



May 9, 2013

## FOUNDATION INVESTIGATION REPORT

**EXTENSION OF WESTBOUND TRUCK CLIMBING LANES AND  
EASTBOUND PASSING LANE  
REHABILITATION OF HIGHWAY 17  
FROM 0.3 KM WEST OF HIGHWAY 94 EASTERLY 12.8 KM  
BONFIELD TOWNSHIP, ONTARIO  
MINISTRY OF TRANSPORTATION, ONTARIO  
GWP 174-98-00**

**Submitted to:**  
MMM Group Limited  
100 Commerce Valley Drive West  
Thornhill, Ontario  
L3T 0A1



**GEOCRES NO.: 31L-160**

**Report Number: 10-1191-0041-R02**

**Distribution:**

5 Copies - Ministry of Transportation, Ontario, North Bay, Ontario (Northeastern Region)  
1 e-copy - Ministry of Transportation, Ontario, Downsview, Ontario (Foundations Section)  
1 e-copy - MMM Group Limited, Thornhill, Ontario  
1 e-copy - Golder Associates Ltd., Sudbury, Ontario

REPORT





## Table of Contents

### PART A – FOUNDATION INVESTIGATION REPORT

<b>1.0 INTRODUCTION.....</b>	<b>1</b>
<b>2.0 SITE DESCRIPTION.....</b>	<b>1</b>
<b>3.0 INVESTIGATION PROCEDURES .....</b>	<b>2</b>
<b>4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS .....</b>	<b>5</b>
4.1 Regional Geology .....	5
4.2 General Overview of Local Subsurface Conditions.....	5
4.3 Westbound Truck Climbing Lane - STA 13+100 to 13+350.....	6
4.4 Eastbound Passing Lane - STA 13+150 to 13+350.....	9
4.5 Westbound Truck Climbing Lane - STA 13+350 to 13+550.....	12
4.6 Eastbound Passing Lane - STA 13+350 to 13+550.....	12
4.7 Westbound Truck Climbing Lane - STA 14+000 to 14+150.....	13
4.8 Westbound Truck Climbing Lane - STA 14+650 to 14+700.....	15
<b>5.0 CLOSURE.....</b>	<b>18</b>

### REFERENCES

### TABLES

Table 1	Summary of Lane Extensions Subsurface Investigation
---------	---

### DRAWINGS

Drawing 1	Truck Climbing/ Passing Lanes Location Index Plan
-----------	---

### LIST OF SYMBOLS AND ABBREVIATIONS

### APPENDICES

<b>Appendix A</b>	<b>Westbound Truck Climbing Lane - STA 13+100 to 13+550 and Eastbound Passing Lane STA 13+150 to 13+550</b>
Drawing A1	Borehole Locations and Soil Strata
Drawing A2	Soil Strata
Drawing A3	Borehole Locations
Record of Boreholes	P4-1 to P4-10, P4-3a and P4-8a and P3-1 to P3-7 Pavement Investigation Boreholes for Westbound Truck Climbing Lane Connection Pavement Investigation Boreholes for Eastbound Passing Lane Connection



## FOUNDATION REPORT - HIGHWAY 17 LANE EXTENSIONS GWP 174-98-00

Figure A1	Grain Size Distribution - Sand and Gravel to Silty Sand (Fill)
Figure A2	Grain Size Distribution - Sand to Sand and Silt
Figure A3	Grain Size Distribution - Clayey Silt to Silty Clay
Figure A4	Plasticity Chart - Clayey Silt to Silty Clay
Figure A5	Consolidation Test Summary - P4-8a Sample 1
Figure A6	Grain Size Distribution - Silt to Sand and Silt
Figure A7	Grain Size Distribution - Gravelly Sand to Sand and Gravel
Figure A8	Grain Size Distribution - Sand and Silt to Sand
Figure A9	Plasticity Chart - Sand and Silt
Figure A10	Grain Size Distribution - Clayey Silt
Figure A11	Plasticity Chart - Clayey Silt to Silty Clay
Figure A12	Consolidation Test Summary - P3-6 Sample 5
Figure A13	Grain Size Distribution - Silt to Sand and Silt
Figure A14	Grain Size Distribution - Sand

### Appendix B

#### Westbound Truck Climbing Lane - STA 14+000 to 14+150

Drawing B1	Borehole Locations and Soil Strata
Record of Boreholes	P2-1 to P2-6, C2-2, C2-3 and C2-3a
Record of Drillholes	P2-1 and C2-3a
Record of Test	P2-TP1 to P2-TP3
Figure B1	Grain Size Distribution - Sand and Gravel to Sand (Fill)
Figure B2	Grain Size Distribution – Sand and Silt
Figure B3	Grain Size Distribution – Sand to Sand and Gravel

### Appendix C

#### Westbound Truck Climbing Lane - STA 14+650 to 14+700

Drawing C1	Borehole Locations and Soil Strata
Record of Boreholes	P1-1 to P1-4, P1-6, C1-1, C1-2 and C1-5
Record of Drillhole	C1-5
Record of DCPTs	P1-DC1, P1-DC2 and C1-DC1
Figure C1	Grain Size Distribution - Sand (Fill)
Figure C2	Plasticity Chart - Silty Clay
Figure C3	Grain Size Distribution - Sand and Gravel to Sand



# **PART A**

**FOUNDATION INVESTIGATION REPORT  
EXTENSION OF WESTBOUND TRUCK CLIMBING LANES AND  
EASTBOUND PASSING LANE  
REHABILITATION OF HIGHWAY 17  
FROM 0.3 KM WEST OF HIGHWAY 94 EASTERLY 12.8 KM  
BONFIELD TOWNSHIP, ONTARIO  
MINISTRY OF TRANSPORTATION, ONTARIO  
GWP 174-98-00**



### 1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by MMM Group Limited (MMM) on behalf of Ministry of Transportation, Ontario (MTO) to provide foundation engineering services for the extension of the westbound truck climbing lanes and eastbound passing lane as part of the rehabilitation of Highway 17 in Bonfield Township east of North Bay, Ontario. The proposed rehabilitation of Highway 17 extends from 0.3 km west of Highway 94 easterly 12.8 km (to west of Highway 531). The locations of the lane extensions where foundation engineering services are required are shown on the Index Plan, Drawing 1 and summarized in Table 1, and comprise:

- Westbound Truck Climbing Lane
  - STA 13+100 to STA 13+350
  - STA 14+000 to STA 14+150
  - STA 14+650 to STA 14+700
- Eastbound Passing Lane
  - STA 13+150 to STA 13+350

The Terms of Reference and the Scope of Work for the foundation investigation are outlined in MTO's Request for Proposal dated September 2010. Golder's proposal for foundation engineering services associated with the lane extensions is contained in Section 6.8 of MMM's Technical Proposal for this assignment. The work has been carried out in accordance with Golder's Supplemental Specialty Quality Control Plan for foundation engineering services for this project, dated January 5, 2011. The existing alignment drawing was provided to Golder by MMM.

This report addresses the investigation carried out for the widening required for lane extensions only. Reports detailing the foundation investigations for the culverts, Kaibuskong River Bridge rehabilitation and the proposed Highway 17/94 Roundabout are submitted separately.

The purpose of this investigation is to establish the subsurface conditions at the locations of the proposed lane extensions associated with the rehabilitation of Highway 17 in the above noted areas by methods of borehole drilling, in situ testing and laboratory testing on selected soil samples. The boreholes for the lane extensions were located in the field by Golder, relative to stakes installed by MMM.

A pavement investigation was also completed for this project and is reported separately. In the area of widening between about STA 13+350 and 13+550, the peat and cohesive deposits encountered at the pavement boreholes advanced immediately beyond the existing embankment toes within the footprint of the proposed lane extensions is up to about 7.8 m thick; as such, the subsurface information gathered at these pavement boreholes is also included in this report.

### 2.0 SITE DESCRIPTION

The extension of the westbound truck climbing lanes and the eastbound passing lane addressed by this report are located along the existing Highway 17 alignment within Bonfield Township. The approximate investigated foundation areas for the westbound truck climbing lanes extend for three sections of lengths of 250 m, 150 m



and 50 m for a total of 450 m, and the eastbound lane extends for a length of 200 m. The approximate investigated areas are shown on Drawing 1.

In general, the topography within these sections of the climbing/passing lane extensions consist of rolling terrain, including numerous bedrock outcrops separated by valleys and swamps containing areas of standing water and various types of vegetation and organic soils, and ground cover consisting of sparsely or densely populated treed areas. The ground surface at the borehole locations advanced within the limits of the study area, including the existing Highway 17 embankment, varies between about Elevation 247 m and 236 m. A description of the topography specifically within the extent of each lane extension is presented in Section 4.0.

### 3.0 INVESTIGATION PROCEDURES

The fieldwork for the foundation investigation associated with the proposed climbing/passing lane extensions was carried out between March 2 and July 6, 2011. A total of thirty-five (35) boreholes (including five culvert boreholes), three test pits and three Dynamic Cone Penetration Tests (DCPTs) (including one culvert DCPT) were advanced within the climbing/passing lane extensions, as presented in Table 1 and shown on Drawings A1 to C1 in Appendices A to C.

The boreholes and DCPTs were advanced using a truck or track mounted CME 55 or portable equipment supplied and operated by Landcore Drilling of Sudbury, Ontario. The test pits were excavated using a track excavator supplied and operated by Bartlett's Towing of North Bay, Ontario.

The boreholes were advanced through the overburden using 108 mm inside diameter hollow-stem augers or NW casing with wash boring techniques. In general, soil samples were obtained at intervals of depth of about 0.75 m and 1.5 m, using a 50 mm outer diameter (O.D.) split-spoon sampler operated by automatic hammers on the drill rigs, driven in accordance with Standard Penetration Test (SPT) procedures (ASTM D1586). Boreholes advanced by portable equipment generally employed a full weight hammer lifted manually and dropped from the SPT height. At some borehole locations where portable equipment was used, as noted on the Record of Borehole sheets where applicable, half-weight hammers were used and the SPT "N"-values were corrected as appropriate. Samples of the cohesive soils were obtained using 76 mm O.D. thin-walled Shelby tubes (ASTM D1587, Standard Practice for Thin-Walled Tube Sampling) for relatively undisturbed samples. Field vane shear tests were carried out in cohesive soils (strata) for determination of undrained shear strengths (ASTM D2573) using MTO Standard 'N' size vanes. Where applicable, rock coring was carried out using MTO Standard 'NQ' core barrels to a depth of 3 m below auger/casing refusal where appropriate and through blast rock fill sections. All boreholes were backfilled with bentonite upon completion in accordance with Ontario Regulation 903-Wells (as amended).

The boreholes were advanced to depths ranging from 0.2 m to 14.6 m below existing ground surface or water surface, generally penetrating 3 m into competent material, which is defined as material that will provide resistance to settlement or instability of the embankments, or refusal. In general, boreholes were terminated on refusal to further auger, casing and/or split spoon advancement, likely on or in proximity to the bedrock surface.

The groundwater conditions and water levels in the open boreholes were observed during the drilling operations and are described on the Record of Borehole sheets in Appendices A to C. Slight artesian conditions, between 0.3 m and 0.6 m above existing ground surface, were encountered in Boreholes P4-2, P4-3 and P4-9.



## FOUNDATION REPORT - HIGHWAY 17 LANE EXTENSIONS GWP 174-98-00

Groundwater elevations as encountered in the boreholes may not be representative of static groundwater levels since the groundwater levels in the boreholes may not have stabilized on completion of drilling. Furthermore, groundwater elevations will vary depending on seasonal fluctuations, precipitation and local soil permeability.

The fieldwork was observed by members of our engineering and technical staff, who located the boreholes, arranged for the clearance of underground services, observed the drilling, sampling and in situ testing operations, logged the boreholes, and examined and cared for the soil samples and rock core. The samples and core were identified in the field, placed in appropriate containers, labelled and transported to our Sudbury Geotechnical laboratory where the samples and core underwent further visual examination and laboratory testing. All of the laboratory tests were carried out to MTO Laboratory Standards and/or ASTM Standards, as appropriate. Classification testing (water content, Atterberg limits and grain size distribution) was carried out on selected samples.

Survey stakes offset from the Highway 17 centerline were installed by MMM prior to the commencement of drilling at the respective sites. The as-drilled borehole locations in the passing lane extension, in stations and offsets, were measured in reference to the applicable stakes installed by MMM and were subsequently converted into MTM NAD 83 coordinates in AutoCAD. Borehole elevations were surveyed by a member of our technical staff in reference to the ground surface elevations at the applicable stakes installed by MMM. The borehole locations shown on Drawings A1 to C1 are positioned relative to MTM NAD 83 northing and easting coordinates and the ground surface elevations are referenced to Geodetic datum. The borehole locations and ground surface elevations are as follows:

Highway 17	Borehole	Location (m)		Ground/Ice/Water Surface Elevation (m)	Borehole/DCPT/ Test Pit Depth (m) (Includes Ice/Water)
		Northing	Easting		
STA 13+100 to 13+350 Westbound Truck Climbing Lane	P4-1	5125791.4	329624.6	246.5	6.5
	P4-2	5125805.5	329648.9	242.3	7.5
	P4-3	5125814.5	329697.7	240.7	10.5
	P4-3a	5125814.8	329700.2	240.6	6.4
	P4-4	5125810.3	329749.8	240.7	6.4
	P4-5	5125809.9	329784.9	241.0	5.0
	P4-6	5125806.8	329814.9	241.4	7.7
	P4-7	5125807.8	329835.9	241.0	7.7
	P4-8	5125812.7	329716.1	241.3	7.7
	P4-8a	5125812.7	329717.1	241.3	4.9
	P4-9	5125812.0	329668.9	242.0	6.7
	P4-10	5125791.1	329700.8	246.7	14.6
STA 13+150 to 13+350 Eastbound Passing Lane	P3-1	5125772.8	329752.6	241.2	8.7
	P3-2	5125776.2	329777.4	241.3	6.4
	P3-3	5125779.8	329801.4	241.3	6.3
	P3-4	5125780.3	329826.4	241.0	7.0
	P3-5	5125766.9	329729.3	241.6	11.7
	P3-6	5125757.6	329705.3	241.0	10.2
	P3-7	5125754.3	329680.6	241.5	10.1





## FOUNDATION REPORT - HIGHWAY 17 LANE EXTENSIONS

### GWP 174-98-00

Highway 17	Borehole	Location (m)		Ground/Ice/Water Surface Elevation (m)	Borehole/DCPT/ Test Pit Depth (m) (Includes Ice/Water)
		Northing	Easting		
STA 14+000 to 14+150 WBL Westbound Truck Climbing Lane	P2-1	5125771.0	330525.8	240.7	9.2
	P2-2	5125779.2	330579.2	237.5	0.9
	P2-3	5125782.8	330579.3	237.0	0.2
	P2-4	5125779.0	330601.2	238.4	0.5
	P2-5	5125777.8	330631.2	239.7	0.2
	P2-6	5125788.0	330526.5	236.6	2.4
	C2-2	5125766.9	330559.9	240.9	7.9
	C2-3	5125781.5	330558.2	236.1	1.8
	C2-3a	5125781.6	330556.2		4.7
	P2-TP1	5125776.7	330620.6	239.8	2.4
	P2-TP2	5125777.8	330610.1	238.7	0.4
	P2-TP3	5125776.1	330635.3	239.6	0.3
STA 14+650 to 14+700 WBL Westbound Truck Climbing Lane	P1-1	5125764.9	331177.7	238.0	9.0
	P1-2	5125768.9	331177.9	238.1	9.6
	P1-3	5125768.2	331195.9	237.9	4.4
	P1-4	5125769.9	331152.9	238.4	4.8
	P1-6	5125746.8	331144.3	247.0	12.7
	C1-1	5125765.4	331164.9	238.1	5.8
	C1-2	5125769.4	331164.9	238.2	7.5
	C1-5	5125739.4	331152.5	247.2	13.9
	P1-DC1	5125762.9	331177.6	238.0	6.8
	P1-DC2	5125768.0	331200.9	238.3	3.1
	C1-DC1	5125769.2	331168.9	238.2	8.4

As noted in Section 1, in addition to the foundation investigation described above, a pavement investigation was completed for this project section of in 2011 and 2012, including for the westbound truck climbing lane and eastbound passing lane extensions between STA 13+350 and 13+550. The pavement boreholes were generally advanced with a power auger drill rig and the boreholes in the off-road areas were advanced with a portable, gasoline-powered, augering and split spoon sampling equipment. The Record of Borehole sheets for the pavement investigation also pertinent to this foundation investigation are included in Appendix A.





## **4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS**

### **4.1 Regional Geology**

Based on terrain mapping by the Ontario Geological Survey<sup>1</sup>, the site generally consists of rock knobs separated by peat/organic terrain. Towards the east end of the site, in the vicinity of Kaibuskong River, the soils consist of glaciolacustrine plain silts and sands.

The bedrock in the area typically consists of gneisses of the Powassan or Tilden Lake Domain, both within the Central Gneiss Belt, a subdivision of the Grenville Structural Province, as described in Geology of Ontario, OGS Special Volume 4<sup>2</sup>.

### **4.2 General Overview of Local Subsurface Conditions**

The detailed subsurface soil and groundwater conditions as encountered in the boreholes advanced during this investigation, together with the results of the laboratory tests carried out on selected soil samples, are presented on the Record of Borehole sheets and the laboratory test sheets in Appendices A to C. The stratigraphic boundaries shown on the Record of Borehole sheets are inferred from non-continuous sampling, observations of drilling progress and in situ testing. These boundaries, therefore, represent transitions between soil types rather than exact planes of geological change. Further, subsurface conditions will vary between and beyond the borehole locations.

The inferred soil stratigraphy as encountered in the boreholes advanced for the climbing/passing lane extensions are shown in profile on Drawings A1, A2, B1 and C1 in Appendices A to C. The orientation (i.e. north, south, east, west) stated in the text of the report is typically referenced to project north. For the purposes of this report, the Highway 17 alignment is in an east-west orientation. Therefore, the directions indicated in the text may differ from those shown on the drawings.

In general, the stratigraphy encountered at the various areas investigated is similar. However, the overburden (soil materials) thickness is variable, ranging from 0.2 m to about 14.6 m. The stratigraphy generally consists of:

- surficial layers of peat or embankment fill;
- relatively thin deposits of glaciolacustrine sand to sand and silt;
- cohesive deposits of glaciolacustrine mixtures of silt and clay interbedded with sand layers in some areas; and
- sand to sand and gravel strata between the cohesive/cohesionless deposits and the inferred bedrock surface.

Detailed descriptions of the subsurface conditions at each investigated climbing/passing lane extension are provided in the following sections of this report. Where relatively significant thicknesses of overburden were encountered, the various soil types are described in detail for each main deposit or stratum.

---

<sup>1</sup> Northern Ontario Engineering Geology Terrain Study, Ontario Geological Society, Map 5044.

<sup>2</sup> Geology of Ontario, 1991. Ontario Geological Society Special Volume 4, Part 2. Ministry of Northern Development and Mines, Ontario.



### **4.3 Westbound Truck Climbing Lane - STA 13+100 to 13+350**

The plan and profile and a cross-section for the westbound truck climbing lane extension showing the borehole locations and interpreted stratigraphy from approximately STA 13+100 to 13+350 in Bonfield Township is shown on Drawings A1 and A2, respectively, in Appendix A. The height of the existing embankment at STA 13+100 is about 2.5 m, increasing to about 7.5 m at STA 13+150 and decreasing to about 2 m at STA 13+350. A total of twelve boreholes (P4-1 to P4-10, P4-3a and P4-8a) were completed to investigate the subsurface conditions along the passing lane extension. The topography of this section of the existing Highway 17 alignment is generally a flat and low-lying in the valley area, sloping up to the west from about STA 13+150 and to the east from about STA 13+250, and is with moderately tree-covered.

#### ***Embankment Fill***

Borehole P4-10, advanced through the existing westbound shoulder with the ground surface at Elevation 246.7 m, encountered 2.1 m of sand and gravel to sand fill underlain by about 2.5 m of blast rock fill, in turn underlain by about 6.4 m of sand to silty sand fill.

Boreholes P4-1, P4-6, P4-7 and P4-9 were advanced within the embankment side slope or near the toe of the existing embankment with the ground surface ranging between Elevation 246.5 m and 241.0 m. Boreholes P4-1, P4-6 and P4-7 penetrated a 0.1 m to 0.5 m thick layer of peat fill material from ground surface underlain by a deposit of layered cohesionless fill consisting of silt, silty sand, sand and sand and gravel, as also encountered from ground surface at Borehole P4-9. The thickness of the cohesionless fill ranges between 1.1 m and 2.4 m.

SPT 'N'-values measured within the peat fill and the cohesionless fill range from 4 blows and 20 blows per 0.3 m of penetration, with one 'N'-value of 219 blows per 0.3 m of penetration, generally indicating a loose to compact and relative density or stiff consistency.

The grain size distribution of five samples of the cohesionless fill is presented on Figure A1 in Appendix A.

The natural water content of cohesionless fill samples is between 9 per cent and 19 per cent, and the natural water content of two samples of the peat fill is 35 per cent and 62 per cent.

#### ***Peat***

A layer of black/brown fibrous and/or amorphous peat was encountered from ground surface in Boreholes P4-2 to P4-5 and P4-8 and below the fill in Boreholes P4-6 and P4-7. The top of the peat was encountered between Elevation 242.3 m and 239.3 m and the thickness of the deposit ranges between 0.1 m and 1.5 m.

SPT 'N'-values measured within the peat range from 2 blows to 5 blows per 0.3 m of penetration, suggesting a soft to firm consistency.

The natural water content measured on samples of this deposit ranges from 47 per cent to 469 per cent.



#### *Sand to Sand and Silt*

A deposit of brown to grey sand, silty sand or sand and silt, was encountered below the fill in Boreholes P4-1 and P4-9 and underlying the peat in Boreholes P4-2 to P4-4. The top of this deposit is between Elevations 243.6 m and 240.0 m and the thickness of the deposit ranges from 1.0 m to 3.6 m. In Borehole P4-1, the bottom of the deposit was defined by split-spoon refusal.

The SPT 'N'-values recorded within this deposit are generally between 3 blows and 41 blows per 0.3 m of penetration, indicating a loose to dense relative density.

The grain size distributions of three samples of the sand to sand and silt are presented on Figure A2 in Appendix A.

The natural water content measured on samples of this deposit is between about 13 per cent and 25 per cent.

#### *Clayey Silt to Silty Clay*

A deposit of brown to grey clayey silt to silty clay was encountered below the fill in Borehole P4-10, below the peat in Boreholes P4-5 to P4-8 and below the sand to sand and silt in Boreholes P4-2 to P4-4 and P4 9. The clayey silt to silty clay deposit was noted to contain silt seams/layers. The top of this deposit was encountered between Elevation 241.1 m and 235.9 m, at depths generally between 0.2 m and 3.9 m below ground surface except in Borehole P4-10 where the top of the deposit was encountered at a depth of 10.8 m below ground surface. The thickness of the clayey silt to silty clay ranges from 1.3 m to 5.6 m and in Borehole P4-5, the bottom of this deposit was defined by refusal to further casing advancements.

The SPT 'N'-values recorded within the clayey silt to silty clay range from 0 blows (weight of hammer) to 15 blows per 0.3 m of penetration and in situ field vane testing carried out within this stratum measured undrained shear strengths ranging from about 8 kPa to 77 kPa. The SPT 'N'-values suggest and the vane testing indicates the cohesive deposit has a very soft to stiff consistency.

A grain size distribution for two samples of the clayey silt to silty clay deposit is shown on Figure A3, in Appendix A.

Atterberg limits testing carried out on fifteen samples of the clayey silt to silty clay deposit yielded liquid limits ranging from about 25 per cent to 47 per cent, plastic limits ranging from about 13 per cent to 23 per cent and plasticity indices ranging from 11 per cent to 26 per cent. The results of the Atterberg limits testing are shown on the plasticity chart on Figure A4 in Appendix A and indicate that the deposit consists of clayey silt of low plasticity to silty clay of intermediate plasticity.

The natural water content measured on samples of the silty clay to clayey silt deposit is between about 22 per cent and 58 per cent.

One laboratory consolidation (oedometer) test was carried out on a specimen of the clayey silt to silty clay obtained from Borehole P4-8a and the test results are shown on Figure A5. The preconsolidation stress was estimated from the Void Ratio versus logarithmic Pressure plots using the Casagrande method as well as from



the Total Work versus Pressure plots. The unit weight of the sample from Borehole P4-8a is about 16 kN/m<sup>3</sup>. The relevant consolidation test results are summarized below.

Borehole/ Sample Number	Elevation (m)	$\sigma_{vo}'$ (kPa)	$\sigma_p'$ (kPa)	$\sigma_p' - \sigma_{vo}'$ (kPa)	OCR	$e_o$	$C_r$	$C_c$	$c_v^*$ (cm <sup>2</sup> /s)
P4-8a/1	236.7	40	66	26	1.7	1.58	0.06	0.47	$3.0 \times 10^{-3}$

Note: \*Approximate stress range between the effective overburden stress and the final stress due to a 9 m embankment widening and approximately 1.7 m embankment grade raise at the embankment centerline is  $66 \text{ kPa} \leq \sigma_v' \leq 137 \text{ kPa}$ .

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

### Silt to Silty Sand

A deposit of grey silt, sand and silt, and silty sand was encountered underlying the clayey silt to silty clay in Boreholes P4-3, P4-6 and P4-8 to P4-10, and underlying a deposit of gravelly sand in Borehole P4-2, at depths ranging from about 5.2 m to 7.2 m below ground surface. The top of the deposit ranges from Elevation 236.8 m to 233.5 m and the thickness of the deposit ranges from 1.0 m and 2.3 m.

SPT 'N'-values measured within the silt to sand and silt deposit range from 11 blows to 43 blows per 0.3 m of penetration, indicating a compact to dense relative density. The bottom of the deposit was defined by refusal to casing advancement in Borehole P4-6.

The grain size distribution of the six samples taken from the silt to silty sand deposit is presented on Figure A6 in Appendix A.

The natural water content measured on five samples of this deposit ranged from 17 per cent to 32 per cent. An Atterberg limits test was attempted on the sample of silt from Borehole P4-3 and the sample was determined to be non-plastic.

### Gravelly Sand to Sand and Gravel

A deposit of brown to grey gravelly sand to sand and gravel was encountered underlying the clayey silt to silty clay in Boreholes P4-2, P4-4 and P4-7 and underlying the silt to silty sand in Boreholes P4-3 and P4-8. The top of this deposit was encountered at depths ranging from 2.9 m to 8.7 m below ground surface, between Elevations 239.4 m and 232.0 m and the thicknesses of the deposit ranges from 0.5 m to 2.9 m.

SPT 'N'-values measured within this deposit range from 3 blows and 71 blows per 0.3 m of penetration, indicating a very loose to very dense relative density.

The grain size distribution of two samples of the gravelly sand to sand and gravel deposit are shown on Figure A7 in Appendix A.



### ***Refusal***

Refusal to further split-spoon or casing penetration was encountered in each of the boreholes at depths ranging from 5.0 m to 14.6 m below ground surface, between Elevation 240.0 m and 230.2 m. These refusal depths, while they do not confirm bedrock elevations, may be likely on or in proximity to the bedrock surface.

### ***Groundwater Conditions***

The unstabilized water levels observed in the boreholes upon completion of drilling range from 0.6 m above ground surface to 4.2 m below ground surface, between Elevation 246.0 m and 240.4 m. Groundwater levels in the area are subject to seasonal fluctuations and variations due to precipitation events.

## **4.4 Eastbound Passing Lane - STA 13+150 to 13+350**

The plan and profile for the eastbound passing lane extension showing the borehole locations and interpreted stratigraphy from approximately STA 13+150 to 13+350 in Bonfield Township are shown on Drawings A1 and A2, respectively, in Appendix A. The height of the existing embankment at this location ranges from about 7 m at STA 13+150 at the west limit and about 2 m at STA 13+350 at the east limit. A total of seven boreholes (P3-1 to P3-7) were completed to investigate the subsurface conditions along the passing lane extension. The topography of this section of the existing Highway 17 alignment is generally flat and low lying with moderate tree cover.

### ***Embankment Fill***

Boreholes P3-1 to P3-3 were advanced near the toe of the existing embankment and encountered sand to sand and silt fill from ground surface. The surface of the fill ranges between Elevation 241.3 m and 241.2 m and the thickness of the fill deposit ranges from 0.5 m to 1.1 m.

SPT 'N'-values recorded within the sand to sand and silt fill deposit range from 2 blows to 8 blows per 0.3 m of penetration, indicating a very loose to loose relative density.

### ***Peat***

A layer of brown to black fibrous and/or amorphous peat was encountered from ground surface in Boreholes P3-4 to P3-7 and below the fill in Boreholes P3-1 to P3-3. The top of the peat ranges from Elevation 241.6 m to 240.1 m and the thickness ranges from 0.5 m to 1.8 m. In Borehole P3-4, a 0.9 m thick interlayer of clayey silt was encountered within the peat at Elevation 240.5 m.

SPT 'N'-values measured within the peat range from 0 blows (weight of hammer) to 6 blows per 0.3 m of penetration, suggesting a very soft to firm consistency.

The natural water content measured on samples of the peat range from about 116 per cent to 441 per cent.



### ***Sand and Silt to Sand***

A deposit of brown to grey sand and silt to sand was encountered in Boreholes P3-5 to P3-7 underlying the peat. The top of the deposit was encountered at depths between 0.8 m and 1.4 m below ground surface, ranging from Elevation 240.7 m to 240.0 m and the thickness of the deposit is between 1.4 m and 2.4 m.

The SPT 'N'-values recorded within the deposit range from 2 blows to 9 blows per 0.3 m of penetration, indicating a very loose to loose relative density.

The grain size distribution of four samples of the sand and silt to sand is shown on Figure A8 in Appendix A.

An Atterberg limits test was carried out on one sample of the sand and silt portion of the deposit and yielded a liquid limit of 18 per cent, a plastic limit of 21 per cent and a plasticity index of 5 per cent. The result of the Atterberg limits testing is shown on the plasticity chart on Figure A9 in Appendix A and indicates that the deposit consists of silt of slight plasticity.

The natural water content measured on samples of this deposit range from 20 per cent to 27 per cent. The organic content measured on one sample of this deposit is 1.0 per cent.

### ***Clayey Silt to Silty Clay***

A deposit of grey clayey silt to silty clay was encountered underlying the peat in Boreholes P3-1 to P3-4 and underlying the sand and silt to sand in Boreholes P3-5 to P3-7. The clayey silt to silty clay deposit was noted to contain silt seams/layers. The top of this deposit was encountered at depths between 1.8 m and 3.8 m below ground surface, ranging from Elevation 239.5 m to 237.8 m, respectively, and the thicknesses of the deposit is between 2.4 m to 4.9 m.

The SPT 'N'-values recorded within the clayey silt to silty clay deposit range from 0 blows (weight of hammer) to 9 blows per 0.3 m of penetration and in situ field vane testing carried out within this stratum measured undrained shear strengths ranging from about 12 kPa to 48 kPa. The SPT 'N'-values suggest that the vane testing indicates that the cohesive deposit has a soft to firm consistency.

The grain size distribution for one sample of the clayey silt portion of the deposit is shown on Figure A10, in Appendix A.

Atterberg limits testing carried out on eleven samples of the clayey silt to silty clay deposit yielded liquid limits ranging from about 31 per cent to 44 per cent, plastic limits ranging from about 16 per cent to 23 per cent and plasticity indices ranging from about 12 per cent to 24 per cent. The results of the Atterberg limits testing are shown on the plasticity chart on Figure A11 in Appendix A and indicate that the deposit consists of clayey silt of low plasticity to silty clay of intermediate plasticity.

The natural water content measured on fourteen samples of the clayey silt to silty clay deposit range from 35 per cent to 60 per cent. The organic content determined on one sample of this deposit is 1.5 per cent.

One laboratory consolidation (oedometer) test was carried out on a specimen of the clayey silt to silty clay obtained from Borehole P3-6 and the test results are shown on Figure A12. The preconsolidation stress was estimated from the Void Ratio versus logarithmic Pressure plots using the Casagrande method as well as from



the Total Work versus Pressure plots. The unit weight of the sample from Borehole P3-6 is about  $17 \text{ kN/m}^3$ , and the measured specific gravity is 2.75. The relevant consolidation test results are summarized below.

Borehole/ Sample Number	Elevation (m)	$\sigma_{vo}'$ (kPa)	$\sigma_p'$ (kPa)	$\sigma_p' - \sigma_{vo}'$ (kPa)	OCR	$e_o$	$C_r$	$C_c$	$c_v^*$ ( $\text{cm}^2/\text{s}$ )
P3-6/5	236.2	37	47	10	1.4	1.46	0.04	0.20	$3.0 \times 10^{-3}$

Note: \*Approximate stress range between the effective overburden stress and the final stress due to a 7 m embankment widening and approximate 1.7 m embankment grade raise at the embankment centerline is  $66 \text{ kPa} \leq \sigma_v' \leq 137 \text{ kPa}$ .

where:  $\sigma_{vo}'$  effective overburden stress in kPa  
 $\sigma_p'$  preconsolidation stress in kPa  
OCR overconsolidation ratio  
 $e_o$  initial void ratio  
 $C_c$  compression index (based on void ratio)  
 $C_r$  recompression index (based on void ratio)  
 $c_v$  coefficient of consolidation in  $\text{cm}^2/\text{s}$  in the normally consolidated range

### Silt to Sand and Silt

A deposit of grey silt to sand and silt was encountered underlying the clayey silt to silty clay stratum in each of the boreholes. The top of the deposit ranges from about 5.3 m to 8.7 m below ground surface, corresponding to between Elevation 236.0 m and 232.9 m, and the thickness of the deposit ranges from 0.3 m to 2.0 m. The bottom of the deposit was defined by refusal to casing or split spoon penetration in Borehole P3-1 to P3-4.

The SPT 'N'-values recorded within the silt to sand and silt deposit range from 3 blows to 8 blows per 0.3 m, indicating a very loose to loose relative density.

The grain size distributions of six samples of the silt to sand and silt deposit are shown on Figure A13, in Appendix A.

Atterberg limits tests were attempted on two samples of silt to sandy silt in Borehole P3-1 and P3-3 and the samples were determined to be non-plastic.

The natural water contents measured on samples of this deposit range from 26 per cent to 32 per cent.

