



**Foundation Investigation and  
Design Report**

Highways 5 and 8 and Hamilton  
Road 52 – Peters Corners

G.W.P. 2829-02-00

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Ministry of Transportation Ontario

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Geocres No. 40P8-200

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**FOUNDATION INVESTIGATION REPORT**

For  
G.W.P 2829-02-00

Overhead Sign  
Stormwater Management Pond  
Gabion Retaining Wall

Highway 5 and 8 and Hamilton Road 52, Peters Corners

## **1.0 Introduction**

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Stantec Consulting Ltd. (Stantec) was retained by the Ministry of Transportation, Ontario (MTO) to undertake the detailed design of the proposed intersection improvements at Peters Corners located at the intersection of Highways 5 and 8, and Hamilton Road 52. The project includes a new Overhead Sign, a Stormwater Management Pond and a Gabion Retaining Wall.

This Foundation Investigation Report has been prepared specifically and solely for the proposed intersection improvements at Peters Corners.

Project Number: GWP 2829-02-00

Project Location: Highways 5 and 8 and Hamilton Road 52, at Peters Corners

The work was carried out under MTO Agreement Number 2829-02-00 with Stantec Consulting Ltd., the Detailed Design Consultant for this project.

## **2.0 Site Description and Geology**

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### Site Location

The site location is shown on the Key Plan inset to Drawing No. 1 provided in Appendix A. The Overhead Sign is anticipated to be on Highway 5 near Station 22+740. The Stormwater Management Pond is to be constructed within the Northeast quadrant of the intersection. The Gabion Retaining Wall will be located on the south side of Highway 5 between approximate Stations 22+950 and 23+000. The intersection of Peters Corners is also being reconfigured to include a traffic circle for the intersection of Highways 5 and 8, and Hamilton Road 52.

### General Site Description

General site photographs showing the intersection are provided in Appendix A.

Highway 5 is oriented in the east-west direction at the project location with chainage increasing from west to east. Highway 8 is oriented in the northwest-southeast direction with chainage

increasing from northwest to southeast. Highways 5 and 8 intersect at Station 22+715 on Highway 5 and 26+509 on Highway 8. Hamilton 52 runs north to south approximately 100 m west of the Highway 5 and 8 intersection.

The existing drainage at the project site consists of drainage ditches and culverts.

### Physiographic Description

The site is located within a physiographic region known as the Norfolk Sand Plain (Chapman and Putnam, 1984). The soils within this region generally consist of silt or clay near surface with sand beds below underlain by dolomite bedrock.

## **3.0 Investigation Procedures**

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### **3.1 FIELD INVESTIGATION**

Prior to carrying out the investigation, Stantec made arrangements to obtain utility clearances for the proposed borehole locations.

A field investigation with 8 boreholes was carried out between March 13 and 16, 2012. The boreholes were designated BH12-1 through BH12-8 and their locations are shown on the Borehole Location Plan, Drawing No.1 in Appendix A.

Boreholes BH12-1 through BH12-3 were advanced within the footprint of the proposed stormwater management pond; borehole BH12-4 was advanced near the anticipated Overhead Sign location; and boreholes BH12-5 through BH12-8 were advanced along the proposed gabion retaining wall structure.

All boreholes were advanced using a track mount CME 75 drill rig with hollow stem augers and soil and bedrock sampling equipment.

The subsurface stratigraphy encountered in each borehole was recorded in the field. Split spoon samples were collected at regularly spaced intervals (typically every 760 mm) during the course of Standard Penetration Testing (ASTM, 1999). All samples recovered were returned to Stantec's Ottawa laboratory for detailed classification and testing. Boreholes were backfilled with auger cuttings and road holes were topped with cold patch asphalt.

Groundwater monitoring wells were installed in borehole BH12-1 and BH12-8. The monitoring well consisted of 50 mm diameter PVC pipe with perforations along the lower 3.0 m and 2.4 m for boreholes BH12-1 and BH12-8, respectively.

### **3.2 LOCATION AND ELEVATION SURVEY**

Elevation and location survey of the borehole locations was performed by Stantec personnel. The ground surface elevation at each borehole location was surveyed with reference to a Geodetic Benchmark provided by MTO.

Table 3.1 summarizes the location and elevation information for the boreholes included in this report.

**Table 3.1: Borehole Information Summary**

	Boreholes							
	BH12-1	BH12-2	BH12-3	BH12-4	BH12-5	BH12-6	BH12-7	BH12-8
MTM Zone 10								
Coordinates								
Northing	4793587	4793629	4793613	4793596	4793636	4793645	4793646	4793654
Easting	258767	258757	258796	258866	259108	259152	259198	259247
Ground Surface Elevation (m)	239.8	239.6	239.5	239.7	242.6	243.5	244.5	245.7
Total Depth Drilled (m)	9.9	9.1	7.6	6.7	6.7	6.7	6.7	6.7
End of Borehole Elevation (m)	229.9	230.5	231.9	233.0	235.9	236.8	237.8	239.0
Number of Soil Samples	10	9	9	9	9	9	9	9
Depth Cored (m)	1.5	1.5						

### 3.3 LABORATORY TESTING

All samples were subjected to a detailed visual examination by a Geotechnical Engineer. The following geotechnical laboratory tests were carried out:

<u>Test</u>	<u>No. of Tests</u>
Moisture Content	52
Grain Size Analysis	19
Atterberg Limits	13

Samples remaining after testing will be stored for one year after issuance of the final report. After the storage period, the samples will be discarded.

## **4.0 Subsurface Conditions**

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### **4.1 GENERAL**

The subsurface conditions observed in the boreholes are presented in detail on the Borehole Records provided in Appendix B. An explanation of the symbols and terms used to describe the Borehole Records is also provided.

In general, the subsurface stratigraphy consisted of a pavement structure or topsoil over a sand and gravel fill over a silt deposit underlain by dolomite bedrock.

A borehole location plan and a stratigraphic section of the soils encountered within the boreholes are provided on Drawing No. 1 in Appendix A.

### **4.2 OVERBURDEN**

#### **4.2.1 Pavement Structure**

A pavement structure was encountered in boreholes BH12-2, BH12-3, BH12-4 and BH12-5. The top of road elevation varied from 239.5 m at BH 12-3 on Highway 8 to 242.6 m at BH12-5 on Highway 5.

The pavement structure consisted of the following:

HM Asphalt	140 to 235 mm
Base/ Subbase (Gravelly Sand)	600 to 820 mm

The base/subbase material consisted of a brown gravelly sand.

#### **4.2.2 Topsoil**

Approximately 100 to 150 mm of topsoil was encountered in boreholes BH12-1, BH12-7 and BH12-8.

#### **4.2.3 Fill**

Fill material was encountered in all of the boreholes beneath a layer of asphalt, topsoil or at the ground surface. The fill generally consisted of a gravelly sand base/subbase material over a silty sand to sandy silt embankment fill material. The fill was approximately 0.7 to 4.2 m thick and extended to an elevation ranging from 244.9 to 238.2 m.

The Standard Penetration Test (SPT) blow count N-values observed within the fill ranged from 1 to 42 blows per 0.3 m suggesting a very loose to dense state of compactness.

Moisture content and grain size distribution tests carried out on representative samples of the fill yielded the following results:

Gravel:	1 and 34%
Sand:	3 and 57%
Fines (silt & clay):	9 and 96%
Moisture content:	4 to 18%

The grain size distribution curve for the fill layer is provided on Figure 1 in Appendix C.

#### **4.2.4 Silt**

A silt deposit was encountered in all boreholes immediately beneath the fill or topsoil. The silt generally included a lightly cohesive or clayey layer about 1.5 m thick. The silt was fully penetrated in boreholes BH12-1 to BH 12-3 where its thickness ranged from 6.1 to 6.8 m and its bottom elevation ranged from 231.9 m to 232.2 m.

The SPT N-values for this deposit ranged from 3 to 88 blows per 0.3 m suggesting a very loose to very dense state of compactness.

Within borehole BH12-4 cobbles were encountered at a depth of 4.1 m. Although not encountered within the silt at other locations, the random presence of cobbles (and possibly boulders) should be anticipated.

Moisture content and grain size distribution tests carried out on representative samples of the silt yielded the following results:

Gravel:	0 to 1%
Sand:	0 to 6%
Silt:	58 to 92%
Clay:	5 to 40%
Moisture Content:	12 to 29%

Atterberg limit tests carried out on this material indicated that the silt material ranged from a clay of low plasticity to a non-plastic silt. The grain size distribution curves and the plasticity chart for the silt material are provided on Figures 2 through 4 in Appendix C.

#### **4.2.5 Sandy Silt Till**

A thin till deposit was encountered below the silt layer at borehole BH12-1. The till consisted of a sandy silt with a trace of gravel. The till layer was 0.8 m thick and extended to elevation 231.4 m.

A single SPT N-value of 8 blows per 0.3 m was measured in the till, indicating a loose state of compactness.



Cobbles and boulders were not observed while drilling in the till, however, the presence of these larger particles is typical within glacial till and is expected to be randomly present within the till at this site.

Moisture content and grain size distribution tests carried out on the till sample yielded the following:

Gravel:	7%
Sand:	16%
Silt:	64%
Clay:	13%
Moisture Content:	18%

An Atterberg limit test carried out on this material indicates that the till is non-plastic. The grain size distribution curve and the plasticity chart are shown on Figure 5 and Figure 6, respectively.

### 4.3 GROUNDWATER

The depth to groundwater was inferred in five of the boreholes at the time of drilling between March 13 and March 16, 2012. Groundwater monitoring wells were installed in BH12-1 and BH12-8; the depth to groundwater was measured in a standpipe well on March 29, 2012 and again on May 15, 2012. The measured and inferred (i.e., at the time of drilling) groundwater levels are summarized in Table 4.1.

**Table 4.1: Groundwater Levels**

Borehole No	Ground Surface Elevation (m)	Groundwater	
		Depth (m)	Elevation (m)
Measured on March 29, 2012			
BH12-1	239.8	1.4	238.4
BH12-8	245.7	3.0	242.7
Measured on May 15, 2012			
BH12-1	239.8	1.5	238.3
BH12-8	245.7	3.0	242.7
Inferred (time of drilling)			
BH12-3	239.5	3.9	235.7
BH12-4	239.7	1.8	237.9
BH12-5	242.6	6.1	236.5
BH12-6	243.5	5.3	238.2
BH12-7	244.5	2.1	241.9

Fluctuations in the groundwater due to seasonal variations or in response to a particular precipitation event should be anticipated.

## **5.0 Miscellaneous**

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The field work was carried out under the supervision of Dan Stunden and Rick Cluthe, Geotechnical Engineering Technologists, under the direction of Mr. Kenton Power, P.Eng.

Down Under Pipe & Cable Locating Ltd. of Rockwood, Ontario, carried out the private and public utility locates for the boreholes.

The CME 75 drilling equipment was supplied and operated by Pontil Drilling of Mount Albert, Ontario.

Elevation and location survey of the borehole locations was carried out by Stantec personnel.

Geotechnical laboratory testing was carried out at Stantec's Ottawa laboratory.

This report was prepared by Katurah Firdawsi, and reviewed by Simon Gudina and Raymond Haché.

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## 6.0 Closure

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A subsurface investigation is a limited sampling of a site. The subsurface conditions given herein are based on information gathered at the specific borehole locations. Should any conditions at the site be encountered which differ from those at the borehole locations, we request that we be notified immediately in order to assess the additional information.

Respectfully Submitted;

**STANTEC CONSULTING LTD.**



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**FOUNDATION DESIGN REPORT**

For

G.W.P. 2829-02-00

Overhead Sign

Stormwater Management Pond

Gabion Retaining Wall

Highway 5 and 8 and Hamilton Road 52, Peters Corners

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## **7.0 Discussion and Engineering Recommendations**

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### **7.1 GENERAL**

#### Project Purpose/Justification

The Peters Corners intersection is being redesigned as a traffic circle and the modifications will include a new overhead sign, a stormwater management pond, and two short gabion walls.

#### Proposed Structures

The overhead sign is anticipated to be located on Highway 5 near Station 22+740. A standard Tri-Chord overhead truss sign support is to be used to support the overhead sign.

