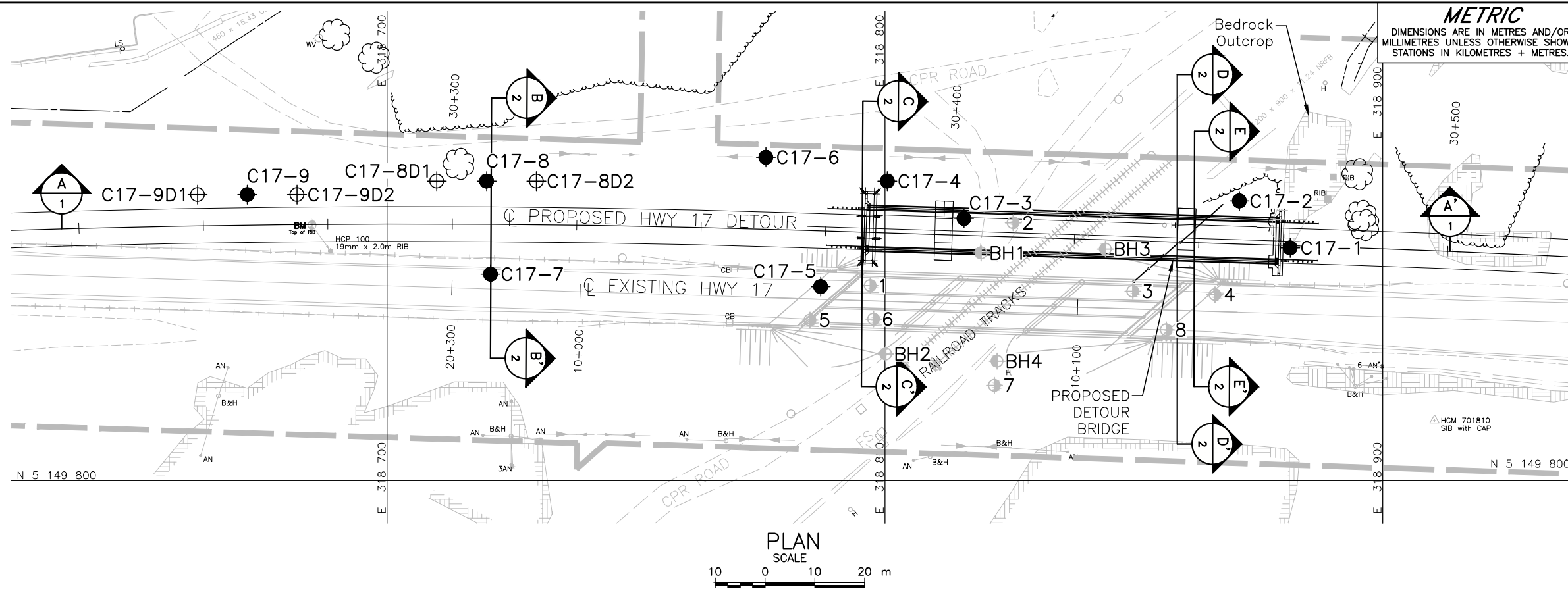


Looking South from Location of Borehole C17-3

Project No.	1651997-WO1
Date:	September, 2017

**Golder Associates Ltd.**

Inputted by:	TB
Checked by:	SP



APPROXIMATE BOREHOLE CO-ORDINATES			
No.	ELEVATION	NORTHING	EASTING
1	262.1	5149839.2	318797.0
2	252.6	5149851.8	318825.8
3	262.4	5149838.1	318849.8
4	262.6	5149837.4	318866.3
5	262.1	5149832.3	318785.0
6	262.2	5149832.5	318797.7
7	253.8	5149819.1	318822.0
8	262.5	5149830.3	318856.5

## NOTES

This drawing is for subsurface information only. The proposed structure details/works are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contracts Documents.

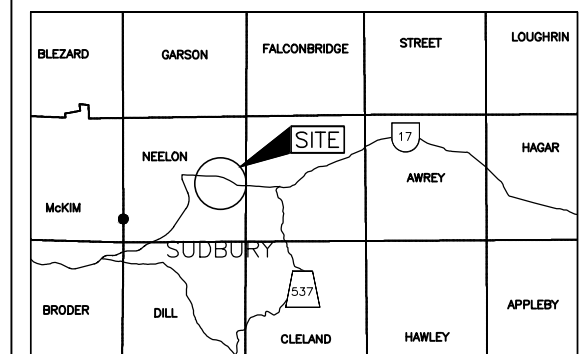
The boundaries between soil strata have been established only at borehole locations. Between boreholes the boundaries are assumed from geological evidence.

## REFERENCE

Base plans provided in digital format by AECOM, drawing file nos. Base.dwg and x1124160\_46-123\_Detour Alignment.dwg, received MAY 31, 2017 and 46-123TMB\_01 - Option 2.dwg, received June 15, 2017.

CONT No.  
WP No. 5165-10-01

HIGHWAY 17  
CONISTON CPR OVERHEAD  
BOREHOLE LOCATIONS AND SOIL  
STRATA

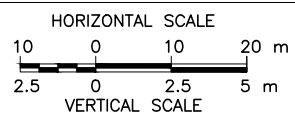


## LEGEND

- Borehole - 2017
- Borehole - 2016 (Previous Investigation - Golder)
- Borehole - 1975 (Previous Investigation - GEOCON)
- ⊕ Dynamic Cone Penetration Test
- ⊕ Seal
- ⊕ Piezometer
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- R Refusal
- 100% Rock Quality Designation (RQD)
- ▽ WL in piezometer, measured on APR 27, 2017
- ▽ WL upon completion of drilling

## BOREHOLE CO-ORDINATES

No.	ELEVATION	NORTHING	EASTING
BH1	253.9	5149845.7	318819.3
BH2	254.1	5149825.5	318800.2
BH3	254.0	5149846.5	318844.3
BH4	254.4	5149824.0	318822.5
C17-1	260.2	5149846.8	318881.4
C17-2	254.0	5149856.2	318871.2
C17-3	253.5	5149852.7	318815.9
C17-4	253.5	5149860.2	318800.5
C17-5	262.6	5149839.0	318787.1
C17-6	253.1	5149865.0	318776.1
C17-7	261.7	5149841.5	318720.8
C17-8	255.9	5149860.2	318720.0
C17-8D1	256.2	5149860.2	318710.0
C17-8D2	255.0	5149860.2	318730.0
C17-9	257.1	5149857.5	318671.9
C17-9D1	257.1	5149857.5	318661.9
C17-9D2	257.1	5149857.5	318681.9



## REFERENCE

Base plans provided in digital format by AECOM, drawing file nos. Base.dwg and x1124160\_46-123\_Detour Alignment.dwg, received MAY 31, 2017 and 46-123TMB\_01 - Option 2.dwg, received June 15, 2017.

NO.	DATE	BY	REVISION
1	2017	JMAC	ISSUED FOR CONSTRUCTION
Geocres No. 411-352			
HWY. 17		PROJECT NO. 1651997	DIST. .
SUBM'D.	CHKD. AC	DATE: 8/31/2017	SITE: 46-123
DRAWN: TB	CHKD. SEMP	APPD. JMAC	DWG. 1





## LEGEND

- Borehole - 2017
- ⊕ Borehole - 2016 (Previous Investigation - Golder)
- ⊙ Borehole - 1975 (Previous Investigation - GEOCON)
- ⬮ Seal
- ⬮ Piezometer
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- R Refusal
- REC Recovery (%)
- 100% Rock Quality Designation (RQD)
- ▽ WL in piezometer, measured on APR 27, 2017
- ▽ WL upon completion of drilling

## BOREHOLE CO-ORDINATES

No.	ELEVATION	NORTHING	EASTING
3	262.4	5149838.1	318849.8
4	262.6	5149837.4	318866.3
6	262.2	5149832.5	318797.7
8	262.5	5149830.3	318856.5
BH3	254.0	5149846.5	318844.3
C17-2	254.0	5149856.2	318871.2
C17-4	253.5	5149860.2	318800.5
C17-5	262.6	5149839.0	318787.1
C17-7	261.7	5149841.5	318720.8
C17-8	255.9	5149860.2	318720.0

## NOTES

This drawing is for subsurface information only. The proposed structure details/works are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contracts Documents.

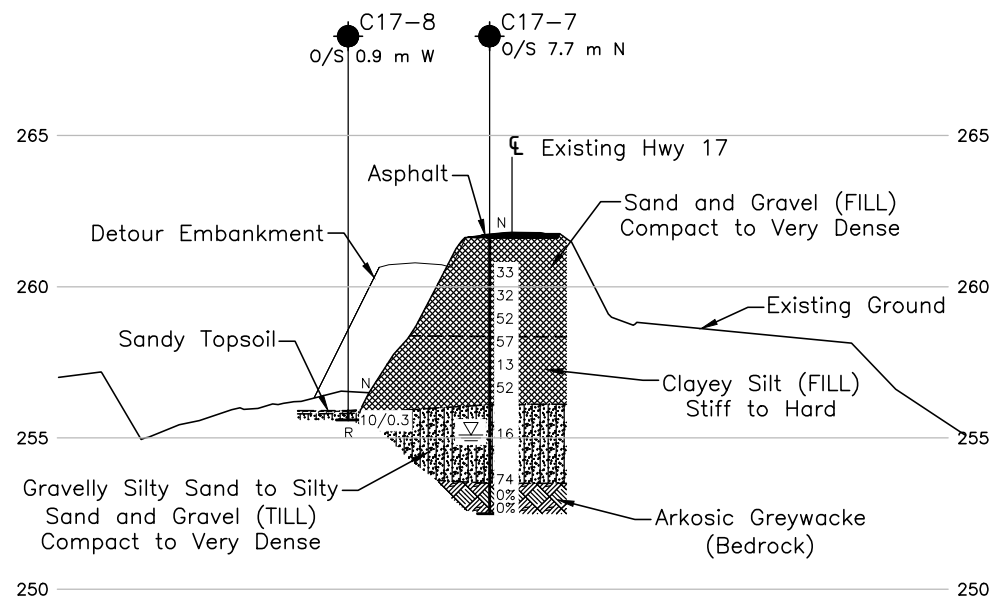
The boundaries between soil strata have been established only at borehole locations. Between boreholes the boundaries are assumed from geological evidence.

## REFERENCE

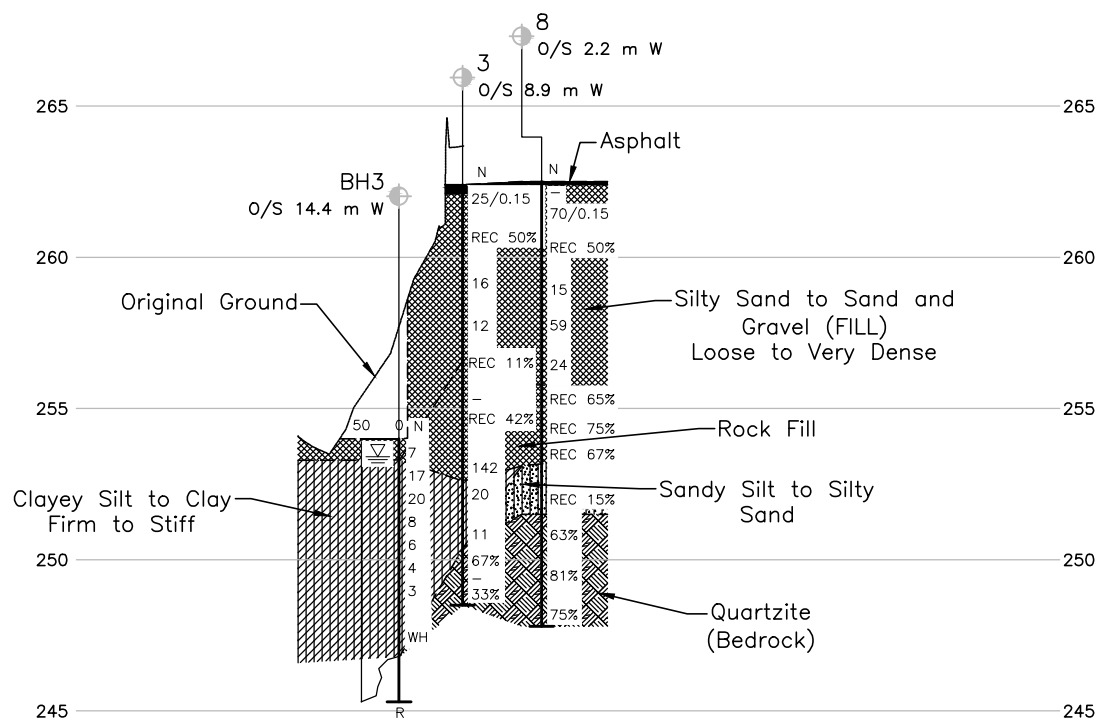
Base plans provided in digital format by AECOM, drawing file nos. Base.dwg and x124160\_46-123\_Detour Alignment.dwg, received MAY 31, 2017 and 46-123TMB\_01 - Option 2.dwg, received June 15, 2017.



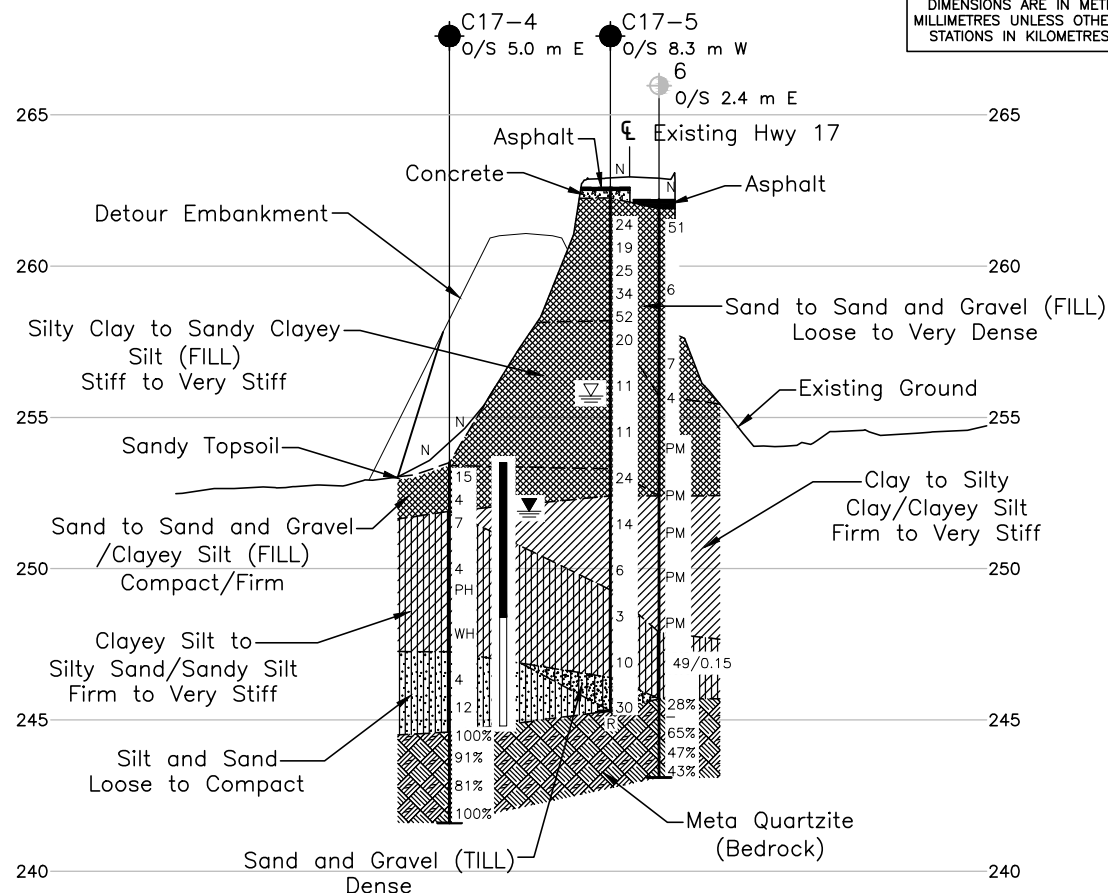
NO.	DATE	BY	REVISION
Geocres No. 411-352			
HWY. 17	PROJECT NO. 1651997	DIST. .	
SUBM'D.	CHKD. AC	DATE: 8/31/2017	SITE: 46-123
DRAWN: TB	CHKD. SEMP	APPD. JMAC	DWG. 2