### Sand to Gravelly Sand

A deposit of grey sand to gravelly sand was encountered underlying the silt to sand and silt deposit in Boreholes P3-5 to P3-7. The top of this deposit varies from about 8.7 m to 10.7 m below ground surface, corresponding to Elevation 232.8 m and 230.9 m and the thickness of the deposit ranges from 1.0 m to 1.5 m. The bottom of this deposit was defined by refusal to further casing penetration.

The SPT 'N'-values recorded within this deposit range from 25 blows to 34 blows per 0.3 m of penetration, indicating a compact to dense relative density.

The grain size distribution of one selected sample of the sand portion of the deposit is shown on Figure A14, in Appendix A.

The natural water content measured on two samples of this deposit is 11 per cent and 21 per cent.





### **Refusal**

Refusal to further split-spoon or casing penetration was encountered in each of the boreholes at depths ranging from 6.3 m to 11.7 m below ground surface, corresponding to Elevation 235.0 m to 229.9 m. These refusal depths, while they do not confirm bedrock elevations, may be likely on or in proximity to the bedrock surface.

### **Groundwater Conditions**

The unstabilized water levels observed in the boreholes upon completion of drilling range from Elevation 241.3 m to 240.4 m, measured between 0.2 m and 1.1 m below the ground surface. Groundwater levels in the area are subject to seasonal fluctuations and variations due to precipitation events.

## **4.5 Westbound Truck Climbing Lane - STA 13+350 to 13+550**

A total of twenty (20) pavement investigation boreholes were completed to investigate the subsurface conditions for the westbound truck climbing lane from STA 13+350 to 13+550 in Bonfield Township. The Record of Boreholes sheets for the pavement boreholes are included in Appendix A. The height of the existing embankment at this location is up to about 2 m. The topography of this section of the existing Highway 17 alignment is generally flat and low lying with moderate tree cover.

The boreholes advanced through the existing roadway or shoulder (i.e. within about 8 m left of centreline), encountered embankment fill consisting of asphalt and/or granular material to depths of up to 6 m below ground pavement surface. It is likely that the embankment fill material was not fully penetrated at these borehole locations.

The boreholes advanced beyond the existing embankment (i.e. beyond about 8 m left of centreline), encountered fill material or topsoil/peat from ground surface to depths of between about 2.3 m and 6.6 m. At the majority of these boreholes, a cohesionless deposit consisting of silt and/or sand was encountered underlying the fill/peat deposit(s) but was not fully penetrated.

Below the topsoil/peat deposits at four boreholes, a cohesive deposit consisting of clayey silt or silty clay was encountered, which was not fully penetrated in three of the boreholes after exploring between 0.3 m and 0.5 m into the deposit. In the fourth borehole, located at STA 13+400 and 16 m left of centreline, the cohesive deposit is 2.6 m thick and is in turn underlain by a silt layer that was not fully penetrated after exploring for 0.3 m into the deposit.

## **4.6 Eastbound Passing Lane - STA 13+350 to 13+550**

A total of twenty (20) pavement investigation boreholes were completed to investigate the subsurface conditions for the eastbound passing lane from STA 13+350 to 13+550 in Bonfield Township. The Record of Borehole sheets for the pavement boreholes are included in Appendix A. The height of the existing embankment at this location is up to about 2 m. The topography of this section of the existing Highway 17 alignment is generally flat and low lying with moderate tree cover.



The boreholes advanced through the existing roadway or shoulder (i.e. within about 8 m right of centreline), encountered embankment fill consisting of asphalt and/or granular material to depths of up to 2 m deep below ground/pavement surface. It is likely that the embankment fill material was not fully penetrated at these borehole locations.

The boreholes advanced beyond the existing embankment (i.e. beyond about 8 m right of centreline), encountered fill material or topsoil/peat from ground surface, with one borehole encountering fill material underlain by a peat deposit (STA 13+350, 12 m right of centreline), to depths of between about 0.5 m and 7.5 m. At the majority of these boreholes, a cohesionless deposit consisting of silt and/or sand was encountered underlying the fill/peat deposit(s), but was not fully penetrated.

Below the topsoil/peat deposit(s) at three boreholes, a cohesive deposit consisting of clayey silt was encountered, which was not fully penetrated in one of the boreholes after exploring 0.5 m into the deposit. In the two other boreholes, located at STA 13+350 and 12 m right of centreline and STA 13+400 and 17 m right of centreline, the cohesive deposit is 2.2 m and 5.2 m thick, respectively, and is in turn underlain by a silt layer that was not fully penetrated after exploring for 0.3 m and 0.6 m into the deposit, respectively.

## **4.7 Westbound Truck Climbing Lane - STA 14+000 to 14+150**

The plan and profile and cross-section for the westbound truck climbing lane extension showing the borehole locations and interpreted stratigraphy from approximately STA 14+000 to 14+150 in Bonfield Township is shown on Drawing B1 in Appendix B. The height of the existing embankment along this extension is up to about 5 m. A total of six boreholes (P2-1 to P2-6) and 3 test pits (P2-TP1 to P2-TP3) were completed to investigate the subsurface conditions along the passing lane extension. In addition, two boreholes (Boreholes C2-2 and C2-3/3a) were completed to investigate the subsurface condition for the new culvert in this area. In general, the topography along the passing lane extension consists of the ground surface sloping down from east to west to a low-lying area at about STA 14+060, rising slightly, then sloping down towards a creek at about STA 14+000. The vegetation in the area consists of moderate to dense tree cover.

### ***Embankment Fill***

Borehole C2-2 was advanced through the existing westbound lane and Borehole P2-1 was advanced within the existing westbound shoulder. From ground surface, Borehole C2-2 encountered 220 mm of asphalt with the ground surface at Elevation 240.9 m. From ground surface in Borehole P2-1 at Elevation 240.7 m and below the asphalt in Borehole C2-2, a 0.9 m and 1.1 m deposit of sand and gravel to sand fill (road base/subbase) was encountered at the respective boreholes. Below the sand and gravel to sand fill in both boreholes, a 3.0 m and 3.2 m thick layer of blast rock fill was encountered.

Underlying the blast rock fill in Boreholes C2-2 and P2-1 and from ground surface in Boreholes P2-2, P2-5 and C2-3 and Test Pits P2-TP1 and P2-TP3, a layer of sand and gravel to sand fill was encountered. The top of the sand and gravel to sand fill layer ranges from Elevation 239.8 m to Elevation 236.1 m, and the thickness of the fill ranges from 0.2 m to 1.8 m.



The SPT 'N'-values measured within the fill range from 2 blows to 23 blows per 0.3 m of penetration, indicating a very loose to compact relative density.

The grain size distributions of four samples of the fill are presented on Figure B1 in Appendix B.

The natural water content of three samples of the fill is between 4 per cent and 26 per cent.

#### **Peat**

A layer of brown to black fibrous and/or amorphous peat was encountered below the fill in Boreholes P2-1 and C2-2 and from ground surface in Boreholes P2-3, P2-4 and P2-6 and Test Pit P2-TP2. The top of the peat deposit was encountered between Elevation 238.7 m to 235.0 m and the thickness of the deposit ranges from 0.2 m to 2.4 m.

The SPT 'N'-values measured within the peat range from 1 blow to 9 blows per 0.3 m of penetration, suggesting a very soft to very stiff consistency.

The natural water content of the two selected samples of the peat layer is 48 per cent and 305 per cent.

#### **Silt to Sand and Silt**

A 0.4 m thick layer of silt was encountered below the peat in Borehole C2-2 at a depth of 7.2 m below ground surface at Elevation 233.7 m and a layer of sand and silt about 0.7 m thick was encountered in Test Pit P2-TP1 at a depth of 1.7 m below ground surface, corresponding to Elevation 233.7 m and 238.1 m.

The grain size distribution for one sample of the sand and silt is shown on Figure B2 in Appendix B.

The natural water content measured on the sample of the sand and silt is 26 per cent.

#### **Sand to Sand and Gravel**

A deposit of brown sand to sand and gravel was encountered below the fill in Boreholes P2-2 and C2-3, below the peat in Test Pit P2-TP2 and below the silt in Borehole C2-2. The top of the sand to sand and gravel deposit was encountered at depths between 0.2 m and 7.6 m below ground surface, corresponding to between Elevation 238.5 m and 233.3 m, and the thicknesses of the deposit ranges between 0.1 m and 0.3 m.

One SPT 'N'-value recorded within the sand and gravel is 25 blows per 0.3 m of penetration, indicating a compact relative density.

Grain size distributions of three samples of the sand to sand and gravel deposit are shown on Figure B3 in Appendix B.

The natural water content measured on samples of the sand to sand and gravel deposit is between 9 per cent and 18 per cent.



### **Bedrock/Refusal**

Bedrock was encountered underlying the sand deposit in Borehole P2-1 at a depth of 5.9 m below ground surface, corresponding to Elevation 234.8 m, and 3.3 m of bedrock core was recovered. Bedrock was encountered at a depth of 1.5 m (Elevation 234.6 m) in Borehole C2-3a located about 2 m west of Borehole C2-3 after encountering split-spoon refusal at a depth of 1.8 m in Borehole C2-3 and 3.2 m of bedrock was recovered. Based on a review of the bedrock core samples, the bedrock at Borehole P2-1 consists of a very coarse grained, fresh, grey, garnetiferous gneiss and in Borehole C2-3a it consists of fine to medium grained, slightly weathered grey to black gneiss.

The Total Core Recovery (TCR) is 100 per cent for the core samples except two runs in Borehole C2-3a which were 81 per cent and 96 per cent. The Solid Core Recovery (SCR) ranges from about 55 per cent to 100 per cent. RQD values measured on the recovered bedrock core samples in Borehole P2-1 range between 95 per cent and 100 per cent, indicating the rock is of excellent quality according to Table 3.10 of CFEM (2006). In Borehole C2-3a, the RQD values are between 44 per cent and 100 per cent indicating the rock is of poor to excellent quality.

Bedrock was exposed at the bottom of Test Pits P2-TP1 to P2-TP3 at depths between 0.3 m and 2.4 m below existing ground surface, corresponding to between Elevation 239.3 m and 237.4 m.

Split-spoon or casing refusal was encountered in Boreholes P2-2 to P2-6, C2-2 and C2-3, at depths ranging from 0.2 m to 7.9 m below ground surface, corresponding to Elevation 239.5 m and Elevation 233.0 m. These depths to refusal, while they do not confirm bedrock, may be likely on or in proximity to the bedrock surface.

### **Groundwater Conditions**

The unstabilized water level observed in Boreholes P2-1 and C2-2 was measured at 3.7 m and 4.6 m below ground surface upon completion of drilling, and in Borehole P2-6 and C7-3 it was measured at a depth of 0.4 m below ground surface and at ground surface, respectively, corresponding to between Elevation 237.0 m and 236.1 m. Boreholes P2-2 to P2-5 were dry upon completion of drilling. Seepage was observed into Test Pit P2-TP1 at a depth of 2.1 m below ground surface and Test Pits P2-TP2 and P2-TP3 were dry upon completion of excavation. Groundwater levels in the area are subject to seasonal fluctuations and variations due to precipitation events.

## **4.8 Westbound Truck Climbing Lane - STA 14+650 to 14+700**

The plan and profile and a cross-section for the westbound truck climbing lane extension showing the borehole locations and interpreted stratigraphy from approximately STA 14+650 to 14+700 in Bonfield Township is shown on Drawing C1 in Appendix C. The height of the existing embankment along this section of lane extension is about 10 m. A total of five boreholes (P1-1 to P1-4 and P1-6) and two DCPTs (P1-DC1 and P1-DC2) were completed to investigate the subsurface conditions along the passing lane extension. In addition, three boreholes (Boreholes C1-1, C1-2 and C1-5) and one DCPT (C1-DC1) were completed to investigate the subsurface condition for the new culvert within the passing lane extension in this area. In general, the topography in this area consists of a swamp with tree cover and exposed bedrock beyond the swamp limits.



#### **Ice**

Boreholes P1-1 and P1-3 were advanced from the ice surface at Elevation 238.0 m and 237.9 m, respectively and the ice is 0.2 m thick.

#### **Embankment Fill**

Borehole C1-5 was advanced through the existing eastbound lane and Borehole P1-6 was advanced within the existing westbound shoulder. From roadway ground surface, Borehole C1-5 encountered a 260 mm thick layer of asphalt at Elevation 247.2 m. From ground surface in Borehole P1-6 (Elevation 247.0 m) and below the asphalt in Borehole C1-5, a 0.8 m thick layer of sand and gravel to sand fill (road base/subbase) was encountered, underlain by a 8.8 m and 7.7 m thick layer of blast rock fill in the respective boreholes.

From ground surface in Borehole C1-1 at Elevation 238.1 m and below the blast rock fill in Borehole P1-6 and Borehole C1-5 at Elevation 237.4 m and 238.4 m, respectively, a 0.9 m to 1.2 m thick layer of sand and gravel to sand fill was encountered.

The SPT 'N'-values measured within the fill range between 1 blow and 39 blows per 0.3 m of penetration, indicating a very loose to a dense relative density.

The grain size distributions of two samples of the sand fill are presented on Figure C1 in Appendix C.

The water content measured on samples of the fill range from 16 per cent to 34 per cent.

#### **Peat**

A layer of brown/black fibrous and/or amorphous peat was encountered below the ice or at ground surface in Boreholes P1-1 to P1-4, and C1-2 and below the fill in Boreholes P1-6, C1-1 and C1-5. The top of the peat deposit was encountered ranging from Elevation 238.4 m to 236.3 m, and the thickness of the deposit ranges from 0.1 m to 9.2 m.

SPT 'N'-values measured within the peat deposit range from 0 blows (weight of rods) to 6 blows per 0.3 m of penetration, suggesting a very soft to firm consistency.

The natural water content measured on samples of the peat range from 86 per cent to 781 per cent. The organic content of five samples of the peat ranges from about 8 per cent to 45 per cent.

#### **Silty Clay**

A 0.2 m thick layer of grey silty clay was encountered below the peat in Borehole P1-2 at Elevation 228.9 m.

An Atterberg limits test carried out on the sample of the silty clay yielded a liquid limit of about 46 per cent, a plastic limit of about 26 per cent and a plasticity index of about 20 per cent. The results of the Atterberg limits test is shown on the plasticity chart on Figure C2 in Appendix C and indicate that the deposit consists of silty clay of intermediate plasticity.



The natural water content measured on the sample of the silty clay is 87 per cent and the organic content is 3 per cent.

### ***Sand to Sand and Gravel***

A deposit of grey to brown sand to sand and gravel was encountered underlying the peat in Boreholes P1-1, P1-3, P1-4, P1-6, C1-1 and C1-2 and beneath the silty clay in Borehole P1-2. The top of the deposit ranges from about 3.0 m to about 10.7 m below ground surface, from Elevation 236.2 m to 228.7 m, and the thickness of the deposit ranges from 0.2 m to 1.9 m.

The SPT 'N'-values recorded within the sand to sand and gravel deposit range from 1 blow to 54 blows per 0.3 m of penetration, indicating a very loose to very dense relative density.

The grain size distributions of nine samples of the sand to sand and gravel deposit are shown on Figure C3 in Appendix C.

The natural water content measured on samples of this deposit range from 8 per cent to 39 per cent.

### ***Refusal***

Bedrock was encountered below the peat in Borehole C1-5 at a depth of 10.6 m (Elevation 236.6 m) and 3.3 m of bedrock core was recovered. Based on a review of the bedrock core samples, the bedrock consists of a fine to coarse grained, fresh, grey gneiss.

The TCR is 100 per cent for the core samples and the SCR is between about 90 per cent and 100 per cent. RQD values measured on the recovered bedrock core samples are between 96 per cent and 100 per cent indicating the rock is of excellent quality according to Table 3.10 of CFEM(2006).

Split-spoon and/or casing refusal was encountered in Boreholes P1-1 to P1-4, P1-6, C1-1 and C1-2 at depths ranging from 4.2 m to 12.7 m below ground surface, corresponding to Elevation 234.3 m to 228.5 m. Refusal to cone penetration was encountered in DCPTs P1-DC1, P1-DC2 and C1-DC1 at a depth between 3.1 m and 8.4 m below ground surface, corresponding to Elevation 235.2 m to 229.8 m. These depths to refusal, while they do not confirm bedrock elevations, may be likely on or in proximity to the bedrock surface.

### ***Groundwater Conditions***

Water levels observed in the boreholes upon completion of drilling range from Elevation 237.3 m to 238.9 m, measured at the ice surface in Boreholes P1-1 and P1-3, measured between 0.2 m and 1.1 m below the ground surface in Boreholes P1-2, P1-4, C1-1 and C1-2 and 8.1 m and 8.8 m below the ground surface in Boreholes P1-6 and C1-5. Groundwater levels in the area are subject to seasonal fluctuations and variations due to precipitation events.



## **5.0 CLOSURE**

The field personnel supervising the drilling program were Mr. Indulis Dumpis, Mr. Luigi Gianfrancesco, Mr. Gabriel Mathieu and Mr. Ed Savard. This report was prepared by Mr. Matthew Thibeault, EIT. The technical aspects were reviewed by Mr. André Bom, P.Eng., and Mr. Jorge M. A. Costa, P.Eng., Principal and Golder's Designated MTO Contact for this project, who also carried out a quality control review of the report.





## Report Signature Page

GOLDER ASSOCIATES LTD.

*Matthew Thibeault*

Matthew Thibeault, EIT  
Geotechnical EIT



André Bom, P.Eng.  
Geotechnical Engineer



Jorege M.A. Costa, P.Eng.  
Designated MTO Contact

MT/AB/JMAC/kp

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

n:\active\2010\1190 sudbury\1191\10-1191-0041 mmm hwy 17 rehab east of nb\reporting\final\02 - passing lanes\10-1191-0041 fnl rpt\02 13may9 passing lanes.docx



## REFERENCES

- Bjerrum, L., 1973. Problems of Soil Mechanics and Construction of Soft Clays and Structurally Unstable Soils. State of the art Report, Session 4. Proceedings, 8th International Conference on Soil Mechanics and Foundation Engineering, Moscow, Vol. 3, pp. 111-159.
- Canadian Geotechnical Society, 2006. Canadian Foundation Engineering Manual, Fourth Edition.
- Geology of Ontario, 1991. Ontario Geological Society, Special Volume 4, Part 2. Eds. P.C. Thurston, H.R. Williams, R.H. Sutcliffe and G.M. Stott. Ministry of Northern Development and Mines, Ontario.
- Kulhawy, F.H. and Mayne, P.W., 1990. Manual on Estimating Soil Properties for Foundation Design. EL 6800, Research Project 1493 6. Prepared for Electric Power Research Institute, Palo Alto, California.
- Mesri, G., 1975. Discussion on new design procedure for stability of soft clays. ASCE Journal of the Geotechnical Engineering Division, Vol. 101, GT4, pp. 409-412.
- Mesri, G. and Ajlouni, M., 2007. Engineering Properties of Fibrous Peat. Journal of Geotechnical and Geoenvironmental Engineering, Vol. 133, No. 7, pp. 850-866.
- Milligan, V. and Lo, K.Y., 1967. Shear Strength Properties of Two Stratified Clays. Journal of the Soil Mechanics and Foundations Division, Proceedings of the American Society of Civil Engineers. January, 1967.
- NAVFAC Design Manual DM 7.2. Soil Mechanics, Foundation and Earth Structures. U.S. Navy, 1982. Alexandria, Virginia.
- Northern Ontario Engineering Geology Terrain Study, Ontario Geological Society, Map 5044.
- ASTM International:
- |            |   |
|------------|---|
| ASTM D1586 | Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils |
| ASTM D1587 | Standard Practice for Thin-Walled Tube Sampling of Soils for Geotechnical Purposes          |
| ASTM D2573 | Standard Test Method for Field Vane Shear Test in Cohesive Soil                             |
- Commercial Software
- GeoStudio (Version 7.17) by Geo-Slope International Ltd.
  - Settle 3D (Version 2.013) by Rocscience Inc.
- Contract Design Estimating and Documentation (CDED):
- Special Provision 206S03 Rock Excavation, Grading; Rock Embankment
- Ministry of Transportation Ontario, Guideline for Rock Fill Settlement and Rock Fill Quantity Estimates, September 2010.
- Ministry of Transportation Ontario, Embankment Settlement Criteria for Design, Final Draft, March 2010.



---

## FOUNDATION REPORT - HIGHWAY 17 LANE EXTENSIONS GWP 174-98-00

---

Northern Region Engineering Directive: Embankment Design Guidelines NRE 98-200, October 1998.

Ontario Occupational Health and Safety Act:

Ontario Regulation 213/91 Construction Projects as amended by O. Reg. 443/09

Ontario Provincial Standard Drawings:

OPSD 202.010	Slope Flattening Using Surplus Excavation Material on Earth or Rock Embankment
OPSD 203.030	Embankments Over Swamp, Existing Slopes Maintained
OPSD 208.010	Benching of Earth Slopes

Ontario Provincial Standard Specification:

OPSS 209	Construction Specification for Embankments Over Swamps and Compressible Soils
OPSS 501	Construction Specification for Compacting
OPSS 539	Construction Specification for Temporary Protection Systems

Ontario Water Resources Act:

Ontario Regulation 903, Wells (as amended)



## FOUNDATION REPORT - HIGHWAY 17 LANE EXTENSIONS

### GWP 174-98-00

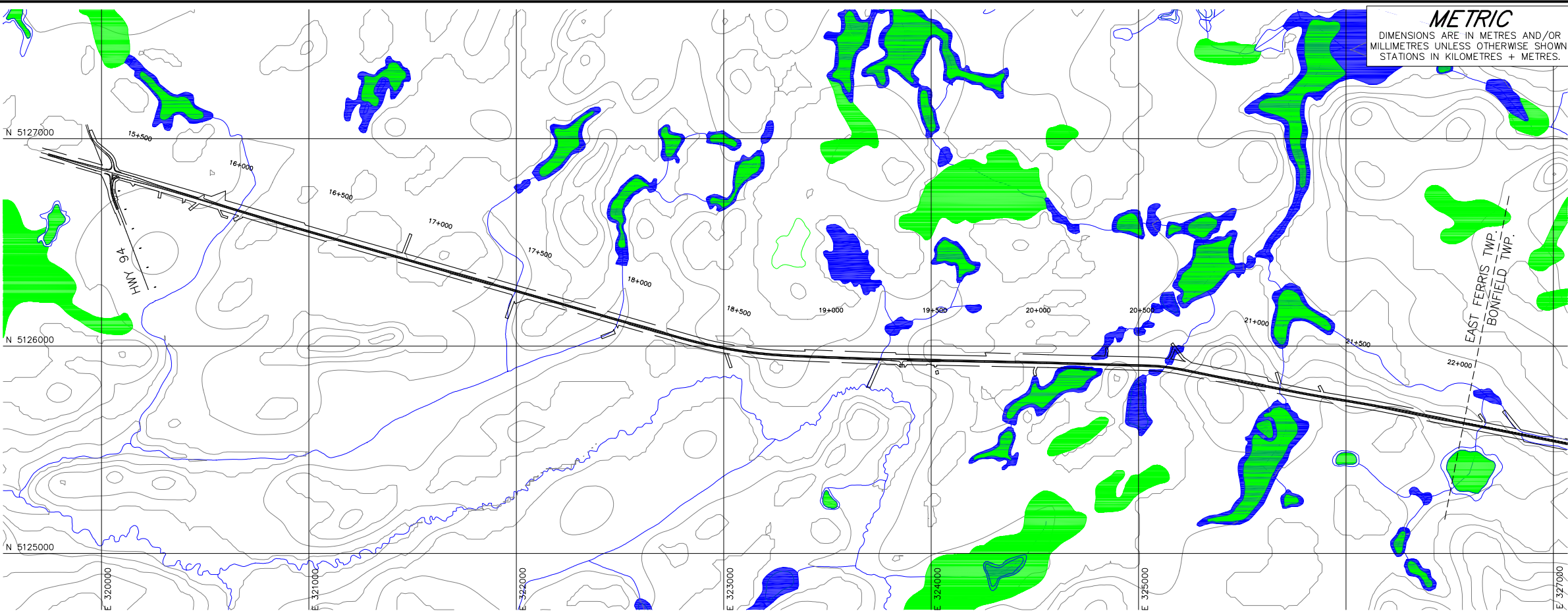
**Table 1: Summary of Lane Extensions Subsurface Investigation**

Highway 17	Approximate Height of Existing Embankment <sup>1</sup>	Proposed Grade Raise	Boreholes/DCPTs	Reference Appendix
Westbound Truck Climbing Lane STA 12+900 to 13+100	1 m from STA 12+900 to 13+050 (Cut)	N/A	N/A	N/A
Westbound Truck Climbing Lane STA 13+100 to 13+350	2 m at STA 13+100 7.5 m at STA 13+150 2 m at STA 13+350	0 m at 13+100 1.7 m at STA 13+220 1.7 m at STA 13+320 1.4 m at STA 13+350	12 Boreholes (P4-1 to P4-10, P4-3a and P4-8a)	Appendix A
Eastbound Passing Lane STA 13+150 to 13+350	7 m at STA 13+150 2 m at STA 13+350	0 m at 13+100 1.7 m at STA 13+220 1.7 m at STA 13+320 1.4 at STA 13+350	7 Boreholes (P3-1 to P3-7)	
Westbound Truck Climbing Lane STA 13+350 to 13+550	2 m	1.4 m at STA 13+350 0.2 m at STA 13+550	20 Pavement Investigation Boreholes	
Eastbound Passing Lane STA 13+350 to 13+550	2 m	1.4 m at STA 13+350 0.2 m at STA 13+550	20 Pavement Investigation Boreholes	
Westbound Truck Climbing Lane STA 14+000 to 14+150	5 m	N/A	6 Boreholes (P2-1 to P2-6) 3 Test Pits (P2-TP1 to P2-TP3) 2 Culvert Boreholes (C2-2 and C2-3/3a)	Appendix B
Westbound Truck Climbing Lane STA 14+650 to 14+700	10 m	N/A	5 Boreholes (P1-1 to P1-4 and P1-6) 2 DCPTs (P1-DC1 and P1-DC2) 3 Culvert Boreholes (C1-1, C1-2 and C1-5) 1 Culvert DCPT (C1-DC1)	Appendix C

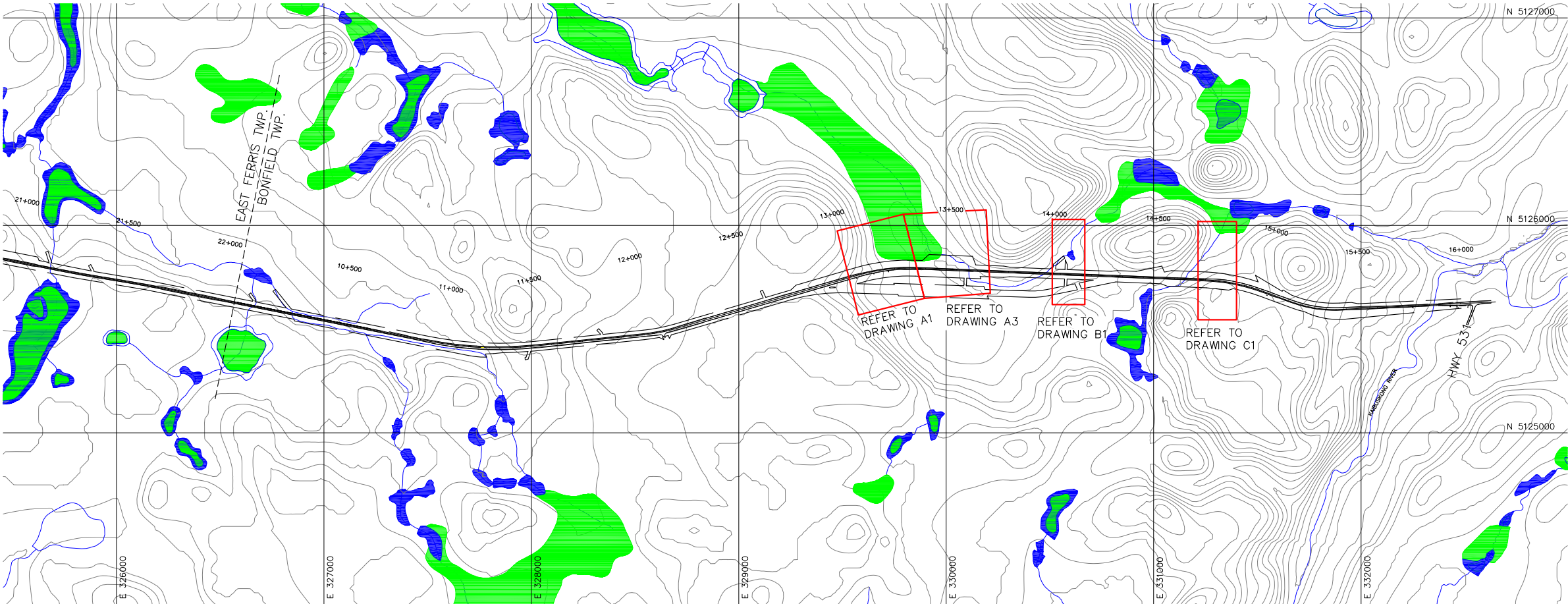
Notes: 1. Embankment height is relative to existing ground surface level near toe of embankment

Prepared By: MT  
Reviewed By: AB





PLAN



**METRIC**  
DIMENSIONS ARE IN METRES AND/OR  
MILLIMETRES UNLESS OTHERWISE SHOWN.  
STATIONS IN KILOMETRES + METRES.

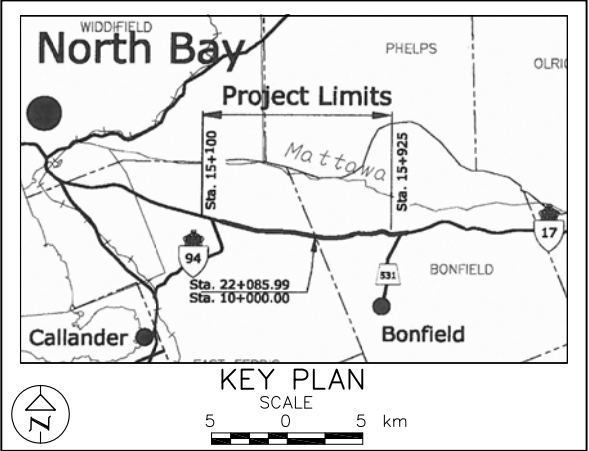
CONT No.  
GWP No.174-98-00

SHEET

HIGHWAY 17  
TRUCK CLIMBING / PASSING LANES  
LOCATION INDEX PLAN

**Golder Associates**

**Golder Associates Ltd.**  
SUDBURY, ONTARIO, CANADA



**LEGEND**

- Approximate Swamp Limits
- Pond / Open Water
- Contours
- TRUCK CLIMBING / PASSING LANES LOCATION

**REFERENCE**  
Base plans provided in digital format by MMM, drawing file nos.  
BASE\_ALL.dwg and Alignment.dwg received NOV 10, 2011. Keyplan received  
DEC 07, 2011.

NO.	DATE	BY	REVISION
Geocres No. 31L-160			
HWY. 17		PROJECT NO. 10-1191-0041	DIST.
SUBM'D.		CHKD. AB	DATE: APR 2013
DRAWN: JUL		CHKD.	APPD. JMAC
			DWG. 1



## 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
SS	Split-spoon
DS	Denison type sample
FS	Foil sample
RC	Rock core
SC	Soil core
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.).