The stormwater management pond is to be located in the north east quadrant of the proposed traffic circle. The pond is anticipated to include a forebay area that is approximately 1 m deeper than the remainder of the pond.

The gabion walls will extend approximately 50 m on each side along Highway 5 from approximate station 22+950 to 23+000.

Key elevations associated with the proposed Stormwater Management Pond are as follows:

Forebay Bottom Elevation:	235.5 m
Pond Bottom Elevation:	236.7 m
Permanent Pool Elevation:	237.0 m
Measured Groundwater Elevation:	238.4 m March 2012

Key elevations associated with the proposed Gabion Wall are as follows:

Top of Gabion Basket:	240.1 – 240.8 m
Top of Rip Rap:	238.7 – 239.7 m

### Construction Staging & Detours

The interference with traffic and need for construction staging for the overhead sign will depend on the location and offset from the road. Construction staging and detours are not anticipated for the stormwater management pond and gabion wall based on their offsets from the road.

## **7.2 GEOTECHNICAL DESIGN PARAMETERS**

The soil conditions at this site generally consist of a pavement structure or topsoil over a sand and gravel fill over a native silt deposit underlain by dolomite bedrock.

For design purposes, the following soils profile will be used:

**Table 7.1: Geotechnical Model**

Depth from ground surface (m) *		Soil Type	Design Properties
From	To		
Sign Support Foundation			
0 – 1.0		FILL: Gravelly sand, compact	Total Unit Weight = 20.0 kN/m <sup>3</sup> Friction Angle, $\phi$ = 32° E' = 50 MPa
1.0 – 3.0		SILT: Loose N-Value 5 to 14	Total Unit Weight = 19.0 kN/m <sup>3</sup> Friction Angle, $\phi$ = 29° E' = 10 MPa
3.0 - >6.7		SILT: Compact to Dense N-Value 28 to >50 - Cobbles anticipated	Total Unit Weight = 20.0 kN/m <sup>3</sup> Friction Angle, $\phi$ = 32° E' = 20 MPa
Stormwater Management Pond			
0	0.8 - 1.5	FILL: Gravelly sand to silty sand with gravel, loose to dense	Total Unit Weight = 20.0 kN/m <sup>3</sup> Friction Angle, $\phi$ = 32° E' = 50 MPa
0.8 – 1.5	7.6 – 8.4	Silt (ML) Loose to very dense	Total Unit Weight = 19 kN/m <sup>3</sup> Friction Angle, $\phi$ = 29° E' = 15 MPa
7.6 – 8.4		Bedrock	
Gabion Retaining Wall			
0	0.8	FILL: Gravelly sand, compact to dense	Total Unit Weight = 20.0 kN/m <sup>3</sup> Friction Angle, $\phi$ = 32° E' = 50 MPa

Depth from ground surface (m) *		Soil Type	Design Properties
From	To		
0.8	4.2	FILL: Sandy silt, Loose to compact	Total Unit Weight = 20.0 kN/m <sup>3</sup> Friction Angle, $\phi$ = 30° E' = 50 MPa
4.2	6.7	Non-Cohesive Silt (ML), very loose to dense	Total Unit Weight = 19.0 kN/m <sup>3</sup> Friction Angle, $\phi$ = 29° E' = 15 MPa

\*Elevation varies at borehole locations

- Note: 1) A design water level elevation of 238.4 m and 239.6 m, respectively for the pond and the gabion wall was assumed.
- 2) Most of the silt encountered contained a slightly cohesive layer of limited thickness, with non-plastic silt being the predominant component.
- 3) The till observed in borehole BH12-1 has not been included in the geotechnical model.

### 7.3 FROST PENETRATION

The design frost penetration depth for foundations,  $f$ , at the site is 1.2 m based on OPSD 3090.101.

Footings should be provided with 1.2 m of earth cover or equivalent insulation for frost protection.

The depth of frost penetration should also be used in the design of frost tapers for backfill.

### 7.4 SEISMIC DESIGN CONSIDERATIONS

#### 7.4.1 Soil Profile Type

It is recommended that a Soil Profile I as defined in CHBDC (CHBDC, 2006) Section 4.4.6 be used in the seismic design of this site.

#### 7.4.2 Zonal Acceleration Ratio

Table A3.1.1 of the CHBDC indicates that the Zonal Acceleration Ratio (ZAR) for Hamilton, Ontario, which is approximately 1.5 km east of the site, is 0.05.

Even though it is not likely very significant, seismically induced lateral earth pressures should be considered for this project with a Zonal Acceleration Ratio of 0.05.

### **7.4.3 Liquefaction Potential**

Liquefaction of the foundation soils is not a concern for this project due to the generally compact to very dense soil conditions and the relatively low Zonal Acceleration Ratio.

## **7.5 OVERHEAD SIGN**

Design frost depth for foundations based on OPSD 3090.101 is 1.2 m.

The MTO Sign Support Manual (MTO, 2004) is applicable to this site since the following conditions were not observed:

- Bedrock at or near the surface;
- Footing located in rock fill; and
- Soil exceptionally soft or loose.

Based on the parameters provided in Table 7.1, footings can be designed using the standard details shown on Drawing SS118-3 Static Sign Support Footing Details (Ground Mounted) from the MTO Sign Support Manual.

It is noted that the soils above the frost penetration depth of 1.2 m and the fill encountered should not be relied upon for geotechnical lateral resistance. For design purposes, the groundwater depth should be assumed to be 1.8 m below ground surface.

## **7.6 GABION RETAINING WALL**

### **7.6.1 Geotechnical Bearing Resistances for Gabion Wall**

The short sections of gabion retaining wall proposed on the left and right sides of Highway 5 will be up to 1.6 m in height and will include a Granular A backfill with a 2H:1V back slope. The anticipated static bearing pressure associated with the dead loads is expected to be less than 50 kPa.

Borehole BH12-5 was drilled in the vicinity of the proposed retaining walls and shows existing fill material extending to el. 238.2 m. This elevation is within 0.5 m or less from the underside of the anticipated granular bedding below the gabion baskets. It is recommended that in areas where there is still fill remaining beneath the proposed excavation depth that it be fully removed and replaced with OPSS Granular A.

The following geotechnical resistances are provided for the gabion walls. It is recommended that the gabion walls be founded on the native silt deposit or on compacted OPSS Granular A placed on the native silt.

The geotechnical resistances provided in Table 7.2 may be used in the design provided the footings are placed on undisturbed native silt or granular bedding over undisturbed native silt as described above.

**Table 7.2: Recommended Footing Design Parameters**

	Founding Elev. (m)	Footing Size (m x m)		Factored Geotechnical Resistance at ULS (kPa)	Geotechnical Reaction at SLS (kPa)
		Width (m)	Length (m)		
Gabion Wall Shallow Foundation at frost depth	237.5 - 239	1.0	50	250	220
		1.5	50	250	175
		2.0	50	250	150

Notes:

- (1) In accordance with Section 6.6.1 of the CHBDC, a resistance factor of 0.5 has been applied to calculate the factored geotechnical resistance at ULS.
- (2) The geotechnical reaction at SLS corresponds to a maximum settlement of 25 mm.
- (3) It is noted that gabion walls can tolerate significant movements and that complete frost penetration protection can be considered optional. Generally, it is recommended that the granular bedding material beneath the wall extend to a depth of at least 2/3 of the frost penetration depth to avoid localized differential movements.

## 7.6.2 Sliding Resistance

The unfactored horizontal resistance of spread footings may be calculated using the following unfactored coefficients of friction:

0.65 between OPSS Granular A and rock-filled gabion wall

0.5 between silt and rock-filled gabion wall

In accordance with Table 6.1 of the CHBDC CAN/CSA-S6-06, a resistance factor against sliding of 0.8 should be applied to obtain the resistance at ULS.

## 7.6.3 Lateral Earth Pressures

### 7.6.3.1 Lateral Earth Pressures under Static Conditions

Earth pressures will need to be considered in the design of the gabion wall.

Computation of earth pressures should be in accordance with Section 6.9 of the CHBDC. For retaining walls that are designed to allow rotation, active earth pressure may be used for design. For rigidly tied and unyielding structures, the at-rest earth pressure should be used for design. The unfactored soil parameters provided in Table 7.3 may be used for design of walls with a horizontal backfill. The effects of compaction should be accounted for by applying a compaction surcharge as shown in Figure 6.6 of the CHBDC.



The total active ( $P_A$ ), at-rest ( $P_O$ ) and passive ( $P_P$ ) thrusts can be calculated using the following equations:

$$P_A = \frac{1}{2} K_a \gamma H^2$$

$$P_O = \frac{1}{2} K_o \gamma H^2$$

$$P_P = \frac{1}{2} K_p \gamma H^2$$

where  $H$  is the height of the wall. Values for  $K_a$ ,  $K_o$ ,  $K_p$ , and  $\gamma$  are provided in Table 7.3.

**Table 7.3: Recommended Non-Seismic Earth Pressure Parameters (Horizontal Backfill)**

Parameter	OPSS Gran A and Gran B Type II	Silt
Bulk Unit Weight, $\gamma$ (kN/m <sup>3</sup> )	22.0	20
Effective Friction Angle	35°	29°
Coefficient of Earth Pressure at Rest ( $K_o$ )	0.43	0.52
Coefficient of Active Earth Pressure ( $K_a$ )	0.27	0.35
Coefficient of Passive Earth Pressure ( $K_p$ )	3.69	2.88

The parameters in Table 7.3 may be used under the following conditions.

1. The slope of the backfill is horizontal.
2. The calculated force is applied to a vertical projection extending from the underside of the heel to ground surface.
3. Applicable to the calculation of resistance to global overturning and sliding of the retaining wall.
4. The thrust force acts at a point one third up the height of the wall.
5. Where the granular wedge behind the retaining wall is less than would be defined by a 1.5H:1V projection from the heel, the parameters for silt shall be used.

**Table 7.4: Recommended Non-Seismic Earth Pressure Parameters (2H:1V Backfill)**

Parameter	OPSS Gran A and Gran B Type II	Silt
Bulk Unit Weight, $\gamma$ (kN/m <sup>3</sup> )	22.0	20
Effective Friction Angle	35°	29°
Coefficient of Earth Pressure at Rest ( $K_o$ )	0.43	0.50
Coefficient of Active Earth Pressure ( $K_a$ )	0.39	0.54
Coefficient of Passive Earth Pressure ( $K_p$ )	10.84	6.98

The parameters in Table 7.4 may be used under the following conditions.

1. The slope of the backfill is 2H:1V
2. The calculated force is applied to a vertical projection from the underside of the heel to the sloping ground surface. In calculating the active force, the effective height of wall will be greater than the actual wall height.
3. Applicable to the calculation of resistance to global overturning and sliding of the retaining wall.
4. The thrust acts at a point one third up the effective wall height defined in point 2 above.
5. Where the granular wedge behind the retaining wall is less than would be defined by a 1.5H:1V projection from the heel, the parameters for silt shall be used.

### **7.6.3.2 Lateral Earth Pressures under Seismic Conditions**

The gabion walls should also be designed to resist the earth pressures induced under seismic loading conditions. The seismic earth pressures may be calculated using the parameters detailed in Table 7.4 below.

The total active and passive thrusts under seismic loading conditions can be calculated using the following equations:

- $P_{AE} = \frac{1}{2} K_{AE} \gamma H^2 (1 - k_v)$
- $P_{PE} = \frac{1}{2} K_{PE} \gamma H^2 (1 - k_v)$

where:

- $K_{AE}$  = active earth pressure coefficient (combined static and seismic)
- $K_{PE}$  = passive earth pressure coefficient (combined static and seismic)
- $H$  = height of wall
- $k_h$  = horizontal acceleration coefficient
- $k_v$  = vertical acceleration coefficient
- $\gamma$  = total unit weight

For this site, the following design parameters were used to develop the recommended  $K_{AE}$  and  $K_{PE}$  values:

- |  |                |                    |
|--|----------------|--------------------|
| • Zonal Acceleration Ratio, A or PGA         | 0.05           |                    |
| • Horizontal Acceleration Coefficient, $k_h$ | 0.025 yielding | 0.075 non-yielding |
| • Vertical Acceleration Coefficient, $k_v$   | 0.017 yielding | 0.05 non-yielding  |
| • Horizontal Backslope to wall               |                |                    |
| • Vertical back of wall                      |                |                    |

The above  $k_h$  value corresponds to  $\frac{1}{2}$  of the A value for yielding walls and 1.5 times for non-yielding walls. The  $k_v$  value corresponds to 0.67 of the  $k_h$  value. The angle of friction between the soil and the wall has been set at  $0^\circ$  to provide a conservative estimate.