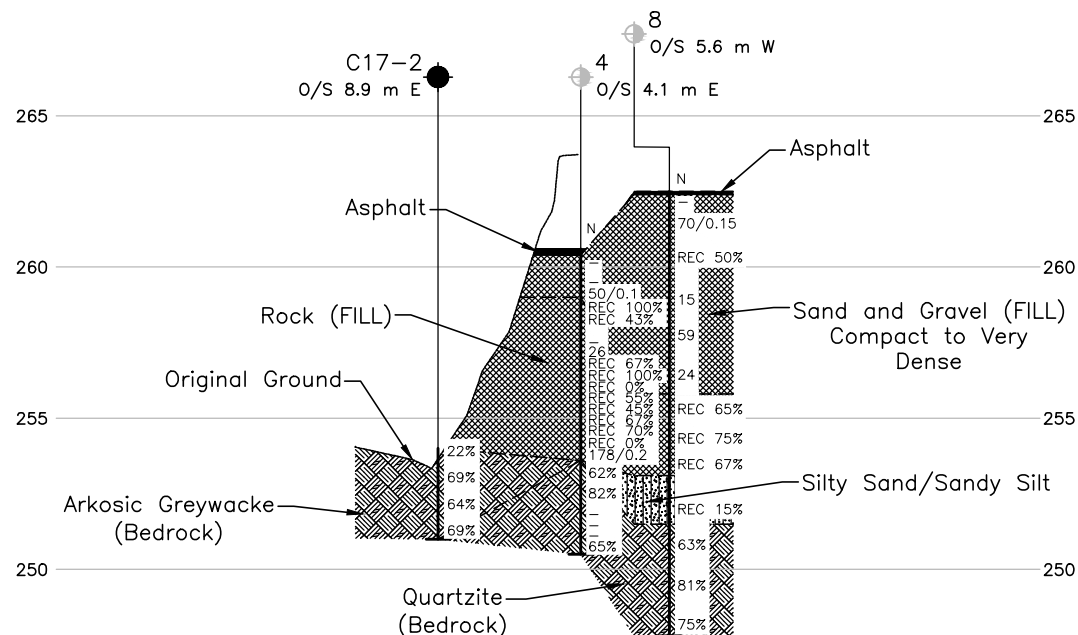
SECTION AT STA 20+308 (30+308 DETOUR)

B-B  
1HORIZONTAL SCALE  
10 0 10 20 m  
2.5 0 2.5 5 m  
VERTICAL SCALE

SECTION AT STA 10+120 (30+446 DETOUR)

D-D  
1HORIZONTAL SCALE  
10 0 10 20 m  
2.5 0 2.5 5 m  
VERTICAL SCALE

SECTION AT STA 10+057 (30+381 DETOUR)

C-C  
1HORIZONTAL SCALE  
10 0 10 20 m  
2.5 0 2.5 5 m  
VERTICAL SCALE

SECTION AT STA 10+123 (30+449 DETOUR)

E-E  
1HORIZONTAL SCALE  
10 0 10 20 m  
2.5 0 2.5 5 m  
VERTICAL SCALE



# **APPENDIX A**

## **Borehole Records – GEOCON 1975**

## RECORD OF BOREHOLE NO 1

ORIGINATED BY AEL

COMPILED BY RAH

CHECKED BY RGE

15  $\phi$  5 % STRAIN AT FAILURE

## HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

## RECORD OF BOREHOLE NO 2

WP 158-74-01 LOCATION Sta. 102 + 86 o/s 48.5 Lt. 6 Hwy. 17 ORIGINATED BY AEL  
 DIST 17 HWY 17 BORING DATE December 10, 13, & 19, 1976 COMPILED BY RAH  
 DATUM Geodetic BOREHOLE TYPE BX & AX Cased & Cored CHECKED BY RGC

SOIL PROFILE		STRAT. PLOT	SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT $W_L$ PLASTIC LIMIT $W_P$ WATER CONTENT $W$			UNIT WEIGHT $\gamma$	REMARKS
ELEV DEPTH	DESCRIPTION		NUMBER	TYPE	N' VALUES		20	40	60	80	100	$W_P$	$W$	$W_L$		
828.6	Ground Level															
0.0	Silty Sand with gravel Compact brown		1	SS	23	↓										
825.6																
3.0	Silty clay/clayey silt Varved Stiff to firm brown		2	SS	4											0 4 67 29
			3	SS	4											
815.1																
13.5	Silty clay/clayey silt Varved Firm grey		4	TW	PM										115	0 2 74 24
			5	TW	PM										111	0 2 78 20
803.6																
25.0	Silty sand/sandy silt with occasional gravel Loose brown		6	WS	-											
			7	SS	5											3 34 48 15
			8	SS	10/11											28 75 (3)
792.1																RQD 22%
36.5	Bedrock Note: Medium to fine grained, grey.		9	BX RC	100%											RQD 69%
			10	BX RC	92%											RQD -
			11	BX RC	75%											RQD -
			12	BX RC	63%											RQD -
			13	AX RC	75%											
	Joint spacing close to very close. Core gen- erally fractured.		14	AX RC	80%											RQD 43%
781.6																
47.0	End of Borehole															

R.Q.D. Rock Quality Designation

20  
15  $\diamond$  5 % STRAIN AT FAILURE  
10

OFFICE REPORT ON SOIL EXPLORATION

—

—

—

—

—

—

—

## HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

## RECORD OF BOREHOLE NO 4

WP158-74-01

LOCATION Sta. 104 + 19 o/s 10.0 Lt. &amp; Hwy. 17

ORIGINATED BY AEL

DIST 17 HWY 17

BORING DATE January 3 - 6, 1977

COMPILED BY RAH

DATUM Geodetic

BOREHOLE TYPE NX &amp; BX Casing, BX &amp; AX Rock Core

CHECKED BY BGC

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT $w_L$ PLASTIC LIMIT $w_p$ WATER CONTENT $w$			UNIT WEIGHT $\gamma$	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	$w_p$	$w$	$w_L$		
861.5	Ground Level															
0.0	Asphalt															
0.5	Fill		1	WS	-	860	Note: Fill from 0.5 to 5.4.									
	Sand and gravel		2	WS	-		Cobbles and boulders encountered up to 6 inches in size from 3 to 5 feet. NXCA drilled from 1.6 to 5.9 feet.									
	Very dense		3	SS	50%											
856.1	grey brown		4	BX, RC	100%	855										
5.4	Fill		5	BX	43%											
	Rock			RC												
	Note:		6	BX, RC	-	850										
	Rock up to 18 inches in size encountered. NXCA drilled from 5.4 to 8.5 feet. BXCA drilled from 8.5 to 22.9 feet.		7	SS	26											
			8	BX, RC	72%											
			9	BX, RC	100%											
			10	BX, RC	0%											
			11	BX	55%	845										
			12	RC	45%											
			13	BX	67%											
			14	RC	70%											
838.6			15	BX, RC	0%	840										
22.9	Bedrock		16	SS	178/3"											
	Note:		17	BX, RC	67%											RQD 62%
	Medium to fine grained grey, hard quartzite. Joint spacing close. Loss of return water down to 28'2". Core generally sound.		18	BX	94%	835										RQD 82%
			19	BX	100%											RQD -
			20	RC	100%											RQD -
828.3			21	RC	100%											RQD -
33.2	End of Borehole		22	AX	100%	830										RQD 65%
	Note: W.L. Not Established															
																R.Q.D. Rock Quality Designation

OFFICE REPORT ON SOIL EXPLORATION

20  
15  $\phi$  5 % STRAIN AT FAILURE  
10



## HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

## RECORD OF BOREHOLE NO 5

WP 158-74-01

LOCATION Sta. 101+56 O/S 12.5 Lt. &amp; Hwy. 17

ORIGINATED BY AEL

DIST 17 HWY 17

BORING DATE January 26-29, 1977

COMPILED BY RAH

DATUM Geodetic

BOREHOLE TYPE H.S. Augers &amp; AX Casing, AXT Rock Core

CHECKED BY RGC

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT $w_L$ PLASTIC LIMIT $w_p$ WATER CONTENT $w$			UNIT WEIGHT $\gamma$	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	VALUES		20	40	60	80	100	$w_p$	$w$	$w_L$		
859.8	Ground level															
0.0	Asphalt															
0.5	Fill Sand and gravel Very dense to compact					855										
						850										
			1	SS	14											
846.3																
13.5	Fill Silty clay/clayey silt Stiff  grey & brown		2	TW	PM	845										
						840										
			3	TW	PM											
						835										
			4	TW	PM											
832.8						830										
27.0	Silty clay/clayey silt Varved Very stiff to stiff brown		5	TW	PM						2700					
						825										
			6	TW	PM											
821.8															116	
38.0	Silty clay/ clayey silt Varved Firm  grey		7	TW	PM	820										
						815										
813.4			8	TW	PM											
46.4	Silty sand/sandy silt with occasional gravel Very dense  grey brown					810										
			9	SS	51											
						805										
			10	SS	50/2											
57.7	Bedrock Note: Medium to fine grained grey, hard quartzite, joint spacing close to very close. Core generally fractured		11	AXT RC	882	800										RQD 42%
797.6			12	AXT RC	1002											RQD -
62.2	End of Borehole Notes: W.L. Not Established															

20  
15-25 % STRAIN AT FAILURE  
10

OFFICE REPORT ON SOIL EXPLORATION

## RECORD OF BOREHOLE NO 6

WP 158-74-01 LOCATION Sta. 101 + 98 o/s 11.0' Rte. 17 ORIGINATED BY AEL  
DIST 17 HWY 17 BORING DATE January 25 - 28, 1977 COMPILED BY RAH  
DATUM Geodetic BOREHOLE TYPE H.S. Augers & AX Casing, AXT Rock Core CHECKED BY BGC

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT ——— $w_L$ PLASTIC LIMIT ——— $w_p$ WATER CONTENT — $w$ $w_p$ — $w$ — $w_L$			UNIT WEIGHT $\gamma$	REMARKS	
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20 40 60 80 100					SHEAR STRENGTH PSF					WATER CONTENT % 20 40 60
							○ UNCONFINED + FIELD VANE					● QUICK TRIAXIAL ▲ HAND VANE					
860.1	Ground Level															% GR SA SI CL	
0.0	Asphalt																
0.9	Fill Sand and gravel Very dense to loose  grey brown		1	SS	51	855							○				
			2	SS	6	850							○				
			3	SS	7	845							○				
			4	SS	4	840							○				
838.8	Fill Silty clay/clayey silt Stiff  grey & brown		5	TW	PM	835							○				
21.3			6	TW	PM	830							○				
828.1	Silty clay/clayey silt Varved Stiff to firm  brown		7	TW	PM	825							○				
32.0			8	TW	PM	820							○				
819.1	Silty clay/clayey silt Varved Firm  grey		9	TW	PM	815							○				
41.0			10	SS	49/77	810											
47.0	Silty sand/sandy silt with occasional gravel Very dense  grey		11	AXT RC	94%	805										RQD 28%	
806.1	Bedrock Note: Medium to fine grained grey, hard quartzite. Joint spacing close to very close.		12	AXT RC	100%											RQD 65%	
54.0			13	AXT RC	82%											RQD 47%	
			14	AXT RC	69%											RQD 43%	
			15	AXT RC	92%	800											
797.9	End of Borehole Note: W.L. Not Established																
62.6																	

70  
15-5 % STRAIN AT FAILURE  
10

OFFICE REPORT ON SOIL EXPLORATION

## HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

## RECORD OF BOREHOLE NO 7

WP 158-74-01

LOCATION Sta. 102 + 78 o/s 47.5 Rt. &amp; Hwy. 17

ORIGINATED BY AEL

DIST 17 HWY 17

BORING DATE December 15 &amp; 16, 1976.

COMPILED BY RAH

DATUM Gcndetic

BOREHOLE TYPE BX Casing, AX Rock Core

CHECKED BY RGC

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT $w_L$ PLASTIC LIMIT $w_p$ WATER CONTENT $w$			UNIT WEIGHT $\gamma$	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	N' VALUES		20	40	60	80	100	$w_p$	$w$	$w_L$		
832.8	Ground Level															
0.0	Silty sand with gravel Loose brown		1	SS	6											
829.8						830										
3.0	Silty clay/clayey silt Varved Stiff to firm brown		2	SS	9										120	4 15 59 22
			3	TW	PM											
			4	TW	PM	825										
819.8						820										
13.0	Silty clay/clayey silt Varved Firm grey		5	TW	PM											0 6 54 40
			6	TW	PM	815										0 2 80 18
809.8						810										
23.0	Silty sand/sandy silt with occasional gravel Loose grey		7	SS	6											0 52 44 4
802.7						805										
30.1	Bedrock Note:  Medium to fine grained grey, hard quartzite. Joint spacing close to very close. Core generally frac- tured.		8	AX RC	97%	800										RQD 50%
			9	AX RC	100%											RQD -
			10	AX RC	83%	795										RQD 17%
791.8			11	AX RC	93%											RQD 40%
41.0	End of Borehole															

R.Q.D. Rock Quality Designation

20  
15  $\diamond$  5 % STRAIN AT FAILURE  
10

OFFICE REPORT ON SOIL EXPLORATION

## HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

## RECORD OF BOREHOLE NO 8

WP 158-74-01

LOCATION Sta. 103 + 88 o/s 11.5' Rt. of Hwy. 17

ORIGINATED BY AEL

DIST 17 HWY 17

BORING DATE January 25 - 26, 1977

COMPILED BY RAH

DATUM Geodetic

BOREHOLE TYPE BX &amp; AX Casing, AXT &amp; BX Rock Core

CHECKED BY RGC

ELEV DEPTH	SOIL PROFILE DESCRIPTION	STRAT. PLT	SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT $w_L$ PLASTIC LIMIT $w_P$ WATER CONTENT $w$			UNIT WEIGHT $\gamma$	REMARKS
			NUMBER	TYPE	'N' VALUES		20	40	60	80	100	$w_p$	$w$	$w_L$		
861.2	Ground Level															
0.3	Asphalt		1	MS	-	860										
	Fill		2	SS	70/5											
	Sand and gravel		3	BX	50%	855										
	Compact to very dense		4	BX	50%											
	grey brown			RC												
	Note:															
	Cobbles and boulders up to 6 inches in size encountered from 3 to 9 feet. BXCA drilled from 0.8 to 16 feet. AXCA drilled from 16 to 22 feet.		5	SS	15	850										
			6	SS	59	845										
			7	SS	24	840										
839.2	Fill		8	AXT	65%											
22.0	Rock		9	AXT	75%	835										
	Note:		10	AXT	67%											
	Rock up to 18 inches encountered			RC												
	AXCA drilled to 31 feet.															
830.2	Silty sand/sandy silt (probable) with occasional gravel		11	AXT	15%	830										
31.0				RC												
825.1	Bedrock		12	AXT	100%	825										RQD 63%
36.1	Note:		13	AXT	97%	820										RQD 81%
	Medium to fine grained grey, hard quartzite. Joint spacing close. Loss of return water 38.5 to 43.5 feet. Core generally sound.		14	AXT	100%	815										RQD 75%
				RC												
813.0	End of Borehole															
48.2	Note: W.L. Not Established															

20  
15  $\phi$  5 % STRAIN AT FAILURE  
10

OFFICE REPORT ON SOIL EXPLORATION







# **APPENDIX B**

## **Borehole Records – Golder 2016**

[illegible]

+ 3, × 3: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE



PROJECT 14-1181-0014			RECORD OF BOREHOLE No BH2			1 OF 1 METRIC														
G.W.P. _____			LOCATION N 5149825.5; E 318800.2			ORIGINATED BY DM														
DIST _____ HWY 17			BOREHOLE TYPE 108 mm I.D. Hollow Stem Augers			COMPILED BY TB														
DATUM GEODETIC			DATE January 19, 2016			CHECKED BY SEMP														
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		ELEVATION SCALE	SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED					WATER CONTENT (%) W <sub>p</sub> — W — W <sub>L</sub>			γ	GR SA SI CL			
254.1	GROUND SURFACE						254	20	40	60	80	100	20	40	60	kN/m <sup>3</sup>				
0.0	Gravelly silty sand (FILL) Compact Brown Frozen		1	SS	11		254													
253.4							253													
0.7	Sandy SILT, some gravel, trace organics Loose Brown-grey to black Moist to wet		2	SS	9		253													
252.7							252													
1.4	CLAYEY SILT to SILTY CLAY, trace sand, varved Firm to stiff Brown/grey Moist to wet		3	SS	6		252													
			4	SS	8		251													
			5	SS	4		251													
							250													
	Becoming grey below 4.3 m depth.		6	SS	1		249													
248.1							248													
6.0	SILT and SAND, trace clay Very loose Brown/grey Wet		7	SS	4		248													
247.4							247													
6.7	END OF BOREHOLE START OF DCPT						246													
							245													
243.9							244													
10.2	END OF DCPT DCPT REFUSAL (100 blows/0.18 m)  Note(s): 1. Water level at a depth of 3.1 m below ground surface (Elev. 251.0 m) upon completion of drilling.																			