<b>PH:</b>	Sampler advanced by hydraulic pressure
<b>PM:</b>	Sampler advanced by manual pressure
<b>WH:</b>	Sampler advanced by static weight of hammer
<b>WR:</b>	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) 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
$w_p$	plastic limit
$w_l$	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>
$D_R$	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

Percent 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 (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

### 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

#### (a) Index Properties

$\rho(\gamma)$	bulk density (bulk unit weight)*
$\rho_d(\gamma_d)$	dry density (dry unit weight)
$\rho_w(\gamma_w)$	density (unit weight) of water
$\rho_s(\gamma_s)$	density (unit weight) of solid particles
$\gamma'$	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

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

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





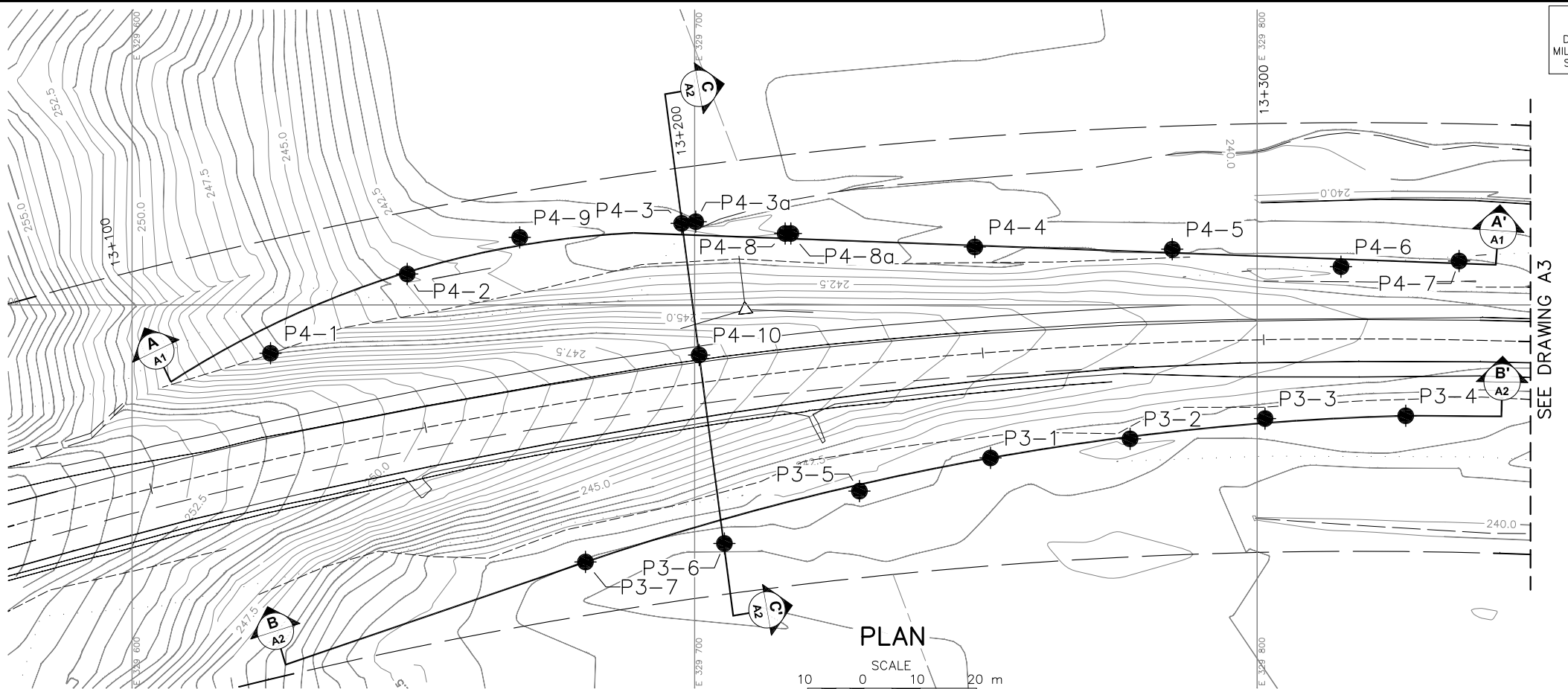
# **APPENDIX A**

## **Foundation Investigation:**

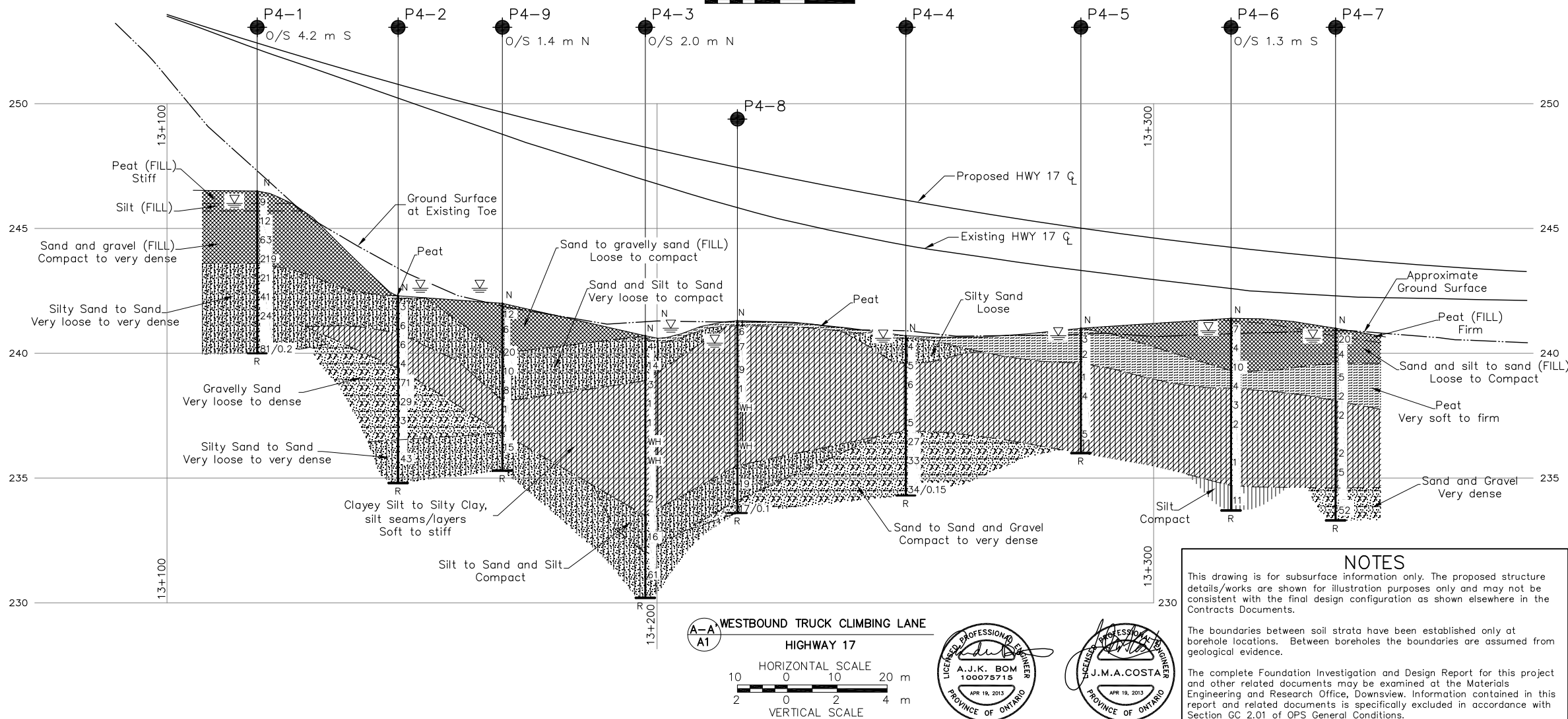
**Westbound Truck Climbing Lane - STA 13+100 to 13+350 and  
Eastbound Passing Lane - STA 13+150 to 13+350**

## **Pavement Investigation:**

**Westbound Truck Climbing Lane - STA 13+350 to 13+550 and  
Eastbound Passing Lane - STA 13+350 to 13+550**



PLAN

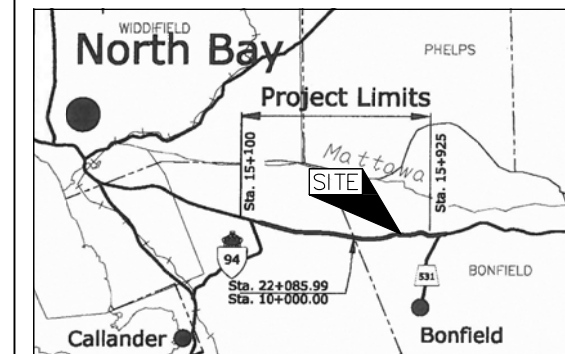
SCALE  
10 0 10 20 m

WESTBOUND TRUCK CLIMBING LANE

HIGHWAY 17

HORIZONTAL SCALE  
10 0 10 20 m  
VERTICAL SCALE  
2 0 2 4 m**METRIC**  
DIMENSIONS ARE IN METRES AND/OR  
MILLIMETRES UNLESS OTHERWISE SHOWN.  
STATIONS IN KILOMETRES + METRES.CONT No.  
GWP No.174-98-00

SHEET

HIGHWAY 17  
STA 13+100 TO 13+350 WESTBOUND TRUCK CLIMBING LANE  
AND 13+150 TO 13+350 EASTBOUND PASSING LANE  
BOREHOLE LOCATIONS AND  
SOIL STRATA**Golder Associates Ltd.**  
SUDBURY, ONTARIO, CANADA

KEY PLAN

SCALE  
5 0 5 km

LEGEND

- Borehole - Current Investigation
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated  
(Std. Pen. Test, 475 j/blow)
- ≡ WL upon completion of drilling
- R Refusal

BOREHOLE CO-ORDINATES

No.	ELEVATION	NORTHING	EASTING
P3-1	241.2	5125772.8	329752.6
P3-2	241.3	5125776.2	329777.4
P3-3	241.3	5125779.8	329801.4
P3-4	241.0	5125780.3	329826.4
P3-5	241.6	5125766.9	329729.3
P3-6	241.0	5125757.6	329705.3
P3-7	241.5	5125754.3	329680.6
P4-1	246.5	5125791.4	329624.6
P4-2	242.3	5125805.5	329648.9
P4-3	240.7	5125814.5	329697.7
P4-3a	240.6	5125814.8	329700.2
P4-4	240.7	5125810.3	329749.8
P4-5	241.0	5125809.9	329784.9
P4-6	241.4	5125806.8	329814.9
P4-7	241.0	5125807.8	329835.9
P4-8	241.3	5125812.7	329716.1
P4-8a	241.3	5125812.7	329717.1
P4-9	242.0	5125812.0	329668.9
P4-10	246.7	5125791.1	329700.8

REFERENCE

Base plans provided in digital format by MMM, drawing file nos.  
BASE\_ALL.dwg and Alignment.dwg received NOV 10, 2011. Keyplan received  
DEC 7, 2011.

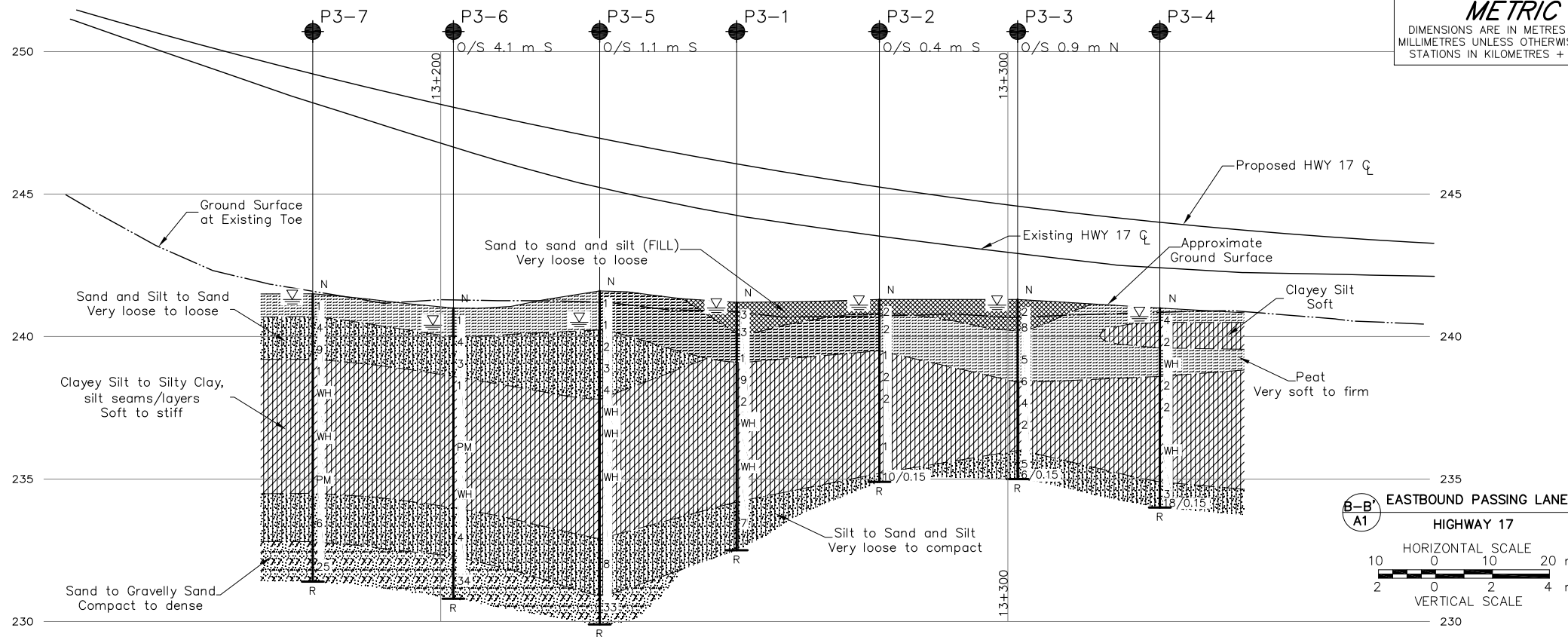
NOTES

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.

The complete Foundation Investigation and Design Report for this project and other related documents may be examined at the Materials Engineering and Research Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with Section GC 2.01 of OPS General Conditions.

NO.	DATE	BY	REVISION
1			
Geocres No. 31L-160			
HWY. 17		PROJECT NO. 10-1191-0041	
SUBM'D. MT		CHKD. AB	DATE: APR 2013
DRAWN: JUL		CHKD.	APPD. JMAC
		DIST.	
		SITE:	
		DWG. A1	



CONT No.  
GWP No.174-98-00

HIGHWAY 17  
13+150 TO 13+350 EASTBOUND PASSING LANE  
SOIL STRATA



Golder Associates Ltd.  
SUDBURY, ONTARIO, CANADA

#### LEGEND

- Borehole - Current Investigation
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- REC Recovery (100%)
- WL upon completion of drilling
- R Refusal

#### BOREHOLE CO-ORDINATES

No.	ELEVATION	NORTHING	EASTING
P3-1	241.2	5125772.8	329752.6
P3-2	241.3	5125776.2	329777.4
P3-3	241.3	5125779.8	329801.4
P3-4	241.0	5125780.3	329826.4
P3-5	241.6	5125766.9	329729.3
P3-6	241.0	5125757.6	329705.3
P3-7	241.5	5125754.3	329680.6
P4-3	240.7	5125814.5	329697.7
P4-10	246.7	5125791.1	329700.8

#### REFERENCE

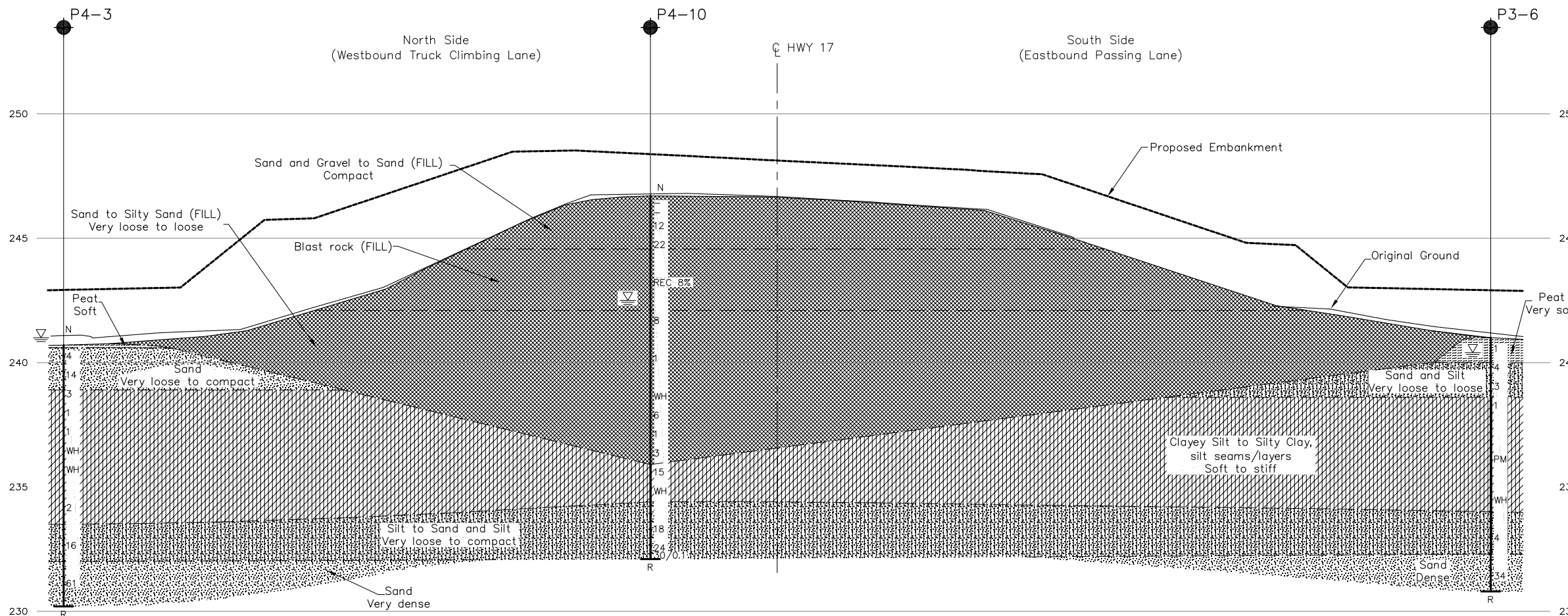
Base plans provided in digital format by MMM, drawing file nos. BASE\_ALL.dwg and Alignment.dwg received NOV 10, 2011. Keyplan received DEC 7, 2011.

#### NOTES

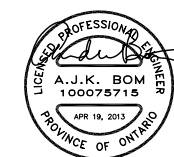
This drawing is for subsurface information only. The proposed structure details/works are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contracts Documents.

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

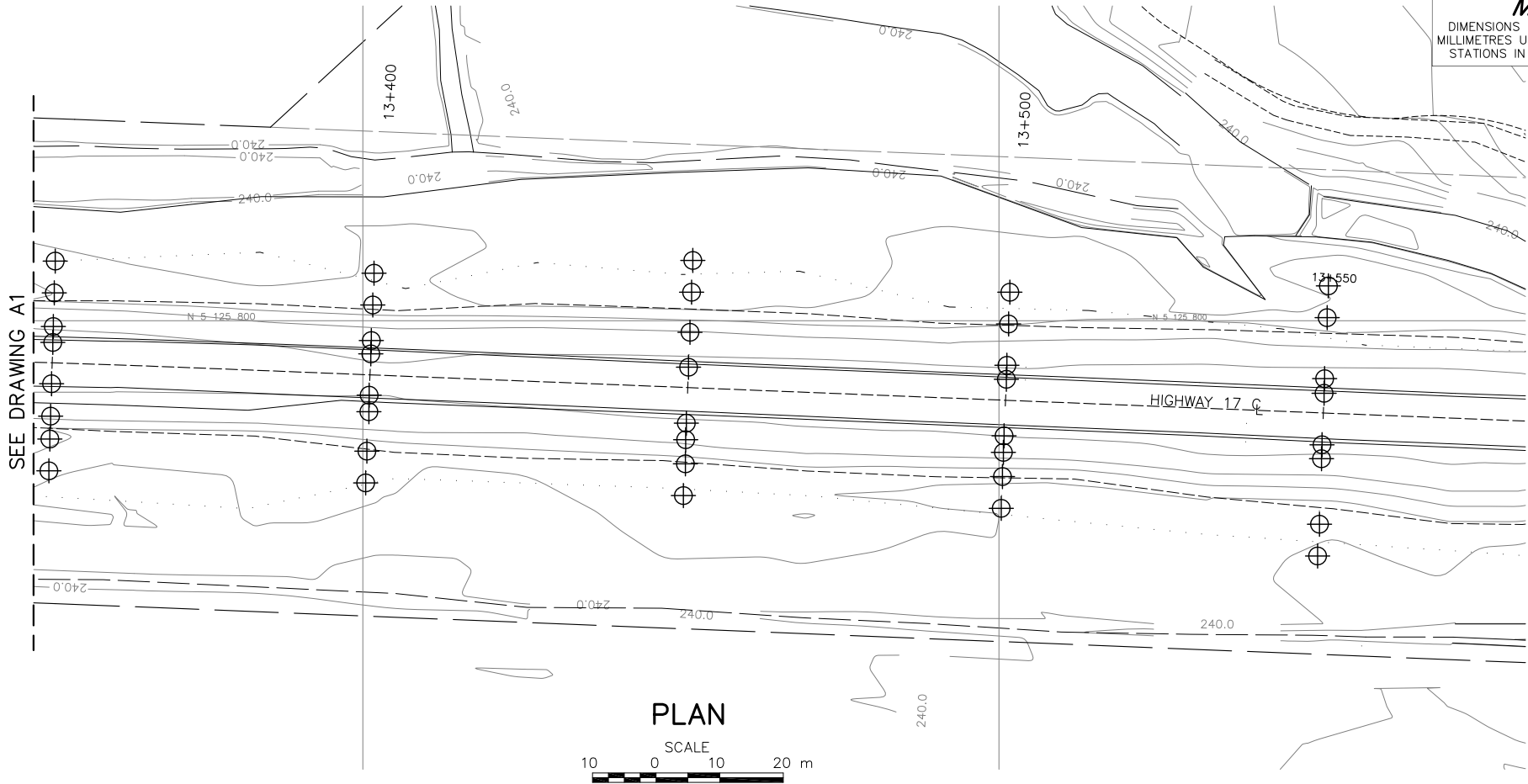
The complete Foundation Investigation and Design Report for this project and other related documents may be examined at the Materials Engineering and Research Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with Section GC 2.01 of OPS General Conditions.



C-C'  
A1  
HIGHWAY 17  
HORIZONTAL SCALE  
2 0 2 4 m  
VERTICAL SCALE  
2 0 2 4 m



NO.	DATE	BY	REVISION
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
21			
22			
23			
24			
25			
26			
27			
28			
29			
30			
31			
32			
33			
34			
35			
36			
37			
38			
39			
40			
41			
42			
43			
44			
45			
46			
47			
48			
49			
50			
51			
52			
53			
54			
55			
56			
57			
58			
59			
60			
61			
62			
63			
64			
65			
66			
67			
68			
69			
70			
71			
72			
73			
74			
75			
76			
77			
78			
79			
80			
81			
82			
83			
84			
85			
86			
87			
88			
89			
90			
91			
92			
93			
94			
95			
96			
97			
98			
99			
100			



**METRIC**  
DIMENSIONS ARE IN METRES AND/OR  
MILLIMETRES UNLESS OTHERWISE SHOWN.  
STATIONS IN KILOMETRES + METRES.

CONT No.  
GWP No.174-98-00

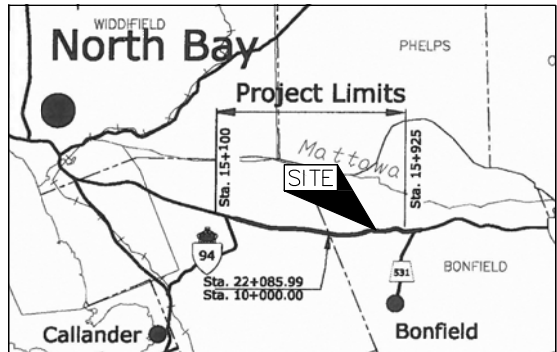


HIGHWAY 17  
STA 13+350 TO 13+550 WESTBOUND TRUCK CLIMBING LANE  
AND EASTBOUND PASSING LANE  
BOREHOLE LOCATIONS

SHEET



**Golder Associates Ltd.**  
SUDBURY, ONTARIO, CANADA



LEGEND

⊕ Pavement Investigation Borehole

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.

The complete Foundation Investigation and Design Report for this project and other related documents may be examined at the Materials Engineering and Research Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with Section GC 2.01 of OPS General Conditions.

REFERENCE

Base plans provided in digital format by MMM, drawing file nos. BASE\_ALL.dwg and Alignment.dwg received NOV 10, 2011. Keyplan received DEC 7, 2011.



NO.	DATE	BY	REVISION
Geocres No. 31L-160			
HWY. 17	PROJECT NO. 10-1191-0041		DIST.
SUBM'D. MT	CHKD. AB	DATE: APR 2013	SITE:
DRAWN: JUL	CHKD.	APPD. JMAC	DWG. A3

PROJECT 10-1191-0041			RECORD OF BOREHOLE No P4-1			1 OF 1 METRIC											
W.P. 174-98-00			LOCATION N 5125791.4; E 329624.6			ORIGINATED BY LG											
DIST _____ HWY 17			BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring			COMPILED BY MT											
DATUM Geodetic			DATE June 1, 2011			CHECKED BY AB											
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					WATER CONTENT (%)			γ kN/m³	GR SA SI CL
							20 40 60 80 100	○ UNCONFINED + FIELD VANE	● QUICK TRIAXIAL × REMOULDED	W <sub>p</sub> W W <sub>L</sub>	20 40 60						
246.5	GROUND SURFACE																
0.0	Peat some gravel (FILL) Stiff Black Moist		1	SS	9	▽	246										
246.0																	
245.7	Silt, some gravel, trace to some sand, trace organics (FILL) Grey Moist		2	SS	12												
0.8																	
	Sand and gravel, trace to some silt, cobbles at 2.6 m depth (FILL) Compact to very dense Brown Wet		3	SS	63		245										53 40 (7)
			4	SS	219		244										
243.6																	
2.9	Silty SAND, trace to some gravel, trace clay Compact to very dense Brown to grey Wet		5	SS	21		243										
			6	SS	41												7 62 29 2
			7	SS	24		242										
							241										
240.0			8	SS	81/0.2		240										
6.5	END OF BOREHOLE SPOON REFUSAL																
	Note:  1. Water level at a depth of 0.5 m below ground surface (Elev. 246.0 m) upon completion of drilling.																

SUD-MTO 001 1011910041.GPJ GAL-MISS.GDT 12/03/13 DATA INPUT:

PROJECT 10-1191-0041			RECORD OF BOREHOLE No P4-2			1 OF 1 METRIC														
W.P. 174-98-00			LOCATION N 5125805.5; E 329648.9			ORIGINATED BY LG														
DIST _____ HWY 17			BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring			COMPILED BY MT														
DATUM Geodetic			DATE June 1 and 2, 2011			CHECKED BY AB														
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 IN CONDITIONS	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
242.3	GROUND SURFACE							20	40	60	80	100	20	40	60					
0.0	PEAT (Fibrous) Brown Wet		1	SS	3		242													
	SAND, trace to some silt, trace gravel, trace organics Very loose to loose Brown to black Wet		2	SS	6		241													
240.8	SILTY CLAY, silt seams/layers Soft to firm Brown Wet		3	SS	6		240													
			4	SS	4		239													
239.4	Gravelly SAND, trace silt Very loose to dense Brown Wet		5	SS	71		238													
			6	SS	29		237													
			7	SS	3		236													
236.7	Silty SAND Dense Brown Wet		8	SS	43		235													
234.8	END OF BOREHOLE CASING REFUSAL																			
7.5	Note:  1. Water level in casing at 0.3 m above ground surface (Elev. 242.6 m) on June 3, 2011.																			



PROJECT 10-1191-0041			RECORD OF BOREHOLE No P4-3			1 OF 1 METRIC											
W.P. 174-98-00			LOCATION N 5125814.5; E 329697.7			ORIGINATED BY LG											
DIST _____ HWY 17			BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring			COMPILED BY MT											
DATUM Geodetic			DATE June 3, 2011			CHECKED BY AB											
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					WATER CONTENT (%)			γ kN/m³	GR SA SI CL
							20 40 60 80 100	20 40 60 80 100	W <sub>p</sub> W W <sub>L</sub>	20 40 60							
240.7	GROUND SURFACE																
0.9	PEAT (Fibrous) Black Wet		1	SS	4		240										
	SAND, some silt, trace organics Very loose to compact Brown to grey Wet		2	SS	14												0 82 (18)
238.9			3	SS	3		239										
1.8	CLAYEY SILT, silt seams/layers Firm Grey Wet  Refer to borehole P4-3a for field vane shear strength		4	SS	1		238										
			5	SS	1		237										
			6	SS	WH		236										
			7	SS	WH		235										
			8	SS	2		234										
233.5			9	SS	16		233										
7.2	SILT, trace to some sand, trace to some clay Compact Grey Wet						232										
232.0			10	SS	61		231										
8.7	SAND, trace to some gravel, trace to some silt Very dense Brown Wet																
230.2	END OF BOREHOLE CASING REFUSAL																
10.5	Note:  1. Water level in casing at 0.3 m above ground surface (Elev. 241.0 m) on June 6, 2011.  2. Moved 1 m east of borehole to obtain Shelby tube sample from 4.3 m to 4.9 m depth.																

SUD-MTO 001 1011910041.GPJ GAL-MISS.GDT 12/03/13 DATA INPUT:





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

SUD-MTO 001 1011910041.GPJ GAL-MISS.GDT 12/03/13 DATA INPUT:

PROJECT 10-1191-0041			RECORD OF BOREHOLE No P4-4			1 OF 1 METRIC											
W.P. 174-98-00			LOCATION N 5125810.3; E 329749.8			ORIGINATED BY LG											
DIST _____ HWY 17			BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring			COMPILED BY MT											
DATUM Geodetic			DATE June 7, 2011			CHECKED BY AB											
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					WATER CONTENT (%)			γ kN/m³	GR SA SI CL
							20 40 60 80 100	○ UNCONFINED + FIELD VANE	● QUICK TRIAXIAL × REMOULDED	Wp	W	WL	20 40 60				
240.7	GROUND SURFACE		1a														
0.0	PEAT (Amorphous) Black Wet		1b	SS	4												
239.6	Silty SAND, trace organics Loose Grey Wet		2	SS	5												
1.1	SILTY CLAY, silt seams/layers Firm Grey Wet		3	SS	6												
			4	SS	5												
236.9	SAND to SAND and GRAVEL, some silt Compact to dense Brown Wet		5	SS	27												
3.8			6	SS	33												
234.3	END OF BOREHOLE SPOON REFUSAL		7	SS	34/0.15												
6.4	Note: 1. Water level at a depth of 0.1 m below ground surface (Elev. 240.6 m) upon completion of drilling.																







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

PROJECT 10-1191-0041			RECORD OF BOREHOLE No P4-6			1 OF 1 METRIC										
W.P. 174-98-00			LOCATION N 5125806.8; E 329814.9			ORIGINATED BY LG										
DIST _____ HWY 17			BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring			COMPILED BY MT										
DATUM Geodetic			DATE June 8, 2011			CHECKED BY AB										
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								
241.4	GROUND SURFACE															
0.9	Peat (FILL) Firm Black Moist		1	SS	7	▽	241									
	Sand and silt to silty sand, trace gravel (FILL) Loose to compact Brown Wet		2	SS	4		240									8 61 28 3
239.3			3	SS	10											
2.1	PEAT (Fibrous) Soft Brown Wet		4	SS	4		239									
238.6																
2.8	SILTY CLAY, silt seams/layers Firm Grey Wet		5	SS	3		238									
			6	SS	2		237									
			7	SS	1		236									
234.7							235									
6.7	SILT, some sand, some gravel, trace to some clay Compact Grey Wet		8	SS	11		234									13 18 62 7
233.7																
7.7	END OF BOREHOLE CASING REFUSAL															
	Note: 1. Water level at a depth of 0.5 m below ground surface (Elev. 240.9 m) upon completion of drilling.															

SUD-MTO 001 1011910041.GPJ GAL-MISS.GDT 12/03/13 DATA INPUT:

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

PROJECT <u>10-1191-0041</u>		<b>RECORD OF BOREHOLE No P4-7</b>				1 OF 1 <b>METRIC</b>												
W.P. <u>174-98-00</u>		LOCATION <u>N 5125807.8; E 329835.9</u>				ORIGINATED BY <u>LG</u>												
DIST <u>          </u> HWY <u>17</u>		BOREHOLE TYPE <u>Portable Equipment, NW Casing, Wash Boring</u>				COMPILED BY <u>MT</u>												
DATUM <u>Geodetic</u>		DATE <u>June 9, 2011</u>				CHECKED BY <u>AB</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 $\gamma$ 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 (%)
241.0	GROUND SURFACE							20	40	60	80	100						
0.0	Peat (FILL)		1a	SS	20		240											
240.7	Black Moist		1b															
0.3	Silty sand, trace to some gravel (FILL)	2	SS	4														
	Loose to compact																	
	Brown																	
	Wet																	
239.6	PEAT (Fibrous)	3	SS	5														
1.4	Soft to firm																	
	Brown	4	SS	2														
	Wet																	
238.1	CLAYEY SILT to SILTY CLAY, silt seams/layers		5	SS	2													
2.9	Soft to firm																	
	Grey																	
	Wet																	
			6	SS	2													
			7	SS	5													
234.6	SAND and GRAVEL																	
6.4	Very dense																	
	Grey																	
	Wet		8	SS	52													
233.3	END OF BOREHOLE CASING REFUSAL																	
7.7	Note: 1. Water level at a depth of 0.4 m below ground surface (Elev. 240.6 m) upon completion of drilling.																	

PROJECT 10-1191-0041		<b>RECORD OF BOREHOLE No P4-8</b>				1 OF 1 <b>METRIC</b>								
W.P. 174-98-00		LOCATION N 5125812.7; E 329716.1				ORIGINATED BY LG								
DIST _____ HWY 17		BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring				COMPILED BY MT								
DATUM Geodetic		DATE June 13, 2011				CHECKED BY AB								
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						
241.3	GROUND SURFACE													
0.0	PEAT (Fibrous) Brown Moist		1a	SS	6									
0.2	CLAYEY SILT to SILTY CLAY, silt seams/layers Soft to firm Brown to grey Wet		1b	SS	7									
			2	SS	7									
			3	SS	9									
			4	SS	1									
			5	SS	WH									
			6	SS	WH									
235.5	SAND and SILT, trace gravel, trace clay Compact Grey Wet		7	SS	19									4 47 45 4
234.1	SAND and GRAVEL Grey Wet		8	SS	17/0.1									
233.6	END OF BOREHOLE SPOON REFUSAL													
7.7	Note:  1. Water level at a depth of 0.9 m below ground surface (Elev. 240.4 m) upon completion of drilling.  2. Moved 1 m east of borehole to obtain Shelby tube sample from 4.3 m to 4.9 m depth.													

PROJECT <u>10-1191-0041</u>		<b>RECORD OF BOREHOLE No P4-8a</b>				1 OF 1 <b>METRIC</b>										
W.P. <u>174-98-00</u>		LOCATION <u>N 5125812.7; E 329717.1</u>				ORIGINATED BY <u>LG</u>										
DIST <u>          </u> HWY <u>17</u>		BOREHOLE TYPE <u>Portable Equipment, NW Casing, Wash Boring</u>				COMPILED BY <u>MT</u>										
DATUM <u>Geodetic</u>		DATE <u>June 13, 2011</u>				CHECKED BY <u>AB</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								
241.3	GROUND SURFACE															
0.0	Refer to Borehole P4-8 for soil stratigraphy.															
						241										
						240										
						239										
						238										
						237										
236.4	END OF BOREHOLE		1	TO	PM										16.3	
4.9	Note:  1. Borehole P4-8a located 1 m east of Borehole P4-8.															

SUD-MTO 001 1011910041.GPJ GAL-MISS.GDT 12/03/13 DATA INPUT:



PROJECT		10-1191-0041				<b>RECORD OF BOREHOLE No P4-9</b>				1 OF 1 <b>METRIC</b>							
W.P.		174-98-00		LOCATION		N 5125812.0; E 329668.9				ORIGINATED BY		LG					
DIST		HWY 17		BOREHOLE TYPE		Portable Equipment, NW Casing, Wash Boring				COMPILED BY		MT					
DATUM		Geodetic		DATE		June 13, 2011				CHECKED BY		AB					
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									
242.0	GROUND SURFACE																
0.0	Sand to gravelly sand (FILL) Loose to compact Brown Wet		1	SS	12												
			2	SS	6												
240.0			3	SS	20												
2.0	SAND and SILT, some clay Loose to compact Brown to black Wet		4	SS	10												
			5	SS	8												
238.1			6	SS	1												
3.9	SILTY CLAY, silt seams/layers Soft Grey Wet		7	SS	1												
236.8			8	SS	15												
5.2	SAND and SILT, some clay Compact Grey Wet																
235.3																	
6.7	END OF BOREHOLE CASING REFUSAL																
	Note: 1. Water level at 0.6 m above ground surface (Elev. 242.6 m) upon completion of drilling.																