**Table 7.5: Recommended Seismic Earth Pressure Parameters (Horizontal Backfill)**

Parameter	OPSS Gran A and Gran B Type II		Silt	
Bulk Unit Weight, $\gamma$ (kN/m <sup>3</sup> )	22.0		20	
Effective Friction Angle	35°		29°	
	Yielding wall	Non-yielding	Yielding wall	Non-yielding
Active Earth Pressure ( $K_{AE}$ )	0.32	0.36	0.40	0.44
Height of Application of $P_{AE}$ from base as a ratio of wall height, (H)	0.340	0.355	0.339	0.351
Passive Earth Pressure, ( $K_{PE}$ )	3.21	3.13	2.57	2.50
Height of Application of $P_{PE}$ from base as a ratio of wall height, (H)	0.326	0.308	0.325	0.307

**Table 7.6: Recommended Seismic Earth Pressure Parameters (2H:1V Backfill)**

Parameter	OPSS Gran A and Gran B Type II		Silt	
Bulk Unit Weight, $\gamma$ (kN/m <sup>3</sup> )	22.0		20	
Effective Friction Angle	35°		29°	
	Yielding wall	Non-yielding	Yielding wall	Non-yielding
Active Earth Pressure ( $K_{AE}$ )	0.43	0.51	0.66	Note 1
Height of Application of $P_{AE}$ from base as a ratio of wall height, (H)	0.349	0.384	0.361	Note 1
Passive Earth Pressure, ( $K_{PE}$ )	10.77	10.64	6.93	6.82
Height of Application of $P_{PE}$ from base as a ratio of wall height, (H)	0.327	0.314	0.327	0.313

Note 1 Under seismic conditions these materials are not suitable for retaining wall backslopes constructed at 2H:1V. Either flatter backslopes or the use of OPSS Granular B Type II or Granular A would be required.

## 7.7 STORM WATER MANAGEMENT POND

### 7.7.1 General

The proposed permanent pond elevation of 237.0 m is approximately 1.4 m below the groundwater level observed in March 2012.

The predominant native soils at the site consist of silt. The permeability for the silt at the site is estimated to be in the range of  $10^{-8}$  to  $10^{-10}$  m/sec.

Based on the pond geometry and the proposed permanent pond elevation, it is anticipated that the approximate daily water inflow would be in the order of 500 to 5000 litres per day. If the

quantity of groundwater inflow is significant to the design of the project a hydrogeological review should be carried out.

### **7.7.2 Stability of Slopes**

A slope stability evaluation for the stormwater management pond was carried out using the program Slope/W (Geo-Slope, 2010). The analysis considered seismic loading using one-half of the ZAR. A 3H:1V slope was considered for the pond. Typical slope stability analysis results are presented on Figures 7 and 8 in Appendix D for the forebay area of the pond. The analysis results indicate that a pond side slope of 3H:1V will provide the required factor of safety against slope failure under both static and seismic conditions.

## **7.8 EROSION AND SCOUR PROTECTION**

Slope protection and drainage measures will be required to ensure the long-term surficial stability of the pond side slopes. All slopes in the vicinity of the pond outlet should be surfaced with rip-rap at least 300 mm thick placed on a Class II non-woven filter fabric; the rip-rap should extend up the slope to 0.3 m above the design high pond level. For the side slopes of the pond, normal slope vegetation should be established as soon as possible after completion of the pond construction in order to control surficial erosion.

The contractor should provide silt fences and erosion control blankets, as required, throughout the duration of the construction to prevent silt/sediments from running off the site.

## **8.0 Construction Considerations**

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### **8.1 CONSTRUCTION STAGING**

Construction staging for the overhead sign will depend on the location and offset from the road. Construction staging and detours are not anticipated for the stormwater management pond and gabion wall based on their offsets from the road.

A construction staging scheme can be established once the final location of the proposed sign has been identified.

### **8.2 EXCAVATION AND BACKFILLING**

Excavation for the stormwater pond should be carried out in accordance with OPSS 402.

Excavation for the gabion wall should be carried out in accordance with OPSS 512.

All fill and deleterious materials should be removed from the proposed gabion wall foundation.

Side slopes for open cut excavations should conform to Occupational Health and Safety Act (OHSa) regulations for Construction Projects. The soils encountered at the site may be classified as Type 3 Soil.

### **8.3 TEMPORARY CONSTRUCTION UNWATERING AND DEWATERING**

The underside of the gabion wall and stormwater pond is anticipated to be lower than the measured groundwater levels in March 2012. The site soil permeabilities are anticipated to be in the range of  $10^{-8}$  to  $10^{-10}$  m/sec and therefore the flow quantities expected should be readily handled using conventional sumps and pumps.

### **8.4 STATIC SIGN SUPPORT FOOTING**

The static sign support footing will likely be constructed within a 1.2 m diameter augered hole extending to 6.2 m below ground surface. The soil conditions observed at the site suggest that where the augered holes extend below the water table, the holes are not expected to remain open for any period of time. Consequently, the use of a temporary liner will be necessary as part of the construction process.

Footings for the proposed signs should be installed in accordance with drawing SS118-3 provided in the MTO Sign Support Manual.

Cobbles were encountered within the dense to very dense portion of the silt deposit. As well, randomly present cobbles and boulders are expected within the glacial till which underlies the silt deposit. An NSSP has been provided in Appendix E to alert the contractor of the presence of cobbles and boulders at this site.

## **9.0 Specifications**

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The following specifications are referenced in this report:

**Table 9.1: Specifications Referenced in Report**

<b>Document</b>	<b>Title</b>
OPSD 3090.101	Foundation, Frost Depths for Southern Ontario
OPSS 402	Construction Specification for Excavating, Backfilling, and Compacting for Maintenance Holes, Catch Basins, Ditch Inlets, and Valve Chambers
OPSS 512	Construction Specification for Installation of Gabions
NSSP	Risk of Cave-in and Difficult Augering Conditions During Construction of Caissons for Sign Support Foundations

## **10.0 References**

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- ASTM. 1999. Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils (ASTM D1586). ASTM International, West Conshohocken, PA.
- ASTM. 2000. Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System) (ASTM D2487). ASTM International, West Conshohocken, PA.
- Chapman, L.J., and Putnam, D.F. 1984. The physiography of Southern Ontario, Ontario Geological Survey Special Volume 2. Ontario Research Foundation, Toronto, Ontario.
- CHBDC. 2006. Canadian Highway Bridge Design Code. Canadian Standards Association, Mississauga, Ontario.
- Geo-Slope International, Ltd. 2010. GeoStudio 2007 (Slope/W 2007), Calgary, Alberta.
- MTO. 2004. Ontario Ministry of Transportation. Sign Support Manual, Toronto.

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## 11.0 Closure

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A soil investigation is a limited sampling of a site. The conclusions given herein are based on information gathered at the specific borehole locations. Should any conditions at the site be encountered which differ from those at the borehole locations, we request that we be notified immediately in order to assess the additional information and its effects on the above recommendations.

We trust the information presented herein meets your present requirements. Should you have any questions or require additional information, please do not hesitate to contact us.

This report was prepared by Katurah Firdawsi and Simon Gudina, and Reviewed by Raymond Haché.

Respectfully submitted,

**STANTEC CONSULTING LTD.**



Katurah Firdawsi, B.Sc.Eng.



Simon Gudina, Ph.D., P.Eng.  
Geotechnical Engineer



Raymond Haché, M.Sc., P.Eng.  
Designated Principal MTO Foundation Contact



# **APPENDIX A**

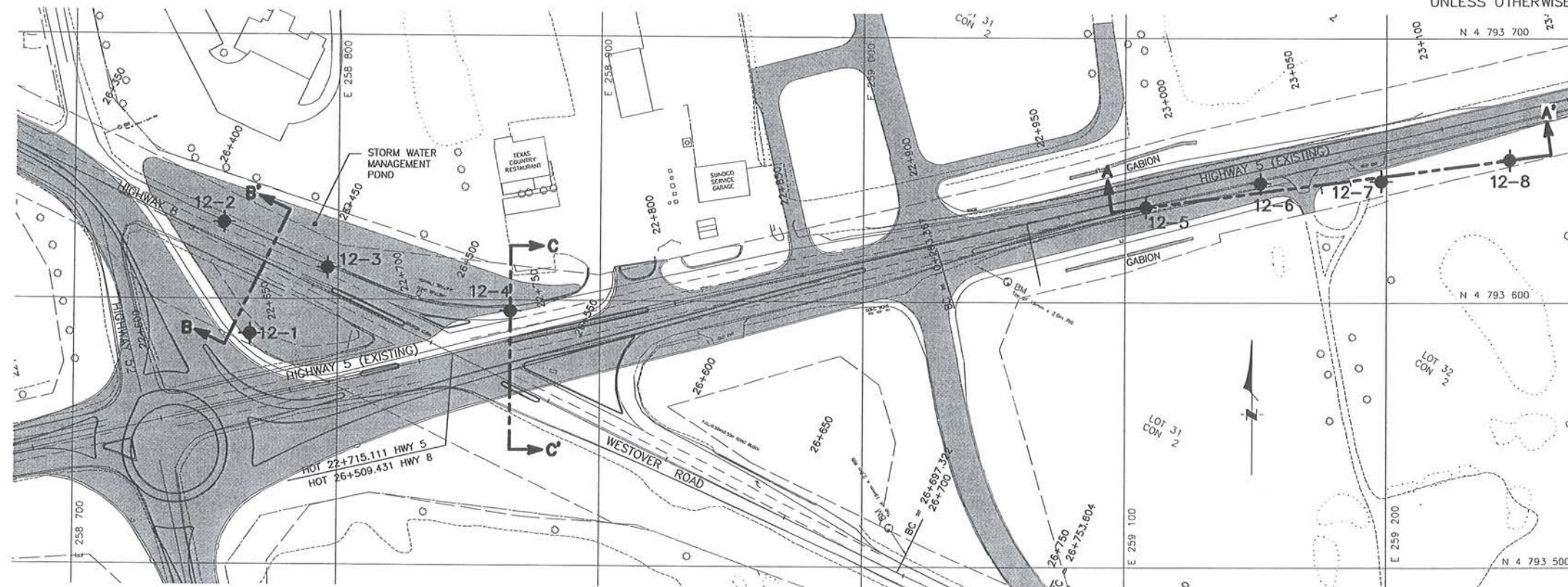
Drawings No. 1 & 2 – Borehole Location Plan and Soil Strata Plot