SUD-MTO 001 1411810014 CONISTON A15.GPJ GAL-MISS.GDT 15/04/16 DATA INPUT:

PROJECT 14-1181-0014			RECORD OF BOREHOLE No BH3			1 OF 1 METRIC											
G.W.P. _____			LOCATION N 5149846.5; E 318844.3			ORIGINATED BY DM											
DIST _____ HWY 17			BOREHOLE TYPE NW Casing, Portable Equipment			COMPILED BY TB											
DATUM GEODETIC			DATE January 19, 2016			CHECKED BY SEMP											
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED					W <sub>p</sub> W W <sub>L</sub> WATER CONTENT (%)			γ	GR SA SI CL
254.0	GROUND SURFACE							20 40 60 80 100									
0.0	Gravelly silty sand, trace organics, trace cobbles (FILL) Loose Black to brown Wet		1	SS	7												
253.3																	
0.7	CLAYEY SILT, trace sand, trace gravel, trace organics Very stiff Brown to grey Wet		2	SS	17		253										0 3 82 15
			3	SS	20		252										
251.8																	
2.2	CLAY, varved Firm to stiff Brown/grey Moist to wet  Trace organics encountered in Sample 4.		4	SS	8		251										
			5	SS	6		250										
			6	SS	4		249										
			7	SS	3		248										
			8	SS	WH		247										
246.8							246										
7.2	END OF BOREHOLE START OF DCPT																
245.3																	
8.7	END OF DCPT DCPT REFUSAL (50 blows/0.15 m)  Note(s):  1. Water level at a depth of 0.6 m below ground surface (Elev. 253.4 m) upon completion of drilling and maybe influenced by introduction of drilling water.																

SUD-MTO 001 1411810014 CONISTON A15.GPJ GAL-MISS.GDT 15/04/16 DATA INPUT:

PROJECT		14-1181-0014		<b>RECORD OF BOREHOLE No BH4</b>		1 OF 2 <b>METRIC</b>												
G.W.P.		LOCATION		N 5149824.0; E 318822.5		ORIGINATED BY												
DIST		HWY		17		BOREHOLE TYPE												
NW Casing, Portable Equipment		COMPILED BY		TB		DATE												
GEODETIC		January 20, 2016		CHECKED BY		SEMP												
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40						60	80	100	20
254.4	GROUND SURFACE																	
0.0	Sand and gravel, some fines, trace organics, some cobbles (FILL) Loose Dark brown to brown Frozen to wet		1	SS	58		254											38 49 (13)
			2	SS	8													
252.9							253											
1.5	SILTY CLAY, trace sand, varved Firm to stiff Brown/grey Moist to wet		3	SS	8													
			4	SS	7		252											
			5	SS	6		251											
			6	SS	2		250											
	Becoming grey below 4.6 m depth.		7	SS	1													
			8	SS	1		248											
247.1	END OF BOREHOLE START OF DCPT						247											
7.3																		
							246											
							245											
							244											
243.0							243											
11.4																		

Continued Next Page

+ 3, × 3: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE

SUD-MTO 001 1411810014 CONISTON A15.GPJ GAL-MISS.GDT 15/04/16 DATA INPUT:



+3, ×3: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE

CSUD-MTO 001 1411810014 CONISTON A15.GPJ GAL-MISS.GDT 15/04/16 DATA INPUT:



# **APPENDIX C**

## **Current Investigation – Borehole Records**



## LIST OF ABBREVIATIONS

The abbreviations commonly employed on Records of Boreholes, on figures and in the text of the report are as follows:

### I. SAMPLE TYPE

AS	Auger sample
BS	Block sample
CS	Chunk sample
DS	Denison type sample
FS	Foil sample
RC	Rock core
SC	Soil core
SS	Split-spoon
ST	Slotted tube
TO	Thin-walled, open
TP	Thin-walled, piston
WS	Wash sample

### II. 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.) drive open sampler for a distance of 300 mm (12 in.)

#### Dynamic Cone Penetration Resistance; $N_d$ :

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

#### Piezo-Cone Penetration Test (CPT)

A electronic cone penetrometer with a 60° conical tip and a project end area of 10 cm<sup>2</sup> pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance ( $Q_t$ ), porewater pressure (PWP) and friction along a sleeve are recorded electronically at 25 mm penetration intervals.

### III. SOIL DESCRIPTION

#### (a) Non-Cohesive (Cohesionless) Soils

Density Index	N
Relative Density	Blows/300 mm or Blows/ft
Very loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very dense	over 50

#### (b) Cohesive Soils Consistency

	$c_u, s_u$	
	kPa	psf
Very soft	0 to 12	0 to 250
Soft	12 to 25	250 to 500
Firm	25 to 50	500 to 1,000
Stiff	50 to 100	1,000 to 2,000
Very stiff	100 to 200	2,000 to 4,000
Hard	over 200	over 4,000

### IV. SOIL TESTS

w	water content
w <sub>p</sub>	plastic limit
w <sub>l</sub>	liquid limit
C	consolidation (oedometer) test
CHEM	chemical analysis (refer to text)
CID	consolidated isotropically drained triaxial test <sup>1</sup>
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement <sup>1</sup>
D <sub>R</sub>	relative density (specific gravity, $G_s$ )
DS	direct shear test
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 <sub>4</sub>	concentration of water-soluble sulphates
UC	unconfined compression test
UU	unconsolidated undrained triaxial test
V	field vane (LV-laboratory vane test)
$\gamma$	unit weight

**Note:** 1 Tests which are anisotropically consolidated prior to shear are shown as CAD, CAU.

### V. MINOR SOIL CONSTITUENTS

Per cent by Weight	Modifier	Example
0 to 5	Trace	Trace sand
5 to 12	Trace to Some (or Little)	Trace to some sand
12 to 20	Some	Some sand
20 to 30	(ey) or (y)	Sandy
over 30	And (non-cohesive (cohesionless)) or With (cohesive)	Sand and Gravel Silty Clay with sand / Clayey Silt with sand





## LIST OF SYMBOLS

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

### I. GENERAL

$\pi$	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
FoS	factor of safety

### II. STRESS AND STRAIN

$\gamma$	shear strain
$\Delta$	change in, e.g. in stress: $\Delta \sigma$
$\varepsilon$	linear strain
$\varepsilon_v$	volumetric strain
$\eta$	coefficient of viscosity
$\nu$	Poisson's ratio
$\sigma$	total stress
$\sigma'$	effective stress ( $\sigma' = \sigma - u$ )
$\sigma'_{vo}$	initial effective overburden stress
$\sigma_1, \sigma_2, \sigma_3$	principal stress (major, intermediate, minor)
$\sigma_{oct}$	mean stress or octahedral stress $= (\sigma_1 + \sigma_2 + \sigma_3)/3$
$\tau$	shear stress
u	porewater pressure
E	modulus of deformation
G	shear modulus of deformation
K	bulk modulus of compressibility

### III. SOIL PROPERTIES

<b>(a)</b>	<b>Index Properties</b>
$\rho(\gamma)$	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
$\gamma'$	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

### (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 = $(w_l - w_p)$
$w_s$	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
$C_\alpha$	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
$\sigma'_p$	pre-consolidation stress
OCR	over-consolidation ratio = $\sigma'_p / \sigma'_{vo}$

### (d) Shear Strength

$\tau_p, \tau_r$	peak and residual shear strength
$\phi'$	effective angle of internal friction
$\delta$	angle of interface friction
$\mu$	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

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

Notes: 1  
2

$$\tau = c' + \sigma' \tan \phi'$$

$$\text{shear strength} = (\text{compressive strength})/2$$



## LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY

### WEATHERINGS STATE

**Fresh:** no visible sign of 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, recovered at full diameter, measured relative to the length of the total core run. RQD varied from 0% for completely broken core to 100% for core in solid sticks.

### DISCONTINUITY DATA

#### Fracture Index

A count of the number of discontinuities (physical separations) in the rock core, including both naturally occurring fractures and mechanically induced breaks caused by drilling.

#### 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° angle is horizontal.

#### Description and Notes

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

#### Abbreviations

JN Joint	PL Planar
FLT Fault	CU Curved
SH Shear	UN Undulating
VN Vein	IR Irregular
FR Fracture	K Slickensided
SY Stylolite	PO Polished
BD Bedding	SM Smooth
FO Foliation	SR Slightly Rough
CO Contact	RO Rough
AXJ Axial Joint	VR Very Rough
KV Karstic Void	
MB Mechanical Break	

<div style="display: flex; justify-content: space-between;"> <div>PROJECT <u>1651997</u></div> <div><b>RECORD OF BOREHOLE No C17-1</b></div> <div>1 OF 1 <b>METRIC</b></div> </div>																	
W.P. <u>5165-10-01</u>		LOCATION <u>N 5149846.8; E 318881.4 (LAT. 46.488138; LONG. -80.81658)</u>				ORIGINATED BY <u>SA</u>											
DIST <u>          </u> HWY <u>17</u>		BOREHOLE TYPE <u>2" Hilti Core</u>				COMPILED BY <u>AC</u>											
DATUM <u>GEODETIC</u>		DATE <u>April 26, 2017</u>				CHECKED BY <u>SEMP</u>											
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
260.2	BEDROCK OUTCROP																
0.0	ARKOSIC GREYWACKE (BEDROCK)																
	For coring details see Record of Drillhole C17-1.		1	RC	REC 93%												RQD = 18%
			2	RC	REC 100%												RQD = 31%
			3	RC	REC 100%												RQD = 67%
			4	RC	REC 75%												RQD = 46%
257.2	END OF BOREHOLE																
3.0	Note: 1. Borehole dry upon completion of coring.																

SUD-MTO 001 LATILONG 1651997.GPJ GAL-MISS.GDT 05/07/17 DATA INPUT:

PROJECT: 1651997

## RECORD OF DRILLHOLE: C17-1

SHEET 1 OF 1

LOCATION: N 5149846.8 ; E 318881.4 (LAT. 46.488138; LONG. -80.81658)

DRILLING DATE: April 26, 2017

DATUM: GEODETIC

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: Hilti

DRILLING CONTRACTOR: Landcore Drilling

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	COLOUR % RETURN	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.																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
							RECOVERY					FRACT. INDEX METRES					DISCONTINUITY DATA										HYDRAULIC CONDUCTIVITY					Diametral Point Load Index (MPa)					RMC -Q' AVG.																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																			
							TOTAL CORE %		SOLID CORE %		R.Q.D. %	B Angle		DIP w.r.t. CORE AXIS		TYPE AND SURFACE DESCRIPTION										k, cm/s					Point Load Index (MPa)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
							FLUSH																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																	

UCS = 91 MPa

DEPTH SCALE


1 : 60



LOGGED: SA

CHECKED: SEMP

SUD-RCK LAT/LONG 1651997 GPJ GAL-MISS.GDT 05/07/17 DATA INPUT:

PROJECT <u>1651997</u>		<b>RECORD OF BOREHOLE No C17-2</b>				1 OF 1 <b>METRIC</b>					
W.P. <u>5165-10-01</u>		LOCATION <u>N 5149856.2; E 318871.2 (LAT. 46.488223; LONG. -80.816713)</u>				ORIGINATED BY <u>SA</u>					
DIST <u>          </u> HWY <u>17</u>		BOREHOLE TYPE <u>2" Hilti Core</u>				COMPILED BY <u>AC</u>					
DATUM <u>GEODETIC</u>		DATE <u>April 28 and May 1, 2017</u>				CHECKED BY <u>SEMP</u>					
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa			
254.0	BEDROCK OUTCROP		1	RC	REC 100%			20 40 60 80 100	20 40 60		GR SA SI CL
0.0	ARKOSIC GREYWACKE (BEDROCK)		2	RC	REC 100%		253	20 40 60 80 100	20 40 60		
	For coring details see Record of Drillhole C17-2.		3	RC	REC 100%		252	20 40 60 80 100	20 40 60		
			4	RC	REC 100%			20 40 60 80 100	20 40 60		
251.0	END OF BOREHOLE						251				
3.0	Note: 1. Borehole dry upon completion of coring.										

SUD-MTO 001 LATILONG 1651997.GPJ GAL-MISS.GDT 05/07/17 DATA INPUT:

SHEET 1 OF 1

DATUM: GEODETIC

DRILLING CONTRACTOR: Landcore Drilling

[illegible]

DEPTH SCALE

1 : 60

LOGGED: SA

CHECKED: SEMP

**RECORD OF BOREHOLE No C17-3**

1 OF 3 **METRIC**

PROJECT 1651997  
W.P. 5165-10-01 LOCATION N 5149852.7; E 318815.9 (LAT. 46.488192; LONG. -80.817433) ORIGINATED BY SA  
DIST HWY 17 BOREHOLE TYPE NW Casing, Wash Boring and NQ Coring COMPILED BY AC  
DATUM GEODETIC DATE April 25, 2017 CHECKED BY SEMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT   NATURAL MOISTURE CONTENT   LIQUID LIMIT			UNIT WEIGHT  γ  kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																							
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				GR	SA	SI	CL																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																				
253.5	GROUND SURFACE																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																							</

Continued Next Page

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

SUD-MTO 001 LAT/LONG 1651997.GPJ GAL-MISS.GDT 05/07/17 DATA INPUT:





SHEET 3 OF 3

DATUM: GEODETIC

DRILLING CONTRACTOR: Landcore Drilling

CHECKED: SEMP

1 OF 3 **METRIC**

CHECKED BY      SEMP

MSUD-MTO 001 LAT/LONG 1651997.GPJ GAL-MISS.GDT 05/07/17 DATA INPUT:

+ 3, × 3: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE

PROJECT <u>1651997</u>		<b>RECORD OF BOREHOLE No C17-4</b>		2 OF 3 <b>METRIC</b>	
W.P. <u>5165-10-01</u>		LOCATION <u>N 5149860.2; E 318800.5 (LAT. 46.48826; LONG. -80.817633)</u>		ORIGINATED BY <u>SA</u>	
DIST <u>          </u> HWY <u>17</u>		BOREHOLE TYPE <u>NW Casing, Wash Boring and NQ Coring</u>		COMPILED BY <u>AC</u>	
DATUM <u>GEODETIC</u>		DATE <u>April 24, 2017</u>		CHECKED BY <u>SEMP</u>	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT   NATURAL MOISTURE CONTENT   LIQUID LIMIT			UNIT WEIGHT  γ  kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				GR	SA	SI	CL
								○ UNCONFINED	● QUICK TRIAXIAL	+	×	FIELD VANE	REMOULDED	W <sub>p</sub>	W		W <sub>L</sub>			
11.9	<div>END OF BOREHOLE</div> <div>Notes:<div>1. Water level at a depth of 1.2 m below ground surface (Elev. 252.3 m) upon completion of drilling.</div><div>2. An additional shelby tube was obtained 2 m northeast of borehole at 5.2 m depth for consolidation testing.</div><div>3. Water level in piezometer mesured at a depth of 1.6 m below ground surface (Elev. 251.9 m) on April 27, 2017 and on July 4, 2017.</div></div>																			

SUD-MTO 001 LATILONG 1651997.GPJ GAL-MISS.GDT 05/07/17 DATA INPUT:

PROJECT: 1651997

**RECORD OF DRILLHOLE: C17-4**

SHEET 3 OF 3

LOCATION: N 5149860.2 ; E 318800.5 (LAT. 46.48826; LONG. -80.817633)