1 OF 2 **METRIC**

CHECKED BY AB


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

SUD-MTO 001 1011910041.GPJ GAL-MISS.GDT 12/03/13 DATA INPUT:



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

PROJECT 10-1191-0041			RECORD OF BOREHOLE No P3-1			1 OF 1 METRIC								
W.P. 174-98-00			LOCATION N 5125772.8; E 329752.6			ORIGINATED BY LG								
DIST _____ HWY 17			BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring			COMPILED BY MT								
DATUM Geodetic			DATE June 16, 2011			CHECKED BY AB								
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						
241.2	GROUND SURFACE							20 40 60 80 100	20 40 60					
0.0	Sand to sand and silt, trace to some gravel (FILL) Very loose Brown to grey Moist		1	SS	3		241							
240.1			2a	SS	3									
1.1	PEAT (Fibrous / Amorphous) Very soft Brown Wet		2b				240							
239.1			3	SS	1									
2.1	SILTY CLAY Soft to stiff Grey Wet		4	SS	9		239							
			5	SS	2		238							
			6	SS	WH		237							
			7	SS	WH		236							
234.2	Sandy SILT, trace to some clay, trace gravel Loose Grey Wet		8	SS	7		234							
7.0							233							
232.5	END OF BOREHOLE CASING REFUSAL													
8.7	Note:  1. Water level at a depth of 0.2 m below ground surface (Elev. 241.0 m) upon completion of drilling.													

PROJECT 10-1191-0041			RECORD OF BOREHOLE No P3-2			1 OF 1 METRIC								
W.P. 174-98-00			LOCATION N 5125776.2; E 329777.4			ORIGINATED BY LG								
DIST _____ HWY 17			BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring			COMPILED BY MT								
DATUM Geodetic			DATE June 16, 2011			CHECKED BY AB								
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						
241.3	GROUND SURFACE							20 40 60 80 100	20 40 60					
0.0	Sand, trace gravel, trace organics (FILL)		1	SS	2	▽	241							
240.8	Very loose Brown Wet		2	SS	2		240							
0.5	PEAT (Fibrous) Very soft Brown to black Wet				240									
239.5	CLAYEY SILT to SILTY CLAY Soft to firm Grey Wet	3	SS	1	239									
1.8		4	SS	2	239									
		5	SS	2	238									
					237									
					237									
					236									
					235									
235.2	Sandy SILT Compact Grey Wet		6	SS	1		236							
234.9	END OF BOREHOLE SPOON REFUSAL		7	SS	10/0.15		235							
6.4														
Note: 1. Water level at a depth of 0.2 m below ground surface (Elev. 241.1 m) upon completion of drilling.														

PROJECT 10-1191-0041				<b>RECORD OF BOREHOLE No P3-3</b>				1 OF 1 <b>METRIC</b>									
W.P. 174-98-00				LOCATION N 5125779.8; E 329801.4				ORIGINATED BY GM									
DIST _____ HWY 17				BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring				COMPILED BY MT									
DATUM Geodetic				DATE June 16 and 17, 2011				CHECKED BY AB									
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									
241.3	GROUND SURFACE							20	40	60	80	100					
0.0	Sand to sand and silt, trace organics (FILL) Very loose to loose Grey Wet		1	SS	2	▽	241										
			2	SS	8		240										
240.2	PEAT (Fibrous) Firm Black Wet						239										
			3	SS	5												
			4	SS	6												
238.4	SILTY CLAY Soft Grey Wet						238										
2.9			5	SS	4												
			6	SS	2		237										
236.0	SILT, trace to some sand, trace to some clay Loose Grey Wet						236										
5.3			7	SS	5												
			8	SS	6/0.15		235										
235.0	END OF BOREHOLE SPOON REFUSAL																
6.3	Note:  1. Water level at a depth of 0.2 m below ground surface (Elev. 241.1 m) upon completion of drilling.  2. Casing refusal at 1.1 m depth, relocated 1 m north west to continue drilling/sampling below 1.5 m depth.																

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



PROJECT		10-1191-0041		<b>RECORD OF BOREHOLE No P3-5</b>				1 OF 1 <b>METRIC</b>					
W.P.		174-98-00		LOCATION		N 5125766.9; E 329729.3		ORIGINATED BY ID					
DIST		HWY 17		BOREHOLE TYPE		Portable Equipment, NW Casing, Wash Boring		COMPILED BY MT					
DATUM		Geodetic		DATE		June 20, 2011		CHECKED BY AB					
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		WATER CONTENT (%)			
241.6	GROUND SURFACE												
0.0	PEAT (Amorphous / Fibrous) Very soft Brown Moist		1	SS	1								
240.2			2	SS	1								
1.4	SAND and SILT, some clay Very loose to loose Grey Wet		3	SS	2								
			4	SS	3								
			5	SS	4								
237.8	SILTY CLAY, silt seams/layers Soft to firm Grey Wet		6	SS	WH								
3.8			7	SS	WH								
			8	SS	WH								
232.9	SAND and SILT, trace clay Loose Grey Wet		9	SS	8								
8.7													
230.9	Gravelly SAND, some silt, trace clay Dense Grey Wet		10	SS	33								
10.7													
229.9	END OF BOREHOLE CASING REFUSAL												
11.7	Note:  1. Water level at a depth of 1.1 m below ground surface (Elev. 240.5 m) upon completion of drilling.												

PROJECT 10-1191-0041			RECORD OF BOREHOLE No P3-6			1 OF 1 METRIC															
W.P. 174-98-00			LOCATION N 5125757.6; E 329705.3			ORIGINATED BY ID															
DIST _____ HWY 17			BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring			COMPILED BY MT															
DATUM Geodetic			DATE June 21, 2011			CHECKED BY AB															
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					WATER CONTENT (%)			γ			GR SA SI CL		
241.0	GROUND SURFACE							20 40 60 80 100	20 40 60 80 100	20 40 60	W <sub>p</sub> W W <sub>L</sub>	162.4									
0.0	PEAT (Fibrous) Very soft Brown Moist to wet		1	SS	1																
240.0			2a																		
1.0	SAND and SILT, some clay, trace gravel Very loose Grey Wet		2b	SS	4		240														
			3	SS	3		239										1 38 47 14				
238.6																					
2.4	CLAYEY SILT to SILTY CLAY, silt seams/layers Soft Grey Wet		4	SS	1		238														
							237														
			5	TO	PM		236														
							235														
234.0			6	SS	WH		234														
7.0	SAND and SILT, trace to some clay Very loose Grey Wet		7	SS	4		233										0 38 55 7				
232.3							232														
8.7	SAND, trace to some silt Dense Grey Wet		8	SS	34		231										0 93 (7)				
230.8																					
10.2	END OF BOREHOLE REFUSAL TO FURTHER CASING PENETRATION  Note:  1. Water level at a depth of 0.6 m below ground surface (Elev. 240.4 m) upon completion of drilling.																				

SUD-MTO 001 1011910041.GPJ GAL-MISS.GDT 12/03/13 DATA INPUT:

PROJECT		10-1191-0041				RECORD OF BOREHOLE No P3-7				1 OF 1 METRIC			
W.P.		174-98-00		LOCATION		N 5125754.3; E 329680.6				ORIGINATED BY ID			
DIST		HWY 17		BOREHOLE TYPE		Portable Equipment, NW Casing, Wash Boring				COMPILED BY MT			
DATUM		Geodetic		DATE		June 22 and 23, 2011				CHECKED BY AB			
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		WATER CONTENT (%)			
241.5	GROUND SURFACE												
0.0	PEAT (Fibrous) Very soft Brown Wet		1	SS	1								
240.7	Silty SAND to SAND, trace to some gravel Loose Brown Wet		2	SS	4							OC=1.0%	1 76 21 2
0.8			3	SS	9								17 75 (8)
239.2	CLAYEY SILT to SILTY CLAY, silt seams/layers Soft Grey Wet		4	SS	1								
2.3			5	SS	WH								
			6	SS	WH								
			7	TO	PM								
234.5	SILT, some sand, trace clay, trace gravel Loose Grey Wet		8	SS	6								1 16 79 4
7.0													
232.8	Gravelly SAND Compact Grey Wet		9	SS	25								
8.7													
231.4	END OF BOREHOLE CASING REFUSAL												
10.1	Note: 1. Water level at a depth of 0.2 m below ground surface (Elev. 241.3 m) upon completion of drilling.												

SUD-MTO 001 1011910041.GPJ GAL-MISS.GDT 12/03/13 DATA INPUT:

**Westbound Truck Climbing Lane Connection**  
Station 13+350 to 13+550, Referenced to C/L

10-1184-0148  
April, 2013

13+350 3.20 Lt C/L D-0 PA

0 - 230 Asph  
230 - 320 Br Cr Gran  
320 - 2.00 Lt Br F Sa Tr Gr, Moist

13+350 5.70 Lt C/L D-100 PA

0 - 150 Br Cr Gran  
150 - 340 Br Med Sa W Gr  
340 - 4.00 Br F Sa Tr Gr Occ Cob, Moist to Wet, Loose  
4.00 - 6.00 Gry F Sa Tr Gr Occ Cob, Moist to Wet, Loose

13+350 11.00 Lt C/L D-1.60 HA

0 - 190 Dk Br Sa Tps  
190 - 1.80 Br Si Sa Tr Cl Tr Gr Occ Cob Occ Blds, Wet, Comp

13+350 16.00 Lt C/L D-1.50 HA

0 - 130 Dk Br Sa Tps  
130 - 2.50 Dk Br Fib-F Org M, Sat, Fr Wat @ 500  
2.50 - 3.00 Gry Cl Si Tr Sa Tr Gr, Wet, Firm

13+400 3.30 Lt C/L D-0 PA

0 - 280 Asph  
280 - 380 Br Cr Gran  
380 - 1.80 Br F Sa Tr Gr, Moist to Wet, Fr Wat @ 1.04  
1.80 - 2.00 Lt Gry F Sa Tr Si, Sat, Comp

13+400 5.40 Lt C/L D-500 PA

0 - 150 Br Cr Gran  
150 - 330 Br Med Sa W Gr  
330 - 1.30 Br F Sa Tr Si Tr Gr, Moist to Wet, Fr Wat @ 880  
1.30 - 6.00 Gry F Sa Occ Cob, Sat, Loose

13+400 11.00 Lt C/L D-1.60 HA

0 - 150 Dk Br Sa Tps  
150 - 1.70 Br Si Sa Tr Cl Tr Gr, Wet, Fr Wat @ 800, Sat, Comp

13+400 16.00 Lt C/L D-1.50 HA

0 - 4.70 Dk Br Fib-F Org M, Sat, Fr Wat @ 600  
4.70 - 7.30 Gry Si Cl Tr Sa Tr Gr, Soft  
7.30 - 7.70 Gry Si Tr Cl Tr Sa Tr Gr, Sat, Comp

13+450 3.20 Lt C/L D-0 PA

0 - 320 Asph  
320 - 430 Br Cr Gran  
430 - 1.80 Br F Sa Tr Gr, Moist to Wet, Fr Wat @ 960  
- 1.80 NFP Blds

13+450 5.50 Lt C/L D-350 PA

0 - 100 Br Cr Gran  
100 - 320 Br Med Sa W Gr  
320 - 1.00 Lt Br F Sa Tr Gr, Moist to Wet, Fr Wat @ 700  
1.00 - 6.00 Gry F Sa Occ Cob, Sat, Loose

**Westbound Truck Climbing Lane Connection**  
Station 13+350 to 13+550, Referenced to C/L

10-1184-0148  
April, 2013

13+450 15.00 Lt C/L D-1.70 HA

0 - 4.30 Dk Br Fib-F Org M, Wet  
4.30 - 4.40 Br F-Med Sa Tr Gr, Wet, Comp  
- 4.40 NFP Blds

13+450 20.00 Lt C/L D-1.60 HA

0 - 5.00 Dk Br Fib-F Org M, Sat, Fr Wat @  
500, Comp  
5.00 - 5.20 Gry F-Med Sa Tr Gr, Sat, Comp  
- 5.20 NFP Blds

13+500 3.30 Lt C/L D-0 PA

0 - 300 Asph  
300 - 420 Br Cr Gran  
420 - 2.00 Lt Br F Sa Tr Gr, Moist to Wet, Fr Wat  
@ 1.28

13+500 5.50 Lt C/L D-100 PA

0 - 080 Br Cr Gran  
080 - 240 Br Med Sa W Gr  
240 - 900 Br F Sa Tr Gr, Moist to Wet  
900 - 6.00 Gry F Sa Occ Cob, Sat, Fr Wat @ 1.10,  
Loose

13+500 12.00 Lt C/L D-1.60 HA

0 - 080 Dk Br Sa Tps  
080 - 6.00 Dk Br Fib-F Org M, Wet  
6.00 - 6.30 Gry Cl Si Tr Sa Tr Gr, Wet, Firm

13+500 17.00 Lt C/L D-1.40 HA

0 - 120 Dk Br Sa Tps  
120 - 6.60 Dk Br Fib-F Org M, Sat, Fr Wat @ 600  
6.60 - 6.90 Gry Cl Si Tr Sa Tr Gr, Wet, Firm

13+550 3.10 Lt C/L D-0 PA

0 - 250 Asph  
250 - 380 Br Cr Gran  
380 - 1.15 Br F Sa Tr Gr, Moist, Fr Wat @ 1.27  
1.15 - 2.00 Br Med Sa W Cob, Moist to Wet

13+550 5.40 Lt C/L D-100 PA

0 - 120 Br Cr Gran  
120 - 240 Br Co Sa Tr Gr  
240 - 2.70 Br F Sa Tr Gr, Moist to Wet, Fr Wat @  
920  
2.70 - 4.20 Br Sa Tr Gr Occ Cob Tr Org M  
- 4.20 NFP BR

13+550 15.00 Lt C/L D-1.50 HA

0 - 130 Dk Br Si Tps  
130 - 1.00 Br Si Sa Tr Gr, Moist, Comp  
1.00 - 1.50 Br Si Tr F Sa, Wet, Comp

13+550 20.00 Lt C/L D-1.80 HA

0 - 2.30 Dk Br Fib-F Org M, Fr Wat @ 600  
- 2.30 NFP BR

Data Input: KZ  
Checked: JB

**Eastbound Passing Lane Extension**

Station 13+350 to 13+550, Referenced to C/L

10-1184-0148

April, 2013

13+350 3.30 Rt C/L D-0 PA

0 - 300 Asph  
300 - 400 Br Cr Gran  
400 - 1.80 Br F Sa Tr Gr, Moist to Wet, Fr Wat @ 900  
1.80 - 2.00 Lt Gry F Sa Tr Si Tr Gr, Sat

13+350 5.10 Rt C/L D-0 PA

0 - 065 Asph  
065 - 190 Br Cr Gran  
190 - 390 Br F-Med Sa W Gr  
390 - 1.60 Br F-Med Sa, Moist to Wet, Fr Wat @ 830  
1.60 - 2.00 Lt Gry F Sa Tr Si Tr Gr, Sat

13+350 12.00 Rt C/L D-1.20 HA

0 - 100 Dk Br Sa Tps  
100 - 550 Br F-Med Sa Tr Si Tr Gr Occ Cob, Moist, Comp  
550 - 1.20 Gry Si Sa Tr Cl Tr Gr, Moist, Fr Wat @ 1.00, Sat, Comp  
1.20 - 2.60 Dk Br Fib-Co Org M  
2.60 - 4.80 Gry Cl Si Tr Sa, Sat, Soft  
4.80 - 5.00 Gry Si Tr Cl Tr Sa, Sat, Comp  
5.00 - 5.10 Gry F-Med Sa Tr Si Tr Gr, Sat, Comp  
- 5.10 NFP Blds

13+350 17.00 Rt C/L D-1.00 HA

0 - 250 Dk Br Sa Tps  
250 - 2.40 Dk Br Fib-Co Org M, Sat, Fr Wat @ 1.00  
2.40 - 2.80 Br F-Med Sa Tr Si Tr Gr, Sat, Comp  
2.80 - 3.30 Gry Cl Si Tr Sa Tr Gr, Sat, Firm

13+400 3.20 Rt C/L D-0 PA

0 - 370 Asph  
370 - 470 Br Cr Gran  
470 - 2.00 Br F-Med Sa Tr Si Tr Gr, Moist to Wet, Fr Wat @ 970

13+400 5.80 Rt C/L D-0 PA

0 - 100 Br Cr Gran  
100 - 400 Br Med Sa W Gr  
400 - 1.70 Br F-Med Sa Tr Gr, Moist to Wet, Fr Wat @ 700  
1.70 - 2.00 Lt Gry F Sa Tr Si Tr Gr, Sat

13+400 12.00 Rt C/L D-1.50 HA

0 - 080 Dk Br Sa Tps  
080 - 500 Br F-Med Sa Tr Si Tr Gr, Moist, Comp  
500 - 750 Br Gry Si Sa Tr Cl Tr Gr Occ Cob Occ Blds, Wet, Comp  
- 750 NFP Blds

13+400 17.00 Rt C/L D-1.80 HA

0 - 400 Dk Br Fib-F Org M  
400 - 600 Gry Si Sa Tr Cl Tr Gr, Wet, Comp  
600 - 2.60 Dk Br Fib-Co Org M, Sat, Fr Wat @ 700  
2.60 - 7.80 Gry Cl Si Tr Sa, Sat, Soft  
7.80 - 8.40 Gry Si Tr Cl Tr Sa, Sat, Comp



**Eastbound Passing Lane Extension**

Station 13+350 to 13+550, Referenced to C/L

10-1184-0148

April, 2013

13+450 5.60 Rt C/L D-250 PA

0	- 100	Br Cr Gran
100	- 330	Br Med Sa W Gr
330	- 1.60	Br F-Med Sa Tr Gr Occ Cob Occ Blds, Moist
1.60	- 2.00	Gry F-Med Sa Tr Si Tr Gr, Moist to Wet

13+450 8.20 Rt C/L D-500 PA

0	- 100	Br Cr Gran
100	- 330	Br Med Sa W Gr
330	- 1.20	Br F-Med Sa Tr Gr, Moist
1.20	- 2.00	Gry F Sa Tr Si, Moist to Wet

13+450 12.00 Rt C/L D-1.40 HA

0	- 210	Dk Br Sa Tps
210	- 500	Br F-Med Sa Tr Si Tr Gr, Moist, Comp
500	- 1.80	Gry Si Sa Tr Gr, Wet, Fr Wat @ 900, Sat, Comp

13+450 17.00 Rt C/L D-1.70 HA

0	- 7.50	Dk Br Fib-F Org M, Sat, Fr Wat @ 800
7.50	- 8.30	Gry Si Tr Cl Tr Sa, Sat, Comp

13+500 5.60 Rt C/L D-250 PA

0	- 180	Br Cr Gran
180	- 410	Br Med Sa W Gr
410	- 1.30	Br Med Sa Tr Gr, Moist to Wet
1.30	- 2.00	Gry F-Med Sa Tr Gr, Moist to Wet

13+500 8.20 Rt C/L D-500 PA

0	- 240	Br Cr Gran
240	- 1.00	Br F-Med Sa Tr Si Tr Gr, Moist
1.00	- 1.20	Br F-Med Sa Tr Si Tr Gr Tr Org M, Moist
1.20	- 2.00	Gry F-Med Sa Tr Si Tr Gr, Moist to Wet

13+500 12.00 Rt C/L D-1.70 HA

0	- 170	Dk Br Sa Tps
170	- 540	Dk Br Fib-F Org M
540	- 1.80	Gry Si Sa Tr Gr Occ Cob Occ Blds, Wet, Fr Wat @ 1.10, Sat, Comp

13+500 17.00 Rt C/L D-2.00 HA

0	- 5.80	Dk Br Fib-F Org M, Sat, Fr Wat @ 100, Comp
5.80	- 6.10	Gry F-Med Sa Tr Si Tr Gr Occ Cob Occ Blds, Sat, Comp
	- 6.10	NFP Blds

13+550 5.00 Rt C/L D-150 PA

0	- 160	Br Cr Gran
160	- 380	Br Med Sa W Gr
380	- 2.00	Br Med Sa Tr Si Tr Gr, Moist to Wet

13+550 7.20 Rt C/L D-400 PA

0	- 300	Br Cr Gran
300	- 1.50	Br Med Sa Tr Si Tr Gr, Moist
1.50	- 2.00	Gry Med Sa Tr Si Tr Gr, Moist to Wet

**Eastbound Passing Lane Extension**  
Station 13+350 to 13+550, Referenced to C/L

10-1184-0148  
April, 2013

---

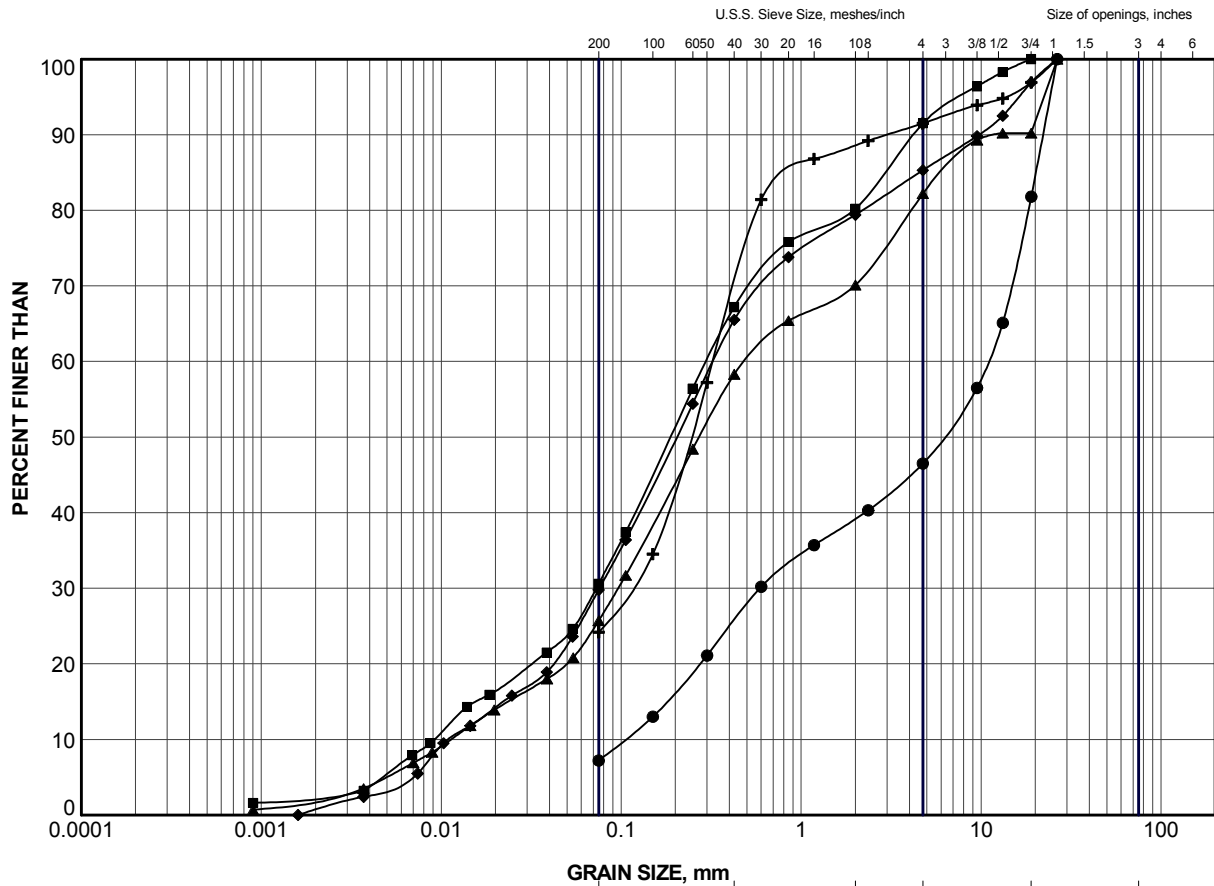
13+550 17.50 Rt C/L D-2.10 HA

0	- 1.70	Dk Br Fib-F Org M, Sat, Fr Wat @ 300
1.70	- 1.80	Gry F-Med Sa Tr Si Tr Gr Occ Cob, Sat, Comp
	- 1.80	NFP Blds

13+550 22.50 Rt C/L D-1.90 HA


0	- 100	Dk Br Sa Tps
100	- 2.80	Dk Br Fib-F Org M, Wet
2.80	- 3.10	Gry Si Sa Tr Cl Tr Gr Occ Cob, Wet, Comp
	- 3.10	NFP Blds

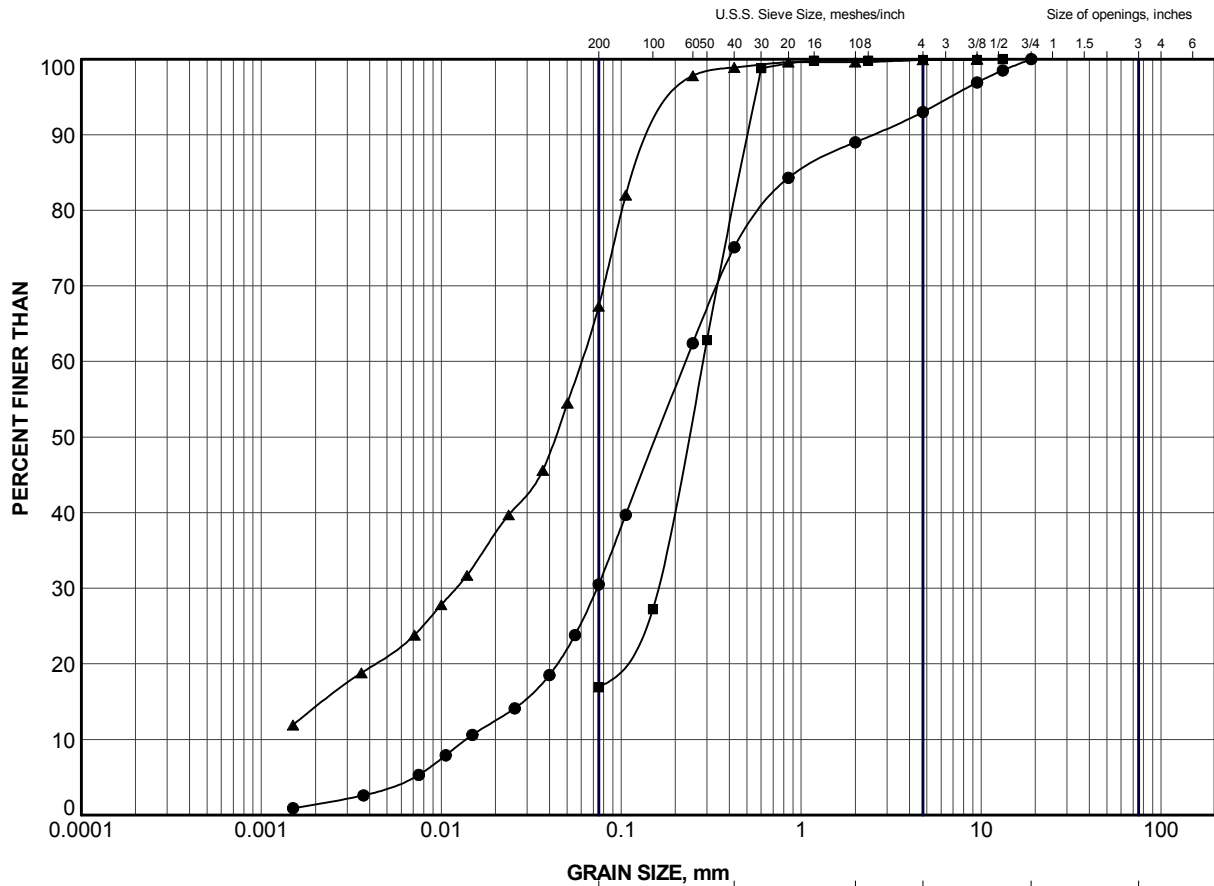
Data Input: KZ  
Checked: JB



### LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	P4-1	3	244.7
■	P4-6	2	240.3
▲	P4-7	2	240.1
+	P4-10	3	245.6
◆	P4-10	7	238.8


PROJECT		HIGHWAY 17 STA 13+100 TO 13+350 WESTBOUND TRUCK CLIMBING LANE			
TITLE		<b>GRAIN SIZE DISTRIBUTION</b> SAND AND GRAVEL TO SILTY SAND (FILL)			
PROJECT No.		10-1191-0041		FILE No. 1011910041.GPJ	
DRAWN	TB	Mar 2012		SCALE	N/A
CHECK	AB	Mar 2012		REV.	
APPR	JMAC	Mar 2012		<b>FIGURE A1</b>	
 <b>Golder Associates</b> SUDBURY, ONTARIO					

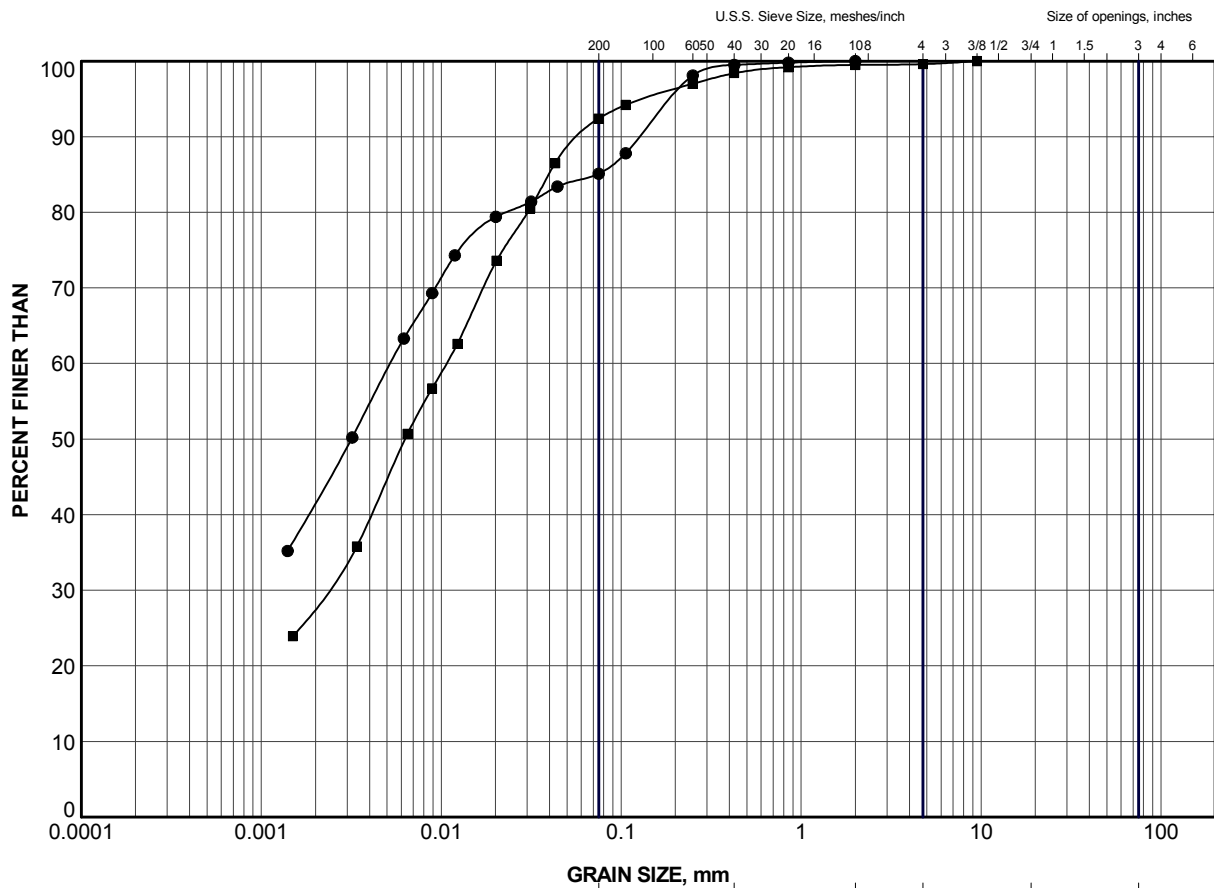


CLAY AND SILT	GRAVEL SIZE, mm					Cobble Size
	fine	medium	coarse	fine	coarse	
	SAND SIZE			GRAVEL SIZE		

### LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	P4-1	6	242.4
■	P4-3	2	239.6
▲	P4-9	5	238.6


PROJECT		HIGHWAY 17 STA 13+100 TO 13+350 WESTBOUND TRUCK CLIMBING LANE			
TITLE		<b>GRAIN SIZE DISTRIBUTION</b> SAND TO SAND AND SILT			
PROJECT No.		10-1191-0041		FILE No. 1011910041.GPJ	
DRAWN	TB	Mar 2012		SCALE	N/A
CHECK	AB	Mar 2012		REV.	
APPR	JMAC	Mar 2012		<b>FIGURE A2</b>	
 <b>Golder Associates</b> SUDBURY, ONTARIO					