Site Photos



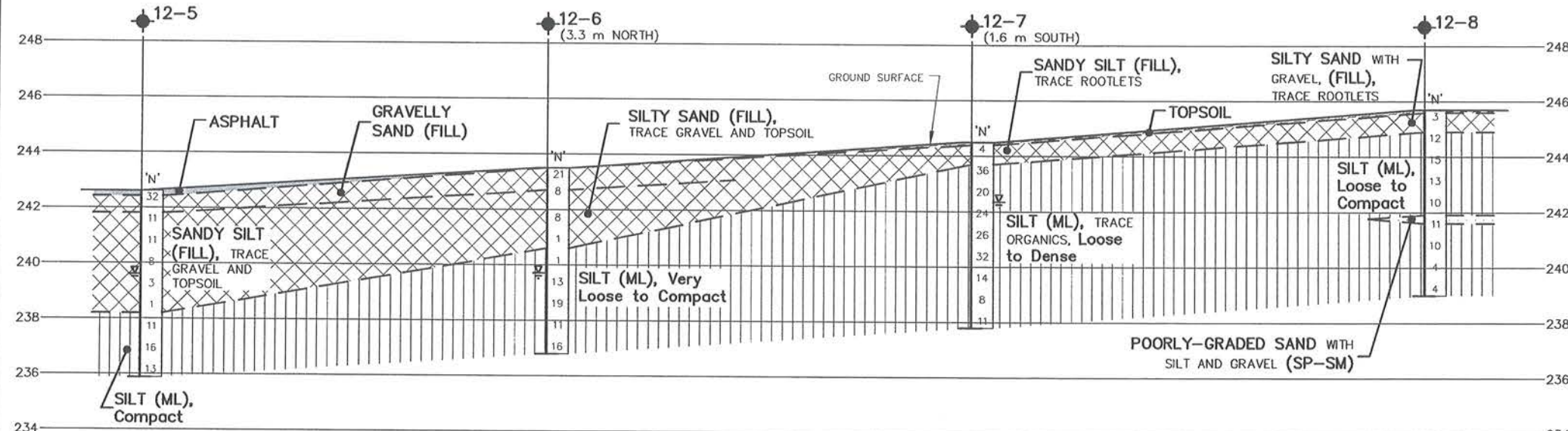
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PLAN

SCALE  
20 m 0 20 40 m



SECTION A-A'

SCALE  
6 m 0 6 12 m HORIZ  
2 m 0 2 4 m VERT

METRIC  
DIMENSIONS ARE IN METRES  
AND/OR MILLIMETRES  
UNLESS OTHERWISE SHOWN

PLATE No  
CONT  
WP 2829-02-00

HIGHWAYS 5 & 8  
PETERS CORNERS, HAMILTON, ONTARIO  
BOREHOLE LOCATIONS & SOIL STRATA



KEY PLAN  
NOT TO SCALE

LEGEND

- Borehole
- N Blows/0.3m (Std Pen Test, 475 J/blow)
- WL at time of investigation, March 29, 2012
- Inferred WL at time of investigation, March 2012
- (m NORTH) OFFSET FROM SECTION LINE

No	ELEVATION	MTM ZONE 10 COORDINATES NORTH	EAST
12-1	239.8	4 793 587	258 767
12-2	239.6	4 793 629	258 757
12-3	239.5	4 793 613	258 796
12-4	239.7	4 793 596	258 866
12-5	242.6	4 793 636	259 108
12-6	243.5	4 793 645	259 152
12-7	244.5	4 793 646	259 198
12-8	245.7	4 793 654	259 247

NOTES

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

This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

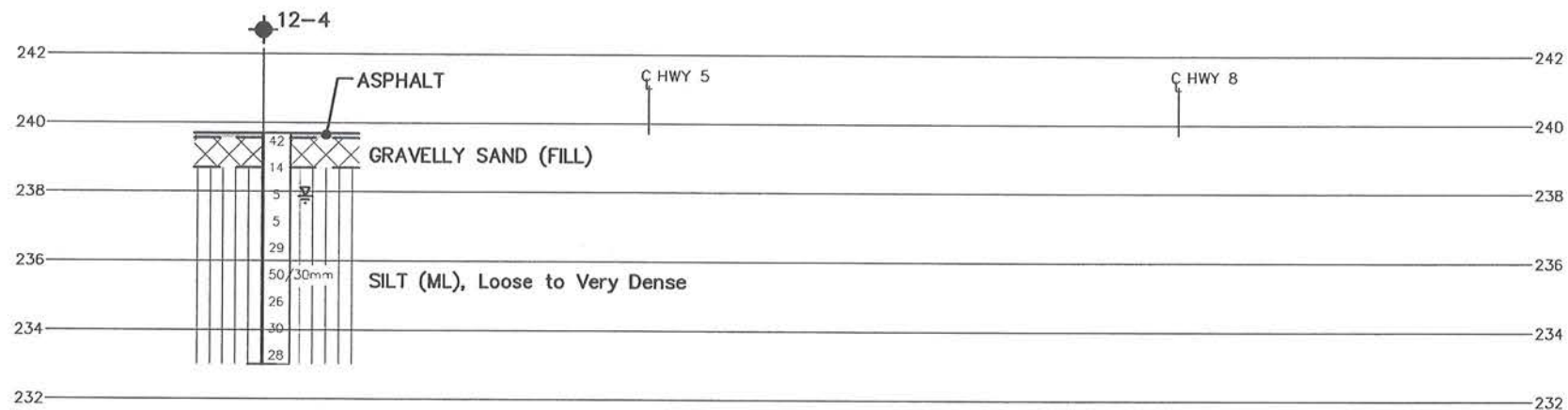
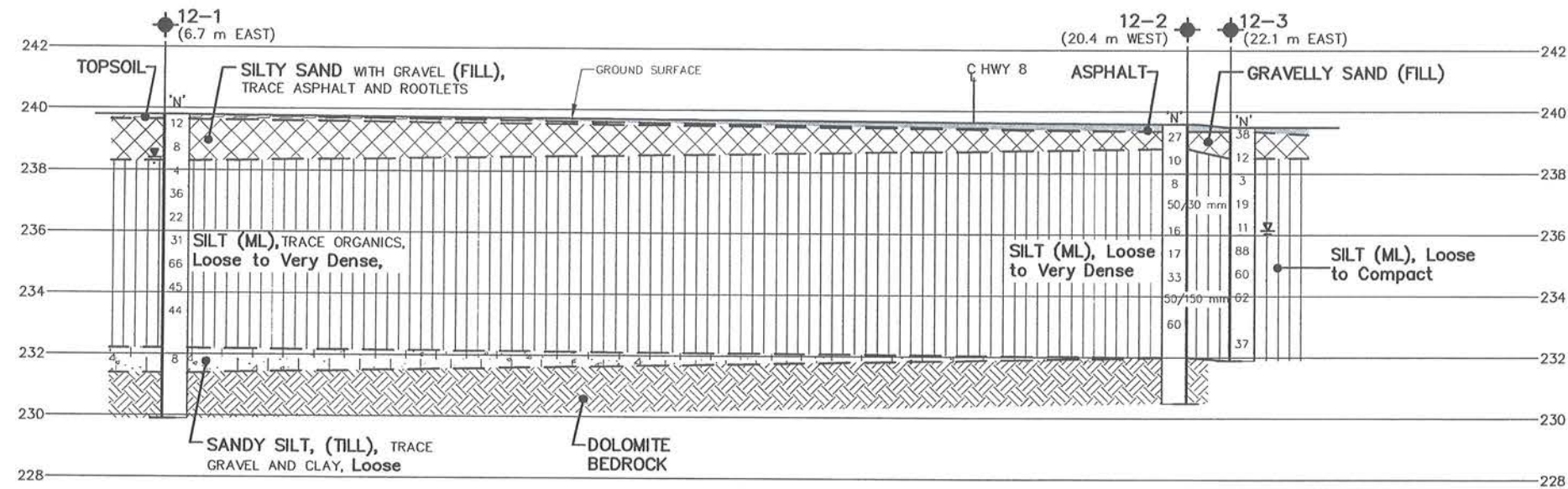
NOTE: The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Materials Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with the conditions of Section 102-2 of Form 100.



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HWY No 5 & 8		DATE	2012-06-20
SUBM'D SGD	CHECKED	DATE	2012-06-20
DRAWN GBB	CHECKED	APPROVED	12/06/12
DWG	1		





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DIMENSIONS ARE IN METRES  
AND/OR MILLIMETRES  
UNLESS OTHERWISE SHOWN

PLATE No  
CONT  
WP 2829-02-00



HIGHWAYS 5 & 8  
PETERS CORNERS, HAMILTON, ONTARIO  
SOIL STRATA

SHEET



KEY PLAN  
NOT TO SCALE

#### LEGEND

- Borehole
- N Blows/0.3m (Std Pen Test, 475 J/blow)
- WL at time of investigation, March 29, 2012
- Inferred WL at time of investigation, March 2012
- (m EAST) OFFSET FROM SECTION LINE

No	ELEVATION	MTM ZONE 10 COORDINATES NORTH	EAST
12-1	239.8	4 793 587	258 767
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12-7	244.5	4 793 646	259 198
12-8	245.7	4 793 654	259 247

#### NOTES

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

This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

NOTE: The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Materials Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with the conditions of Section 102-2 of Form 100.

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GEORES No 40PB-200			
HWY No 5 & 8		DIST	
SUBM'D SGD	CHECKED	DATE 2012-06-20	SITE
DRAWN GBB	CHECKED	APPROVED SG	DWG 2





**Photo No. 1: Borehole 12-4 looking west along Hwy 5 – Overhead Sign**



**Photo No. 2: Borehole 12-2 looking south along Hwy 8 – Stormwater Pond**





**Photo No. 3: Borehole 12-3 looking north along Hwy 8 - Stormwater Pond**



**Photo No. 4: Borehole 12-7 looking east along Highway 5 – Gabion Retaining Wall**





**Photo No. 5: Borehole 12-8 looking west along Highway 5 – Gabion Retaining Wall**



**Photo No. 6: Highway 5 Station 23+100 looking east – Gabion Retaining Wall**

# **APPENDIX B**

Symbols and Terms Used on Borehole Records

Borehole Records

## SYMBOLS AND TERMS USED ON BOREHOLE AND TEST PIT RECORDS

### SOIL DESCRIPTION

#### Terminology describing common soil genesis:

<i>Topsoil</i>	- mixture of soil and humus capable of supporting vegetative growth
<i>Peat</i>	- mixture of visible and invisible fragments of decayed organic matter
<i>Till</i>	- unstratified glacial deposit which may range from clay to boulders
<i>Fill</i>	- material below the surface identified as placed by humans (excluding buried services)

#### Terminology describing soil structure:

<i>Desiccated</i>	- having visible signs of weathering by oxidization of clay minerals, shrinkage cracks, etc.
<i>Fissured</i>	- having cracks, and hence a blocky structure
<i>Varved</i>	- composed of regular alternating layers of silt and clay
<i>Stratified</i>	- composed of alternating successions of different soil types, e.g. silt and sand
<i>Layer</i>	- > 75 mm in thickness
<i>Seam</i>	- 2 mm to 75 mm in thickness
<i>Parting</i>	- < 2 mm in thickness

#### Terminology describing soil types:

The classification of soil types are made on the basis of grain size and plasticity in accordance with the Unified Soil Classification System (USCS) (ASTM D 2487 or D 2488). The classification excludes particles larger than 76 mm (3 inches). The USCS provides a group symbol (e.g. SM) and group name (e.g. silty sand) for identification.

#### Terminology describing cobbles, boulders, and non-matrix materials (organic matter or debris):

Terminology describing materials outside the USCS, (e.g. particles larger than 76 mm, visible organic matter, construction debris) is based upon the proportion of these materials present:

<i>Trace, or occasional</i>	Less than 10%
<i>Some</i>	10-20%
<i>Frequent</i>	> 20%

#### Terminology describing compactness of cohesionless soils:

The standard terminology to describe cohesionless soils includes compactness (formerly "relative density"), as determined by the Standard Penetration Test N-Value (also known as N-Index). A relationship between compactness condition and N-Value is shown in the following table.

Compactness Condition	SPT N-Value
<i>Very Loose</i>	<4
<i>Loose</i>	4-10
<i>Compact</i>	10-30
<i>Dense</i>	30-50
<i>Very Dense</i>	>50

#### Terminology describing consistency of cohesive soils:

The standard terminology to describe cohesive soils includes the consistency, which is based on undrained shear strength as measured by *in situ* vane tests, penetrometer tests, or unconfined compression tests.

Consistency	Undrained Shear Strength	
	kips/sq.ft.	kPa
<i>Very Soft</i>	<0.25	<12.5
<i>Soft</i>	0.25 - 0.5	12.5 - 25
<i>Firm</i>	0.5 - 1.0	25 - 50
<i>Stiff</i>	1.0 - 2.0	50 - 100
<i>Very Stiff</i>	2.0 - 4.0	100 - 200
<i>Hard</i>	>4.0	>200



## ROCK DESCRIPTION

### Terminology describing rock quality:

RQD	Rock Mass Quality
0-25	<i>Very Poor</i>
25-50	<i>Poor</i>
50-75	<i>Fair</i>
75-90	<i>Good</i>
90-100	<i>Excellent</i>

Rock quality classification is based on a modified core recovery percentage (RQD) in which all pieces of sound core over 100 mm long are counted as recovery. The smaller pieces are considered to be due to close shearing, jointing, faulting, or weathering in the rock mass and are not counted. RQD was originally intended to be done on NW core; however, it can be used on different core sizes if the bulk of the fractures caused by drilling stresses are easily distinguishable from *in situ* fractures. The terminology describing rock mass quality based on RQD is subjective and is underlain by the presumption that sound strong rock is of higher engineering value than fractured weak rock.