DRILLING DATE: April 24, 2017

DATUM: GEODETIC

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 55

DRILLING CONTRACTOR: Landcore Drilling

DEPTH SCALE METRES	DRILLING RECORD		DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	COLOUR % RETURN	RECOVERY		R.Q.D. %	FRACT. INDEX METRES	DISCONTINUITY DATA						HYDRAULIC CONDUCTIVITY			Diametral Point Load Index (MPa)	RMC -Q AVG.																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
								FLUSH	TOTAL CORE %			SOLID CORE %	B Angle	DIP w.r.t. CORE AXIS	TYPE AND SURFACE DESCRIPTION			Jr	Ja	Jn			k, cm/s	10°	10°	10°																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																					
															JN - Joint	FLT - Fault	SHR - Shear										VN - Vein	CJ - Conjugate	BD - Bedding	FO - Foliation	CO - Contact	OR - Orthogonal	CL - Cleavage	PL - Planar	CU - Curved	PO - Polished	K - Slickensided	SM - Smooth	Ro - Rough	MB - Mechanical Break																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																							
																																									UN - Undulating	ST - Stepped	IR - Irregular																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																				
																						NOTE: For additional abbreviations refer to list of abbreviations & symbols.																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
9	CME 55 HQ NQ	REFER TO PREVIOUS PAGE			244.6																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										

DEPTH SCALE

1 : 60



LOGGED: SA

CHECKED: SEMP

SUD-RCK LAT/LONG 1651997 GPJ GAL-MISS GDT 05/07/17 DATA INPUT:



PROJECT <u>1651997</u>		<b>RECORD OF BOREHOLE No C17-5</b>		1 OF 2 <b>METRIC</b>	
W.P. <u>5165-10-01</u>		LOCATION <u>N 5149839.0; E 318787.1 (LAT. 46.48807; LONG. -80.817809)</u>		ORIGINATED BY <u>SA</u>	
DIST _____ HWY <u>17</u>		BOREHOLE TYPE <u>108 mm I.D. Hollow Stem Augers and NW Casing</u>		COMPILED BY <u>AC</u>	
DATUM <u>GEODETIC</u>		DATE <u>April 19, 2017</u>		CHECKED BY <u>SEMP</u>	

[illegible]

Continued Next Page

+ 3, × 3: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE

○ 3% STRAIN AT FAILURE

PROJECT 1651997				<b>RECORD OF BOREHOLE No C17-5</b>				2 OF 2 <b>METRIC</b>											
W.P. 5165-10-01		LOCATION N 5149839.0; E 318787.1 (LAT. 46.48807; LONG. -80.817809)				ORIGINATED BY SA													
DIST _____ HWY 17		BOREHOLE TYPE 108 mm I.D. Hollow Stem Augers and NW Casing				COMPILED BY AC													
DATUM GEODETIC		DATE April 19, 2017				CHECKED BY SEMP													
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)	
								20	40	60	80	100						20	40
--- CONTINUED FROM PREVIOUS PAGE ---																			
249.3	CLAY Very stiff Brown to grey Wet		11	SS	6														
13.3	CLAYEY SILT, trace sand, silt seams throughout Very stiff to firm Grey Wet		12	SS	3												0 1 72 27		
			13	SS	10												0 0 76 24		
246.4	SAND and GRAVEL, trace to some silt, trace clay (TILL) Dense Brown Wet																		
16.2	Cobble encountered at 16.9 m depth.		14	SS	30												40 50 8 2		
245.3	END OF BOREHOLE REFUSAL TO FURTHER CASING AND SPLIT-SPOON ADVANCEMENT  Note:  1. Water level at a depth of 6.9 m below ground surface (Elev. 255.7 m) upon completion of drilling.																		
17.3																			

PROJECT 1651997		RECORD OF BOREHOLE No C17-6				1 OF 1 METRIC							
W.P. 5165-10-01		LOCATION N 5149865.0; E 318776.1 (LAT. 46.488304; LONG. -80.817951)				ORIGINATED BY SA							
DIST HWY 17		BOREHOLE TYPE 108 mm I.D. Hollow Stem Augers				COMPILED BY AC							
DATUM GEODETIC		DATE April 20, 2017				CHECKED BY SEMP							
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
253.1	GROUND SURFACE							20 40 60 80 100	PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>		
0.0	Sandy TOPSOIL		1	SS	7			20 40 60 80 100					
0.1	Sand and gravel, some silt, trace organics (FILL) Loose Brown Moist												
252.0			2	SS	6								
1.1	Sandy silt, trace gravel, trace organics (FILL) Loose Grey Wet												
251.6			3	SS	7								
1.5	CLAYEY SILT to SILTY CLAY, trace sand, varved Soft to stiff Grey to red-grey Wet		4	SS	6								
			5	SS	4								
			6	SS	WH								
			7	SS	WH								
			8	SS	WH								
	Silt seams below 7.6 m depth.		9A	SS	15								
			9B										
243.8	SILT and SAND, trace gravel, trace clay Compact Grey Wet												
242.4	Attempted spoon at 10.7 m depth, hammer bouncing.												
10.7	END OF BOREHOLE AUGER AND SPLIT-SPOON REFUSAL  Note: 1. Water level at a depth of 5.9 m below ground surface (Elev. 247.2 m) upon completion of drilling.												

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

SUD-MTO 001 LAT/LONG 1651997.GPJ GAL-MISS.GDT 05/07/17 DATA INPUT:



PROJECT 1651997				RECORD OF BOREHOLE No C17-7				1 OF 2 METRIC									
W.P. 5165-10-01		LOCATION N 5149841.5; E 318720.8 (LAT. 46.488094; LONG. -80.818672)				ORIGINATED BY SA											
DIST _____ HWY 17		BOREHOLE TYPE NW Casing, Wash Boring and NQ Coring				COMPILED BY AC											
DATUM GEODETIC		DATE April 18, 2017				CHECKED BY SEMP											
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
261.7	GROUND SURFACE																
0.0	ASPHALT (100 mm)																
0.1	Sand and gravel to gravelly sand, trace to some silt (FILL) Compact to very dense Brown Moist  Cobbles between 0.3 m and 3.4 m depth.		1	SS	33												
			2	SS	32												32 51 (17)
			3	SS	52												
			4	SS	57												
258.3	Clayey silt, some sand to sandy silt (FILL) Stiff to hard Brown Moist		5	SS	13												0 15 59 26
3.4			6	SS	52												
256.1	Silty SAND and GRAVEL, trace clay (TILL) Compact to very dense Reddish brown to grey Wet  Trace organics in Sample 7  Cobbles below 6.1 m depth		7	SS	16												30 38 29 3
5.6			8	SS	74												31 45 20 4
253.5	ARKOSIC GREYWACKE (BEDROCK)  For coring details see Record of Drillhole C17-7.		1	RC	REC 100%												RQD = 0%
8.2			2	RC	REC 100%												RQD = 0%
252.5	END OF BOREHOLE  Note:  1. Water level at a depth of 6.6 m below ground surface (Elev. 255.1 m) upon completion of drilling.																
9.2																	

SUD-MTO 001 LATILONG 1651997.GPJ GAL-MISS.GDT 05/07/17 DATA INPUT:





<b>PROJECT</b> 1651997		<b>RECORD OF BOREHOLE No C17-8</b>		1 OF 1 <b>METRIC</b>	
W.P. 5165-10-01		LOCATION N 5149860.2; E 318720.0 (LAT. 46.488262; LONG. -80.818682)		ORIGINATED BY SA	
DIST _____ HWY 17		BOREHOLE TYPE 108 mm I.D. Hollow Stem Augers		COMPILED BY AC	
DATUM GEODETIC		DATE April 20, 2017		CHECKED BY SEMP	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT  $\gamma$  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				GR	SA	SI	CL
								20	40	60	80	100	W <sub>p</sub>	W	W <sub>L</sub>					
255.9	GROUND SURFACE																			
0.0	Sandy TOPSOIL		1	SS	10/0.2															
0.3	Gravelly Silty SAND (TILL) Compact Reddish brown END OF BOREHOLE AUGER AND SPLIT-SPOON REFUSAL																			
	Note:  1. Borehole dry upon completion of drilling.  2. Advanced dynamic cone penetration tests 10 m west (C17-8D1) and 10 m east (C17-8D2) of borehole.  3. A bedrock outcrop noted approximately 22 m northwest of borehole.																			

SUD-MTO 001 LATILONG 1651997.GPJ GAL-MISS.GDT 05/07/17 DATA INPUT:



PROJECT		RECORD OF PENETRATION TEST					No C17-8D1		1 OF 1		METRIC					
W.P.		LOCATION					ORIGINATED BY									
DIST		BOREHOLE TYPE					COMPILED BY									
DATUM		DATE					CHECKED BY									
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		UNIT WEIGHT $\gamma$	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					W <sub>p</sub> W W <sub>L</sub>			
256.2	GROUND SURFACE						20	40	60	80	100					
0.0							20	40	60	80	100					
0.2	END OF DCPT REFUSAL TO FURTHER PENETRATION (HAMMER BOUNCING)						20	40	60	80	100					

SUD-MTO 001 LATILONG 1651997.GPJ GAL-MISS.GDT 05/07/17 DATA INPUT:

PROJECT <u>1651997</u>		<b>RECORD OF PENETRATION TEST No C17-8D2</b>		1 OF 1 <b>METRIC</b>	
W.P. <u>5165-10-01</u>		LOCATION <u>N 5149860.2; E 318730.0 (LAT. 46.488262; LONG. -80.818552)</u>		ORIGINATED BY <u>SA</u>	
DIST <u>          </u> HWY <u>17</u>		BOREHOLE TYPE <u>Dynamic Cone Penetration Test</u>		COMPILED BY <u>AC</u>	
DATUM <u>GEODETIC</u>		DATE <u>April 20, 2017</u>		CHECKED BY <u>SEMP</u>	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT   NATURAL MOISTURE CONTENT   LIQUID LIMIT			UNIT WEIGHT  γ  kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				GR	SA	SI	CL
								○ UNCONFINED	● QUICK TRIAXIAL	+	×	FIELD VANE	REMOULDED	W <sub>p</sub>	W		W <sub>L</sub>			
255.0 0.0	GROUND SURFACE																			
254.0 1.0	END OF DCPT REFUSAL TO FURTHER PENETRATION (HAMMER BOUNCING)																			

SUD-MTO 001 LATILONG 1651997.GPJ GAL-MISS.GDT 05/07/17 DATA INPUT:

PROJECT 1651997				<b>RECORD OF BOREHOLE No C17-9</b>				1 OF 1 <b>METRIC</b>									
W.P. 5165-10-01		LOCATION N 5149857.5; E 318671.9 (LAT. 46.488239; LONG. -80.819309)				ORIGINATED BY SA											
DIST _____ HWY 17		BOREHOLE TYPE 108 mm I.D. Hollow Stem Augers				COMPILED BY AC											
DATUM GEODETIC		DATE April 20, 2017				CHECKED BY SEMP											
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				
257.1	GROUND SURFACE						20	40	60	80	100						
0.0	Silty TOPSOIL																
0.2	Sand, some gravel, some silt (FILL) Loose to dense Brown Moist		1	SS	9												
256.0																	
1.1	SILT, trace to some sand, trace organics Dense		2	SS	36												
255.6																	
1.5	Brown Moist																
255.3																	
1.8	SAND, trace gravel, trace to some silt Compact Reddish brown Wet		3	SS	24												
254.8																	
2.3	Gravelly Silty SAND (TILL) Compact Dark brown to grey Wet																
END OF BOREHOLE AUGER AND SPLIT-SPOON REFUSAL  Note: 1. Water level at a depth of 1.8 m below ground surface (Elev. 255.3 m) upon completion of drilling.  2. Advanced dynamic cone penetration tests 10 m west (C17-9D1) and 10 m east (C17-9D2) of borehole.																	

SUD-MTO 001 LATILONG 1651997.GPJ GAL-MISS.GDT 05/07/17 DATA INPUT:

PROJECT 1651997						RECORD OF PENETRATION TEST No C17-9D1						1 OF 1 METRIC					
W.P. 5165-10-01			LOCATION N 5149857.5; E 318661.9 (LAT. 46.488239; LONG. -80.819439)						ORIGINATED BY SA								
DIST _____ HWY 17			BOREHOLE TYPE Dynamic Cone Penetration Test						COMPILED BY AC								
DATUM GEODETIC			DATE April 20, 2017						CHECKED BY SEMP								
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
257.1 0.0	GROUND SURFACE						257	20	40	60	80	100	20	40	60		GR SA SI CL
254.4 2.7	END OF DCPT REFUSAL TO FURTHER PENETRATION (HAMMER BOUNCING)						255										

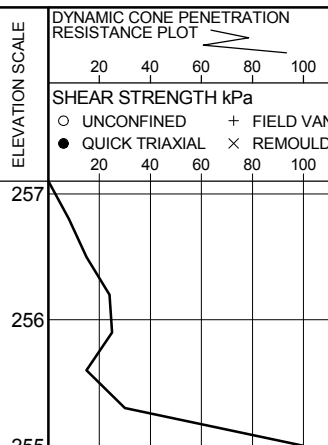
SUD-MTO 001 LATILONG 1651997.GPJ GAL-MISS.GDT 05/07/17 DATA INPUT:

PROJECT <u>1651997</u>		<b>RECORD OF PENETRATION TEST No C17-9D2</b>				1 OF 1 <b>METRIC</b>	
W.P. <u>5165-10-01</u>		LOCATION <u>N 5149857.5; E 318681.9 (LAT. 46.488238; LONG. -80.819178)</u>				ORIGINATED BY <u>SA</u>	
DIST <u>          </u> HWY <u>17</u>		BOREHOLE TYPE <u>Dynamic Cone Penetration Test</u>				COMPILED BY <u>AC</u>	
DATUM <u>GEODETIC</u>		DATE <u>April 20, 2017</u>				CHECKED BY <u>SEMP</u>	

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT $\gamma$	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80			100	W <sub>p</sub>	W	W <sub>L</sub>
257.1 0.0	GROUND SURFACE																
255.0 2.1	END OF DCPT REFUSAL TO FURTHER PENETRATION (HAMMER BOUNCING)																



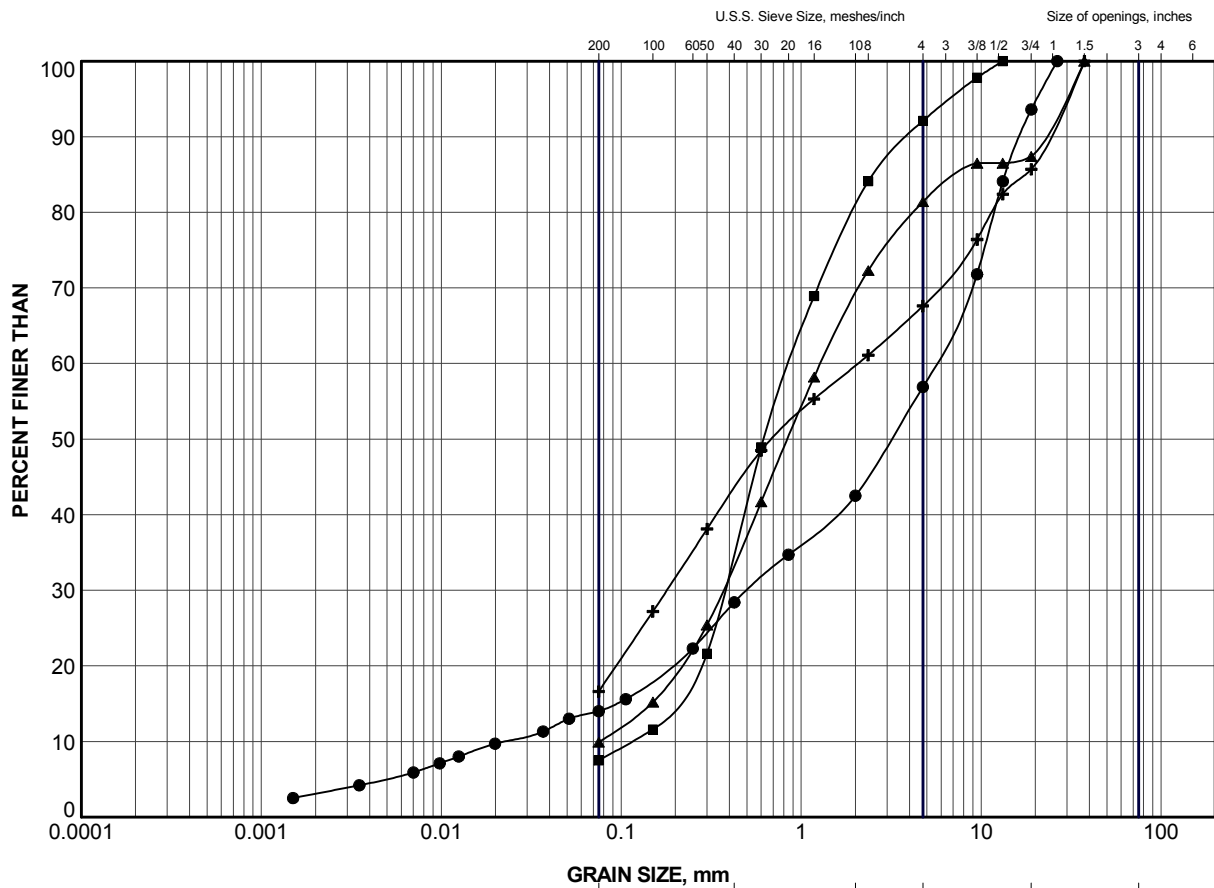
○ UNCONFINED + FIELD VANE  
● QUICK TRIAXIAL × REMOULDED