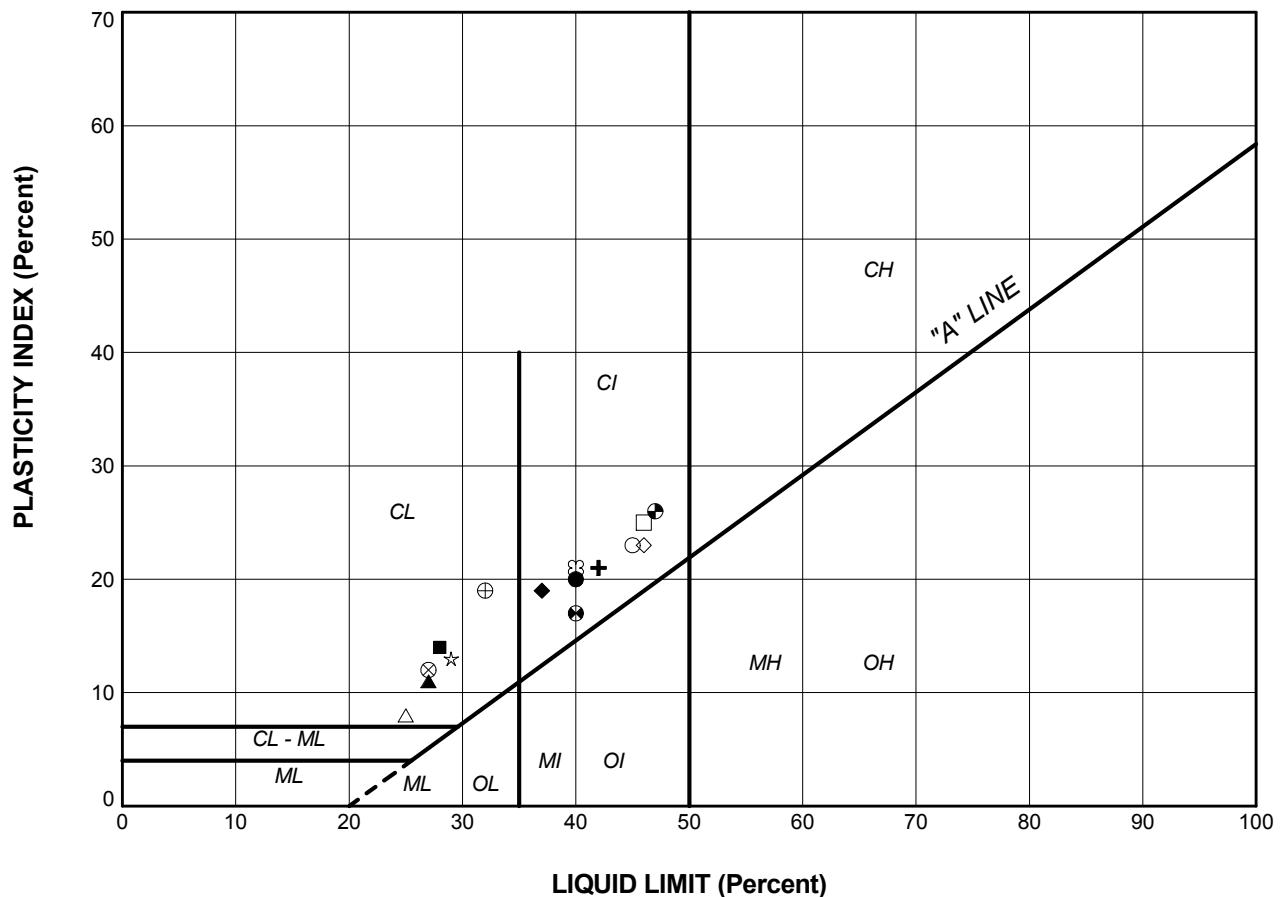


GRAIN SIZE, mm						
CLAY AND SILT	fine	medium	coarse	fine	coarse	Cobble Size
	SAND SIZE			GRAVEL SIZE		

#### LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	P4-3a	1	237.5
■	P4-10	11b	235.7

PROJECT		HIGHWAY 17 STA 13+100 TO 13+350 WESTBOUND TRUCK CLIMBING LANE			
TITLE		<b>GRAIN SIZE DISTRIBUTION</b> CLAYEY SILT TO SILTY CLAY			
PROJECT No.		10-1191-0041		FILE No. 1011910041.GPJ	
DRAWN	TB	Mar 2012		SCALE	N/A
CHECK	AB	Mar 2012		REV.	
APPR	JMAC	Mar 2012		<b>FIGURE A3</b>	
 <b>Golder Associates</b> SUDBURY, ONTARIO					



### LEGEND

SYMBOL	BOREHOLE	SAMPLE	LL(%)	PL(%)	PI
●	P4-2	3	40.0	20.0	20.0
■	P4-3	4	28.0	14.0	14.0
▲	P4-3	7	27.0	16.0	11.0
+	P4-4	3	42.0	21.0	21.0
◆	P4-5	4	37.0	18.0	19.0
◇	P4-6	6	46.0	23.0	23.0
○	P4-7	5	45.0	22.0	23.0
△	P4-7	7	25.0	17.0	8.0
⊗	P4-8	1b	27.0	15.0	12.0
⊕	P4-8	4	32.0	13.0	19.0
□	P4-8	6	46.0	21.0	25.0
⊗	P4-8a	1	40.0	23.0	17.0
⊕	P4-9	7	47.0	21.0	26.0
☆	P4-10	11b	29.0	16.0	13.0
⊗	P4-10	12	40.0	19.0	21.0

PROJECT		HIGHWAY 17 STA 13+100 TO 13+350 WESTBOUND TRUCK CLIMBING LANE		
TITLE		<b>PLASTICITY CHART</b> CLAYEY SILT TO SILTY CLAY		
PROJECT No.		10-1191-0041	FILE No. 1011910041.GPJ	
DRAWN	TB	Mar 2012	SCALE	N/A
CHECK	AB	Mar 2012	REV.	
APPR	JMAC	Mar 2012	<b>FIGURE A4</b>	



**CONSOLIDATION TEST SUMMARY****FIGURE A5**

Page 1 of 4

**SAMPLE IDENTIFICATION**

Project Number 10-1191-0041

Sample Number 1

Borehole Number P4-8a

Sample Depth, m 4.6

**TEST CONDITIONS**

Test Type Standard

Load Duration, hr 24

Date Started

7/29/11

Date Completed

8/10/11

**SAMPLE DIMENSIONS AND PROPERTIES - INITIAL**

Sample Height, cm	2.52	Unit Weight, kN/m <sup>3</sup>	16.34
Sample Diameter, cm	6.36	Dry Unit Weight, kN/m <sup>3</sup>	10.26
Area, cm <sup>2</sup>	31.77	Specific Gravity, assumed	2.70
Volume, cm <sup>3</sup>	80.15	Solids Height, cm	0.978
Water Content, %	59.17	Volume of Solids, cm <sup>3</sup>	31.07
Wet Mass, g	133.53	Volume of Voids, cm <sup>3</sup>	49.08
Dry Mass, g	83.89	Degree of Saturation, %	101.1

**TEST COMPUTATIONS**

Pressure	Primary Consolidation	Corr. Height	Void Ratio	Average Height	t <sub>90</sub>	cv.	mv	k	Total Work
kPa	mm	cm		cm	sec	cm <sup>2</sup> /s	m <sup>2</sup> /kN	cm/s	kJ/m <sup>3</sup>
0	0	2.523	1.580	2.523					
4.2	0.04	2.519	1.575	2.521	290	0.005	4.15E-04	1.89E-07	0.004
13.1	0.04	2.514	1.571	2.516	135	0.010	1.91E-04	1.87E-07	0.018
30.9	0.10	2.505	1.561	2.510	155	0.009	2.14E-04	1.80E-07	0.102
66.3	0.21	2.484	1.540	2.494	265	0.005	2.35E-04	1.15E-07	0.510
136.6	1.98	2.286	1.337	2.385	2160	0.001	1.12E-03	6.11E-08	8.597
277.2	1.54	2.132	1.180	2.209	1215	0.001	4.34E-04	3.62E-08	22.537
557.9	0.99	2.033	1.078	2.082	595	0.002	1.40E-04	2.12E-08	41.929
1115.8	1.56	1.877	0.919	1.955	320	0.003	1.11E-04	2.75E-08	106.153
557.9	-0.17	1.894	0.937	1.885					
136.6	-0.39	1.933	0.977	1.914					
30.9	-0.49	1.982	1.027	1.958					
4.2	-0.45	2.028	1.073	2.005					

Note:

k calculated using cv based on t<sub>90</sub> values.**SAMPLE DIMENSIONS AND PROPERTIES - FINAL**

Sample Height, cm	1.98	Unit Weight, kN/m <sup>3</sup>	17.63
Sample Diameter, cm	6.36	Dry Unit Weight, kN/m <sup>3</sup>	13.06
Area, cm <sup>2</sup>	31.77	Specific Gravity, assumed	2.70
Volume, cm <sup>3</sup>	62.98	Solids Height, cm	0.978
Water Content, %	34.96	Volume of Solids, cm <sup>3</sup>	31.07
Wet Mass, g	113.22	Volume of Voids, cm <sup>3</sup>	31.91
Dry Mass, g	83.89		

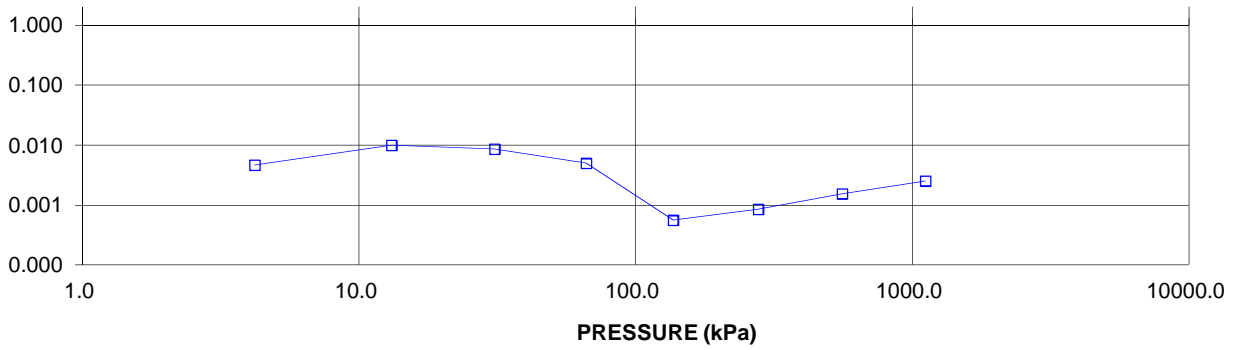
Prepared By: TG/SL

**Golder Associates**

Checked By: AB

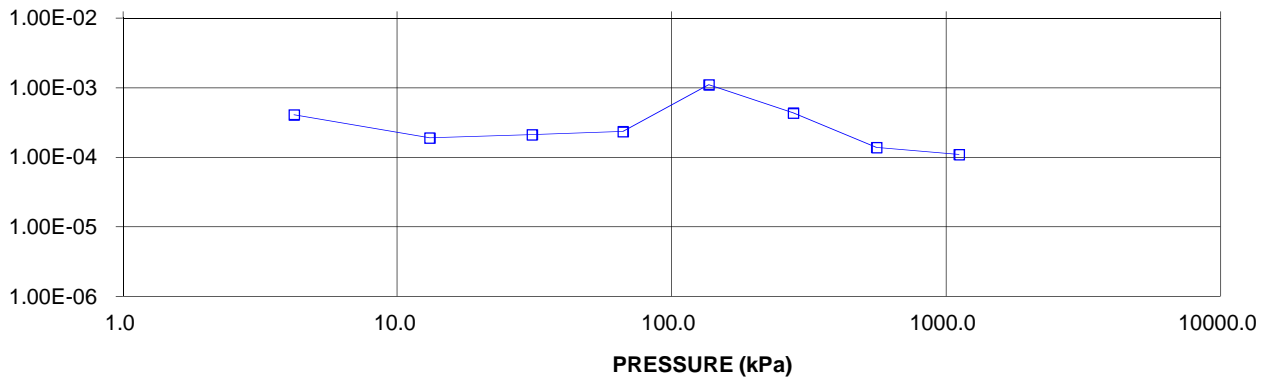
COEFFICIENT OF CONSOLIDATION,  
cm<sup>2</sup>/s

CONSOLIDATION TEST  
CV cm<sup>2</sup>/s VS PRESSURE (kPa)  
Borehole P4-8a Sample 1



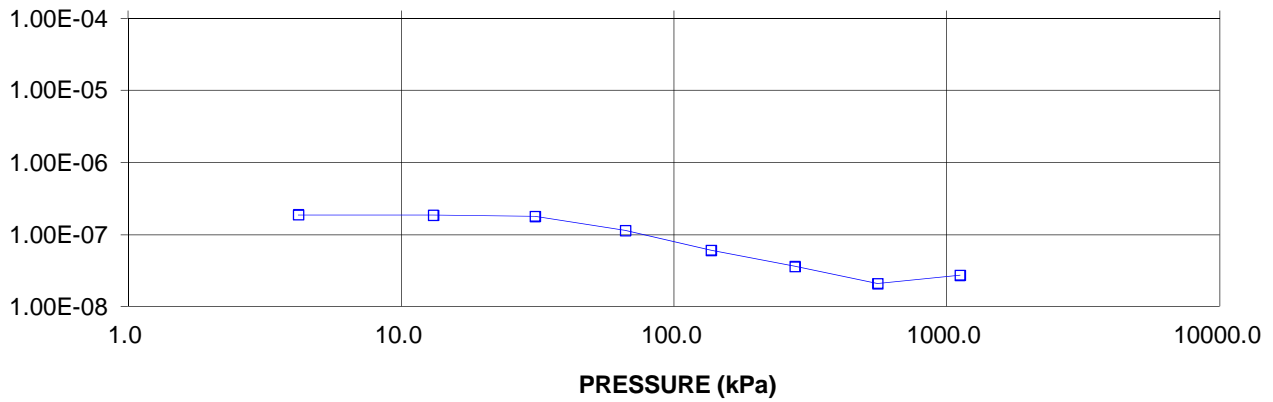
VOLUME COMPRESSIBILITY, m<sup>2</sup>/kN

CONSOLIDATION TEST  
MV m<sup>2</sup>/kN vs PRESSURE (kPa)  
Borehole P4-8a Sample 1

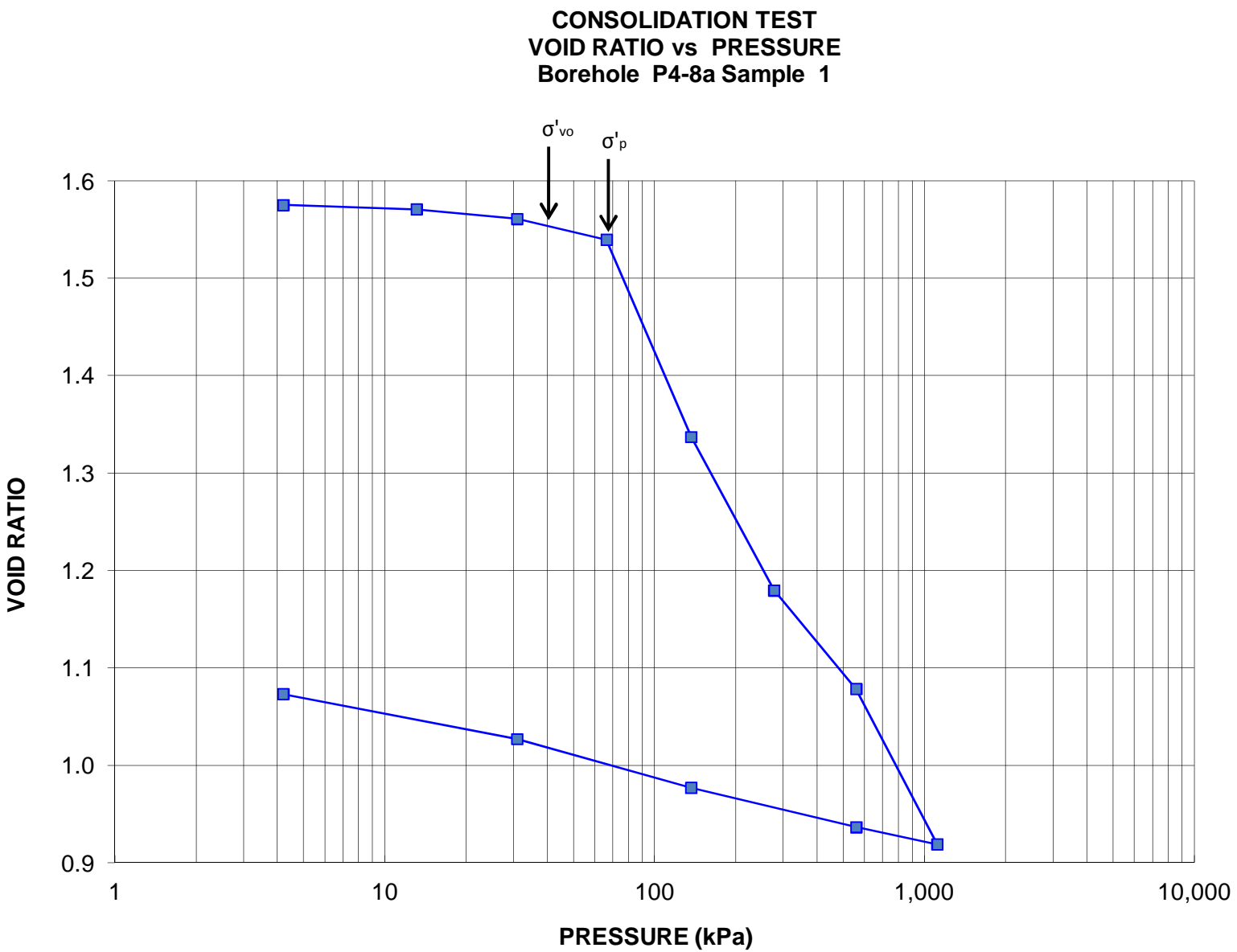


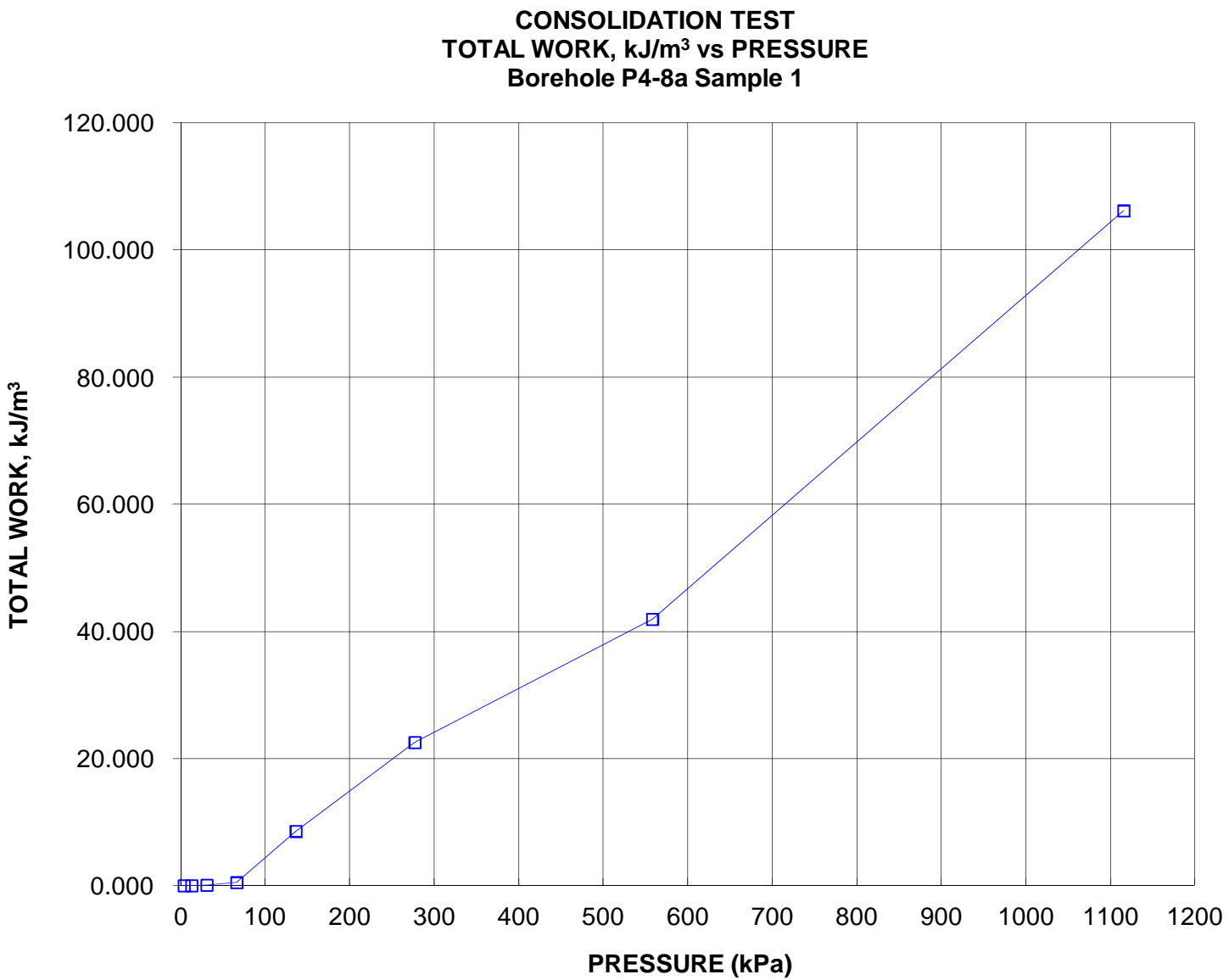
HYDRAULIC CONDUCTIVITY,  
cm/s

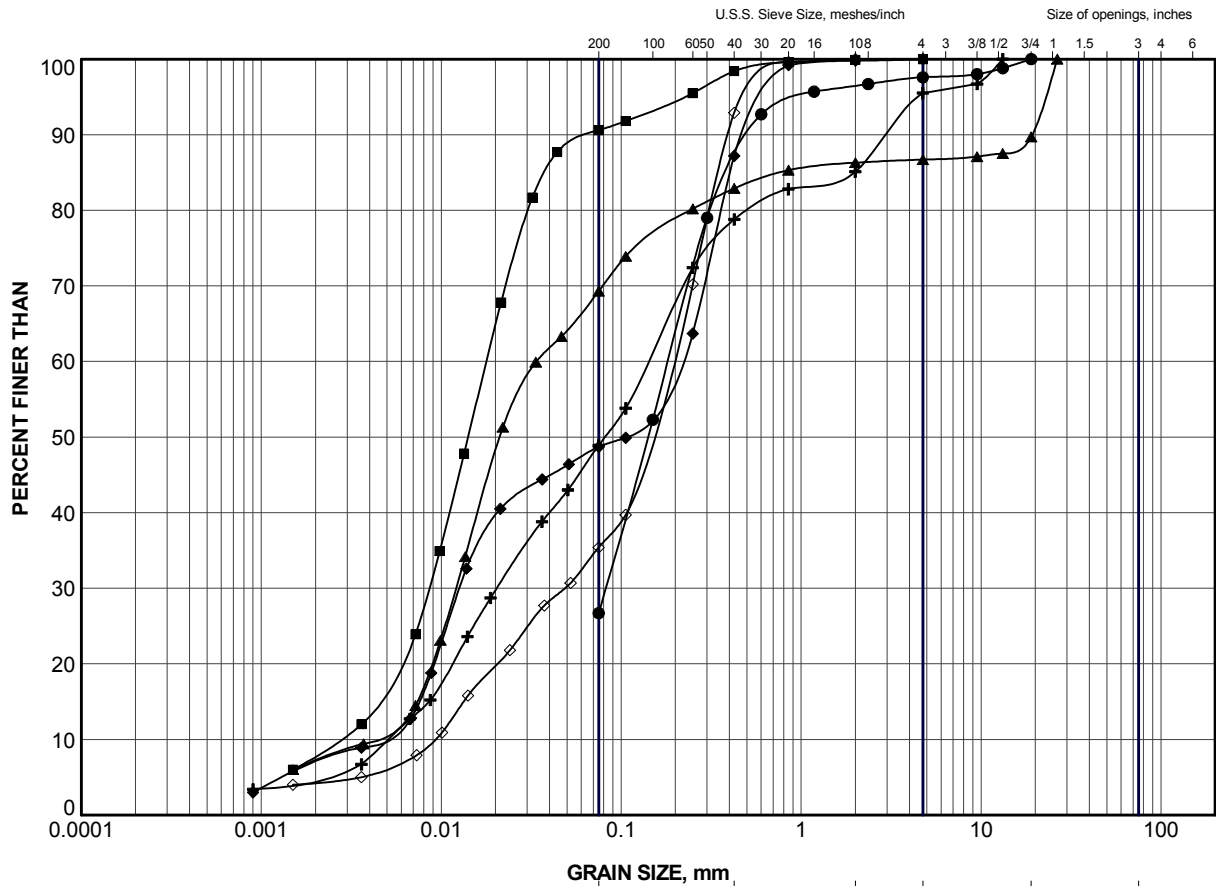
CONSOLIDATION TEST  
HYDRAULIC CONDUCTIVITY vs PRESSURE  
Borehole P4-8 Sample 1










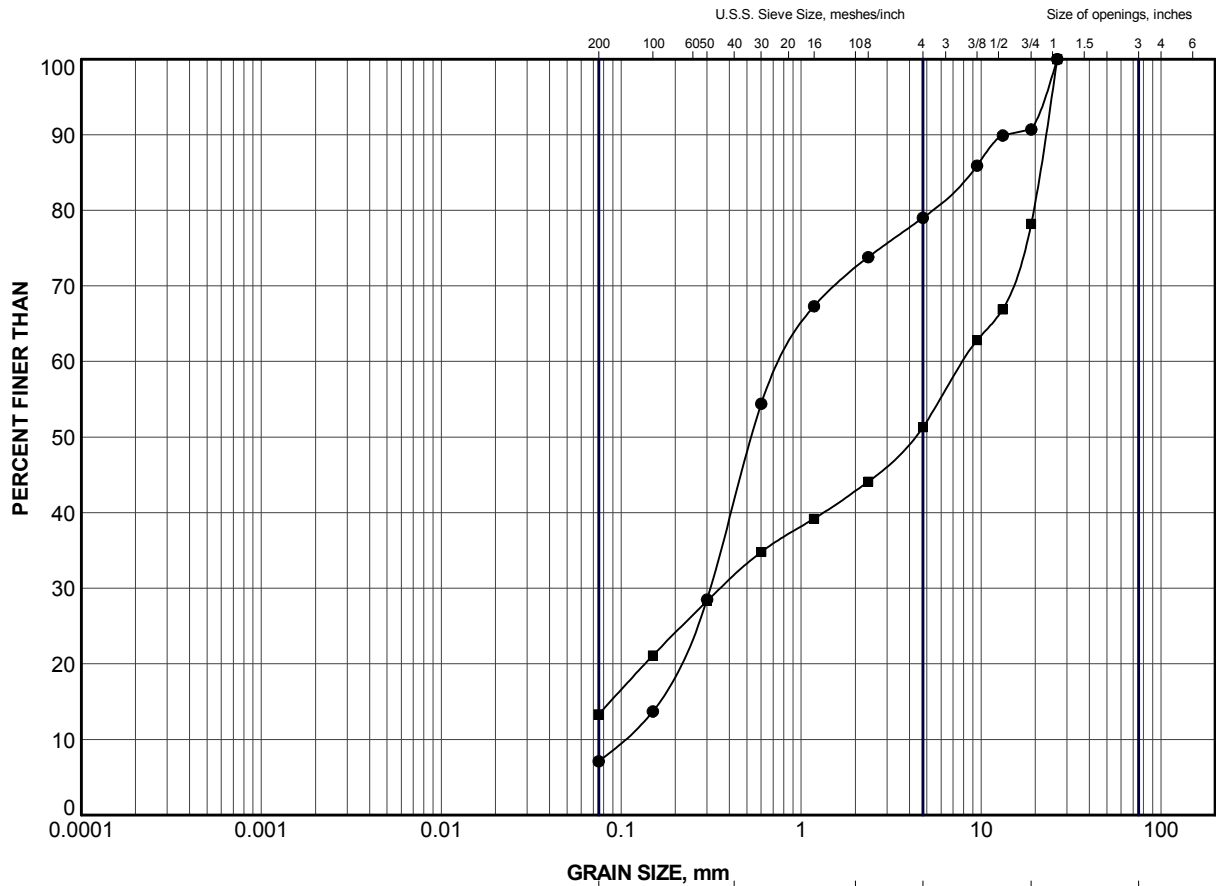


CLAY AND SILT	GRAVEL SIZE, mm					Cobble Size
	fine	medium	coarse	fine	coarse	
	SAND SIZE			GRAVEL SIZE		

### LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	P4-2	8	235.9
■	P4-3	9	232.8
▲	P4-6	8	234.2
+	P4-8	7	234.9
◆	P4-9	8	236.4
◇	P4-10	14	232.7


PROJECT		HIGHWAY 17 STA 13+100 TO 13+350 WESTBOUND TRUCK CLIMBING LANE			
TITLE		<b>GRAIN SIZE DISTRIBUTION</b> SILT TO SAND AND SILT			
PROJECT No.		10-1191-0041		FILE No. 1011910041.GPJ	
DRAWN	TB	Mar 2012		SCALE	N/A
CHECK	AB	Mar 2012		REV.	
APPR	JMAC	Mar 2012		<b>FIGURE A6</b>	
 <b>Golder Associates</b> SUDBURY, ONTARIO					

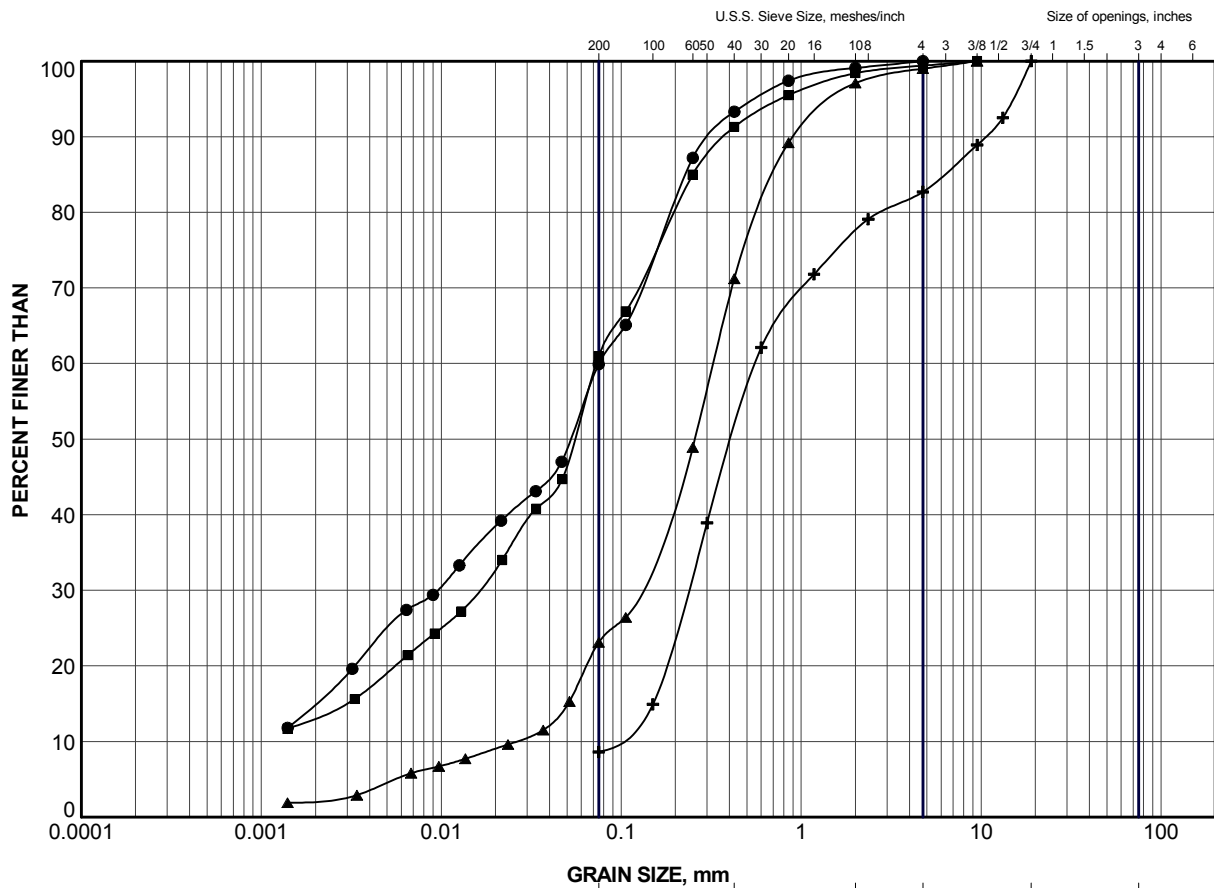


CLAY AND SILT	fine	medium	coarse	fine	coarse	Cobble Size
	SAND SIZE			GRAVEL SIZE		

### LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	P4-2	5	238.9
■	P4-4	6	235.8

PROJECT						HIGHWAY 17 STA 13+100 TO 13+350 WESTBOUND TRUCK CLIMBING LANE					
TITLE						<b>GRAIN SIZE DISTRIBUTION</b> GRAVELLY SAND TO SAND AND GRAVEL					
PROJECT No.			10-1191-0041			FILE No.			1011910041.GPJ		
DRAWN	TB	Mar 2012	SCALE	N/A	REV.						
CHECK	AB	Mar 2012									
APPR	JMAC	Mar 2012									
 <b>Golder Associates</b> SUDBURY, ONTARIO			<b>FIGURE A7</b>								