### Terminology describing rock mass:

Spacing (mm)	Joint Classification	Bedding, Laminations, Bands
> 6000	<i>Extremely Wide</i>	-
2000-6000	<i>Very Wide</i>	<i>Very Thick</i>
600-2000	<i>Wide</i>	<i>Thick</i>
200-600	<i>Moderate</i>	<i>Medium</i>
60-200	<i>Close</i>	<i>Thin</i>
20-60	<i>Very Close</i>	<i>Very Thin</i>
<20	<i>Extremely Close</i>	<i>Laminated</i>
<6	-	<i>Thinly Laminated</i>

### Terminology describing rock strength:

Strength Classification	Unconfined Compressive Strength (MPa)
<i>Extremely Weak</i>	< 1
<i>Very Weak</i>	1 – 5
<i>Weak</i>	5 – 25
<i>Medium Strong</i>	25 – 50
<i>Strong</i>	50 – 100
<i>Very Strong</i>	100 – 250
<i>Extremely Strong</i>	> 250

### Terminology describing rock weathering:

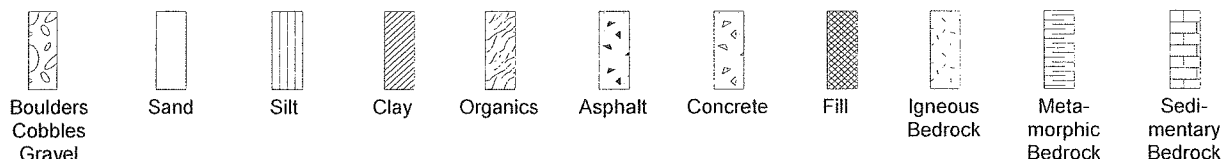
Term	Description
<i>Fresh</i>	No visible signs of rock weathering. Slight discolouration along major discontinuities
<i>Slightly Weathered</i>	Discolouration indicates weathering of rock on discontinuity surfaces. All the rock material may be discoloured.
<i>Moderately Weathered</i>	Less than half the rock is decomposed and/or disintegrated into soil.
<i>Highly Weathered</i>	More than half the rock is decomposed and/or disintegrated into soil.
<i>Completely Weathered</i>	All the rock material is decomposed and/or disintegrated into soil. The original mass structure is still largely intact.





## STRATA PLOT

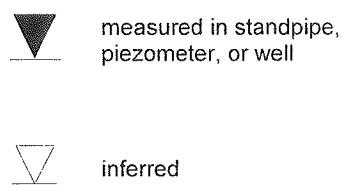
Strata plots symbolize the soil or bedrock description. They are combinations of the following basic symbols. The dimensions within the strata symbols are not indicative of the particle size, layer thickness, etc.



## SAMPLE TYPE

SS	Split spoon sample (obtained by performing the Standard Penetration Test)
ST	Shelby tube or thin wall tube
DP	Direct-Push sample (small diameter tube sampler hydraulically advanced)
PS	Piston sample
BS	Bulk sample
WS	Wash sample
HQ, NQ, BQ, etc.	Rock core samples obtained with the use of standard size diamond coring bits.

## WATER LEVEL MEASUREMENT



## RECOVERY

For soil samples, the recovery is recorded as the length of the soil sample recovered. For rock core, recovery is defined as the total cumulative length of all core recovered in the core barrel divided by the length drilled and is recorded as a percentage on a per run basis.

## N-VALUE

Numbers in this column are the field results of the Standard Penetration Test: the number of blows of a 140 pound (64 kg) hammer falling 30 inches (760 mm), required to drive a 2 inch (50.8 mm) O.D. split spoon sampler one foot (305 mm) into the soil. For split spoon samples where insufficient penetration was achieved and N-values cannot be presented, the number of blows are reported over sampler penetration in millimetres (e.g. 50/75). Some design methods make use of N value corrected for various factors such as overburden pressure, energy ratio, borehole diameter, etc. No corrections have been applied to the N-values presented on the log.

## DYNAMIC CONE PENETRATION TEST (DCPT)

Dynamic cone penetration tests are performed using a standard 60 degree apex cone connected to A size drill rods with the same standard fall height and weight as the Standard Penetration Test. The DCPT value is the number of blows of the hammer required to drive the cone one foot (305 mm) into the soil. The DCPT is used as a probe to assess soil variability.

## OTHER TESTS

S	Sieve analysis
H	Hydrometer analysis
k	Laboratory permeability
$\gamma$	Unit weight
$G_s$	Specific gravity of soil particles
CD	Consolidated drained triaxial
CU	Consolidated undrained triaxial with pore pressure measurements
UU	Unconsolidated undrained triaxial
DS	Direct Shear
C	Consolidation
$Q_u$	Unconfined compression
$I_p$	Point Load Index ( $I_p$ on Borehole Record equals $I_p(50)$ in which the index is corrected to a reference diameter of 50 mm)

	Single packer permeability test; test interval from depth shown to bottom of borehole
	Double packer permeability test; test interval as indicated
	Falling head permeability test using casing
	Falling head permeability test using well point or piezometer



# RECORD OF BOREHOLE No BH 12-1

1 OF 1

METRIC

W.P. 2829-02-00 LOCATION Hwy 8, Peters Corners N: 4 793 587 E: 258 767 ORIGINATED BY DS  
 DIST Eastern HWY 5 & 8 BOREHOLE TYPE Hollow Stem Augers, Splittspoon Sampler COMPILED BY BB  
 DATUM Geodetic DATE 2012 03 13 - 2012 03 13 CHECKED BY KF

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							WATER CONTENT (%)
								○ UNCONFINED	✕ FIELD VANE						
								20 40 60 80 100							
239.8	Topsoil														
239.8	150 mm TOPSOIL														
0.2	FILL: Silty sand with gravel, brown -trace asphalt -trace rootlets		1	SS	12		239			○				1 3 87 9	
			2	SS	8						○				
238.3															
1.5	SILT (ML) Loose to very dense Brown, moist -trace organics		3	SS	4		238				○			Non-Plastic	
	- dense below 2.3 m - clayey from 2.3 to 3.8 m		4	SS	36		237				○				
			5	SS	22						○			0 3 61 36	
			6	SS	31		236				○			Non-Plastic	
			7	SS	66		235				○				
			8	SS	45		234				○			0 3 92 5	
			9	SS	44		233				○			Non-Plastic	
232.2															
7.6	Sandy silt trace gravel trace clay: TILL - Loose - Greyish brown		10	SS	8		232				○ ○			7 16 64 13	
231.4															
8.4	Dolomite BEDROCK - light grey to grey - excellent rock mass quality - close to moderate joint spacing - near horizontal discontinuities - unweathered (fresh) discontinuities		11	HQ			231							REC = 100% RQD = 100%	
229.9							230								
9.9	End of Borehole														
	Groundwater Level Measured on March 29, 2012														

ONTARIO MTO STANTEC 165000773 HWY5&8 PETERSCORNERS.GPJ ONTARIO MOT.GDT 12/6/21



**Client:** Ministry of Transportation Ontario (MTO)

Project: Peters Corners Intersection

**Contractor:** Pontil Drilling Ltd. CME-75 Track Mount

Logger: Kenton C. Power

[illegible]

# RECORD OF BOREHOLE No BH 12-2

1 OF 1

METRIC

W.P. 2829-02-00 LOCATION Hwy 8, Peters Corners N: 4 793 629 E: 258 757 ORIGINATED BY DS  
 DIST Eastern HWY 5 & 8 BOREHOLE TYPE Hollow Stem Augers, Splitspoon Sampler, HQ Rock Core COMPILED BY BB  
 DATUM Geodetic DATE 2012 03 14 - 2012 03 14 CHECKED BY KF

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										WATER CONTENT (%)		
								○ UNCONFINED	✕ FIELD VANE	● QUICK TRIAXIAL	✕ LAB VANE	20						40	60	80
239.6	Asphalt																GR SA SI CL			
0.0 239.4	235 mm ASPHALT																			
0.2	FILL: Gravelly sand, brown -crushed		1	SS	27												34 57 (9)			
238.8							239										Non-Plastic			
0.8	SILT (ML) Loose to very dense Brown, moist		2	SS	10															
							238													
			3	SS	8												Non-Plastic			
			4	SS	50/ 30mm		237													
	- clayey from 3.0 to 4.5		5	SS	16		236										0 2 69 29			
			6	SS	17		235													
	- dense to very dense below 4.6 m																			
			7	SS	33		234													
			8	SS	50/ 150mm		233										0 2 90 8			
			9	SS	60		232													
							231													
232.0																				
7.6	Dolomite BEDROCK - light grey to grey - excellent rock mass quality - close to moderate joint spacing - near horizontal discontinuities - unweathered (fresh) discontinuities		10	HQ													REC = 100% RQD = 100%			
230.5																				
9.1	End of Borehole																			

ONTARIO MTO STANTEC 165000773 HWY5&8 PETERSCORNERS GPJ ONTARIO MOT GDT 12/6/21



**Client:** Ministry of Transportation Ontario (MTO)

Project: Peters Corners Intersection

**Contractor:** Pontil Drilling Ltd.

Date: March 20, 2212

Logger: Kenton C. Power

DEPTH FROM	RUN NO.	% CORE RECOVERY	% RQD	DEPTH TO	GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.)	STRENGTH	WEATHERING	DISCONTINUITIES						OCCASIONAL FEATURES	DRILLING OBSERVATIONS	
								NO. OF SETS	TYPE/S	ORIENTATION	SPACING	ROUGHNESS	APERTURE			FILLING
7.6	1	100	100	9.1	Grey DOLOMITE bedrock		S	1	B	F	CM	RU		T		

**STRENGTH (MPa)**

EH = Extremely Strong = > 250  
VS = Very Strong = 100-250  
S = Strong = 50-100  
MS = Medium Strong = 25-50  
W = Weak = 5 - 25

**WEATHERING**

U = Unweathered = No Signs  
S = Slightly = Oxidized  
M = Moderately = Discoloured  
H = Highly = Friable  
C = Completely = Soil-like

**SPACING**

VW = Very Wide = >3m  
W = Wide = 1-3 m  
M = Moderate = 0.3-1 m  
C = Close = 5-30 cm  
VC = Very Close = <5 cm

**DISCONTINUITY TYPE**

B = Bedding Joint  
J = Cross Joint  
F = Fault  
S = Shear Plane

**ORIENTATION**

F = Flat = 0-20°  
D = Dipping = 20-50°  
V = n-Vertical = >50°

**ROUGHNESS**

RU = Rough Undulating  
RP = Rough Planar  
SU = Smooth Undulating  
SP = Smooth Planar  
LU = Slickensided Undulating  
LP = Slickensided Planar

**FILLING**

T = Tight, Hard  
O = Oxidized  
SA = Slightly Altered, Clay Free  
S = Sandy, Clay Free  
Si = Sandy, Silty, Minor Clay  
NC = Non-softening Clay  
SC = Swelling, Soft Clay

# RECORD OF BOREHOLE No BH 12-3

1 OF 1

METRIC

W.P. 2829-02-00 LOCATION Hwy 8, Peters Corners N: 4 793 613 E: 258 796 ORIGINATED BY DS  
 DIST Eastern HWY 5 & 8 BOREHOLE TYPE Hollow Stem Augers, Splitspoon Sampler, HQ Rock Core COMPILED BY BB  
 DATUM Geodetic DATE 2012 03 13 - 2012 03 14 CHECKED BY KE

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 (%)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																												
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											
239.5	Asphalt							20	40	60	80	100																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														</