# **APPENDIX D**

## **Current Investigation – Geotechnical Laboratory Test Results**





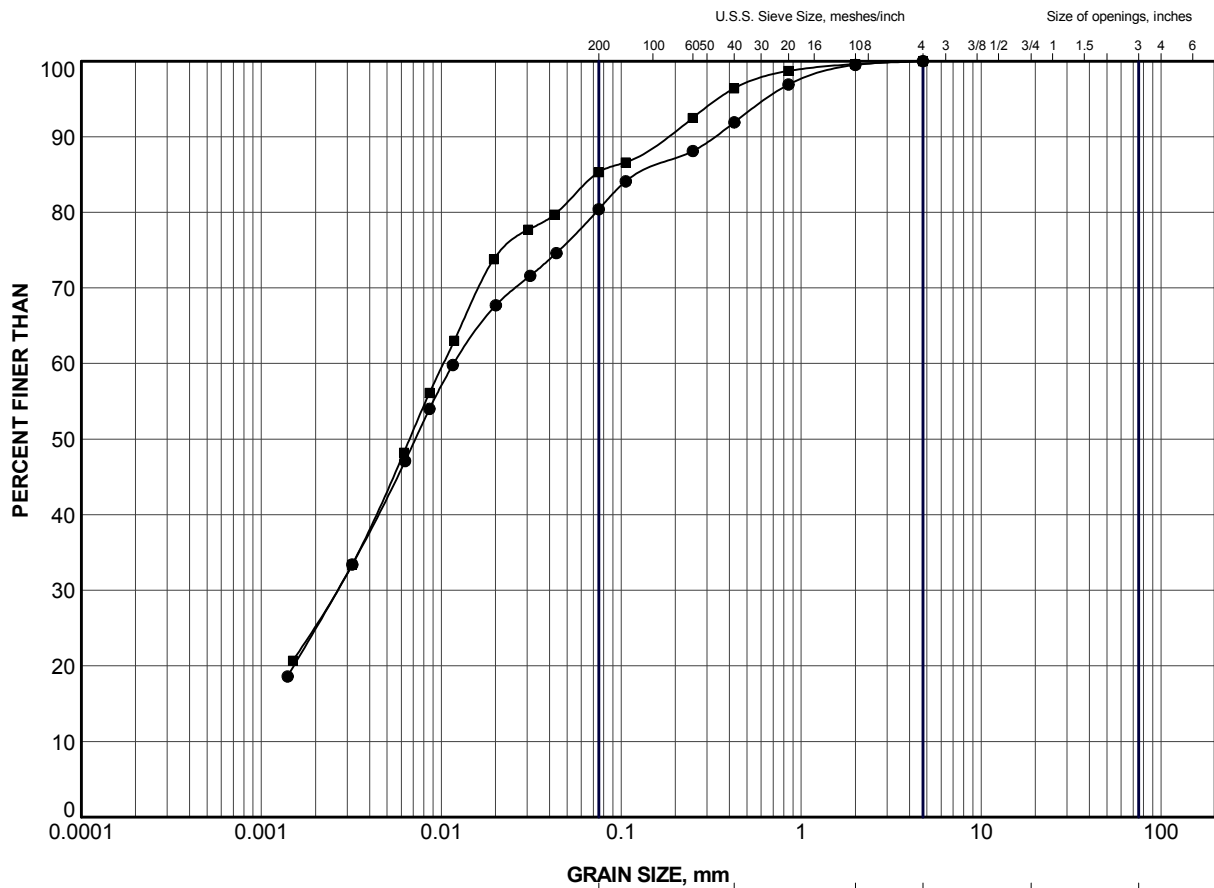
CLAY AND SILT	GRAVEL SIZE, mm					Cobble Size
	fine	medium	coarse	fine	coarse	
	SAND SIZE			GRAVEL SIZE		

#### LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	C17-3	1	253.3
■	C17-5	1	261.5
▲	C17-5	3	260.0
+	C17-7	2	259.9

PROJECT						HIGHWAY 17 CONISTON CPR OVERHEAD BRIDGE					
TITLE						GRAIN SIZE DISTRIBUTION SAND to SAND and GRAVEL (FILL)					
PROJECT No.			1651997			FILE No.			1651997.GPJ		
DRAWN	TB	Sept 2017	SCALE	N/A	REV.						
CHECK	SEMP	Sept 2017									
APPR	JMAC	Sept 2017									
						FIGURE D1					




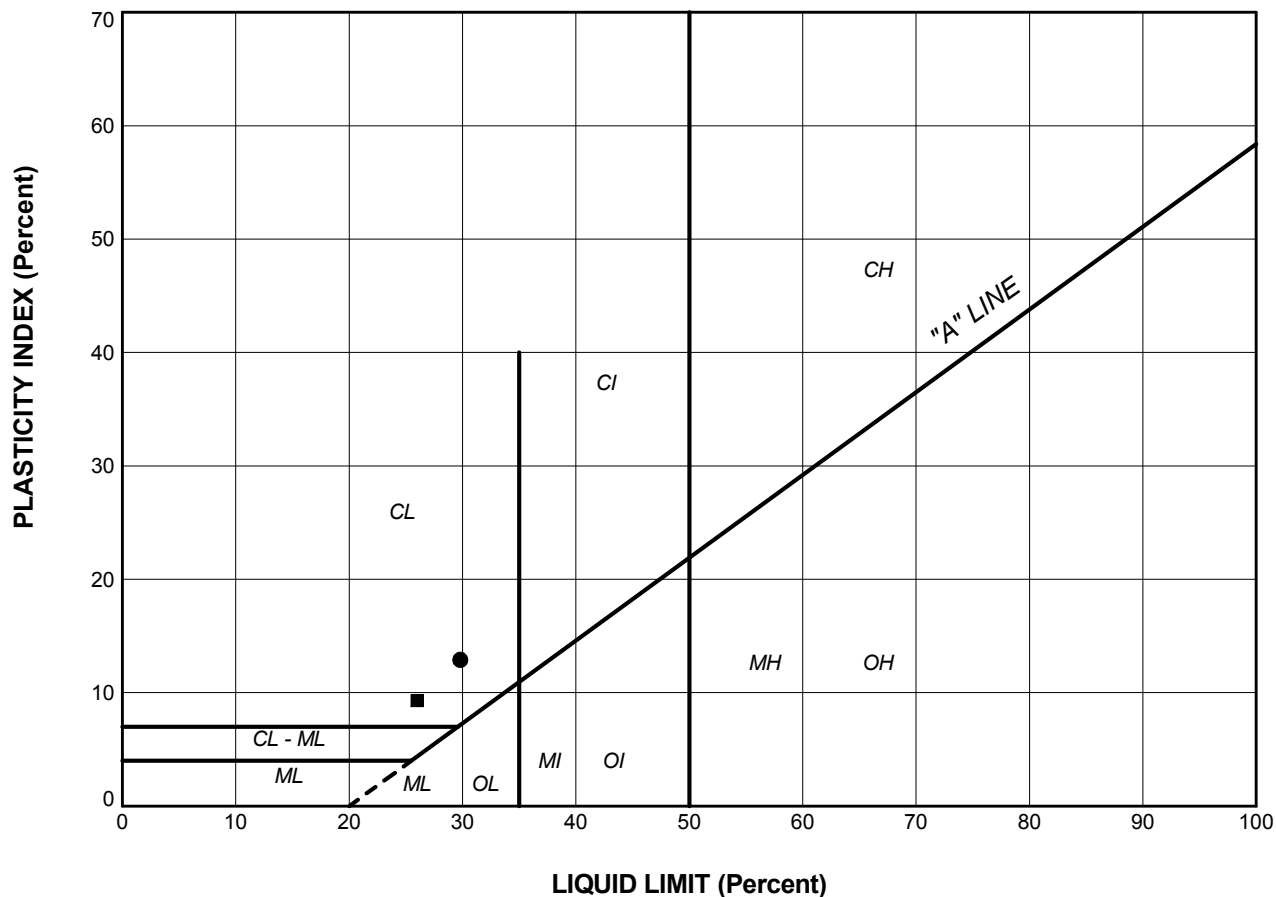


GRAIN SIZE, mm						
CLAY AND SILT	fine	medium	coarse	fine	coarse	Cobble Size
	SAND SIZE			GRAVEL SIZE		

#### LEGEND

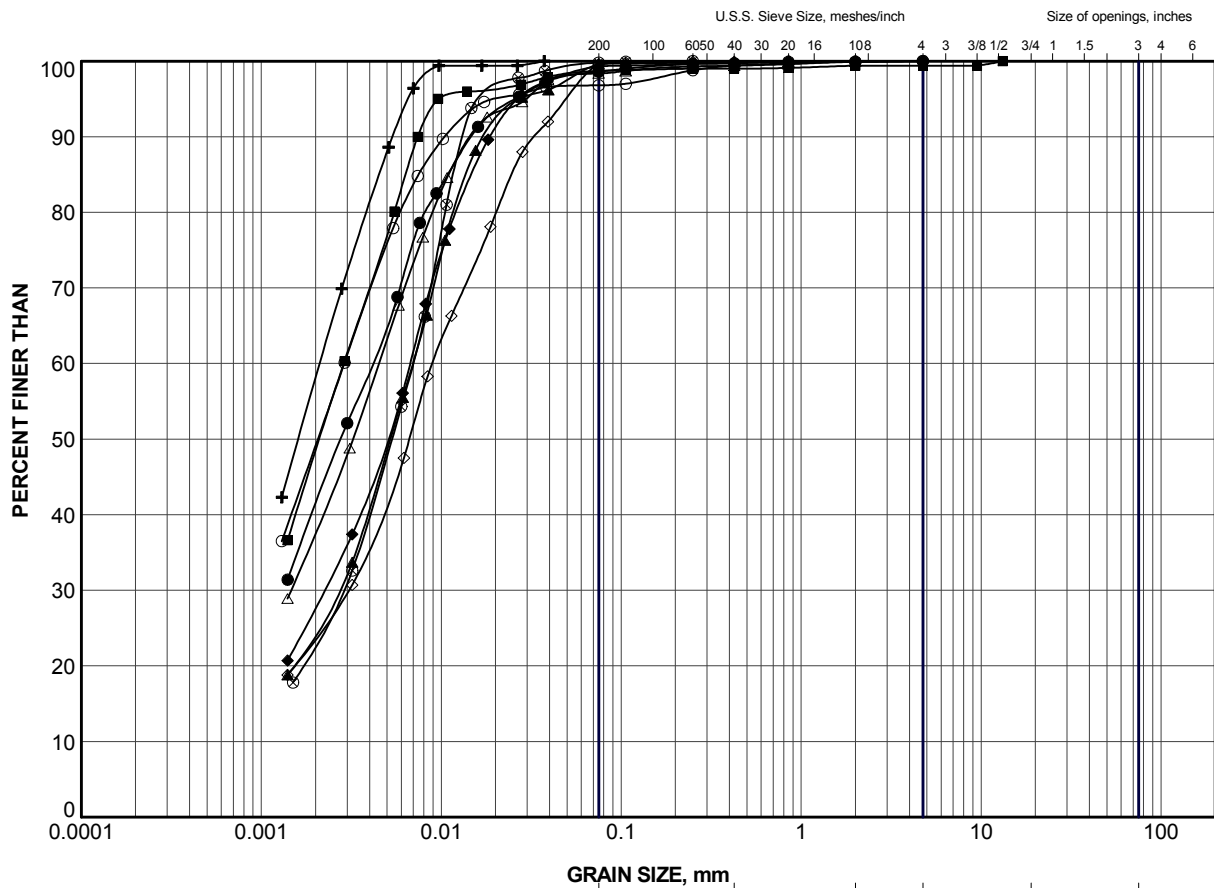
SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	C17-5	7	256.2
■	C17-7	5	257.6

PROJECT						HIGHWAY 17 CONISTON CPR OVERHEAD BRIDGE					
TITLE						GRAIN SIZE DISTRIBUTION CLAYEY SILT (FILL)					
PROJECT No.				1651997		FILE No.				1651997.GPJ	
DRAWN	TB	Sept 2017		SCALE	N/A	REV.					
CHECK	SEMP	Sept 2017									
APPR	JMAC	Sept 2017									
 <b>Golder Associates</b> SUDBURY, ONTARIO				<b>FIGURE D2</b>							



PROJECT					
HIGHWAY 17 CONISTON CPR OVERHEAD BRIDGE					
TITLE					
PLASTICITY CHART CLAYEY SILT (FILL)					
PROJECT No. 1651997			FILE No. 1651997.GPJ		
DRAWN	TB	Sept 2017	SCALE	N/A	REV.
CHECK	SEMP	Sept 2017	FIGURE D3		
APPR	JMAC	Sept 2017			





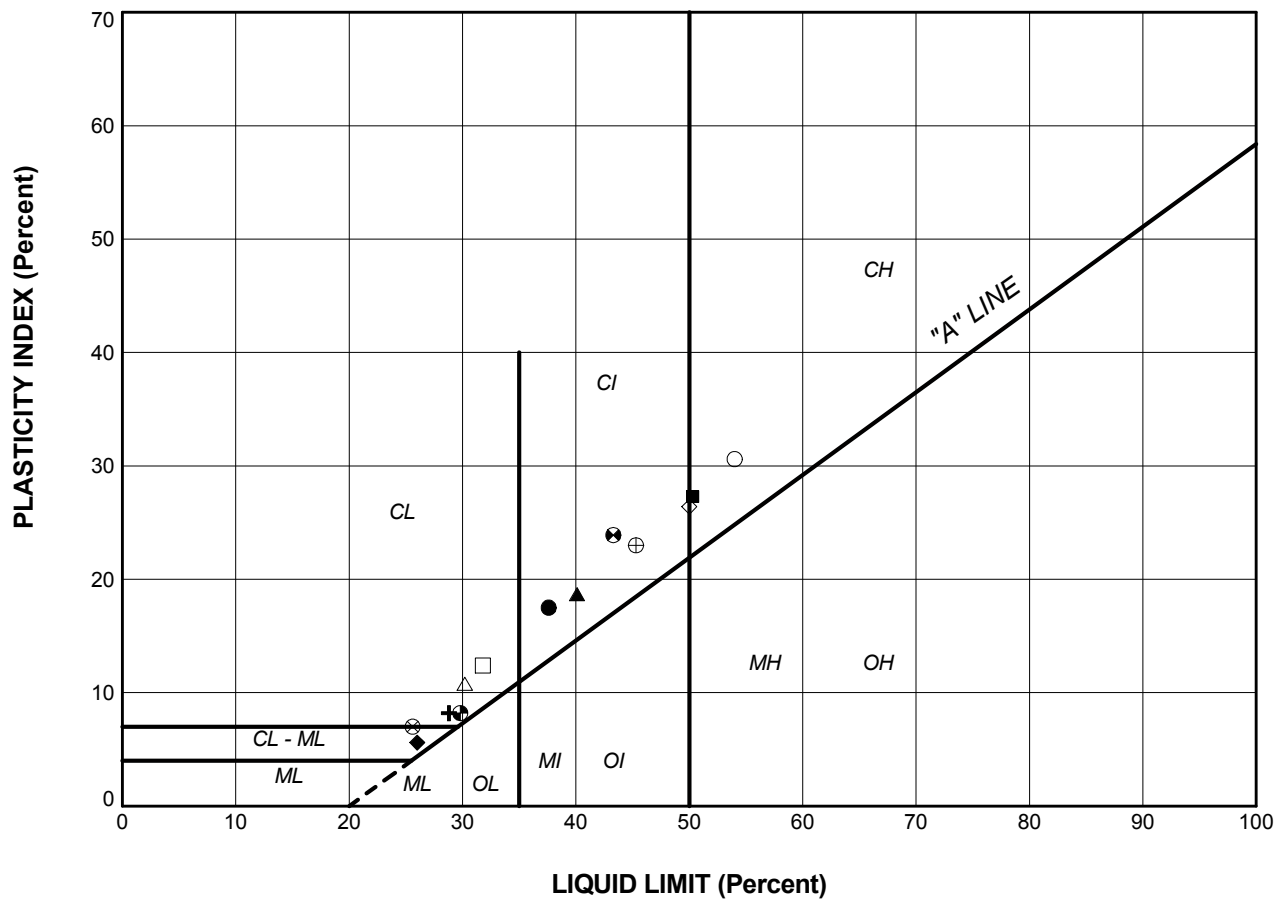
GRAIN SIZE, mm						
CLAY AND SILT	fine	medium	coarse	fine	coarse	Cobble Size
	SAND SIZE			GRAVEL SIZE		

#### LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	C17-3	4	250.9
■	C17-3	6	249.4
▲	C17-4	6A	248.2
+	C17-5	10	251.6
◆	C17-5	12	248.6
◇	C17-5	13	247.1
○	C17-6	3	251.3
△	C17-6	5	249.8
⊗	C17-6	7	246.7

PROJECT						HIGHWAY 17 CONISTON CPR OVERHEAD BRIDGE					
TITLE						GRAIN SIZE DISTRIBUTION CLAYEY SILT to CLAY					
PROJECT No.			1651997			FILE No.			1651997.GPJ		
DRAWN	TB	Sept 2017	SCALE	N/A	REV.	<b>FIGURE D4</b>					
CHECK	SEMP	Sept 2017									
APPR	JMAC	Sept 2017									





### LEGEND

SYMBOL	BOREHOLE	SAMPLE	LL(%)	PL(%)	PI
●	C17-3	4	37.6	20.1	17.5
■	C17-3	6	50.3	23.0	27.3
▲	C17-3	7	40.1	21.4	18.7
+	C17-4	6A	28.8	20.6	8.2
◆	C17-4	6B	26.0	20.4	5.6
◇	C17-5	10	50.0	23.6	26.4
○	C17-5	11	54.0	23.4	30.6
△	C17-5	12	30.2	19.4	10.8
⊗	C17-5	13	25.6	18.6	7.0
⊕	C17-6	3	45.3	22.3	23.0
□	C17-6	5	31.8	19.4	12.4
⊗	C17-6	6	43.3	19.4	23.9
⊕	C17-6	7	29.8	21.6	8.2

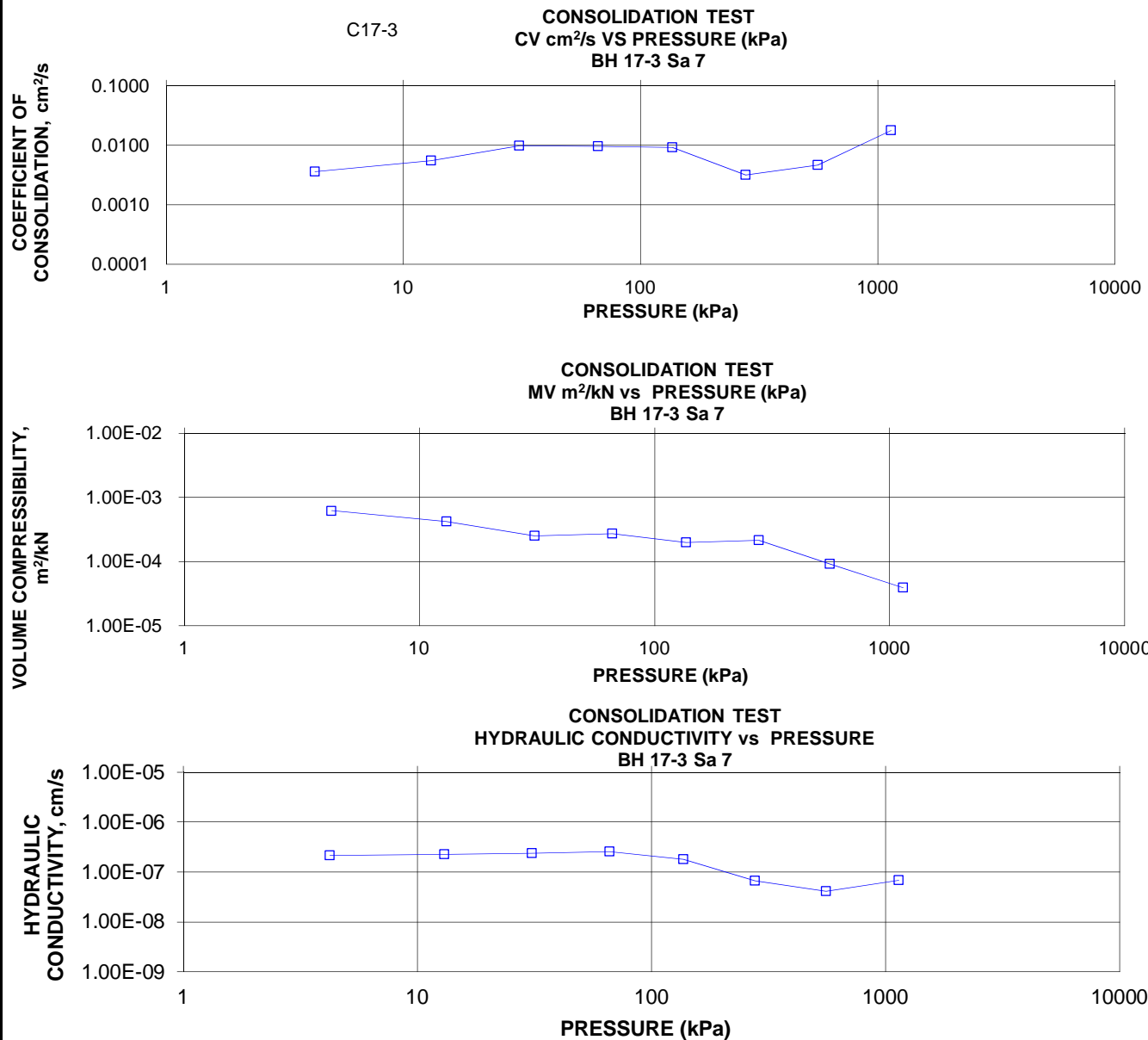
PROJECT					
HIGHWAY 17 CONISTON CPR OVERHEAD BRIDGE					
TITLE					
PLASTICITY CHART CLAYEY SILT to CLAY					
PROJECT No.		1651997		FILE No.	
DRAWN		TB		Sept 2017	
CHECK		SEMP		Sept 2017	
APPR		JMAC		Sept 2017	
SCALE		N/A		REV.	
FIGURE		D5			



CONSOLIDATION TEST SUMMARY						FIGURE D6 Pg. 1 of 4			
<b>SAMPLE IDENTIFICATION</b>									
Project Number		1651997-1203			Sample Number		7		
Borehole Number		C17-3			Sample Depth, m		5.5		
<b>TEST CONDITIONS</b>									
Test Type		Standard			Load Duration, hr		24		
Oedometer Number		2							
Date Started		May 17, 2017							
Date Completed		May 25, 2017							
<b>SAMPLE DIMENSIONS AND PROPERTIES - INITIAL</b>									
Sample Height, cm		2.522			Unit Weight, kN/m <sup>3</sup>		18.72		
Sample Diameter, cm		6.358			Dry Unit Weight, kN/m <sup>3</sup>		13.86		
Area, cm <sup>2</sup>		31.74			Specific Gravity, Measurec		2.766		
Volume, cm <sup>3</sup>		80.06			Solids Height, cm		1.289		
Water Content, %		35.09			Volume of Solids, cm <sup>3</sup>		40.91		
Wet Mass, g		152.85			Volume of Voids, cm <sup>3</sup>		39.15		
Dry Mass, g		113.15							
<b>TEST COMPUTATIONS</b>									
Pressure kPa	Primary Consolidation mm	Corr. Height cm	End of Primary Void Ratio	Average Height cm	t <sub>90</sub> sec	cv, cm <sup>2</sup> /s	mv m <sup>2</sup> /kN	k cm/s	Total Work kJ/m3
0	0	2.522	0.957	2.522					
4	0.07	2.510	0.952	2.516	375	0.0036	6.17E-04	2.16E-07	0.006
13	0.04	2.500	0.945	2.505	240	0.0055	4.18E-04	2.27E-07	0.038
31	0.06	2.481	0.936	2.491	135	0.0097	2.50E-04	2.39E-07	0.136
66	0.11	2.453	0.917	2.467	135	0.0096	2.71E-04	2.54E-07	0.606
137	0.18	2.403	0.890	2.428	135	0.0093	2.00E-04	1.81E-07	2.063
277	0.44	2.326	0.831	2.365	375	0.0032	2.14E-04	6.63E-08	8.506
558	0.31	2.265	0.781	2.295	240	0.0047	9.11E-05	4.16E-08	19.921
1140	0.28	2.205	0.736	2.235	60	0.0176	3.90E-05	6.75E-08	41.105
558	-0.05	2.210	0.715	2.207					
137	-0.14	2.224	0.726	2.217					
31	-0.16	2.241	0.739	2.232					
4	-0.12	2.252	0.748	2.246					
Note: k calculated using cv based on t <sub>90</sub> values. Void ratio for unloading (or rebound) calculated for the end of increment									
<b>SAMPLE DIMENSIONS AND PROPERTIES - FINAL</b>									
Sample Height, cm		2.423			Unit Weight, kN/m <sup>3</sup>		18.31		
Sample Diameter, cm		6.36			Dry Unit Weight, kN/m <sup>3</sup>		14.42		
Area, cm <sup>2</sup>		31.74			Specific Gravity, Measurec		2.766		
Volume, cm <sup>3</sup>		76.93			Solids Height, cm		1.289		
Water Content, %		26.95			Volume of Solids, cm <sup>3</sup>		40.91		
Wet Mass, g		143.64			Volume of Voids, cm <sup>3</sup>		36.02		
Dry Mass, g		113.15							
<div style="display: flex; justify-content: space-between;"> <span>Prepared By: TC</span> <span><b>Golder Associates</b></span> <span>Checked By: MT</span> </div>									