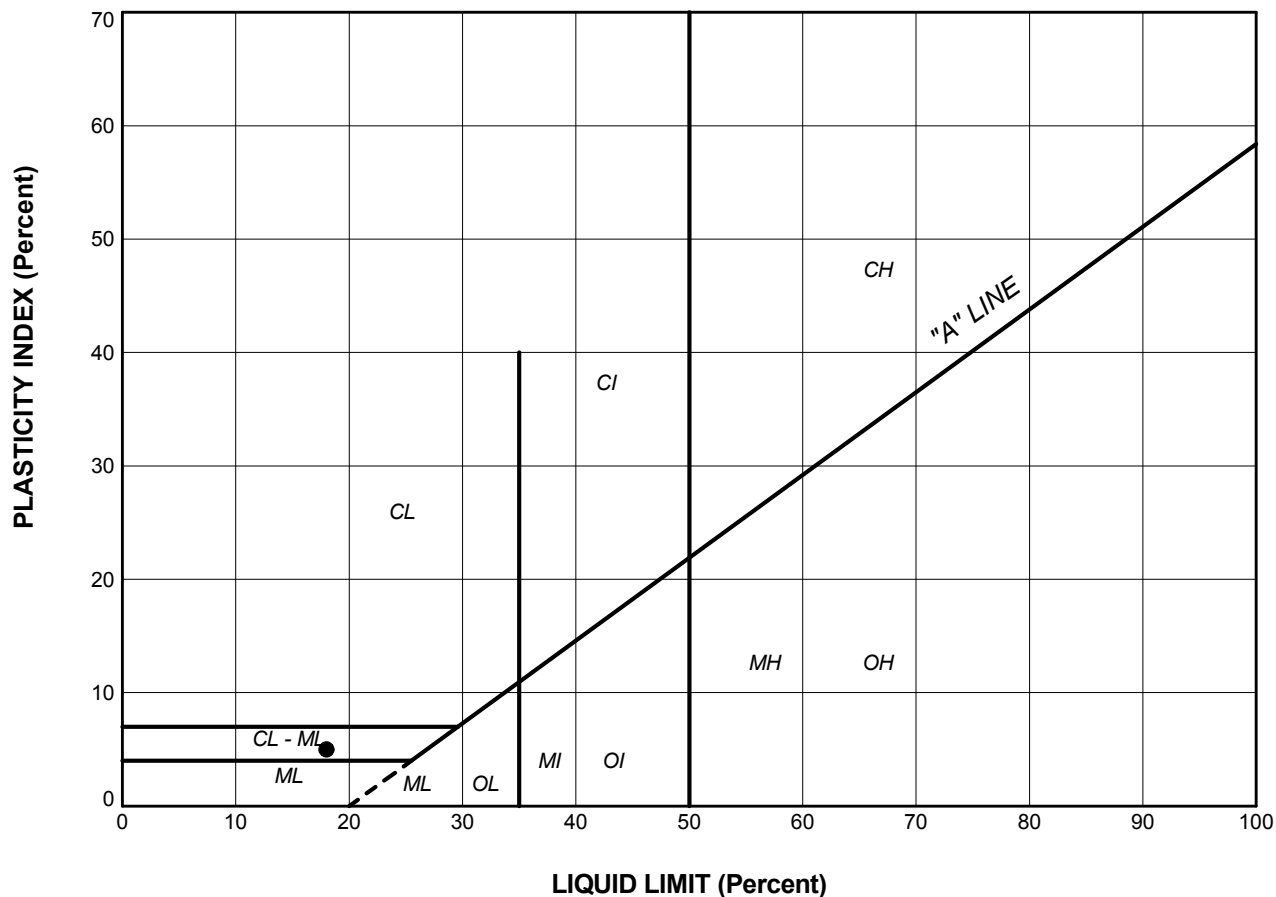
CLAY AND SILT	GRAVEL SIZE, mm					Cobble Size
	fine	medium	coarse	fine	coarse	
	SAND SIZE			GRAVEL SIZE		

### LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	P3-5	4	239.0
■	P3-6	3	239.2
▲	P3-7	2	240.4
+	P3-7	3	239.7

PROJECT					
HIGHWAY 17 STA 13+150 TO 13+350 EASTBOUND PASSING LANE					
TITLE					
GRAIN SIZE DISTRIBUTION SAND AND SILT TO SAND					
PROJECT No.		10-1191-0041		FILE No. 1011910041.GPJ	
DRAWN	TB	Mar 2013	SCALE	N/A	REV.
CHECK	AB	Mar 2013			
APPR	JMAC	Mar 2013			
			FIGURE A8		





**SOIL TYPE**  
 C = Clay  
 M = Silt  
 O = Organic

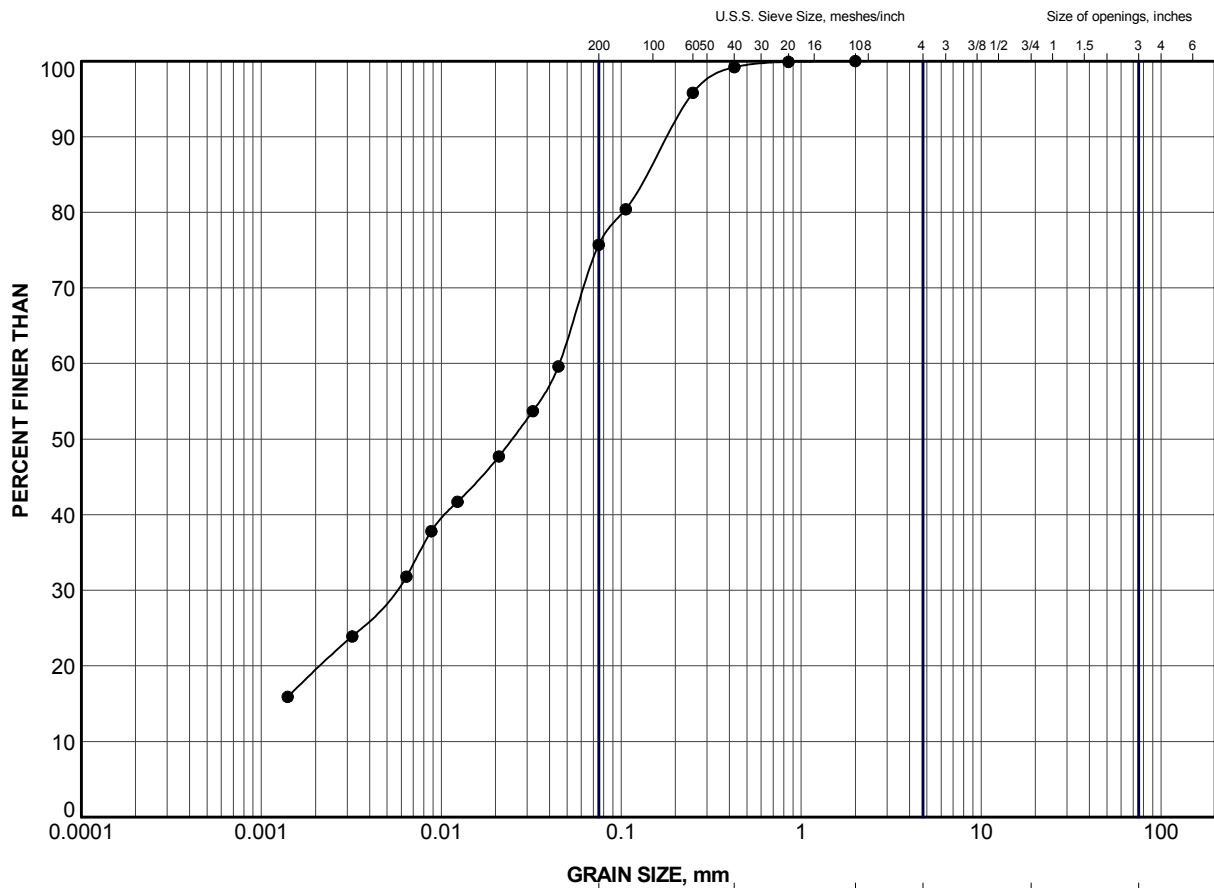
**PLASTICITY**  
 L = Low  
 I = Intermediate  
 H = High

### LEGEND

SYMBOL	BOREHOLE	SAMPLE	LL(%)	PL(%)	PI
●	P3-5	5	18.0	13.0	5.0

PROJECT					
HIGHWAY 17 STA 13+150 TO 13+350 EASTBOUND PASSING LANE					
TITLE					
PLASTICITY CHART SAND AND SILT					
PROJECT No.		10-1191-0041		FILE No.	
				1011910041.GPJ	
DRAWN	TB	Mar 2013	SCALE	N/A	REV.
CHECK	AB	Mar 2013			
APPR	JMAC	Mar 2013			
			FIGURE A9		





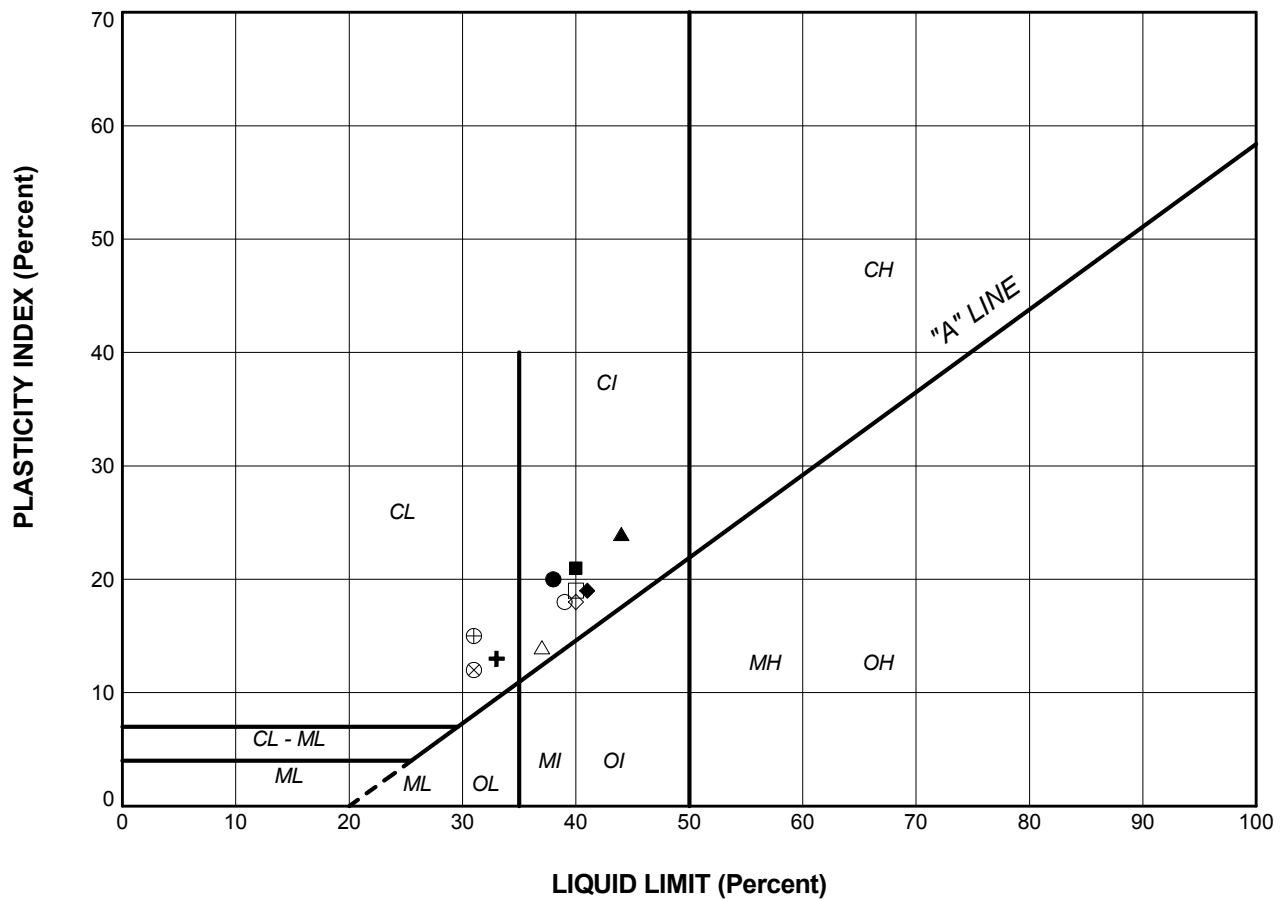
GRAIN SIZE, mm						
CLAY AND SILT	fine	medium	coarse	fine	coarse	Cobble Size
	SAND SIZE			GRAVEL SIZE		

#### LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	P3-4	4b	238.4

PROJECT					HIGHWAY 17 STA 13+150 TO 13+350 EASTBOUND PASSING LANE				
TITLE					GRAIN SIZE DISTRIBUTION CLAYEY SILT				
PROJECT No.		10-1191-0041		FILE No.		1011910041.GPJ			
DRAWN	TB	Mar 2013		SCALE	N/A	REV.			
CHECK	AB	Mar 2013		FIGURE A10					
APPR	JMAC	Mar 2013							





### LEGEND

SYMBOL	BOREHOLE	SAMPLE	LL(%)	PL(%)	PI
●	P3-1	5	38.0	18.0	20.0
■	P3-1	7	40.0	19.0	21.0
▲	P3-2	4	44.0	20.0	24.0
+	P3-2	6	33.0	20.0	13.0
◆	P3-3	5	41.0	22.0	19.0
◇	P3-4	6	40.0	22.0	18.0
○	P3-5	6	39.0	21.0	18.0
△	P3-6	5	37.0	23.0	14.0
⊗	P3-6	6	31.0	19.0	12.0
⊕	P3-7	4	31.0	16.0	15.0
□	P3-7	6	40.0	21.0	19.0

PROJECT					
HIGHWAY 17 STA 13+150 TO 13+350 EASTBOUND PASSING LANE					
TITLE					
PLASTICITY CHART CLAYEY SILT TO SILTY CLAY					
PROJECT No.		10-1191-0041		FILE No. 1011910041.GPJ	
DRAWN	TB	Mar 2013	SCALE	N/A	REV.
CHECK	AB	Mar 2013	FIGURE A11		
APPR	JMAC	Mar 2013			





**CONSOLIDATION TEST SUMMARY****FIGURE A12**

Page 1 of 4

**SAMPLE IDENTIFICATION**

Project Number 10-1191-0041 Sample Number 5  
 Borehole Number P3-6 Sample Depth, m 4.8

**TEST CONDITIONS**

Test Type Standard Load Duration, hr 24  
 Date Started 8/18/11  
 Date Completed 8/29/11

**SAMPLE DIMENSIONS AND PROPERTIES - INITIAL**

Sample Height, cm	2.52	Unit Weight, kN/m <sup>3</sup>	16.94
Sample Diameter, cm	6.36	Dry Unit Weight, kN/m <sup>3</sup>	10.99
Area, cm <sup>2</sup>	31.77	Specific Gravity, measured	2.75
Volume, cm <sup>3</sup>	80.15	Solids Height, cm	1.027
Water Content, %	54.23	Volume of Solids, cm <sup>3</sup>	32.64
Wet Mass, g	138.48	Volume of Voids, cm <sup>3</sup>	47.51
Dry Mass, g	89.79	Degree of Saturation, %	102.5

**TEST COMPUTATIONS**

Pressure kPa	Primary Consolidation mm	Corr. Height cm	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	2.523	1.456	2.523					
4.2	0.09	2.514	1.447	2.519	240	0.006	8.30E-04	4.56E-07	0.007
13.1	0.10	2.504	1.438	2.509	265	0.005	4.41E-04	2.18E-07	0.041
30.9	0.22	2.482	1.416	2.493	345	0.004	4.90E-04	1.83E-07	0.235
66.3	0.34	2.448	1.383	2.465	375	0.003	3.81E-04	1.28E-07	0.900
136.6	0.78	2.370	1.307	2.409	540	0.002	4.40E-04	9.82E-08	4.132
277.2	0.61	2.309	1.248	2.340	375	0.003	1.72E-04	5.22E-08	9.457
557.9	0.50	2.259	1.199	2.284	135	0.008	7.06E-05	5.67E-08	18.498
277.2	-0.06	2.265	1.205	2.262					
66.3	-0.24	2.289	1.228	2.277					
13.1	-0.27	2.316	1.254	2.303					
4.2	-0.06	2.322	1.260	2.319					

Note:

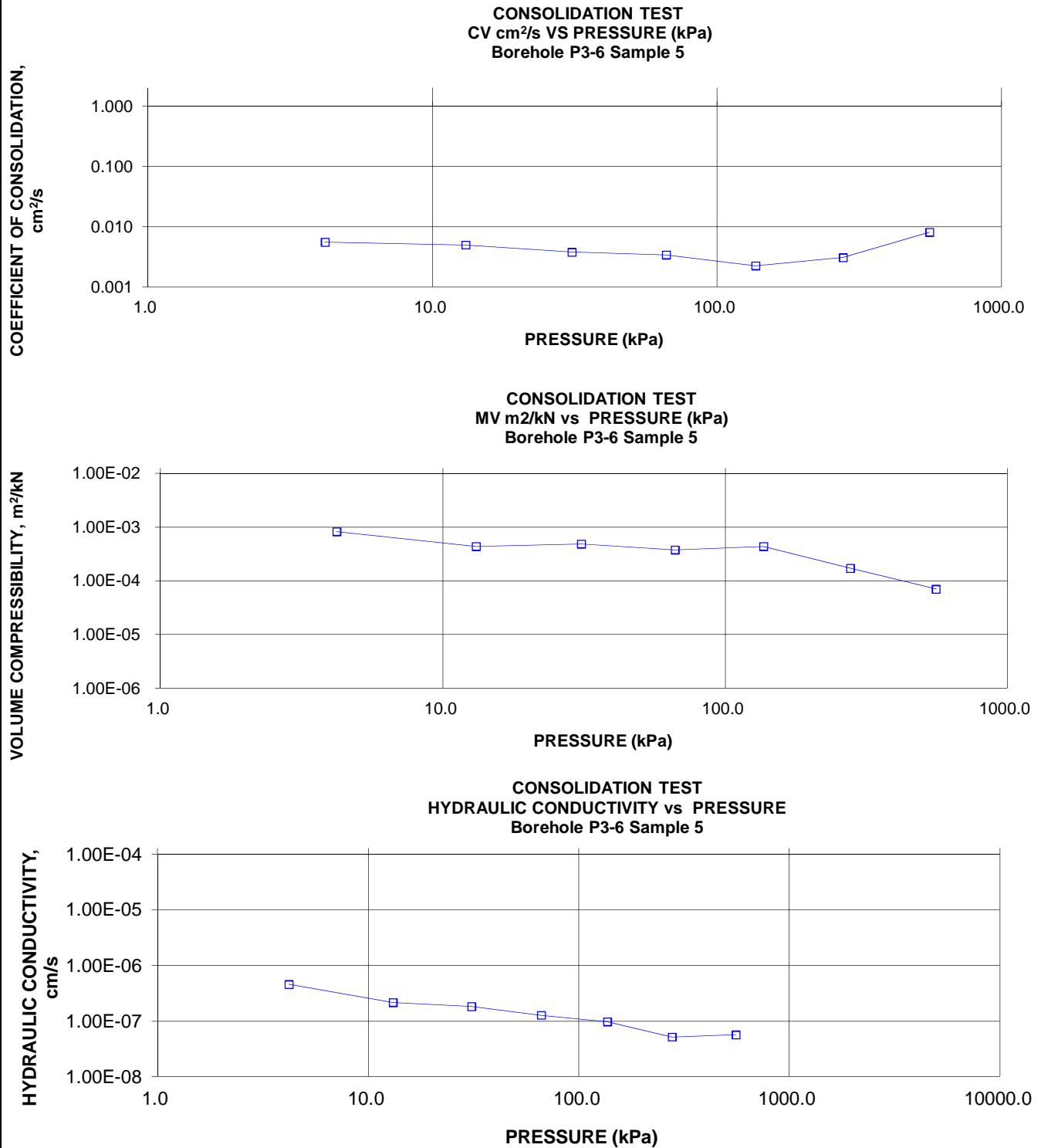
k calculated using cv based on t<sub>90</sub> values.**SAMPLE DIMENSIONS AND PROPERTIES - FINAL**

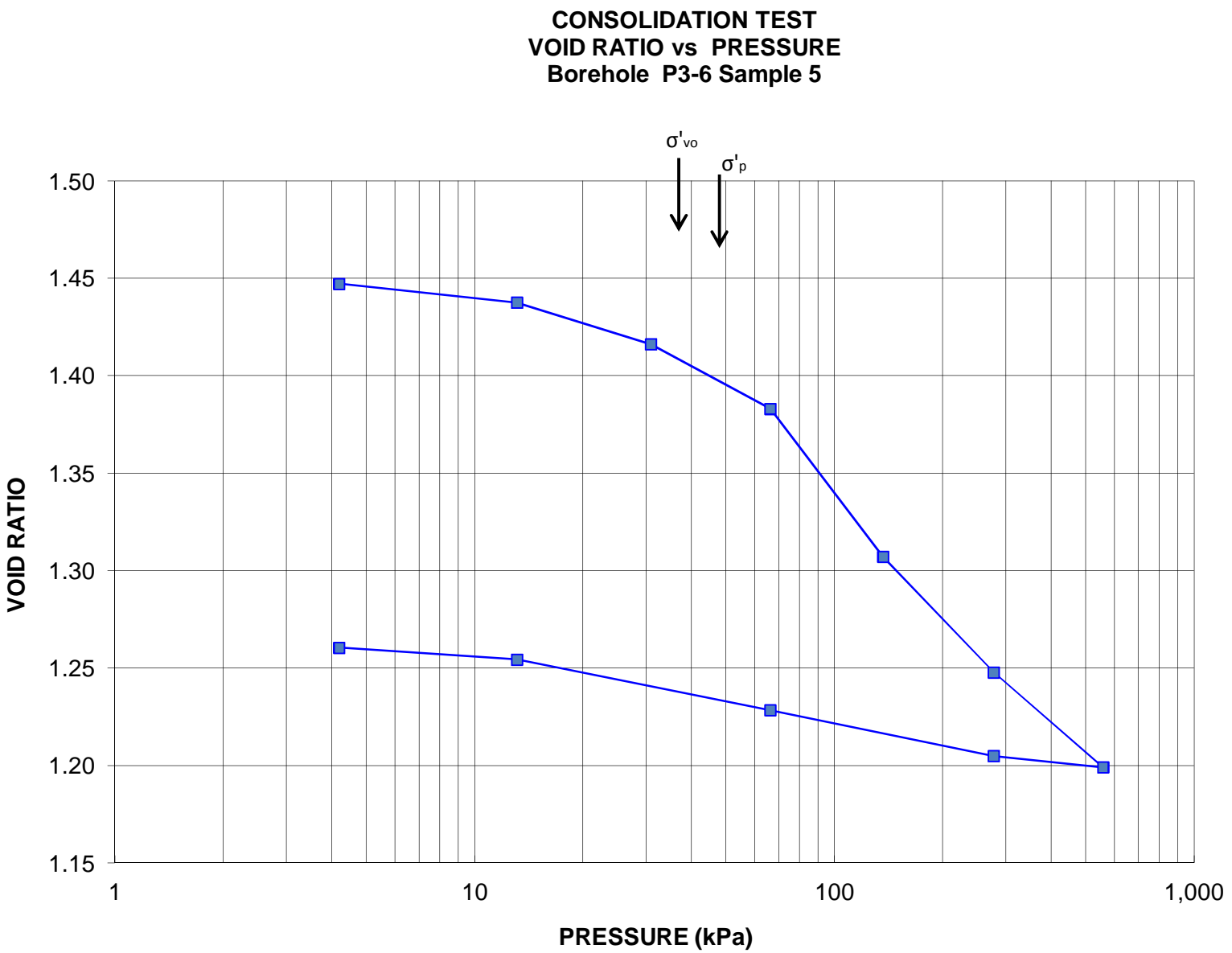
Sample Height, cm	2.32	Unit Weight, kN/m <sup>3</sup>	16.35
Sample Diameter, cm	6.36	Dry Unit Weight, kN/m <sup>3</sup>	11.94
Area, cm <sup>2</sup>	31.77	Specific Gravity, measured	2.75
Volume, cm <sup>3</sup>	73.78	Solids Height, cm	1.027
Water Content, %	36.98	Volume of Solids, cm <sup>3</sup>	32.64
Wet Mass, g	122.99	Volume of Voids, cm <sup>3</sup>	41.14
Dry Mass, g	89.79		

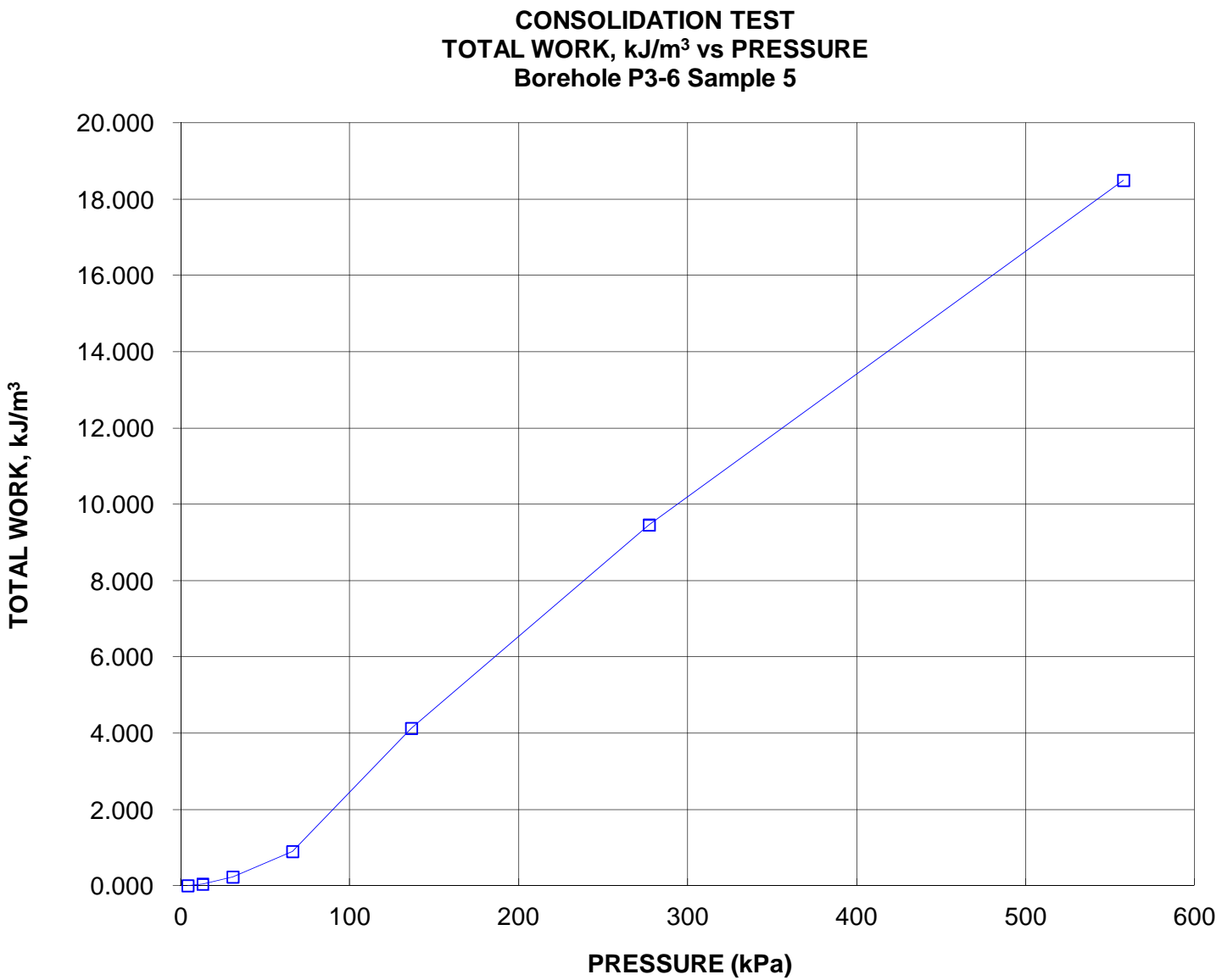
Prepared By: TG/SL

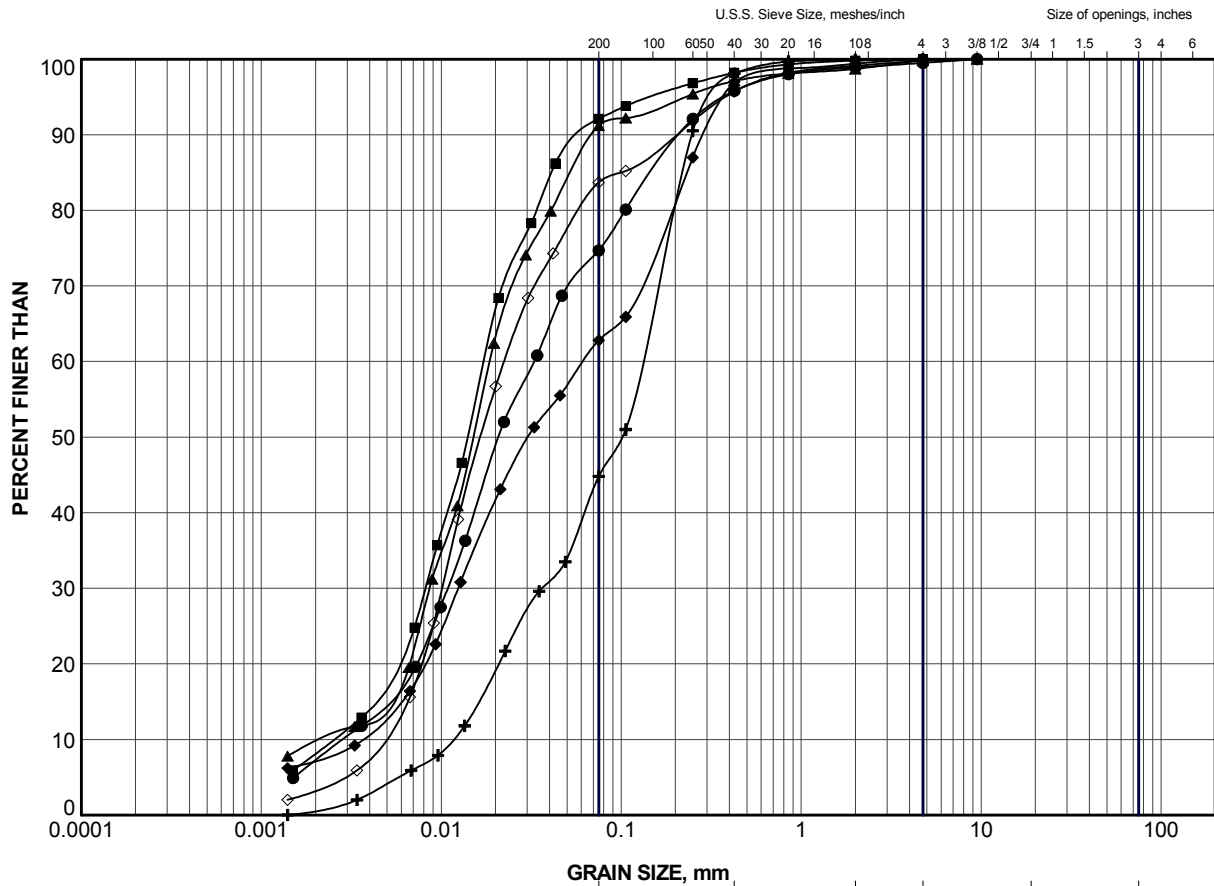
**Golder Associates**

Checked By: AB








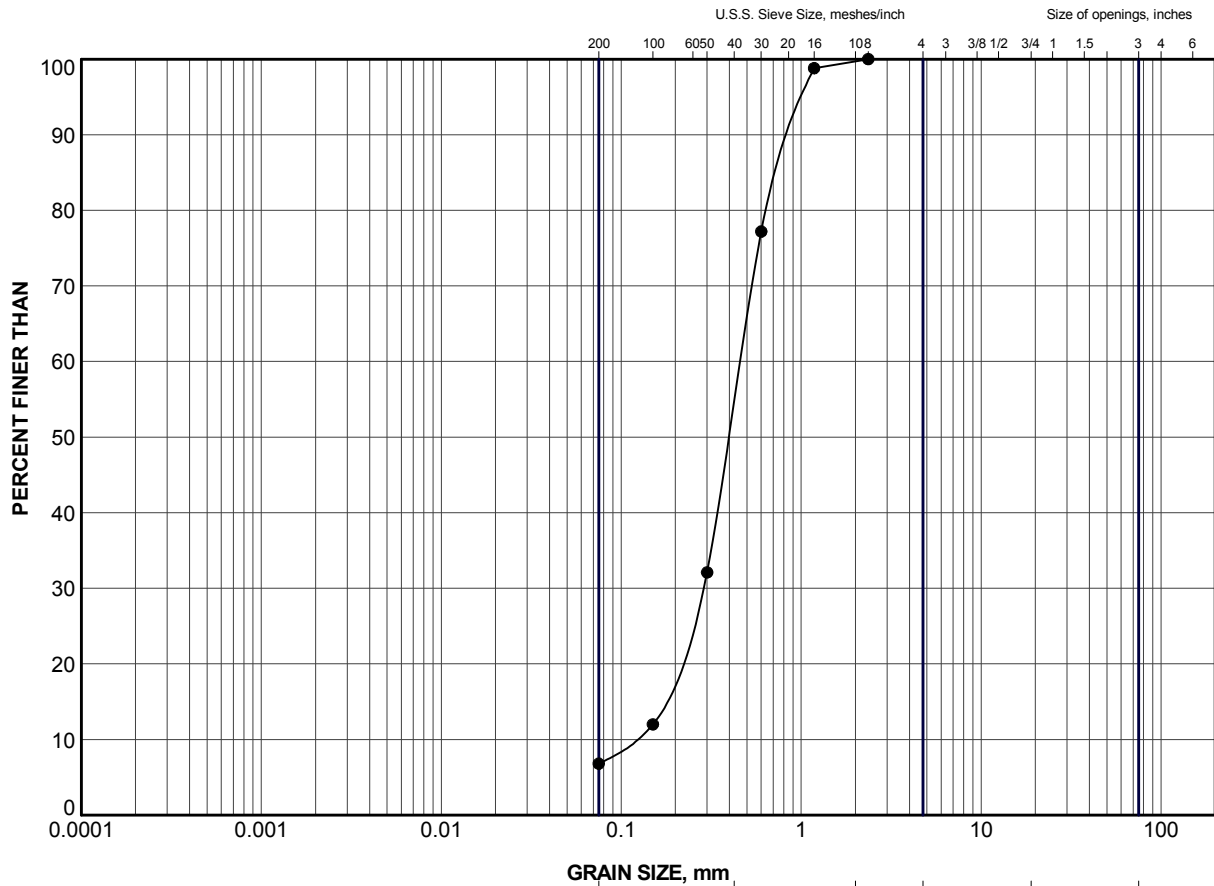


CLAY AND SILT	GRAVEL SIZE, mm					Cobble Size
	fine	medium	coarse	fine	coarse	
	SAND SIZE			GRAVEL SIZE		

### LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	P3-1	8	233.6
■	P3-3	7	235.7
▲	P3-4	7	234.6
+	P3-5	9	232.2
◆	P3-6	7	233.1
◇	P3-7	8	233.6

PROJECT					
HIGHWAY 17 STA 13+150 TO 13+350 EASTBOUND PASSING LANE					
TITLE					
GRAIN SIZE DISTRIBUTION SILT TO SAND AND SILT					
PROJECT No.		10-1191-0041		FILE No. 1011910041.GPJ	
DRAWN	TB	Mar 2013	SCALE	N/A	REV.
CHECK	AB	Mar 2013			
APPR	JMAC	Mar 2013			
 <b>Golder Associates</b> SUDBURY, ONTARIO			<b>FIGURE A13</b>		