ONTARIO MTO STANTEC 165000773 HWY5&8 PETERSCORNERS GPJ ONTARIO MOT.GDT 12/6/21

# RECORD OF BOREHOLE No BH 12-4

1 OF 1

METRIC

W.P. 2829-02-00 LOCATION Hwy 8, Peters Corners N: 4 793 596 E: 258 866 ORIGINATED BY DS  
 DIST Eastern HWY 5 & 8 BOREHOLE TYPE Hollow Stem Augers, Splitspoon Sampler COMPILED BY BB  
 DATUM Geodetic DATE 2012 03 13 - 2012 03 13 CHECKED BY KF

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 (%)						
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)	GR	SA	SI	CL	
								UNCONFINED ○	FIELD VANE ✕	QUICK TRIAXIAL ●											LAB VANE ×
239.7	Asphalt																				
239.6	140 mm ASPHALT																				
239.4	FILL: Gravelly sand, brown -crushed		1	SS	42																
0.3	FILL: Gravelly sand, brown																				
238.7																					
1.0	SILT (ML) Loose to very dense Brown, moist to wet		2	SS	14										3 18 66 13						
			3	SS	5																
	- clayey from 1.5 to 2.3 m		4	SS	5																
			5	SS	29										0 0 91 9 Non-Plastic						
			6	SS	50/ 30 mm																
			7	SS	26																
			8	SS	30										0 3 92 5						
			9	SS	28																
233.0																					
6.7	End of Borehole																				
	Groundwater observed at 1.83 m depth during drilling																				

ONTARIO MTO STANTEC 165000773 HWY5&8\_PETERSCORNERS.GPJ ONTARIO MOT.GDT 12/6/21

# RECORD OF BOREHOLE No BH 12-5

1 OF 1

METRIC

W.P. 2829-02-00 LOCATION Hwy 5, Peters Corners N: 4 793 636 E: 259 108 ORIGINATED BY RC  
 DIST Eastern HWY 5 & 8 BOREHOLE TYPE Hollow Stem Augers, Splitspoon Sampler COMPILED BY BB  
 DATUM Geodetic DATE 2012 03 16 - 2012 03 16 CHECKED BY KE

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	✕ LAB VANE							
242.6	Asphalt							20	40	60	80	100						
242.4	190 mm ASPHALT																	
0.2	FILL: Gravelly sand, brown		1	SS	32													
241.8							242											
0.8	FILL: Sandy silt, brown -trace gravel and topsoil		2	SS	11													
			3	SS	11		241											
			4	SS	8		240											
			5	SS	3		239											
			6	SS	1													
238.2	- some topsoil material																	
4.4	SILT (ML) Compact Brown to grey, wet		7	SS	11		238											
			8	SS	16		237											
	- clayey below 6.0 m																	
			9	SS	13													
235.9							236											
6.7	End of Borehole																	
	Groundwater observed at 3.0 m depth during drilling																	

ONTARIO MTO STANTEC 165000773\_HWY5&8\_PETERSCORNERS.GPJ ONTARIO MOT. GOT 12/6/21




# RECORD OF BOREHOLE No BH 12-6

1 OF 1

METRIC

W.P. 2829-02-00 LOCATION Hwy 5, Peters Corners N: 4 793 645 E: 259 152 ORIGINATED BY RC  
 DIST Eastern HWY 5 & 8 BOREHOLE TYPE Hollow Stem Augers, Split Spoon Sampler COMPILED BY BB  
 DATUM Geodetic DATE 2012 03 16 - 2012 03 16 CHECKED BY KF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT   NATURAL MOISTURE   LIQUID CONTENT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	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>			WATER CONTENT (%)		
243.5	Gravel							20	40	60	80	100						
0.0	FILL: Gravelly sand, brown -crushed		1	SS	21		243											
242.7			2	SS	8		242											
0.8	FILL: Silty sand Brown, wet -trace gravel and topsoil		3	SS	8													
			4	SS	1		241											
240.6																		
2.9	SILT (ML) Very loose to compact Brown to grey, moist to wet		5	SS	1		240											
			6	SS	13													
			7	SS	19		239											
			8	SS	11	238												
	- grey below 6.1 m		9	SS	16	237												
236.8	End of Borehole																	
6.7	Groundwater observed at 3.8 m depth during drilling																	



ONTARIO MTO STANTEC 165000773\_HWY5&8\_PETERSCORNERS.GPJ ONTARIO MOT GDT 12/6/21

# RECORD OF BOREHOLE No BH 12-7

1 OF 1

METRIC

W.P. 2829-02-00 LOCATION Hwy 5, Peters Corners N: 4 793 646 E: 259 198 ORIGINATED BY DS  
 DIST Eastern HWY 5 & 8 BOREHOLE TYPE Hollow Stem Augers, Splitspoon Sampler COMPILED BY BB  
 DATUM Geodetic DATE 2012 03 15 - 2012 03 16 CHECKED BY K/F

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	✕ LAB VANE	WATER CONTENT (%)					
							20	40	60	80	100		10	20	30		
244.5	Topsoil					▽											
244.4 0.1	100 mm TOPSOIL FILL: Sandy silt Brown -trace rootlets		1	SS	4										○		
243.7 0.8	SILT (ML) Loose to dense Brown, moist -trace organics		2	SS	36										○		
			3	SS	20												
			4	SS	24												
			5	SS	26										○		
			6	SS	32												
			7	SS	14												
			8	SS	8										○		
			9	SS	11												
237.8 6.7	End of Borehole																

ONTARIO MTO STANTEC 165000773 HWY5&8 PETERSCORNERS GPJ ONTARIO MOT GDT 12/6/21

# RECORD OF BOREHOLE No BH 12-8

1 OF 1

METRIC

W.P. 2829-02-00 LOCATION Hwy 5, Peters Corners N: 4 793 654 E: 259 247 ORIGINATED BY DS  
 DIST Eastern HWY 5 & 8 BOREHOLE TYPE Hollow Stem Augers, Splitspoon Sampler COMPILED BY BB  
 DATUM Geodetic DATE 2012 03 15 - 2012 03 15 CHECKED BY KE

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
								20 40 60 80 100						
245.7	Topsoil													
244.9 0.1	100 mm TOPSOIL FILL: Silty sand with gravel, brown -trace rootlets		1	SS	3									
244.9 0.8	SILT (ML) Loose to compact Brown, moist to wet		2	SS	12									1 3 88 8
			3	SS	15									
			4	SS	13									
			5	SS	10									
			6	SS	11									15 77 (8)
			7	SS	10									
			8	SS	4									0 0 92 8
			9	SS	4									Non-Plastic
239.0 6.7	End of Borehole  Monitoring Well Measured On March 29, 2012													

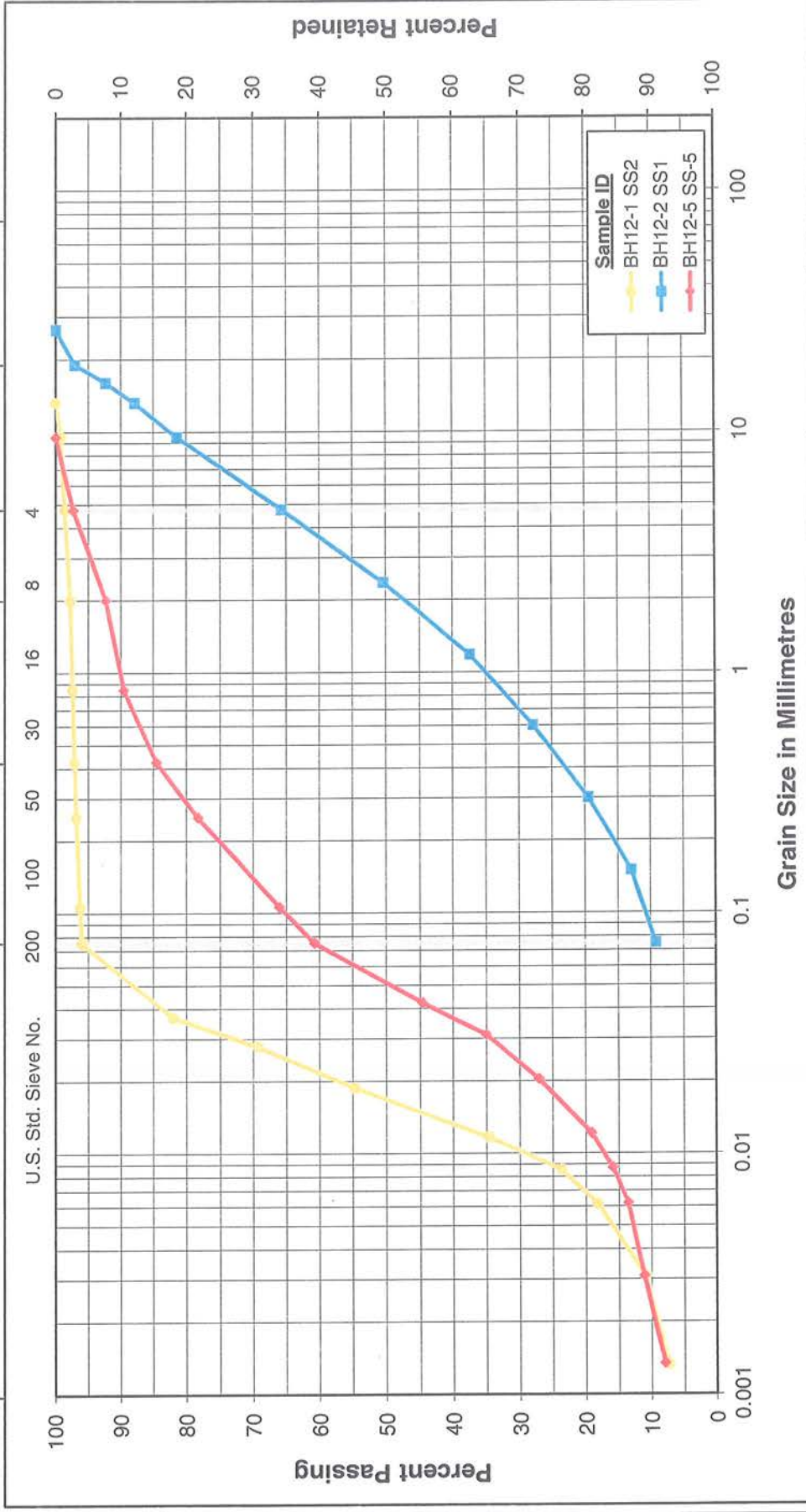
ONTARIO MTO STANTEC 165000773\_HWY5&8\_PETERSCORNERS GPJ ONTARIO MOT GDT 12/6/21