# CONSOLIDATION TEST SUMMARY

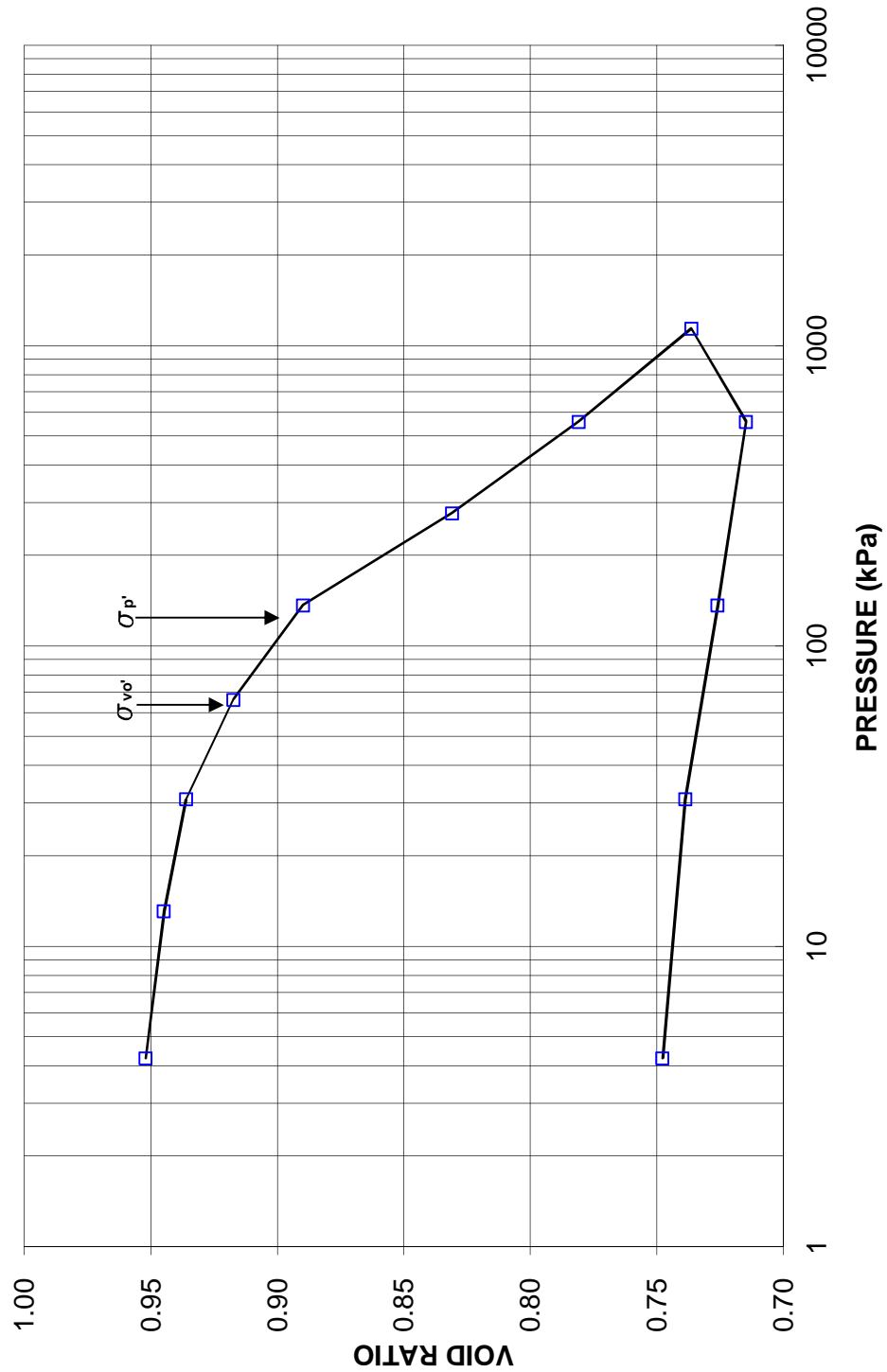
FIGURE D6  
Pg. 2 of 4



**CONSOLIDATION TEST  
VOID RATIO VS LOG PRESSURE**

**FIGURE D6**  
Pg. 3 of 4

**CONSOLIDATION TEST  
VOID RATIO vs PRESSURE  
BH 17-3 Sa 7**

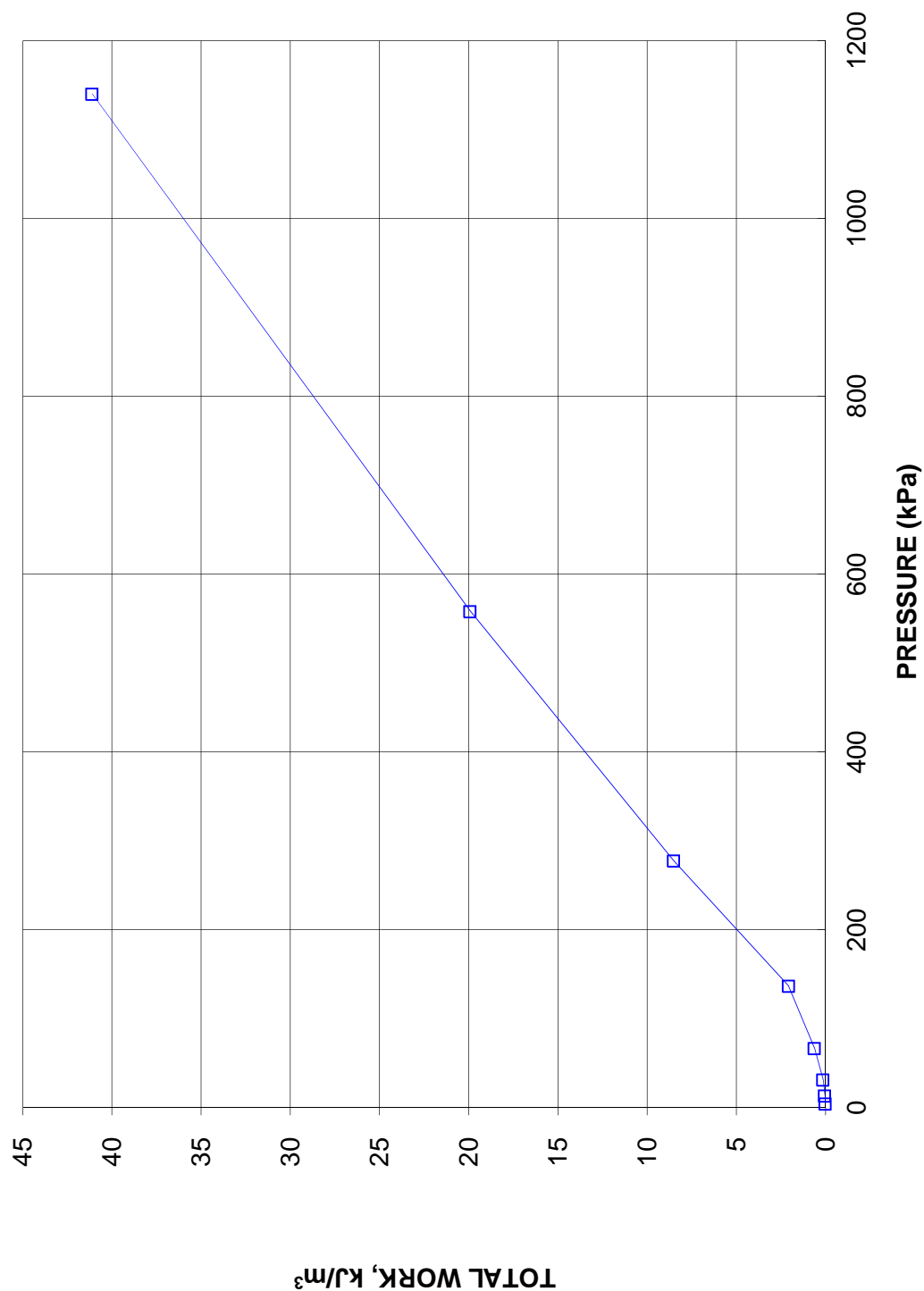




**CONSOLIDATION TEST  
TOTAL WORK VS PRESSURE**

**FIGURE D6**  
Pg. 4 of 4

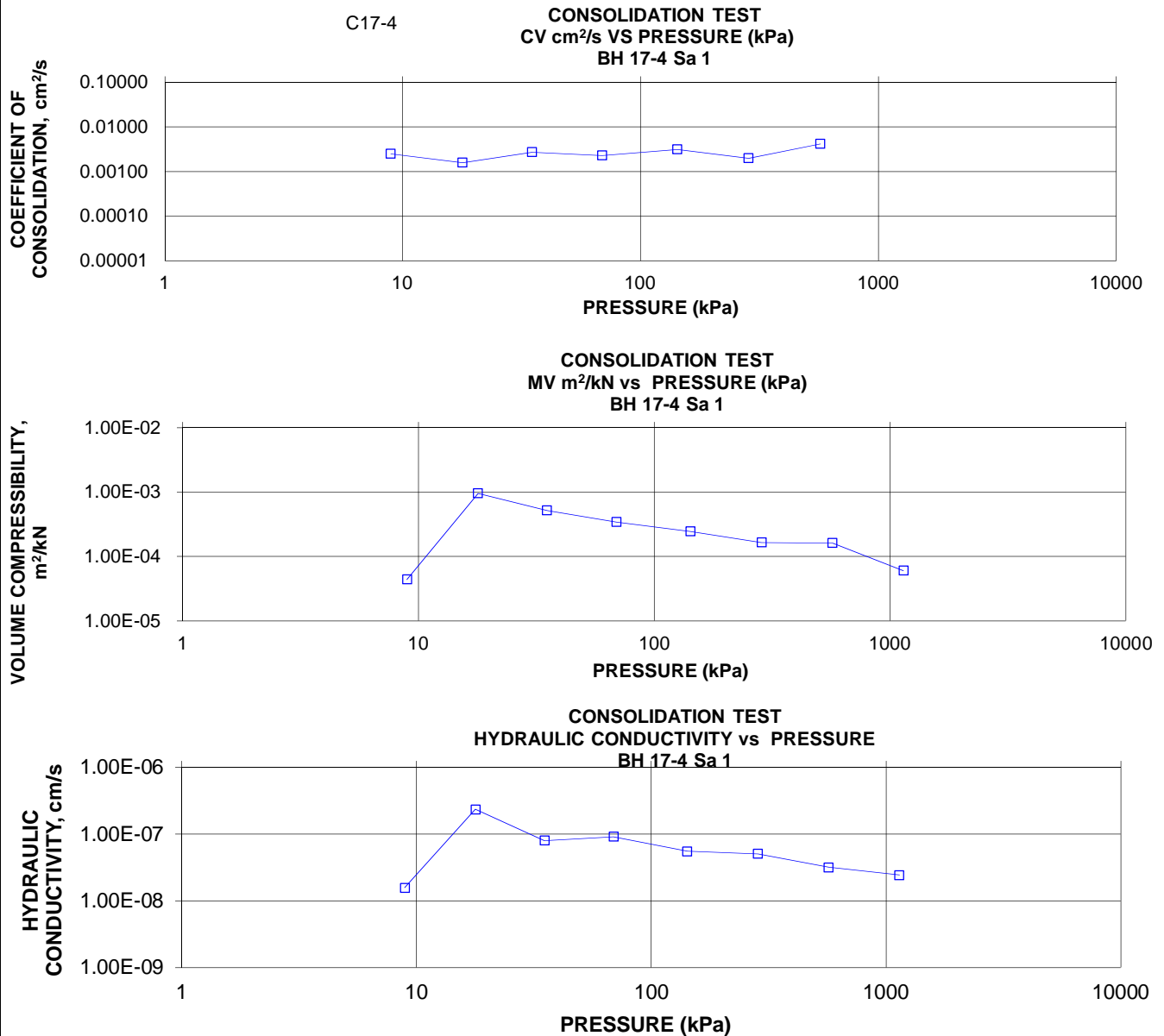
**CONSOLIDATION TEST  
TOTAL WORK,  $\text{kJ/m}^3$  vs PRESSURE  
BH 17-3 Sa 7**



CONSOLIDATION TEST SUMMARY						FIGURE D7 Pg. 1 of 4			
<b>SAMPLE IDENTIFICATION</b>									
Project Number	1651997-1203			Sample Number	1				
Borehole Number	C17-4			Sample Depth, m	5.5				
<b>TEST CONDITIONS</b>									
Test Type	Standard			Load Duration, hr	24				
Oedometer Number	1								
Date Started	May 9, 2017								
Date Completed	May 25, 2017								
<b>SAMPLE DIMENSIONS AND PROPERTIES - INITIAL</b>									
Sample Height, cm	2.544			Unit Weight, kN/m <sup>3</sup>	18.00				
Sample Diameter, cm	6.357			Dry Unit Weight, kN/m <sup>3</sup>	12.99				
Area, cm <sup>2</sup>	31.74			Specific Gravity, measured	2.765				
Volume, cm <sup>3</sup>	80.75			Solids Height, cm	1.219				
Water Content, %	38.53			Volume of Solids, cm <sup>3</sup>	38.69				
Wet Mass, g	148.20			Volume of Voids, cm <sup>3</sup>	42.06				
Dry Mass, g	106.98								
<b>TEST COMPUTATIONS</b>									
Pressure kPa	Primary Consolidation mm	Corr. Height cm	End of Primary Void Ratio	Average Height cm	t <sub>90</sub> sec	cv, cm <sup>2</sup> /s	mv m <sup>2</sup> /kN	k cm/s	Total Work kJ/m <sup>3</sup>
0	0.00	2.544	1.087	2.544					
9	0.01	2.526	1.086	2.535	375	0.00363	4.40E-05	1.57E-08	0.002
18	0.04	2.512	1.068	2.519	540	0.00249	9.59E-04	2.34E-07	0.117
35	0.14	2.485	1.050	2.499	844	0.00157	5.21E-04	8.01E-08	0.356
69	0.17	2.447	1.025	2.466	470	0.00274	3.42E-04	9.19E-08	0.975
143	0.24	2.396	0.988	2.422	540	0.00230	2.45E-04	5.52E-08	2.936
285	0.33	2.311	0.939	2.353	375	0.00313	1.66E-04	5.09E-08	8.238
570	0.65	2.206	0.842	2.258	540	0.00200	1.63E-04	3.19E-08	29.574
1140	0.48	2.121	0.770	2.163	240	0.00413	6.00E-05	2.43E-08	62.723
570	-0.05	2.126	0.744	2.123					
143	-0.18	2.144	0.759	2.135					
35	-0.20	2.164	0.775	2.154					
9	-0.19	2.182	0.790	2.173					
Note: k calculated using $\alpha_v$ based on $t_{90}$ values. Void ratio for unloading (or rebound) calculated for the end of increment									
<b>SAMPLE DIMENSIONS AND PROPERTIES - FINAL</b>									
Sample Height, cm	2.400			Unit Weight, kN/m <sup>3</sup>	17.57				
Sample Diameter, cm	6.36			Dry Unit Weight, kN/m <sup>3</sup>	13.77				
Area, cm <sup>2</sup>	31.74			Specific Gravity, measured	2.765				
Volume, cm <sup>3</sup>	76.17			Solids Height, cm	1.219				
Water Content, %	27.58			Volume of Solids, cm <sup>3</sup>	38.69				
Wet Mass, g	136.49			Volume of Voids, cm <sup>3</sup>	37.48				
Dry Mass, g	106.98								
Prepared By: TG <div style="float: right; text-align: right;">             Golder Associates             <span style="margin-left: 50px;">Checked By: MT</span> </div>									