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

#### LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	P3-6	8	231.5

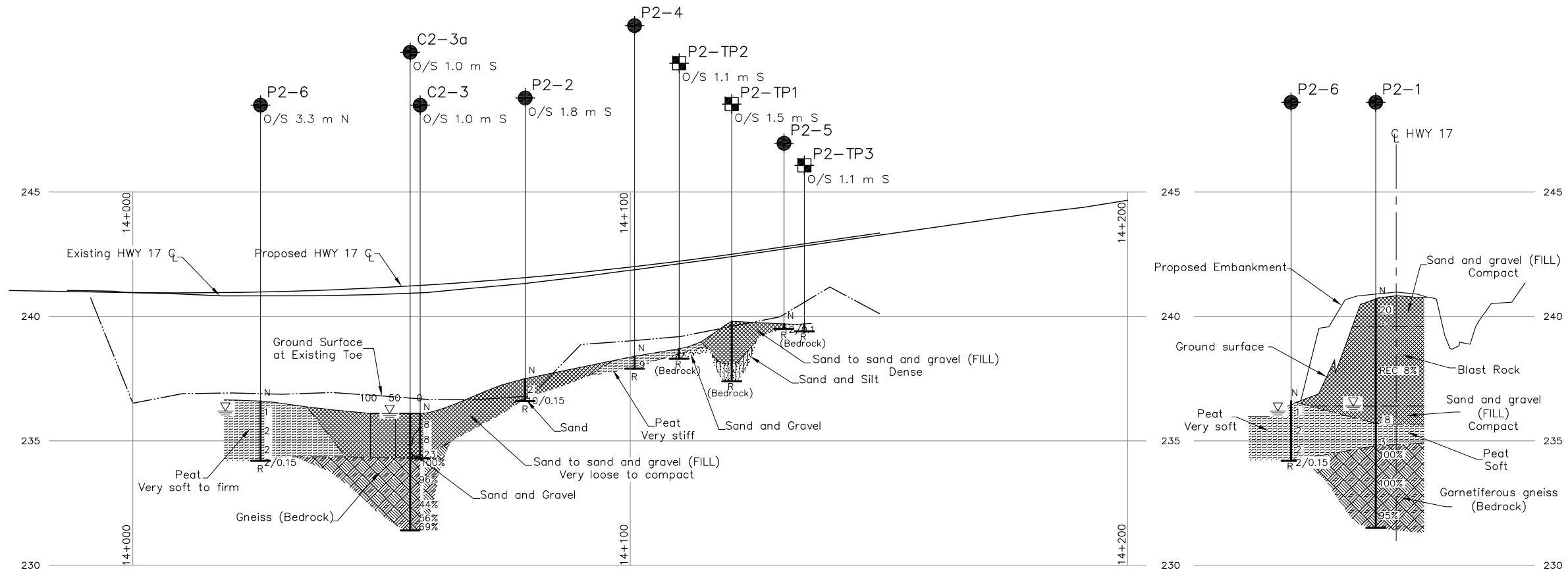
PROJECT					
HIGHWAY 17 STA 13+150 TO 13+350 EASTBOUND PASSING LANE					
TITLE					
GRAIN SIZE DISTRIBUTION SAND					
PROJECT No.		10-1191-0041		FILE No. 1011910041.GPJ	
DRAWN	TB	Mar 2013	SCALE	N/A	REV.
CHECK	AB	Mar 2013	FIGURE A14		
APPR	JMAC	Mar 2013			





# **APPENDIX B**

**Westbound Truck Climbing Lane - STA 14+000 to 14+150**



**WESTBOUND TRUCK CLIMBING LANE**

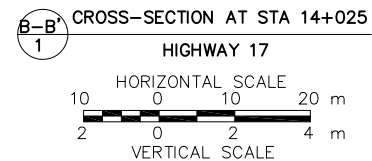
**HIGHWAY 17**

**HORIZONTAL SCALE**

10 0 10 20 m

**VERTICAL SCALE**

2 0 2 4 m



NO.	DATE	BY	REVISION	
Geocres No. 31L-160				
HWY. 17		PROJECT NO. 10-1191-0041		DIST.
SUBM'D. MT	CHKD. AB	DATE: APR 2013		SITE:
DRAWN: JLL	CHKD.	APPD. JMAC		DWG. B1



[illegible]

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

PROJECT: 10-1191-0041

**RECORD OF DRILLHOLE: P2-1**

SHEET 1 OF 1

LOCATION: N 5125771.0 ; E 330525.8


DRILLING DATE: May 26, 2011 and June 7, 2011

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME-55-Bomb and CME-850

DRILLING CONTRACTOR: Landcore

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV.		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				NOTES WATER LEVELS INSTRUMENTATION																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
				DEPTH (m)	RECOVERY			R.Q.D. %	FRACT. INDEX METRES	DISCONTINUITY DATA				HYDRAULIC CONDUCTIVITY				Diametral Load Index (MPa)	RMC -Q' AVG.																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
					TOTAL CORE %					SOLID CORE %	B Angle	DIP w.r.t. CORE AXIS	TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	10 <sup>0</sup>			10 <sup>1</sup>	10 <sup>2</sup>	10 <sup>3</sup>																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																			
6	NW  7/6/2011 NQ Coring	REFER TO PREVIOUS PAGE		234.8																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																					</

DEPTH SCALE

1 : 50




LOGGED: EHS



CHECKED: AB

SUD-RCK 1011910041.GPJ GAL-MISS.GDT 13/03/13 DATA INPUT:

PROJECT <u>10-1191-0041</u>		<b>RECORD OF BOREHOLE No P2-2</b>		1 OF 1 <b>METRIC</b>	
W.P. <u>174-98-00</u>		LOCATION <u>N 5125779.2 ; E 330579.2</u>		ORIGINATED BY <u>ID</u>	
DIST <u>          </u> HWY <u>17</u>		BOREHOLE TYPE <u>Portable Equipment</u>		COMPILED BY <u>LG</u>	
DATUM <u>Geodetic</u>		DATE <u>May 25, 2011</u>		CHECKED BY <u>AB</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										WATER CONTENT (%)		
								○ UNCONFINED      + FIELD VANE ● QUICK TRIAXIAL    × REMOULDED												
237.5	GROUND SURFACE							20	40	60	80	100								
0.0	Sand and gravel, containing organics (FILL) Very loose Brown Moist		1	SS	2		237													
236.7			2 a b	SS	10/0.15												0 81 (19)			
0.9	SAND, some silt Brown Moist  END OF BOREHOLE SPOON REFUSAL  Note:  1. Borehole dry upon completion of drilling.  2. Split Spoon samples obtained by driving with a 1/2 weight hammer. SPT 'N' values have been adjusted to the inferred values that would be obtained using a standard weight hammer.																			

PROJECT <u>10-1191-0041</u>		<b>RECORD OF BOREHOLE No P2-3</b>		1 OF 1 <b>METRIC</b>	
W.P. <u>174-98-00</u>		LOCATION <u>N 5125782.8 ; E 330579.3</u>		ORIGINATED BY <u>ID</u>	
DIST <u>          </u> HWY <u>17</u>		BOREHOLE TYPE <u>Portable Equipment</u>		COMPILED BY <u>LG</u>	
DATUM <u>Geodetic</u>		DATE <u>May 25, 2011</u>		CHECKED BY <u>AB</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									
								○ UNCONFINED      + FIELD VANE ● QUICK TRIAXIAL    × REMOULDED									
237.0	GROUND SURFACE							20	40	60	80	100					
0.0	PEAT (Fibrous)		1	SS	3/0.2												
0.2	Very soft Brown Moist  END OF BOREHOLE SPOON REFUSAL  Note:  1. Borehole dry upon completion of drilling.																

SUD-MTO 002 1011910041.GPJ GAL-MISS.GDT 16/04/13 DATA INPUT:

PROJECT <u>10-1191-0041</u>		<b>RECORD OF BOREHOLE No P2-4</b>		1 OF 1 <b>METRIC</b>	
W.P. <u>174-98-00</u>		LOCATION <u>N 5125779.0 ;E 330601.2</u>		ORIGINATED BY <u>ID</u>	
DIST <u>          </u> HWY <u>17</u>		BOREHOLE TYPE <u>Portable Equipment</u>		COMPILED BY <u>LG</u>	
DATUM <u>Geodetic</u>		DATE <u>May 25, 2011</u>		CHECKED BY <u>AB</u>	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT   NATURAL MOISTURE   LIQUID CONTENT			UNIT WEIGHT  γ  kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR   SA   SI   CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				
								○ UNCONFINED   + FIELD VANE ● QUICK TRIAXIAL   × REMOULDED									
238.4	GROUND SURFACE							20	40	60	80	100	W <sub>p</sub>	W	W <sub>L</sub>		
237.9	PEAT (Fibrous) Very stiff Brown / black Moist		1	SS	9		238										
0.5	END OF BOREHOLE SPOON REFUSAL  Note:  1. Borehole dry upon completion of drilling.																



PROJECT <u>10-1191-0041</u>		<b>RECORD OF BOREHOLE No P2-5</b>		1 OF 1 <b>METRIC</b>	
W.P. <u>174-98-00</u>		LOCATION <u>N 5125777.8 ;E 330631.2</u>		ORIGINATED BY <u>ID</u>	
DIST <u>          </u> HWY <u>17</u>		BOREHOLE TYPE <u>Portable Equipment</u>		COMPILED BY <u>LG</u>	
DATUM <u>Geodetic</u>		DATE <u>May 25, 2011</u>		CHECKED BY <u>AB</u>	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			UNIT WEIGHT  γ  kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED					WATER CONTENT (%)				
239.7	GROUND SURFACE	⊗	1	SS	12/0.1												
0.2	Sand and gravel, containing organics (FILL) Brown Moist	⊗															
	END OF BOREHOLE SPOON REFUSAL																
	Note:  1. Borehole dry upon completion of drilling.																

SUD-MTO 002 1011910041.GPJ GAL-MISS.GDT 16/04/13 DATA INPUT:

PROJECT <u>10-1191-0041</u>			<b>RECORD OF BOREHOLE No P2-6</b>			1 OF 1 <b>METRIC</b>		
W.P. <u>174-98-00</u>			LOCATION <u>N 5125788.0 ;E 330526.5</u>			ORIGINATED BY <u>ID</u>		
DIST <u>          </u> HWY <u>17</u>			BOREHOLE TYPE <u>Portable Equipment</u>			COMPILED BY <u>LG</u>		
DATUM <u>Geodetic</u>			DATE <u>May 26, 2011</u>			CHECKED BY <u>AB</u>		

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			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	60			
236.6	GROUND SURFACE																	
	PEAT (Fibrous) Very soft to firm Black Moist		1	SS	1		236											
			2	SS	2		235											
			3	SS	2													
234.2	END OF BOREHOLE SPOON REFUSAL		4	SS	2/0 15													
2.4	Note:  1. Water level at a depth of 0.4 m below ground surface (Elev. 236.2 m) upon completion of drilling.																	

PROJECT		10-1191-0041				RECORD OF BOREHOLE No C2-2				1 OF 1 METRIC							
W.P.		174-98-00		LOCATION		N 5125766.9; E 330559.9				ORIGINATED BY EHS							
DIST		HWY 17		BOREHOLE TYPE		108mm ID Continuous Flight Hollow Stem Augers, NW Casing, NQ Coring				COMPILED BY LG							
DATUM		Geodetic		DATE		May 19 and 24, 2011				CHECKED BY AB							
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					WATER CONTENT (%)				
240.9	GROUND SURFACE																
0.0	ASPHALT (220 mm)																
0.2	Sand and gravel to sand, trace to some silt (FILL)		1	AS	-												
	Brown Moist		2	AS	-												
239.8	Blast rock (FILL)																
1.1																	
				RC	REC 64%												
				RC	REC 57%												
236.8	Sand to sand and gravel, some organics (FILL)																
4.1	Very loose to compact		3	SS	3												
	Brown Wet																
			4	SS	21												
235.0	PEAT (Amorphous / Fibrous)																
5.9	Very soft to soft		5	SS	3												
	Brown / black Wet																
233.7	SILT, trace organics		6	SS	2												
233.3	Very loose Grey																
233.0	Wet		7	SS	25												
7.9	SAND and GRAVEL, some silt																
	Compact Grey Wet																
	END OF BOREHOLE REFUSAL TO FURTHER CASING PENETRATION																
	Note:																
	1. Water level at a depth of 4.6 m below ground surface (Elev. 236.3 m) upon completion of drilling.																

SUD-MTO 001 1011910041.GPJ GAL-MISS.GDT 12/03/13 DATA INPUT:

PROJECT 10-1191-0041				<b>RECORD OF BOREHOLE No C2-3</b>				1 OF 1 <b>METRIC</b>									
W.P. 174-98-00				LOCATION N 5125781.5; E 330558.2				ORIGINATED BY ID									
DIST HWY 17				BOREHOLE TYPE Portable Equipment				COMPILED BY LG									
DATUM Geodetic				DATE May 24, 2011				CHECKED BY AB									
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									
236.1	GROUND SURFACE						20	40	60	80	100						
0.0	Sand, trace gravel, trace silt, trace organics (FILL) Loose to compact Brown Wet		1	SS	8												
			2	SS	8												
234.4			3	SS	23												
1.8	SAND and GRAVEL Grey Wet END OF BOREHOLE SPOON REFUSAL  Note: 1. Water level at ground surface upon completion of drilling. 2. Split Spoon samples obtained by driving with a 1/2 weight hammer. SPT "N" values have been adjusted to the inferred values that would be obtained using a standard weight hammer. 3. Moved 2 m east to advance DCPT, refusal at 1.3 m depth. 4. Moved 2 m west and cored bedrock. See record of Borehole C2-3a for coring details.																

PROJECT		10-1191-0041				<b>RECORD OF BOREHOLE No C2-3a</b>				1 OF 1 <b>METRIC</b>							
W.P.		174-98-00		LOCATION		N 5125781.6; E 330556.2				ORIGINATED BY				LG			
DIST		HWY 17		BOREHOLE TYPE		Portable Equipment, NW Casing, Wash Boring, NQ Coring				COMPILED BY				LG			
DATUM		Geodetic		DATE		May 25, 2011				CHECKED BY				AB			
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			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 (%)				
236.1	GROUND SURFACE																
0.0	For stratigraphic details see Record of Borehole C2-3																
234.6	GNEISS (BEDROCK)																
1.5	Bedrock cored from 1.5 m depth to 4.7 m depth.  For coring details see Record of Drillhole C2-3b.		1	RC	REC 100%											RQD = 100%	
			2	RC	REC 96%											RQD = 96%	
			3	RC	REC 81%											RQD = 44%	
			4	RC	REC 100%											RQD = 56%	
			5	RC	REC 100%											RQD = 69%	
231.4	END OF BOREHOLE																
4.7	Note:  1. Cored bedrock 2 m west of Borehole C2-3.																



PROJECT: 10-1191-0041

# RECORD OF DRILLHOLE: C2-3a

SHEET 1 OF 1

LOCATION: N 5125781.6 ; E 330556.2

DRILLING DATE: May 25, 2011

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: Portable Hilti Drill

DRILLING CONTRACTOR: Landcore

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										NOTES WATER LEVELS INSTRUMENTATION																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											
							RECOVERY		R.Q.D. %	FRACT. INDEX METRES	DISCONTINUITY DATA										HYDRAULIC CONDUCTIVITY		Diameter Point Load Index (MPa)	RMC -Q AVG.																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																												
							TOTAL CORE %	SOLID CORE %			TYPE AND SURFACE DESCRIPTION										k, cm/s	10°																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
							FLUSH	80 85 90 95 100			80 85 90 95 100	10° 15° 20° 25° 30°	B Angle 0° 5° 10° 15° 20° 25° 30°	DIP w.r.t. CORE AXIS 0° 5° 10° 15° 20° 25° 30°	TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	10° 15° 20° 25° 30°	10° 15° 20° 25° 30°	10° 15° 20° 25° 30°																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
		REFER TO PREVIOUS PAGE		234.6																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																

DEPTH SCALE

1 : 50



LOGGED: LG

CHECKED: AB

SUD-RCK 1011910041.GPJ GAL-MISS.GDT 13/03/13 DATA INPUT:

# RECORD OF TEST PIT

**Job Number:** 10-1191-0041      **Date:** July 6, 2011      **Datum:** Geodetic

**Contractor:** Bartlett's Towing      **Machine Type:** CAT 3200

**Test Pit No:** P2-TP1      **Test Pit Size:** 2 m x 4 m      **Location:** N 5125776.7  
E 330620.6      **Ground Elevation:** 239.8 m

Depth (m)		Soil Description	Samples		Lab Testing
From	To		No.	Depth (m)	
0	1.7	Sand, trace to some silt, some gravel, with boulders (500 mm in size) throughout (FILL)	1 2	0.6 1.4	W = 15% GR = 32% SA = 59% SI + CL = 9%
1.7	2.4	SAND and SILT, trace clay	3	2.0	W = 26% GR = 0% SA = 38% SI = 58% CL = 4%
2.4		End of Test Pit (Bedrock) (Elevation 237.4 m)			

**Comments**

Blast rock boulders at ground surface.

**Water Conditions in Test Pit**

Seepage into test pit at a depth of 2.1 m below ground surface (Elev. 237.7 m)

**Test Pit No:** P2-TP2      **Test Pit Size:** 1 m x 1 m      **Location:** N 5125777.8  
E 330610.1      **Ground Elevation:** 238.7 m

Depth (m)		Soil Description	Samples		Lab Testing
From	To		No.	Depth (m)	
0	0.2	Sandy PEAT	1	0.1	W = 48%
0.2	0.4	SAND and GRAVEL, trace organics	2	0.3	W = 9% GR = 34% SA = 63% SI + CL = 3%
0.4		End of Test Pit (Bedrock) (Elevation 238.3 m)			

**Comments**

Blast rock boulders at ground surface.

**Water Conditions in Test Pit**

Dry

Golder Associates

Logged: LG/MT  
Checked: AB

# RECORD OF TEST PIT

**Job Number:** 10-1191-0041      **Date:** July 6, 2011      **Datum:** Geodetic

**Contractor:** Bartlett's Towing      **Machine Type:** CAT 3200

**Test Pit No:** P2-TP3      **Test Pit Size:** 1 m x 1 m      **Location:** N 5125776.1  
E 330635.3      **Ground Elevation:** 239.6 m

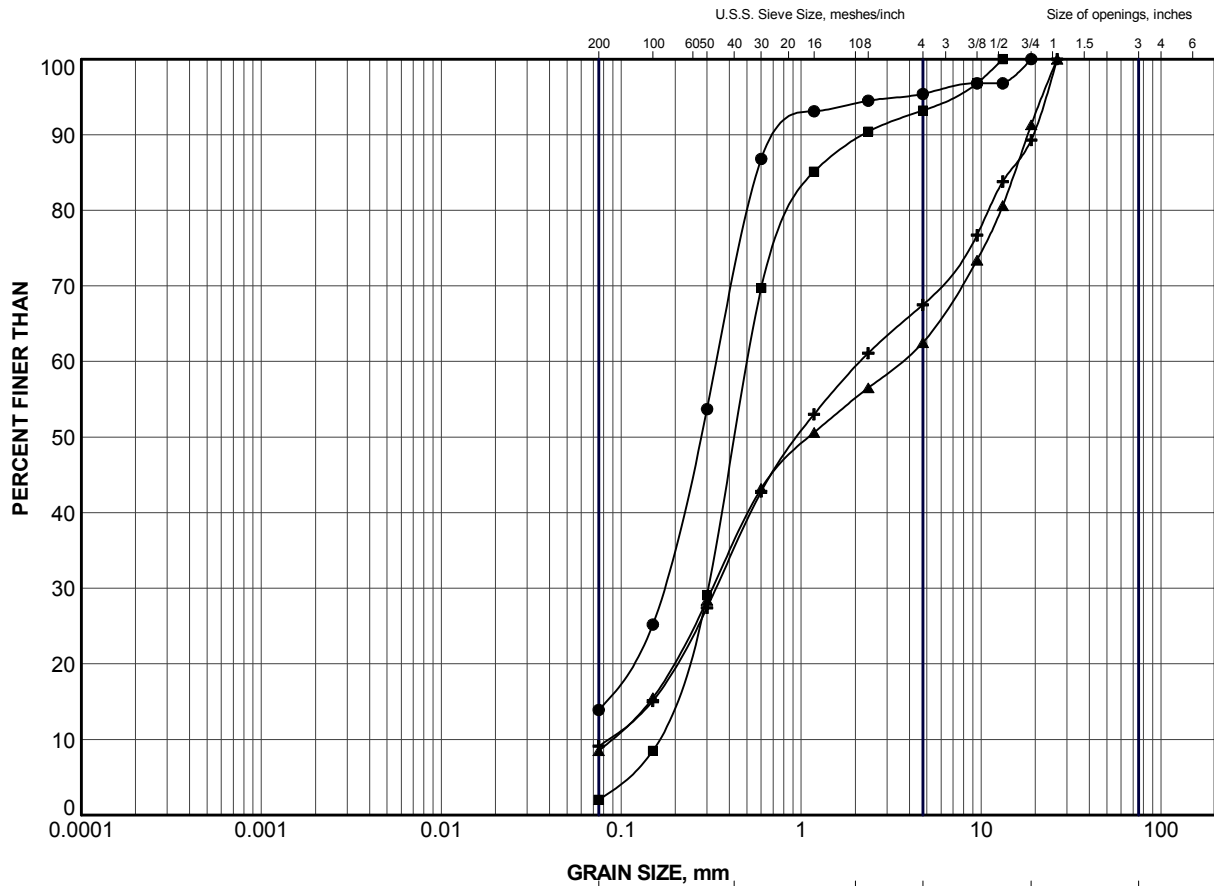
Depth (m)		Soil Description	Samples		Lab Testing
From	To		No.	Depth (m)	
0	0.3	Sand, some gravel, trace to some organics (FILL)	1	0.2	
0.3		End of Test Pit (Bedrock) (Elevation 239.3)			

**Comments**

Blast rock boulders at ground surface.

**Water Conditions in Test Pit**

Dry



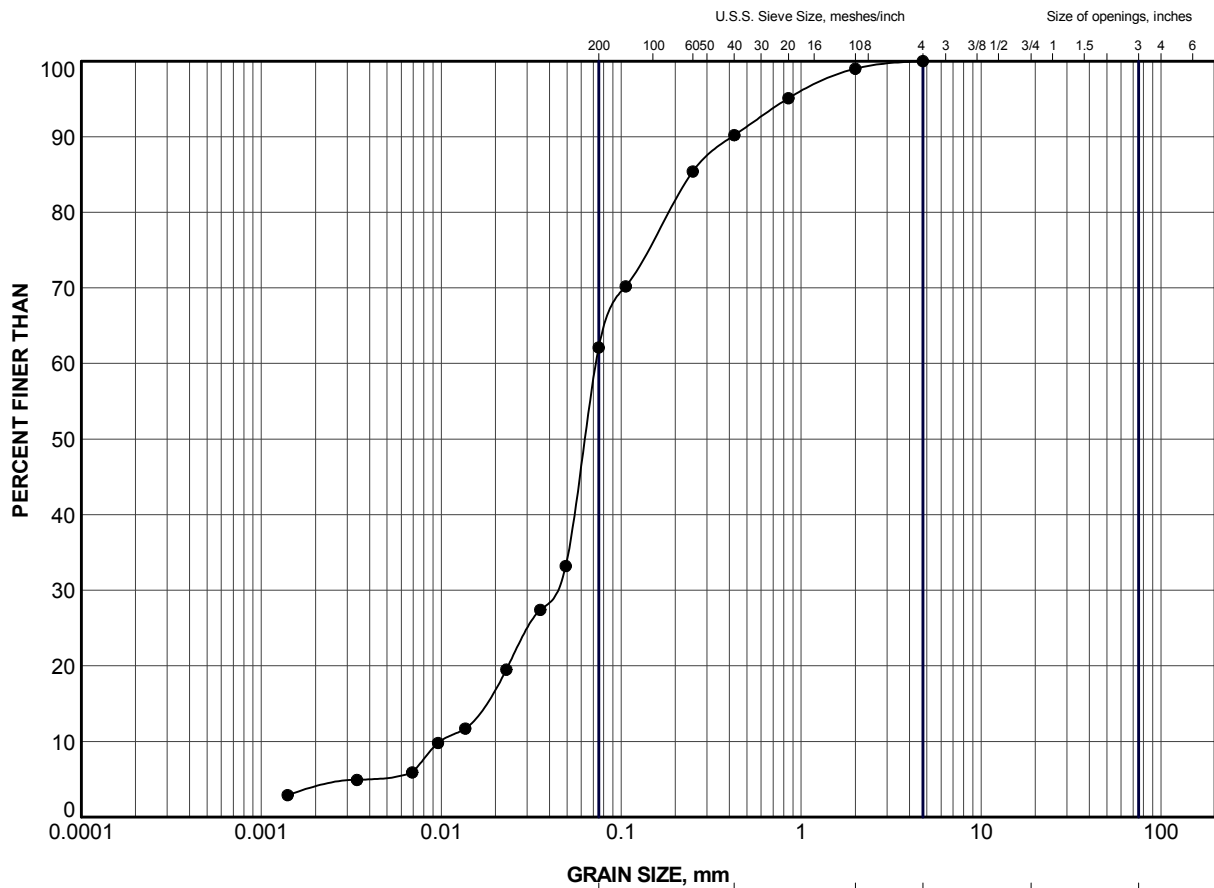
CLAY AND SILT	GRAVEL SIZE, mm					Cobble Size
	fine	medium	coarse	fine	coarse	
	SAND SIZE			GRAVEL SIZE		

#### LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	C2-2	2	240.3
■	C2-3	2	235.2
▲	P2-1	2	239.8
+	P2-TP1	1	239.2

PROJECT		HIGHWAY 17 STA 14+000 to 14+150 WESTBOUND TRUCK CLIMBING LANE			
TITLE		<b>GRAIN SIZE DISTRIBUTION</b> SAND AND GRAVEL TO SAND (FILL)			
PROJECT No.		10-1191-0041		FILE No. 1011910041.GPJ	
DRAWN	TB	Mar 2012		SCALE	N/A
CHECK	AB	Mar 2012		REV.	
APPR	JMAC	Mar 2012		<b>FIGURE B1</b>	




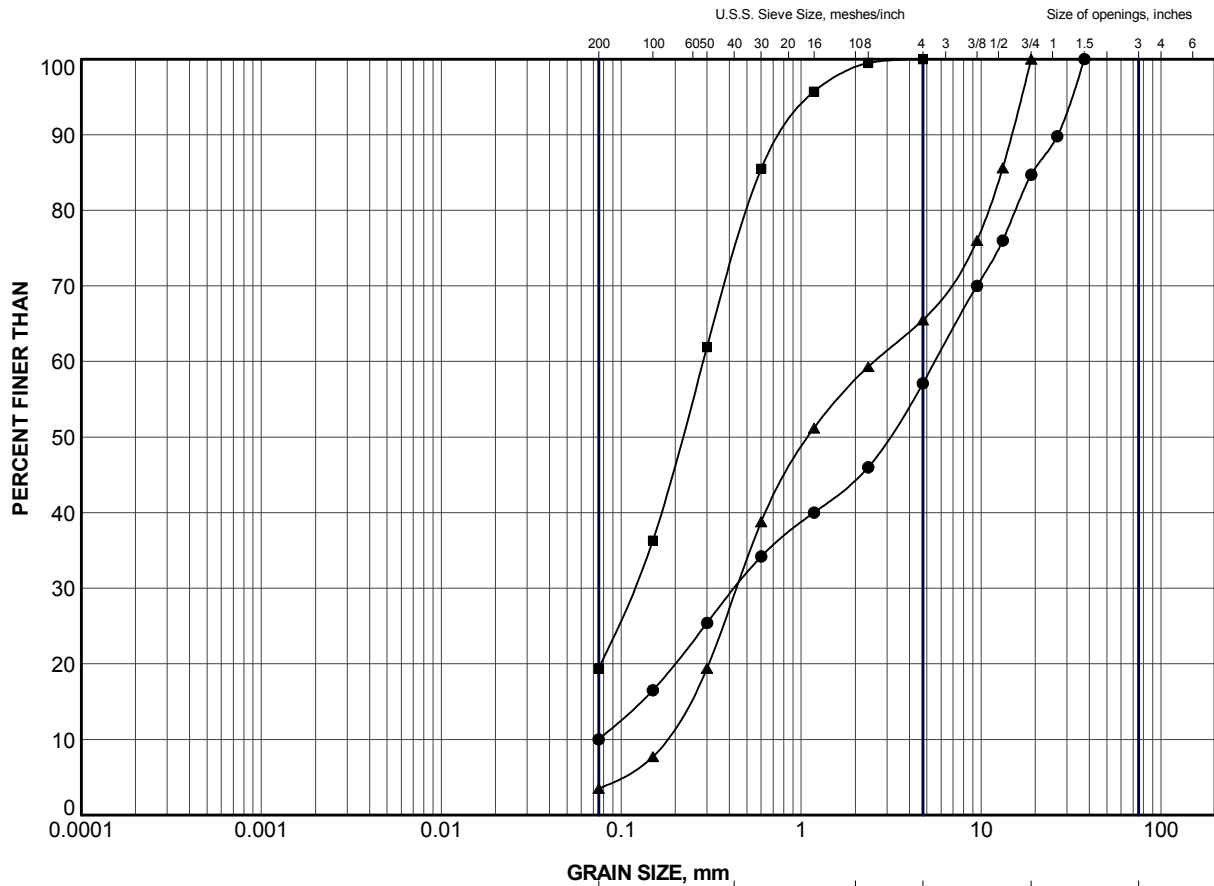


GRAIN SIZE, mm						
CLAY AND SILT	fine	medium	coarse	fine	coarse	Cobble Size
	SAND SIZE			GRAVEL SIZE		

#### LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	P2-TP1	3	237.8


PROJECT		HIGHWAY 17 STA 14+000 to 14+150 WESTBOUND TRUCK CLIMBING LANE			
TITLE		<b>GRAIN SIZE DISTRIBUTION</b> SAND AND SILT			
PROJECT No.		10-1191-0041		FILE No. 1011910041.GPJ	
DRAWN	TB	Mar 2012	SCALE	N/A	REV.
CHECK	AB	Mar 2012			
APPR	JMAC	Mar 2012			
 <b>Golder Associates</b> SUDBURY, ONTARIO			<b>FIGURE B2</b>		



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

#### LEGEND

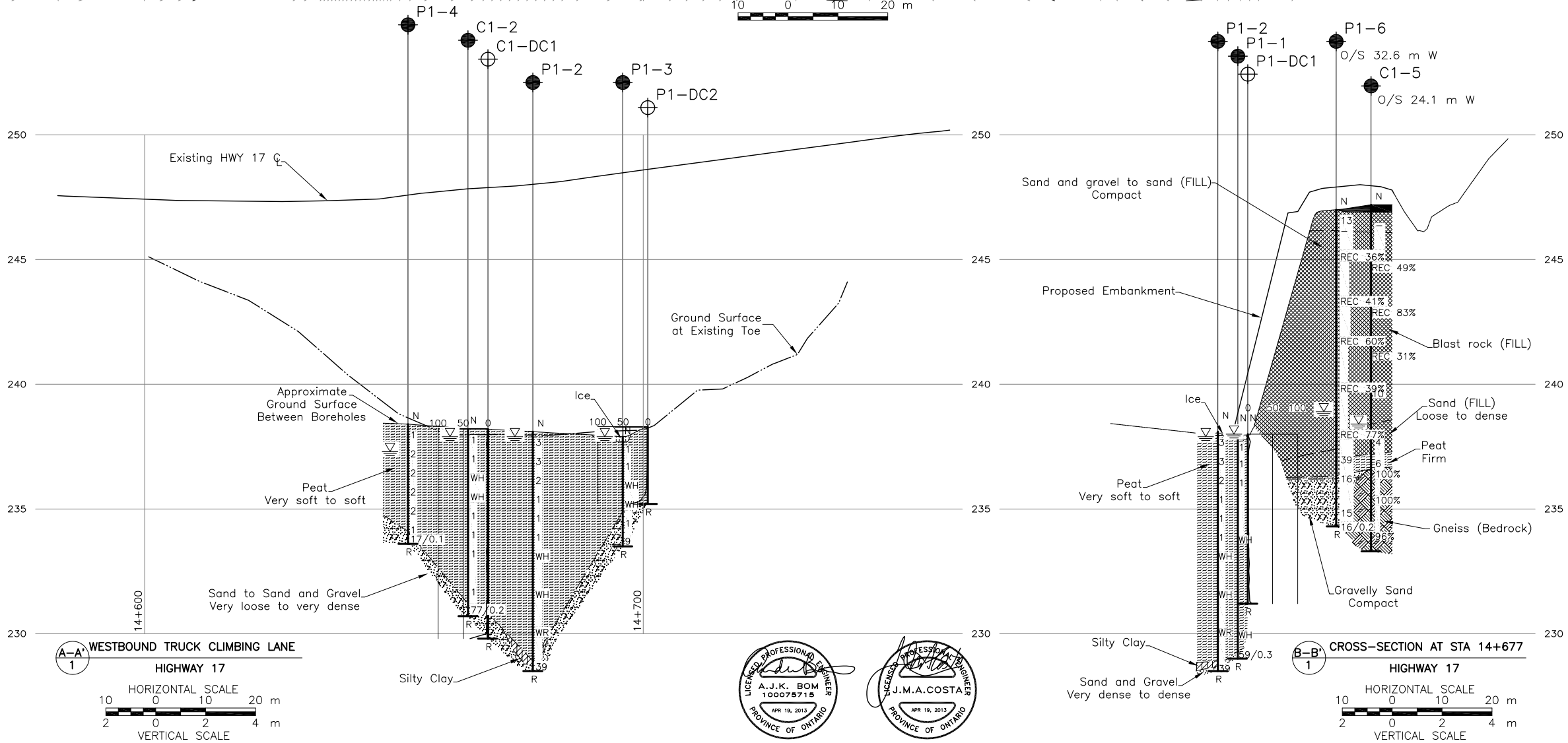
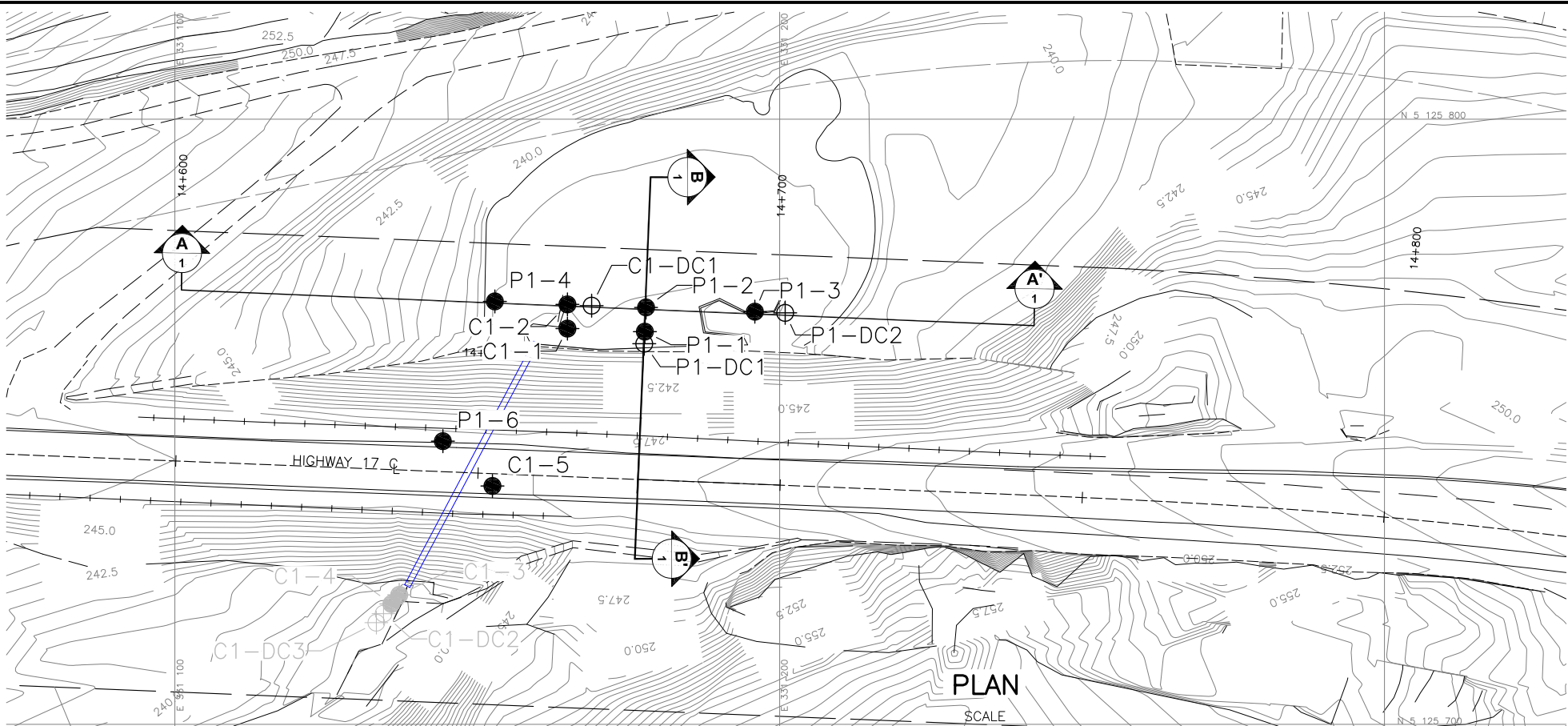
SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	C2-2	7	233.1
■	P2-2	2b	236.6
▲	P2-TP2	2	238.6