# **APPENDIX C**

Laboratory Test Results

# Unified Soil Classification System

CLAY & SILT				SAND			Gravel	
				Fine	Medium	Coarse	Fine	Coarse



	SAND			Gravel	
	Fine	Medium	Coarse	Fine	Coarse
CLAY & SILT					



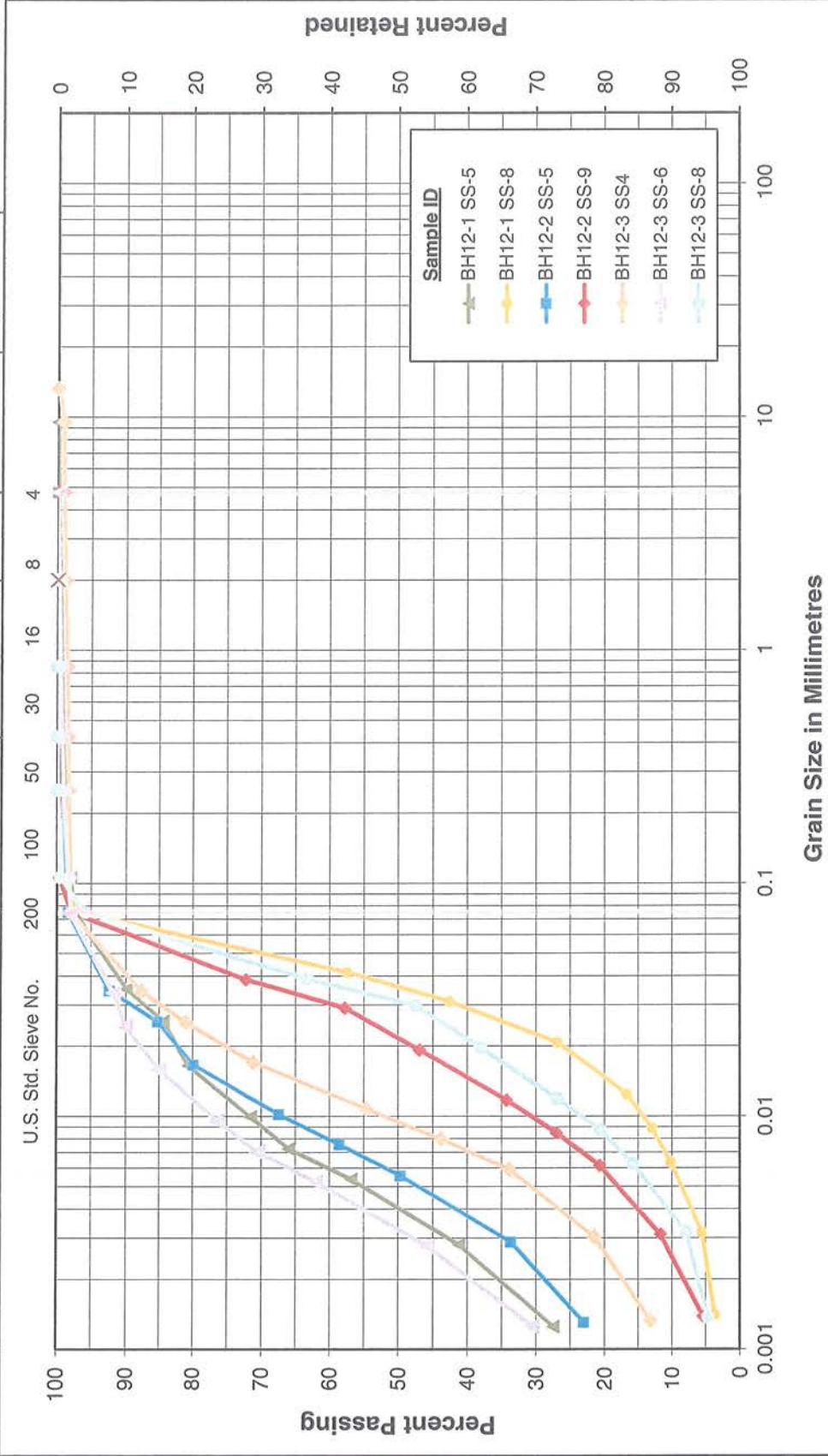
Project No. 165000773

## GRAIN SIZE DISTRIBUTION



# Unified Soil Classification System

CLAY & SILT		SAND				Gravel	
		Fine	Medium	Coarse		Fine	Coarse



## GRAIN SIZE DISTRIBUTION SILT (ML)

Figure No. 3

Project No. 165000773





# Unified Soil Classification System

CLAY & SILT	SAND				Gravel	
	Fine	Medium	Coarse		Fine	Coarse

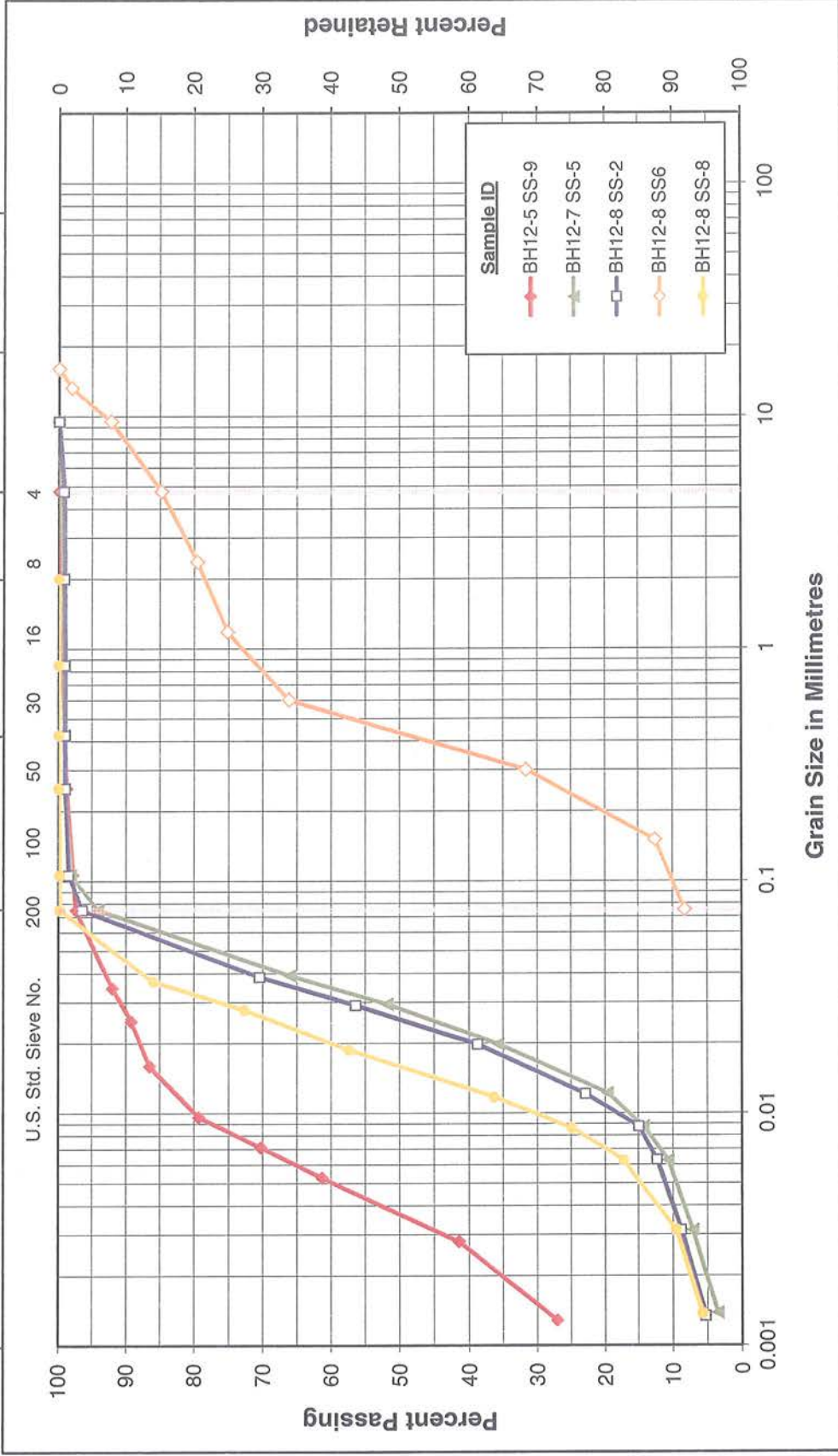


Figure No. 4

**GRAIN SIZE DISTRIBUTION**  
SILT (ML) to Poorly Graded SAND (SP-SM)

Project No. 165000773

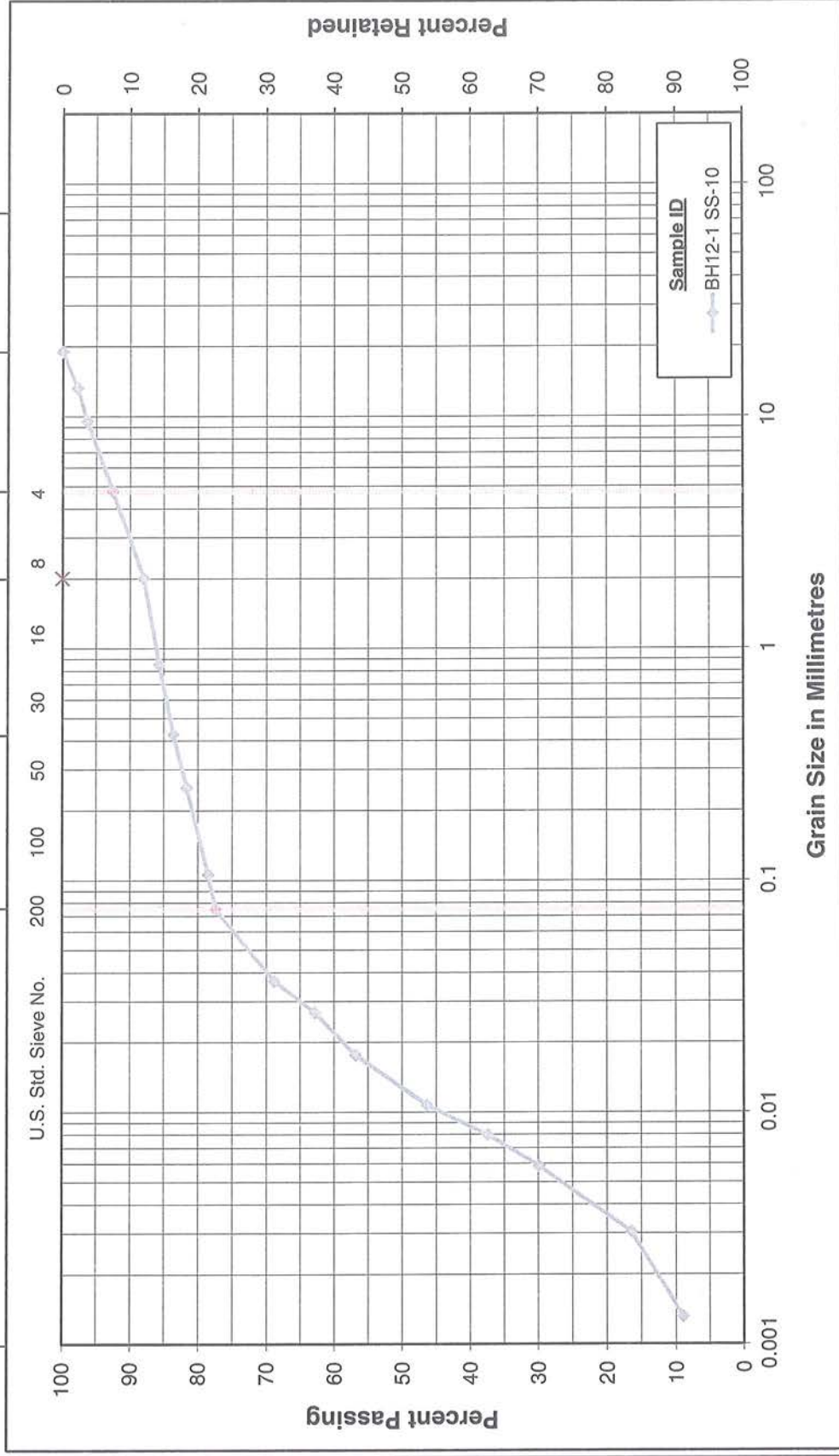


Stantec



# Unified Soil Classification System

CLAY & SILT	SAND			Gravel	
	Fine	Medium	Coarse	Fine	Coarse



## GRAIN SIZE DISTRIBUTION

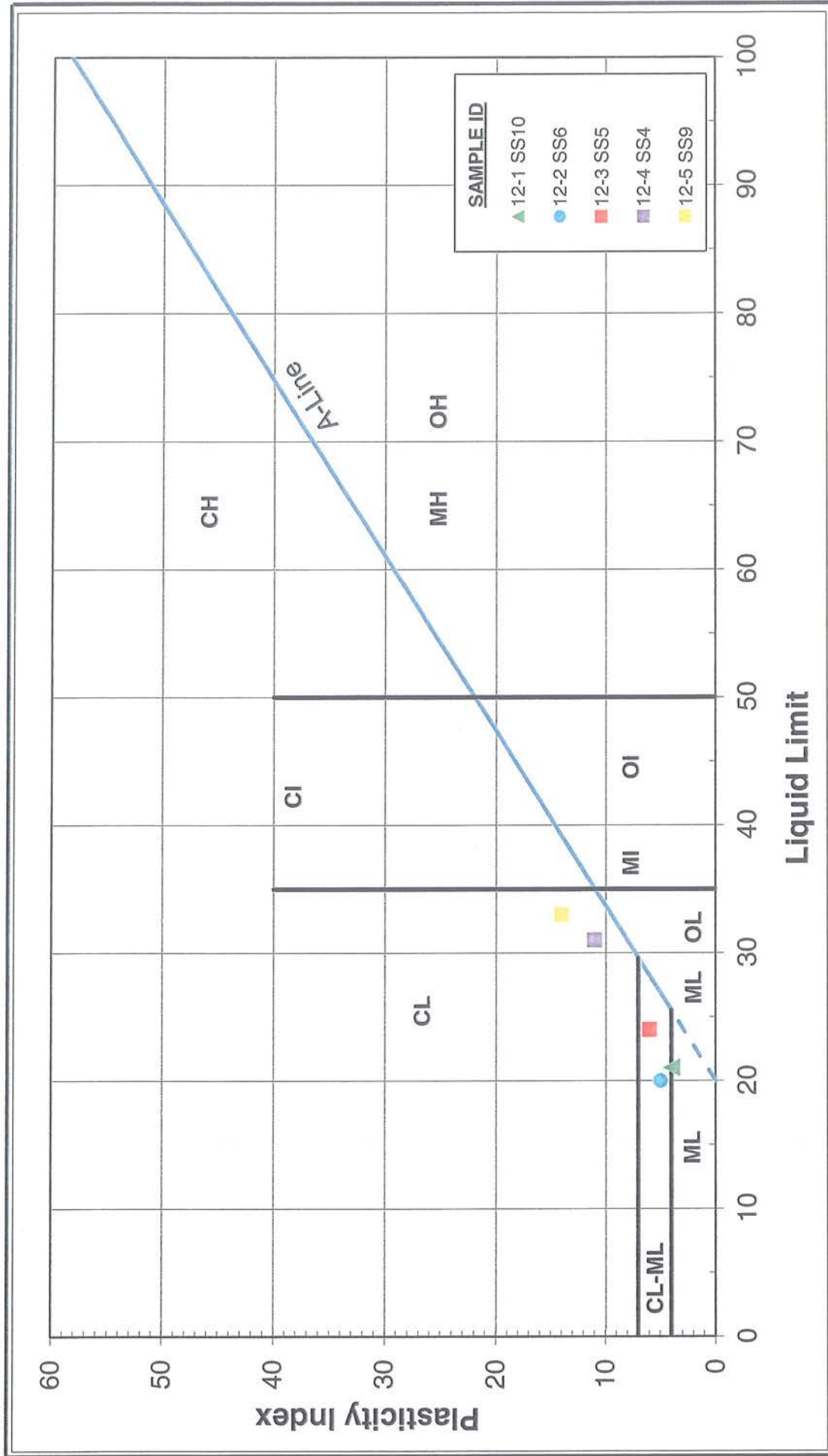
Sandy Silt TILL

Figure No. 5

Project No. 165000773



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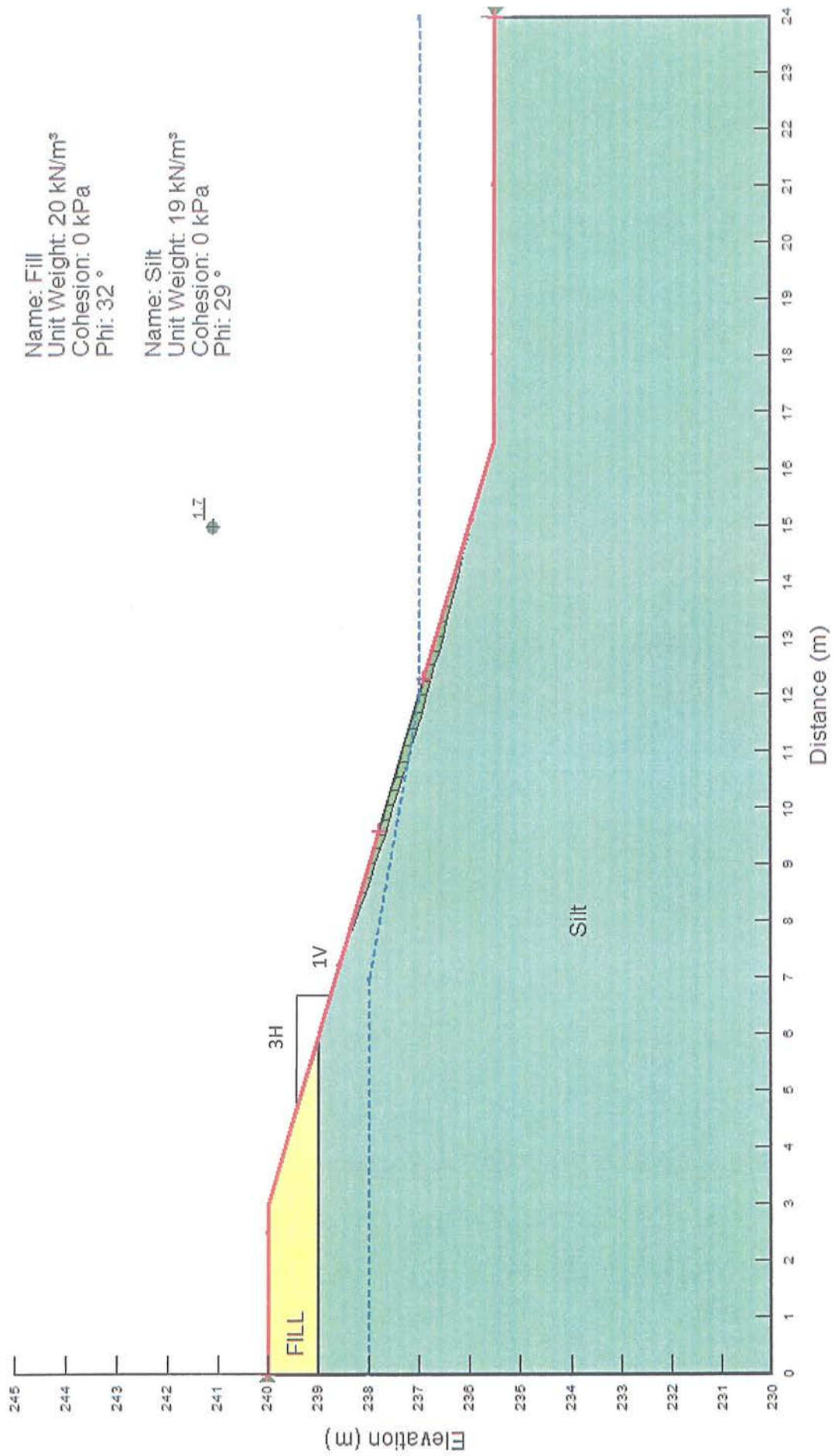
# PLASTICITY CHART

Figure No. 6

Project No. 165000773

# **APPENDIX D**

Slope Stability Results



**Stantec**

# Static Slope Stability Analysis

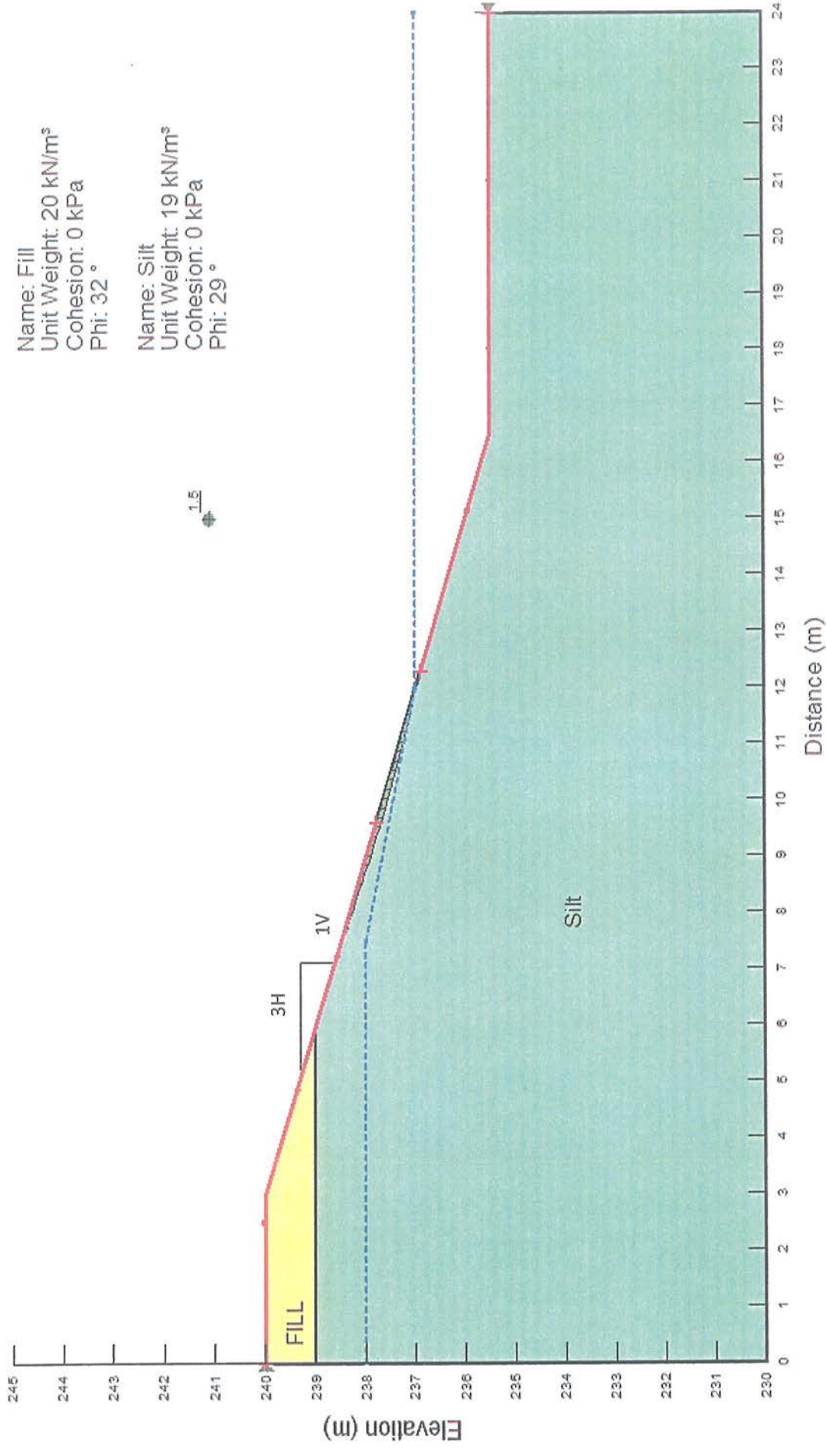
## Stormwater Management Pond

### Peters Corners

Figure No. 7

Project No. 165000773





# Seismic Slope Stability Analysis

## Stormwater Management Pond

### Peters Corners

Figure No. 8

Project No. 165000773



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## **APPENDIX E**

NSSP Risk of Cave-In and Difficult Augering Conditions During Construction of  
Caissons for Sign Support Foundations

**RISK OF CAVE-IN AND DIFFICULT AUGERING CONDITIONS DURING CONSTRUCTION  
OF CAISSONS FOR SIGN SUPPORT FOUNDATIONS—Item No.**

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Special Provision

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**SCOPE**

The work required for the above tender item shall include consideration of the potential for soil cave-in and difficult augering conditions during construction of the sign support foundations.

**CONSTRUCTION**

The soil conditions observed at the site suggest that where the augered holes extend below the water table, the holes are not expected to remain open for any period of time. Consequently, the use of a temporary liner is expected to be required as part of the construction process.

Cobbles have been observed within the dense portion of the silt deposit. As well, randomly present cobbles and boulders are expected within the glacial till which underlies the silt deposit. Therefore, difficult augering conditions may be encountered.

The contractor shall monitor the observed conditions during augering and shall accordingly devise appropriate procedures when constructing the sign support foundations.

**BASIS OF PAYMENT**

Payment at the contract price for the tender item shall be full compensation for all labour, equipment and material to do the work.