# CONSOLIDATION TEST SUMMARY

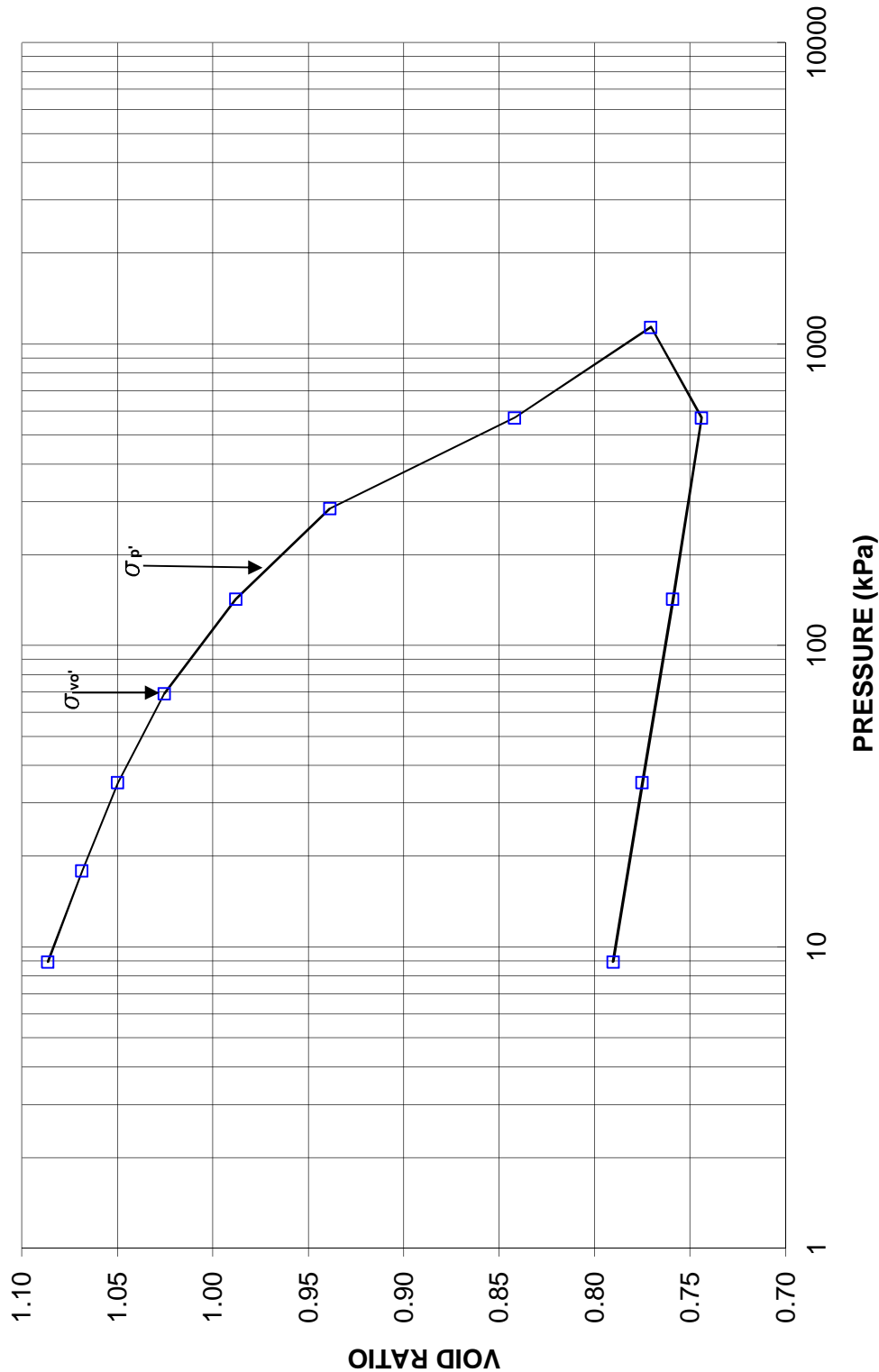
FIGURE D7  
Pg. 2 of 4



CONSOLIDATION TEST  
VOID RATIO VS LOG PRESSURE

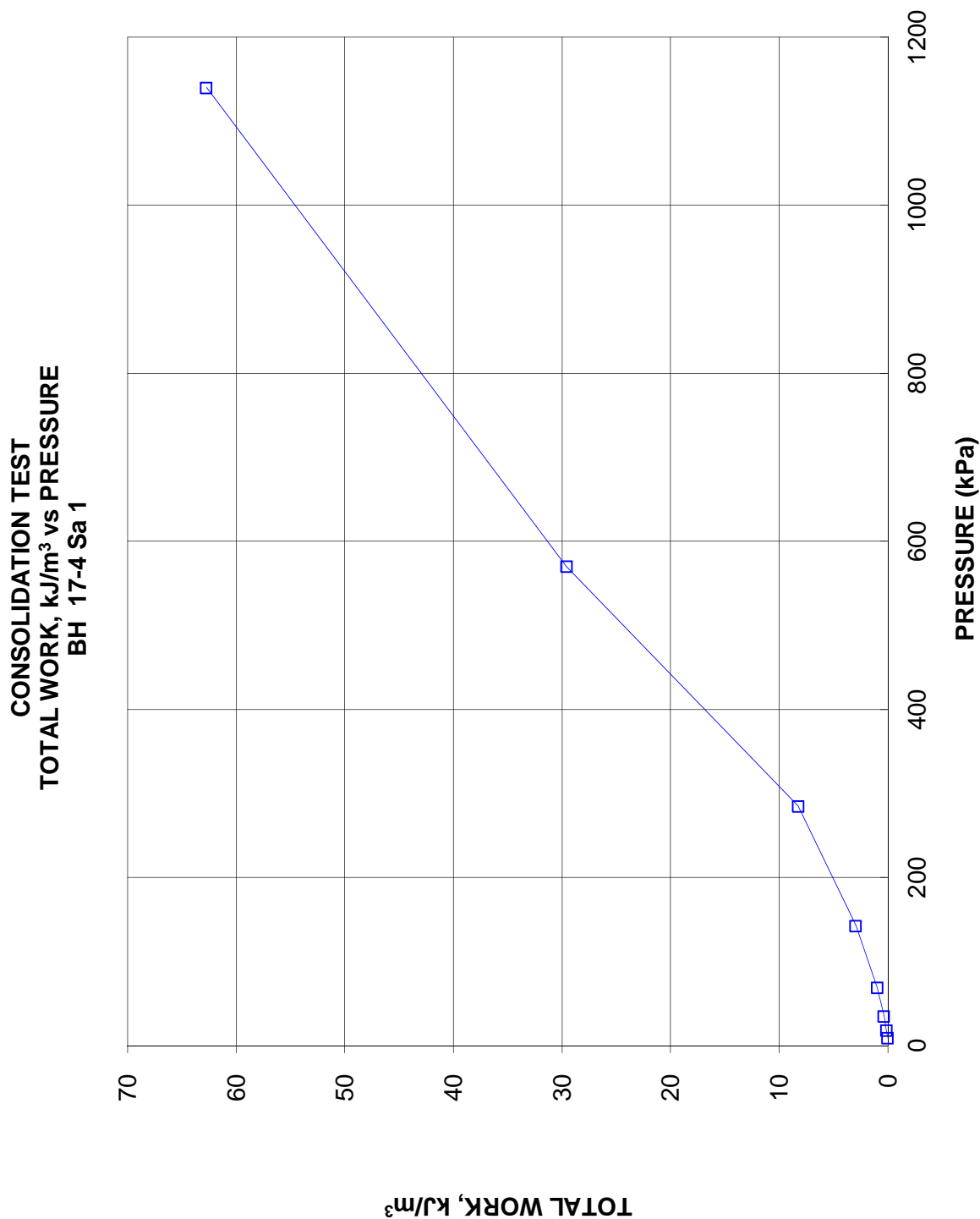
FIGURE D7  
Pg. 3 of 4

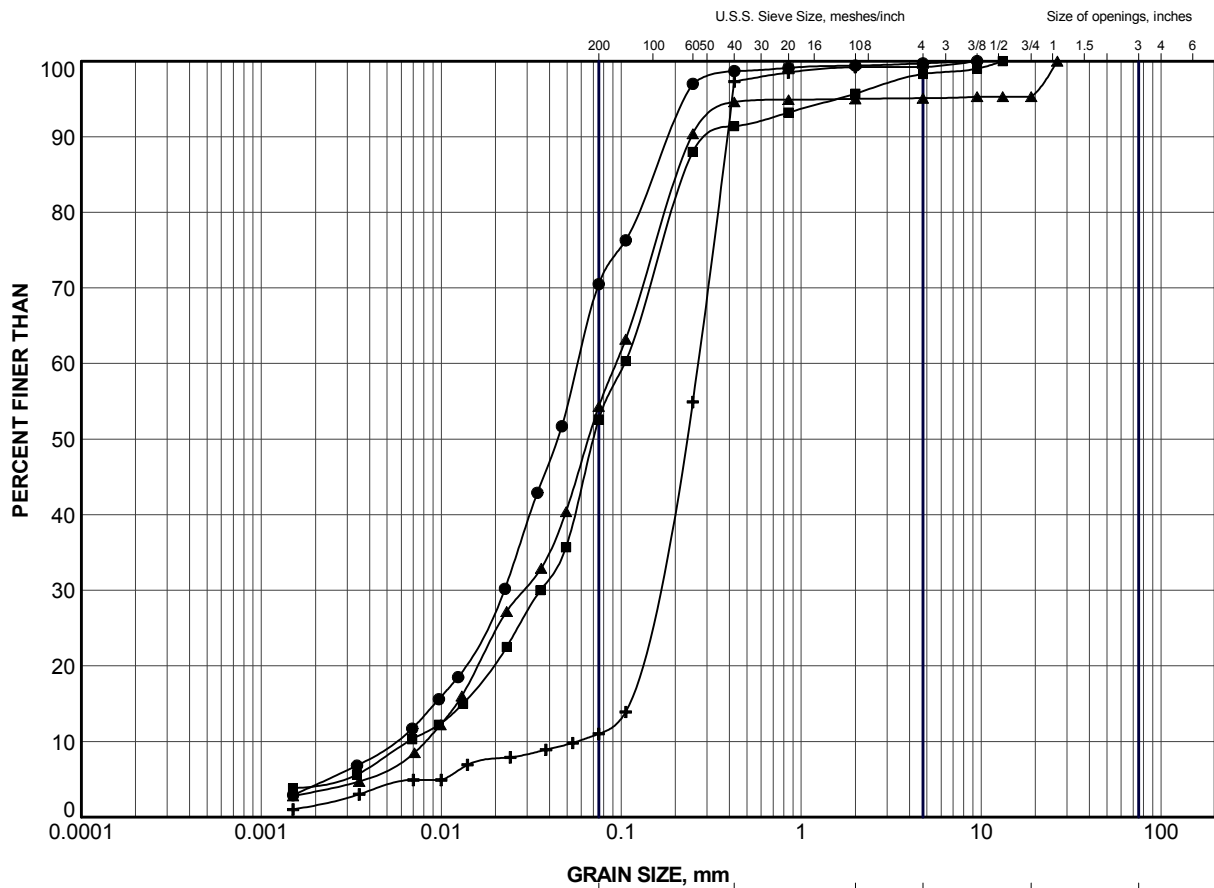
CONSOLIDATION TEST  
VOID RATIO vs PRESSURE  
BH 17-4 Sa 1



# CONSOLIDATION TEST TOTAL WORK VS PRESSURE

FIGURE D7  
Pg. 4 of 4





### LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	C17-3	8	245.6
■	C17-4	7	246.5
▲	C17-6	9B	243.7
+	C17-9	3	255.5

PROJECT

HIGHWAY 17  
CONISTON CPR OVERHEAD BRIDGE

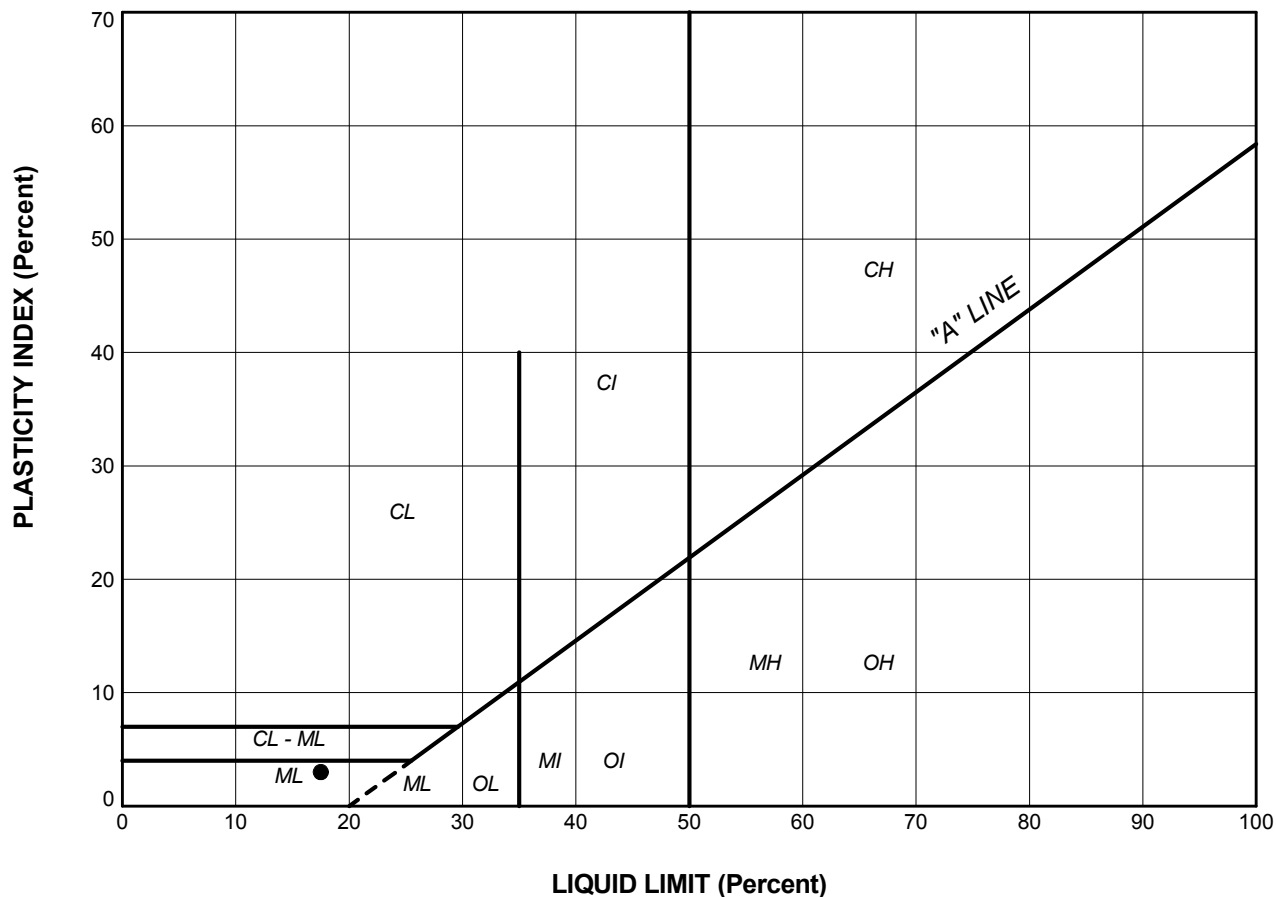
TITLE

**GRAIN SIZE DISTRIBUTION**  
SANDY SILT to SILT and SAND to SAND



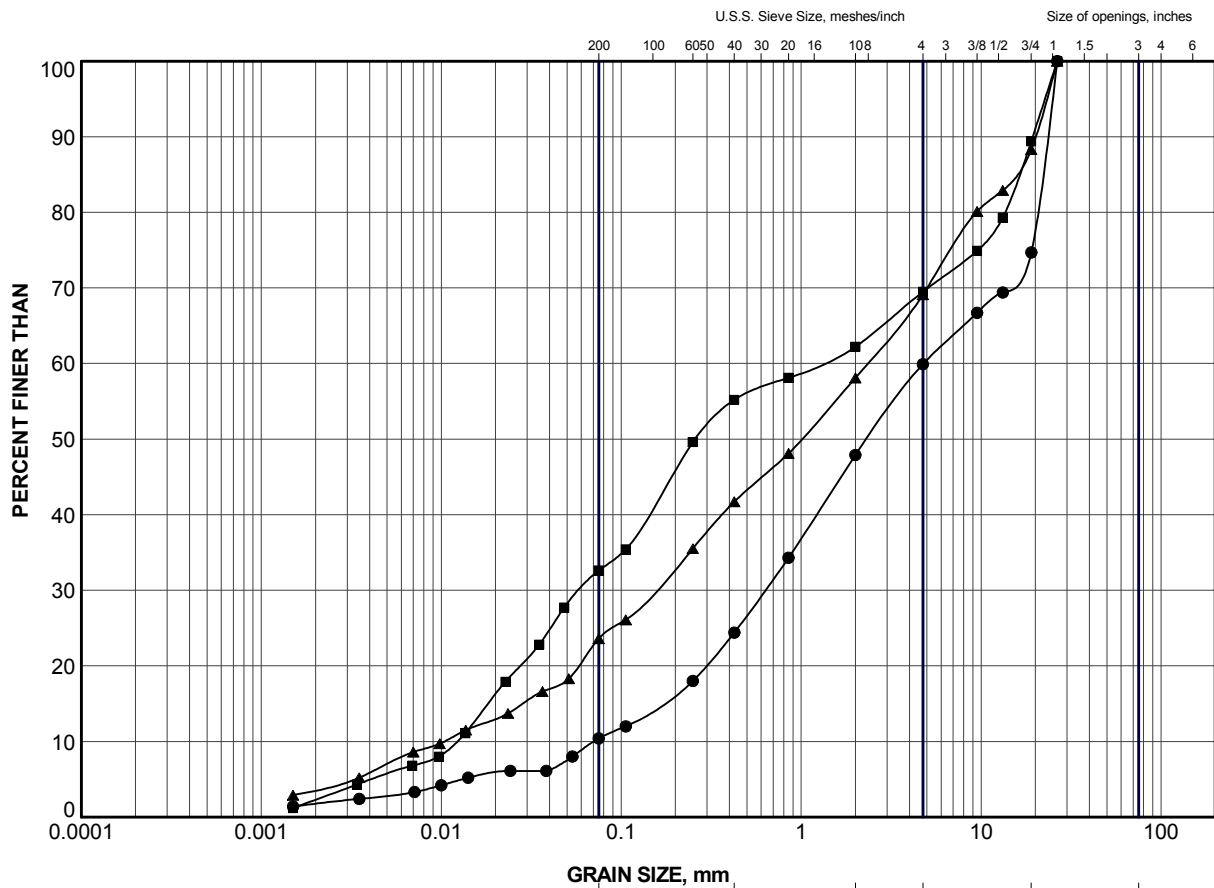
**Golder  
Associates**  
SUDBURY, ONTARIO

PROJECT No.		1651997	FILE No.		1651997.GPJ
DRAWN	TB	Sept 2017	SCALE	N/A	REV.
CHECK	SEMP	Sept 2017	<b>FIGURE D8</b>		
APPR	JMAC	Sept 2017			



PROJECT					
HIGHWAY 17 CONISTON CPR OVERHEAD BRIDGE					
TITLE					
PLASTICITY CHART SILT					
PROJECT No. 1651997			FILE No. 1651997.GPJ		
DRAWN	TB	Sept 2017	SCALE	N/A	REV.
CHECK	SEMP	Sept 2017	FIGURE D9		
APPR	JMAC	Sept 2017			






CLAY AND SILT	GRAVEL SIZE, mm					Cobble Size
	fine	medium	coarse	fine	coarse	
	SAND SIZE			GRAVEL SIZE		

#### LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	C17-5	14	245.6
■	C17-7	7	255.3
▲	C17-7	8	253.8

PROJECT						HIGHWAY 17 CONISTON CPR OVERHEAD BRIDGE					
TITLE						<b>GRAIN SIZE DISTRIBUTION</b> SILTY SAND and GRAVEL to SAND and GRAVEL (TILL)					
PROJECT No.			1651997			FILE No.			1651997.GPJ		
DRAWN	TB	Sept 2017	SCALE	N/A	REV.	<b>FIGURE D10</b>					
CHECK	SEMP	Sept 2017									
APPR	JMAC	Sept 2017									
 <b>Golder Associates</b> SUDBURY, ONTARIO											



### Borehole C17-1



Box 1: 0.0 m – 3.0 m

### Borehole C17-2



Box 1: 0.0 m – 3.0 m

### Borehole C17-3



Box 1: 8.6 m – 11.7 m

### Borehole C17-4

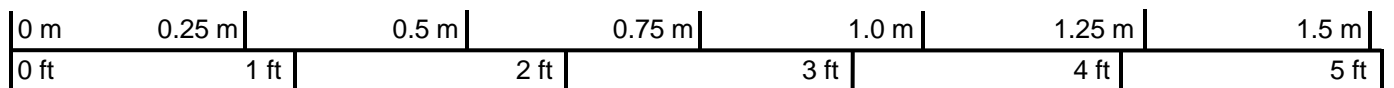


Box 1: 8.9 m – 11.9 m

### Borehole C17-7



Box 1: 8.2 m – 9.2 m



Scale

PROJECT

**CPR Overhead on Highway 17 at Coniston  
Sudbury Area, Ontario**

TITLE

**Bedrock Core Photographs  
Borehole C17-1, C17-2, C17-3, C17-4, C17-7**



PROJECT No. 1651997			FILE No. ----		
DESIGN	AC	JUN 17	SCALE	NTS	REV.
CADD	--		<b>FIGURE D11</b>		
CHECK	SEMP	JUN 17			
REVIEW	SEMP	JUN 17			

As a global, employee-owned organisation with over 50 years of experience, Golder Associates is driven by our purpose to engineer earth's development while preserving earth's integrity. We deliver solutions that help our clients achieve their sustainable development goals by providing a wide range of independent consulting, design and construction services in our specialist areas of earth, environment and energy.

For more information, visit [golder.com](http://golder.com)

Africa	+ 27 11 254 4800
Asia	+ 86 21 6258 5522
Australasia	+ 61 3 8862 3500
Europe	+ 44 1628 851851
North America	+ 1 800 275 3281
South America	+ 56 2 2616 2000

[solutions@golder.com](mailto:solutions@golder.com)  
[www.golder.com](http://www.golder.com)

**Golder Associates Ltd.**  
**100, Scotia Court**  
**Whitby, Ontario, L1N 8Y6**  
**Canada**  
**T: +1 (905) 723 2727**