PROJECT						HIGHWAY 17 STA 14+000 to 14+150 WESTBOUND TRUCK CLIMBING LANE					
TITLE						GRAIN SIZE DISTRIBUTION SAND TO SAND AND GRAVEL					
PROJECT No.			10-1191-0041			FILE No.			1011910041.GPJ		
DRAWN	TB	Mar 2012	SCALE	N/A	REV.						
CHECK	AB	Mar 2012									
APPR	JMAC	Mar 2012									
 <b>Golder Associates</b> SUDBURY, ONTARIO						<b>FIGURE B3</b>					



# **APPENDIX C**

**Westbound Truck Climbing Lane - STA 14+650 to 14+700**



**METRIC**  
DIMENSIONS ARE IN METRES AND/OR  
MILLIMETRES UNLESS OTHERWISE SHOWN.  
STATIONS IN KILOMETRES + METRES.

CONT No.  
GWP No.174-98-00

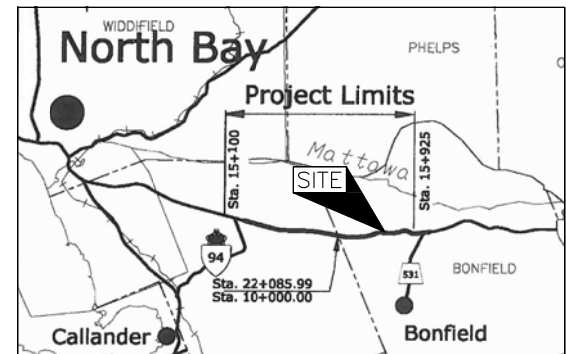
HIGHWAY 17  
STA 14+650 TO 14+700 WESTBOUND TRUCK CLIMBING LANE  
BOREHOLE LOCATIONS AND  
SOIL STRATA



SHEET



**Golder Associates Ltd.**  
SUDBURY, ONTARIO, CANADA



KEY PLAN  
SCALE  
5 0 5 km

#### LEGEND

- Borehole - Current Investigation
- ⊕ Dynamic Cone Penetration Test
- N Standard Penetration Test Value
- R Refusal
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- ▽ WL upon completion of drilling

#### BOREHOLE CO-ORDINATES

No.	ELEVATION	NORTHING	EASTING
C1-1	238.1	5125765.4	331164.9
C1-2	238.2	5125769.4	331164.9
C1-5	247.2	5125739.4	331152.5
C1-DC1	238.2	5125769.2	331168.9
P1-1	238.0	5125764.9	331177.7
P1-2	238.1	5125768.9	331177.9
P1-3	237.9	5125768.2	331195.9
P1-4	238.4	5125769.9	331152.9
P1-6	247.0	5125746.8	331144.3
P1-DC1	238.0	5125762.9	331177.6
P1-DC2	238.3	5125768.0	331200.9

#### 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.

The complete Foundation Investigation and Design Report for this project and other related documents may be examined at the Materials Engineering and Research Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with Section GC 2.01 of OPS General Conditions.

#### REFERENCE

Base plans provided in digital format by MMM, drawing file nos. BASE\_ALL.dwg and Alignment.dwg received NOV 10, 2011. Keyplan received DEC 7, 2011.



NO.	DATE	BY	REVISION
1	NOV 10, 2011	JJL	BASE PLAN
2	DEC 7, 2011	JJL	KEY PLAN
3	MAR 13, 2013	JJL	FINAL

Geocres No.31L-160




HWY. 17	PROJECT NO. 10-1191-0041	DIST.
SUBM'D. MT	CHKD. AB	DATE: MAR 2013
DRAWN: JJL	CHKD.	APPD. JMAC
		DWG. C1



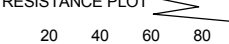


PROJECT		10-1191-0041		<b>RECORD OF BOREHOLE No P1-1</b>				1 OF 1 <b>METRIC</b>						
W.P.		174-98-00		LOCATION		N 5125764.9; E 331177.7		ORIGINATED BY ID						
DIST		HWY 17		BOREHOLE TYPE		Portable Equipment, NW Casing, Wash Boring		COMPILED BY LG						
DATUM		Geodetic		DATE		March 2, 2011		CHECKED BY AB						
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						
238.0	ICE SURFACE													
0.0	ICE													
0.2	PEAT (Fibrous) Very soft Brown / black Wet		1	SS	1								205.5	
			2	SS	1								120.7	
			3	SS	1								185.5	
			4	SS	1									
			5	SS	1								704.6	
			6	SS	WH									
			7	SS	1								584.5	
232.4	PEAT (Amorphous) Very soft Brown / black Wet													
5.6			8	SS	1									
			9	SS	WH									
229.3														
229.0	SAND and GRAVEL, trace silt Very dense Grey Wet		10	SS	59/0.3									
9.0	END OF BOREHOLE SPOON REFUSAL													
	Note:  1. Water level at ice surface (Elev. 238.0 m) upon completion of drilling.													

SUD-MTO 001 1011910041.GPJ GAL-MISS.GDT 12/03/13 DATA INPUT:

PROJECT <u>10-1191-0041</u>		<b>RECORD OF BOREHOLE No P1-2</b>		1 OF 1 <b>METRIC</b>	
W.P. <u>174-98-00</u>		LOCATION <u>N 5125768.9; E 331177.9</u>		ORIGINATED BY <u>ID</u>	
DIST <u>          </u> HWY <u>17</u>		BOREHOLE TYPE <u>Portable Equipment, NW Casing, Wash Boring</u>		COMPILED BY <u>LG</u>	
DATUM <u>Geodetic</u>		DATE <u>March 3, 2011</u>		CHECKED BY <u>AB</u>	

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 (%)					
								20	40	60	80	100	W <sub>p</sub>	W			
238.1	GROUND SURFACE																
0.0	PEAT (Fibrous) Very soft to soft Brown / black Wet		1	SS	3												
			2	SS	3												
			3	SS	2												
			4	SS	1												
			5	SS	1												
			6	SS	1												
			7	SS	WH												
231.7	PEAT (Amorphopus) Very soft Brown / black Wet		8	SS	WH												
6.4																	
			9	SS	WR												
228.9	SILTY CLAY Grey Wet		10a	SS	39												
			10b														
9.6	SAND and GRAVEL, trace to some silt Dense Grey Wet  END OF BOREHOLE SPOON REFUSAL  Note:  1. Water level at a depth of 0.2 m below ground surface (Elev. 237.9 m) upon completion of drilling.																



PROJECT 10-1191-0041				RECORD OF BOREHOLE No P1-3				1 OF 1 METRIC									
W.P. 174-98-00				LOCATION N 5125768.2; E 331195.9				ORIGINATED BY ID									
DIST HWY 17				BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring				COMPILED BY LG									
DATUM Geodetic				DATE March 4, 2011				CHECKED BY AB									
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									
237.9	ICE SURFACE																
0.0	ICE																
0.2	PEAT (Fibrous) Very soft Brown / black Wet		1	SS	1												
			2	SS	1												
			3	SS	WH												
			4	SS	WH												
234.9	SAND to SAND and GRAVEL, trace silt Very loose to loose Grey Wet		5	SS	1												
3.0			6	SS	9												
233.5	END OF BOREHOLE SPOON AND CASING REFUSAL																
4.4	Note:  1. Water level at ice surface (Elev. 237.9 m) upon completion of drilling.																

PROJECT 10-1191-0041			<b>RECORD OF BOREHOLE No P1-4</b>				1 OF 1 <b>METRIC</b>					
W.P. 174-98-00		LOCATION N 5125769.9; E 331152.9				ORIGINATED BY ID						
DIST HWY 17		BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring				COMPILED BY LG						
DATUM Geodetic		DATE March 3, 2011				CHECKED BY AB						
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT  SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED	PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT W <sub>p</sub> — W — W <sub>L</sub> WATER CONTENT (%)	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES							
238.4	GROUND SURFACE											
0.0	PEAT (Fibrous) Very soft to soft Brown / black Wet		1	SS	1	▽	238				22.0	
			2	SS	2		237				107.5	
			3	SS	2		236				105.4	
			4	SS	2		235					
			5	SS	2							
234.1			6a	SS	1						190.2	OC=17.1%
4.3	SAND to SAND and GRAVEL, trace to some silt		6b				234					34 48 (18)
233.6	Dense Brown Wet		7	SS	17/0.1							11 81 (8)
4.8	END OF BOREHOLE SPOON REFUSAL											
Note: 1. Water level at a depth of 1.1 m below ground surface (Elev. 237.3 m) upon completion of drilling. 2. Split Spoon samples obtained by driving with a 1/2 weight hammer. SPT 'N' values have been adjusted to the inferred values that would be obtained using a standard weight hammer.												

PROJECT 10-1191-0041				RECORD OF BOREHOLE No P1-6				1 OF 1 METRIC								
W.P. 174-98-00				LOCATION N 5125746.8; E 331144.3				ORIGINATED BY EHS								
DIST _____ HWY 17				BOREHOLE TYPE 108mm ID Continuous Flight Hollow Stem Augers, NW Casing, NQ Coring				COMPILED BY LG								
DATUM Geodetic				DATE May 26 and 27, 2011				CHECKED BY AB								
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								
247.0	GROUND SURFACE															
0.0	Sand and gravel to sand, trace silt (FILL) Compact Brown to grey Moist		1a	SS	13											
246.2			1b	AS	-											
0.8	Blast rock (FILL)															
				RC	REC 36%											
				RC	REC 41%											
				RC	REC 60%											
				RC	REC 39%											
				RC	REC 77%											
237.4																
9.6	Sand, some silt, trace gravel (FILL) Dense Brown Wet		2	SS	39											3 87 (10)
236.3																
10.8	PEAT (Amorphous) Black Wet		3	SS	16											
	Gravelly SAND, trace to some silt, with cobbles at 12.6 m depth Compact Brown Wet															
			4	SS	15											21 72 (7)
234.3																
12.7	END OF BOREHOLE SPOON AND CASING REFUSAL		5	SS	16/0.2											
	Note:  1. Water level at a depth of 8.1 m below ground surface (Elev. 238.9 m) upon completion of drilling.															

SUD-MTO 001 1011910041.GPJ CAL-MISS.GDT 12/03/13 DATA INPUT:

PROJECT 10-1191-0041			RECORD OF BOREHOLE No C1-1			1 OF 1 METRIC								
W.P. 174-98-00			LOCATION N 5125765.4; E 331164.9			ORIGINATED BY ID								
DIST _____ HWY 17			BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring			COMPILED BY LG								
DATUM Geodetic			DATE March 11 and 12, 2011			CHECKED BY AB								
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						
238.1	GROUND SURFACE							20 40 60 80 100	20 40 60					
0.0	Sand and gravel, trace organics (FILL) Compact Brown Wet		1	SS	12		238							
237.0			2	SS	4		237							
236.6	PEAT (Amorphous) Soft Brown / black Wet		3	SS	3		236						512.4	
1.5	PEAT (Fibrous) Very soft to soft Brown to black Wet		4	SS	1		235						780.6	
			5	SS	1		234							
			6	SS	1		233							
			7	SS	1									
232.6			8a											
232.3	SAND and GRAVEL, trace to some silt Very dense Grey Wet		8b	SS	54									48 45 (7)
5.8	END OF BOREHOLE SPOON REFUSAL													
Note: 1. Water level at a depth of 0.2 m below ground surface (Elev. 237.9 m) upon completion of drilling.														

PROJECT 10-1191-0041			RECORD OF BOREHOLE No C1-2				1 OF 1 METRIC							
W.P. 174-98-00		LOCATION N 5125769.4; E 331164.9				ORIGINATED BY ID								
DIST _____ HWY 17		BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring				COMPILED BY LG								
DATUM Geodetic		DATE March 2, 2011				CHECKED BY AB								
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						
238.2	GROUND SURFACE							20 40 60 80 100	20 40 60					
0.0	PEAT (Amorphous) Very soft Brown / black Wet		1	SS	1		238							
			2	SS	1		237							
236.4			3	SS	WH		236							
1.8	PEAT (Fibrous) Very soft Brown / black Wet		4	SS	WH		235							
			5	SS	1		234							
			6	SS	1		233							
			7	SS	1		232							
231.8		8	SS	1	231									
6.4	PEAT (Amorphous) Very soft Brown / black Wet													
231.2														
7.0	SAND and GRAVEL, some silt													
230.7	Very dense Grey Wet													
7.5	END OF BOREHOLE SPOON REFUSAL													
	Note:  1. Water level at a depth of 0.3 m below ground surface (Elev. 237.9 m) upon completion of drilling.													

SUD-MTO 001 1011910041.GPJ GAL-MISS.GDT 12/03/13 DATA INPUT:

PROJECT <u>10-1191-0041</u>		<b>RECORD OF BOREHOLE No C1-5</b>		1 OF 2		<b>METRIC</b>	
W.P. <u>174-98-00</u>		LOCATION <u>N 5125739.4; E 331152.5</u>		ORIGINATED BY <u>EHS</u>			
DIST _____ HWY <u>17</u>		BOREHOLE TYPE <u>108mm ID Continous Flight Hollow Stem Augers, NW Casing, NQ Coring</u>		COMPILED BY <u>LG</u>			
DATUM <u>Geodetic</u>		DATE <u>May 11, 2011</u>		CHECKED BY <u>AB</u>			

[illegible]

Continued Next Page

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

○ 3% STRAIN AT FAILURE

SUD-MTO 001 1011910041.GPJ GAL-MISS.GDT 12/03/13 DATA INPUT:



PROJECT <u>10-1191-0041</u>		<b>RECORD OF BOREHOLE No C1-5</b>		2 OF 2 <b>METRIC</b>	
W.P. <u>174-98-00</u>		LOCATION <u>N 5125739.4; E 331152.5</u>		ORIGINATED BY <u>EHS</u>	
DIST <u>          </u> HWY <u>17</u>		BOREHOLE TYPE <u>108mm ID Continous Flight Hollow Stem Augers, NW Casing, NQ Coring</u>		COMPILED BY <u>LG</u>	
DATUM <u>Geodetic</u>		DATE <u>May 11, 2011</u>		CHECKED BY <u>AB</u>	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT   NATURAL MOISTURE   LIQUID CONTENT   LIMIT			UNIT WEIGHT  γ  kN/m³	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>		GR	SA	SI	CL	
								20	40	60	80	100									
	--- CONTINUED FROM PREVIOUS PAGE ---  END OF BOREHOLE  Note:  1. Water level at a depth of 8.8 m below ground surface (Elev. 238.4 m) upon completion of drilling.																				

SUD-MTO 001 1011910041.GPJ GAL-MISS.GDT 12/03/13 DATA INPUT:

PROJECT: 10-1191-0041

**RECORD OF DRILLHOLE: C1-5**

SHEET 1 OF 1

LOCATION: N 5125739.4 ;E 331152.5

DRILLING DATE: May 11, 2011

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME-53-Bomb

DRILLING CONTRACTOR: Landcore

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.	NOTES WATER LEVELS INSTRUMENTATION																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																												
							RECOVERY		R.Q.D. %	FRACT. INDEX METRES	DISCONTINUITY DATA										HYDRAULIC CONDUCTIVITY		Diameter Point Load Index (MPa)	RMC -Q' AVG.																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																					
							TOTAL CORE %	SOLID CORE %			B Angle	DIP w.r.t. CORE AXIS	TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	k, cm/s	10 <sup>-6</sup>	10 <sup>-6</sup>	10 <sup>-6</sup>																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
							888888	888888																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																					
		REFER TO PREVIOUS PAGE		236.6																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									

DEPTH SCALE

1 : 50



LOGGED: EHS

CHECKED: AB

SUD-RCK 1011910041.GPJ GAL-MISS.GDT 13/03/13 DATA INPUT:



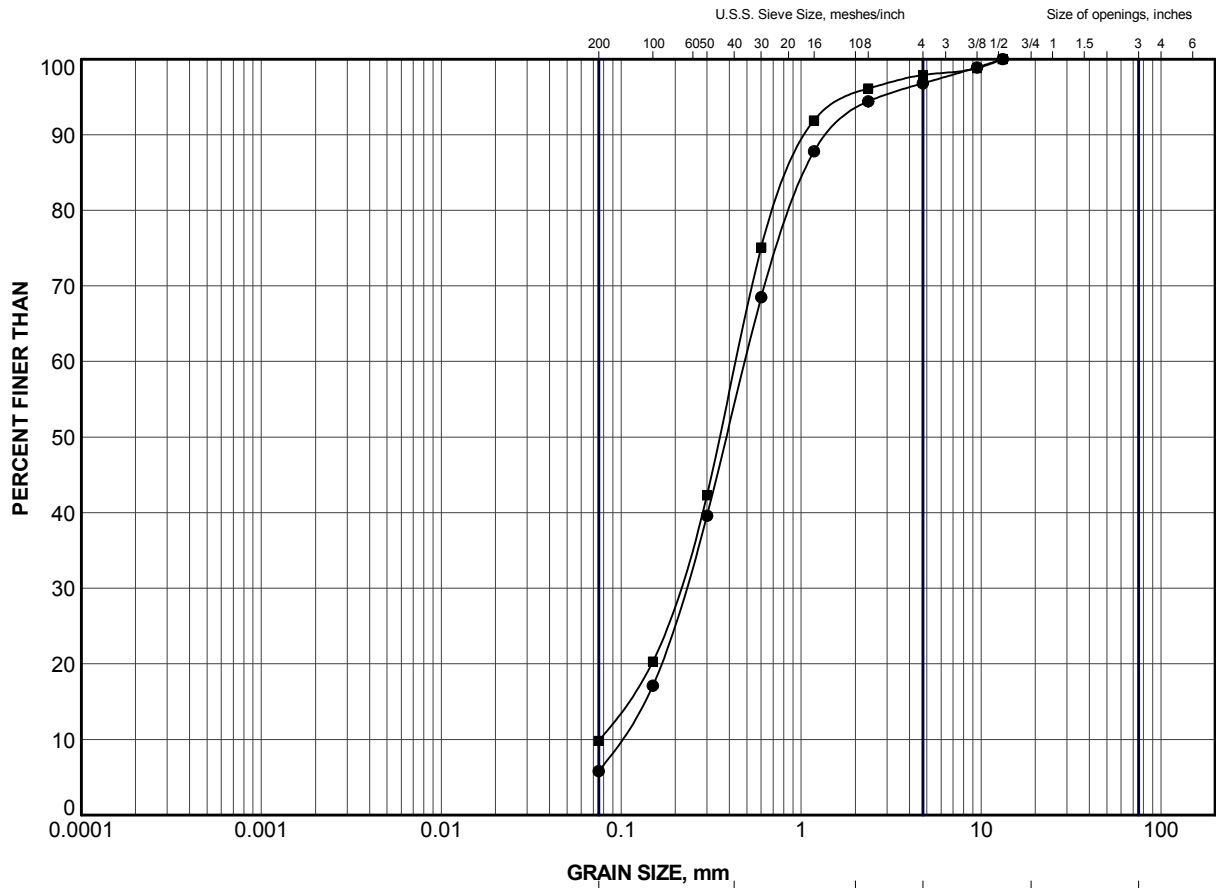
+ 3, × 3: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE

PROJECT <u>10-1191-0041</u>		<b>RECORD OF DCPT No P1-DC2</b>		1 OF 1 <b>METRIC</b>	
W.P. <u>174-98-00</u>		LOCATION <u>N 5125768.0; E 331200.9</u>		ORIGINATED BY <u>ID</u>	
DIST <u>          </u> HWY <u>17</u>		BOREHOLE TYPE <u>DYNAMIC CONE PENETRATION TEST</u>		COMPILED BY <u>LG</u>	
DATUM <u>Geodetic</u>		DATE <u>March 4, 2011</u>		CHECKED BY <u>AB</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	
								20	40	60	80	100	W <sub>p</sub>	W	W <sub>L</sub>						
238.3 0.0	GROUND SURFACE START OF DCPT						238														
							237														
							236														
235.2 3.1	END OF DCPT REFUSAL TO FUTHER PENETRATION (HAMMER BOUNCING)																				

PROJECT <u>10-1191-0041</u>		<b>RECORD OF DCPT No C1-DC1</b>		1 OF 1 <b>METRIC</b>	
W.P. <u>174-98-00</u>		LOCATION <u>N 5125769.2; E 331168.9</u>		ORIGINATED BY <u>ID</u>	
DIST <u>          </u> HWY <u>17</u>		BOREHOLE TYPE <u>DYNAMIC CONE PENETRATION TEST</u>		COMPILED BY <u>LG</u>	
DATUM <u>Geodetic</u>		DATE <u>March 4, 2011</u>		CHECKED BY <u>AB</u>	


SOIL PROFILE		SAMPLES				GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			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		W <sub>p</sub>	W	W <sub>L</sub>		
238.2 0.0	GROUND SURFACE START OF DCPT							<div><div></div><div></div><div></div><div></div><div></div></div>						
							238							
							237							
							236							
							235							
							234							
							233							
							232							
							231							
229.8 8.4	END OF DCPT REFUSAL TO FURTHER PENETRATION (HAMMER BOUNCING)						230							



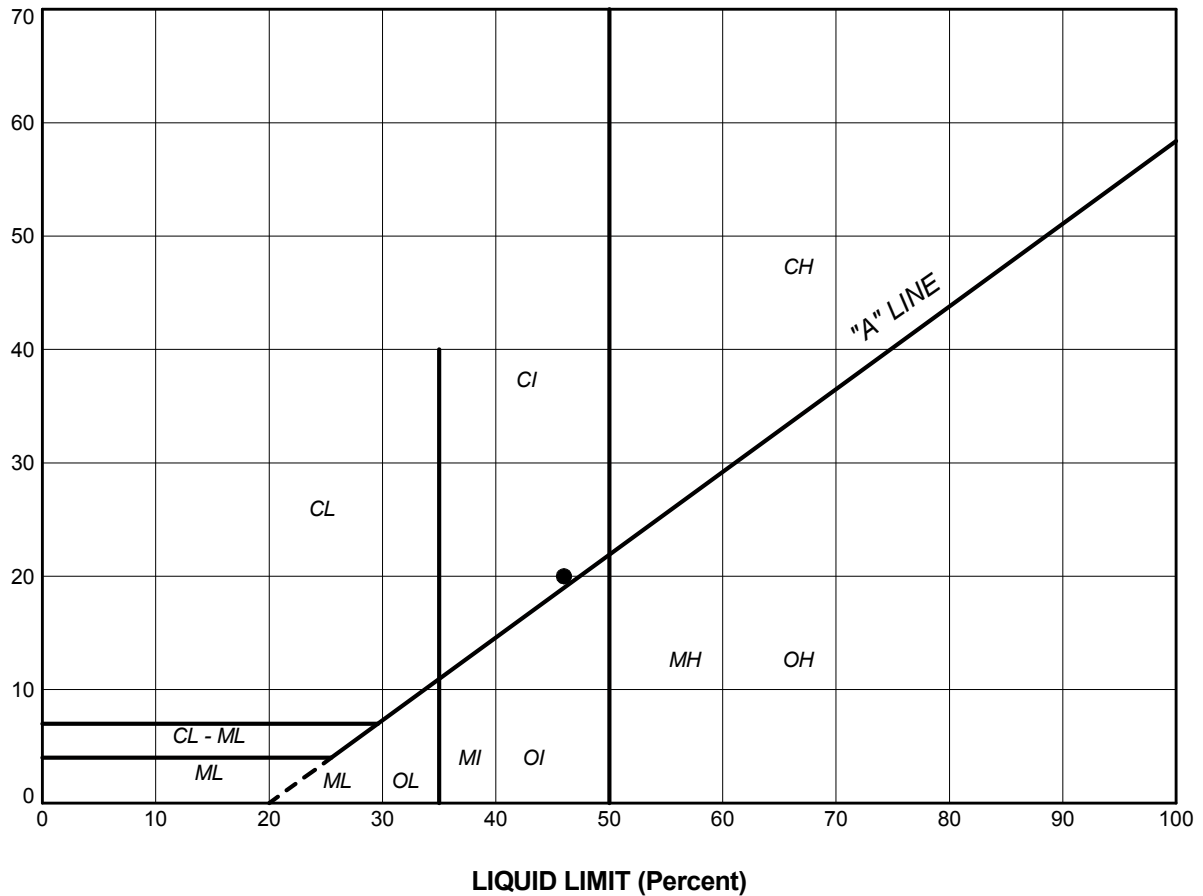
CLAY AND SILT	SAND SIZE, mm			GRAVEL SIZE, mm		Cobble Size
	fine	medium	coarse	fine	coarse	
	SAND SIZE			GRAVEL SIZE		

### LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	C1-5	2	237.8
■	P1-6	2	237.1

PROJECT						HIGHWAY 17 STA 14+650 to 14+700 WESTBOUND TRUCK CLIMBING LANE					
TITLE						GRAIN SIZE DISTRIBUTION SAND (FILL)					
PROJECT No.			10-1191-0041			FILE No.			1011910041.GPJ		
DRAWN	JJL	Mar 2012	SCALE	N/A	REV.						
CHECK	AB	Mar 2012									
APPR	JMAC	Mar 2012									
 <b>Golder Associates</b> SUDBURY, ONTARIO			<b>FIGURE C1</b>								


PLASTICITY INDEX (Percent)

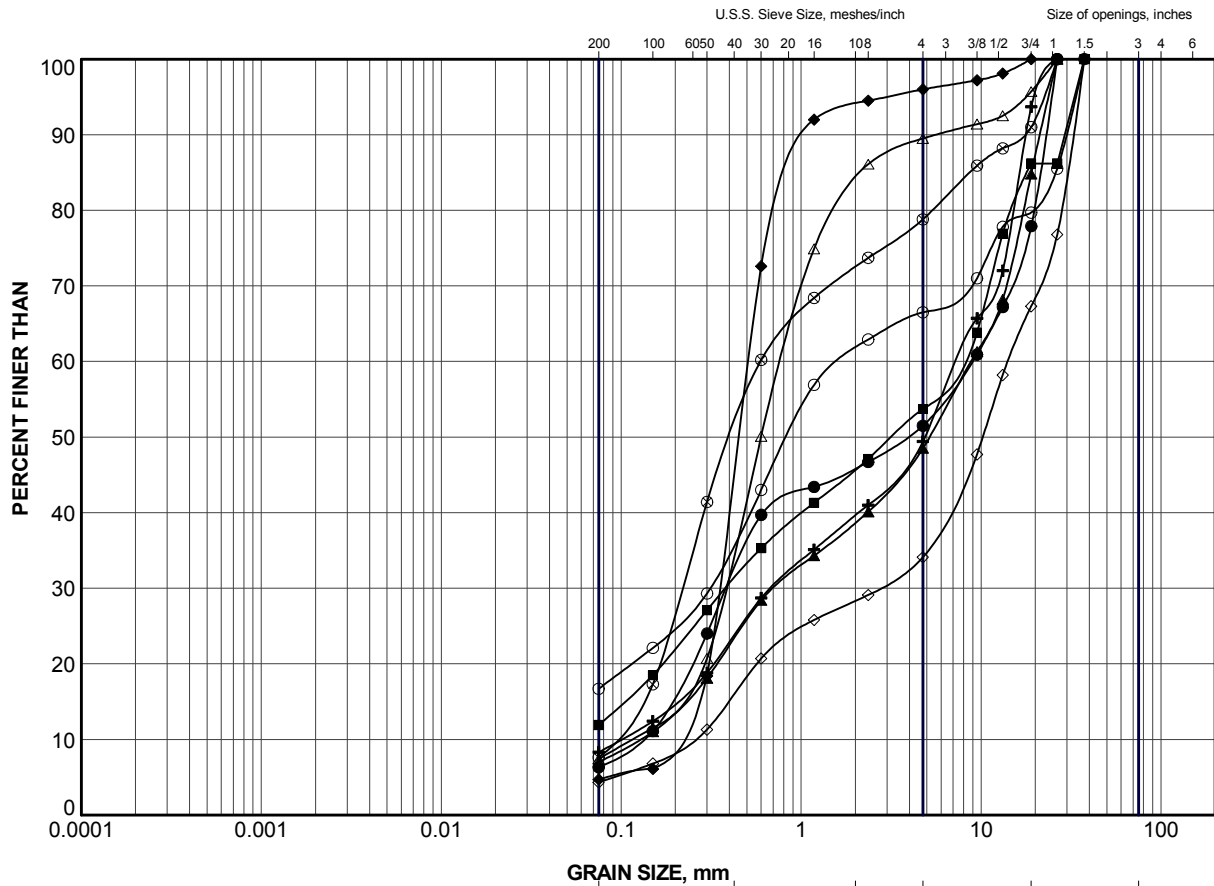


**SOIL TYPE**  
 C = Clay  
 M = Silt  
 O = Organic

**PLASTICITY**  
 L = Low  
 I = Intermediate  
 H = High

<b>LEGEND</b>					
SYMBOL	BOREHOLE	SAMPLE	LL(%)	PL(%)	PI
●	P1-2	10a	46.0	26.0	20.0

PROJECT		HIGHWAY 17 STA 14+650 to 14+700 WESTBOUND TRUCK CLIMBING LANE			
TITLE		<b>PLASTICITY CHART</b> SILTY CLAY			
PROJECT No.		10-1191-0041		FILE No. 1011910041.GPJ	
DRAWN	JJL	Mar 2012	SCALE	N/A	REV.
CHECK	AB	Mar 2012			
APPR	JMAC	Mar 2012			
 <b>Golder Associates</b> SUDBURY, ONTARIO			<b>FIGURE C2</b>		



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

### LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	C1-1	8b	232.5
■	C1-2	9	230.8
▲	P1-1	10	229.2
+	P1-2	10b	228.6
◆	P1-3	5	234.6
◇	P1-3	6	233.8
○	P1-4	6b	234.1
△	P1-4	7	233.7
⊗	P1-6	4	234.9

PROJECT		HIGHWAY 17 STA 14+650 to 14+700 WESTBOUND TRUCK CLIMBING LANE			
TITLE		<b>GRAIN SIZE DISTRIBUTION</b> SAND TO SAND AND GRAVEL			
PROJECT No.		10-1191-0041		FILE No. 1011910041.GPJ	
DRAWN	JJL	Mar 2012		SCALE	N/A
CHECK	AB	Mar 2012		REV.	
APPR	JMAC	Mar 2012		<b>FIGURE C3</b>	





At Golder Associates we strive to be the most respected global company providing consulting, design, and construction services in earth, environment, and related areas of energy. Employee owned since our formation in 1960, our focus, unique culture and operating environment offer opportunities and the freedom to excel, which attracts the leading specialists in our fields. Golder professionals take the time to build an understanding of client needs and of the specific environments in which they operate. We continue to expand our technical capabilities and have experienced steady growth with employees who operate from offices located throughout Africa, Asia, Australasia, Europe, North America, and South America.

Africa	+ 27 11 254 4800
Asia	+ 86 21 6258 5522
Australasia	+ 61 3 8862 3500
Europe	+ 356 21 42 30 20
North America	+ 1 800 275 3281
South America	+ 55 21 3095 9500

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

**Golder Associates Ltd.**  
**1010 Lorne Street**  
**Sudbury, Ontario, P3C 4R9**  
**Canada**  
**T: +1 (705) 524 6861**

