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Highway 427 Expansion  
Major Mackenzie Drive Overpass (Structure B18)

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## Statement of Limitations and Conditions

### APPENDICES

Appendix A	Record of Borehole Sheets – Current Investigation
Appendix B	Geotechnical and Analytical Laboratory Test Results – Current Investigation
Appendix C	Record of Borehole Sheets – Previous Investigations
Appendix D	Borehole Locations and Soil Strata Drawings
Appendix E	Stability Analysis Output for Approach Embankments

## 1. INTRODUCTION

This report presents the results of a foundation investigation and provides foundation recommendations for the design and construction of the proposed overpass structure to carry E-S ramp and S-W ramp of Highway 427 over the realigned Major Mackenzie Drive. The project is part of the proposed 6.6 km long extension of Highway 427 from Highway 7 to Major Mackenzie Drive in the City of Vaughan, Ontario.

Recommendations on the foundation aspects of the overpass design presented in this report were based on the interpretation of the subsurface information obtained during the current foundation investigation by Thurber Engineering (Thurber) as well as previous investigations at the site the results of which were presented in the reports listed below:

- GEOCRE 30M13-174: Preliminary Foundation Investigation and Design Report, Major Mackenzie Overpass (NBL and SBL), Highway 427 Extension from Highway 7 to Major Mackenzie Drive, Ministry of Transportation, Ontario, W.O. 05-20012, dated August 2009, prepared by Golder Associates.
- GEOCRE 30M13-216: Preliminary Foundation Investigation and Design Report, Highway 427 Expansion Project, Extension from Highway 7 to Major Mackenzie Drive, City of Vaughan, Ontario, W.O. 18, dated March 2016, prepared by Peto MacCallum Ltd.
- GEOCRE 30M13-177: Preliminary Foundation Investigation and Design Report, High Fill Embankments, Highway 427 Extension from Highway 7 to Major Mackenzie Drive, Ministry of Transportation, Ontario, W.O. 05-20012, dated August 2009, prepared by Golder Associates.

Foundation recommendations presented in this report are prepared based on Preliminary General Arrangement (GA) drawing H427-D-F-5-STR-B18-DWG-700-A.

It is a condition of this report that Thurber's performance of its professional services is subject to the attached Statement of Limitations and Conditions.

## 2. SITE DESCRIPTION, GEOLOGY BACKGROUND AND PROJECT DESCRIPTION

The site is located approximately 150 m north of the existing Major Mackenzie Drive and 50 m west of Huntington Road in Vaughan, Ontario. The site is surrounded by agricultural properties.

The site is situated within the Peel Plain physiographic region the subsurface condition in which generally comprises clayey silt to silty clay of Halton till with interlayers of sand and silt. Localized recent deposits of sands, silts and soft clays formed in small glacial meltwater ponds throughout the region may be encountered near the river and creek valleys. The site is underlain by shale bedrock of the Georgian Bay Formation with siltstone and limestone interlayers.

Based on the GA drawing, the proposed overpass is a single-span structure with integral abutment configuration and retained soil systems (RSS) walls. The proposed foundations for the abutments are driven steel H-piles. The side slopes of the approach embankments will have a slope inclination of 2H:1V.

## 3. GEOTECHNICAL INVESTIGATION

The current field investigation at the proposed bridge site was conducted between June 22 and July 4, 2017, and consisted of advancing seven (7) boreholes, designated as Boreholes MMO 17-01 to MMO 17-07 to depths ranging between 9.8 to 61.3 m.

Borehole coordinates and ground surface elevations were provided by CJV. The Record of Borehole sheets (which includes the approximate locations in MTM NAD 83, Zone 10 coordinates) and the Borehole Locations and Soil Strata drawings are included in Appendix A and Appendix D, respectively.

Truck and track mounted drill rigs supplied by Landshark Drilling Inc. of Brantford, Ontario, and Walker Drilling Ltd., of Utopia, Ontario, were used to advance the boreholes. Soil samples were obtained at selected intervals using a 50 mm nominal inner diameter split spoon sampler in conjunction with Standard Penetration Testing (SPT) procedures as per ASTM D1586. The bedrock was confirmed by a minimum of 3 m coring using NQ-sized coring equipment in two boreholes. All rock cores were logged, and Total Core Recovery (TCR), Solid Core Recovery (SCR), Rock Quality Designation (RQD) and Fracture Index (FI) were determined.

Groundwater conditions were observed in the open boreholes throughout the drilling operations and measured upon completion of drilling. However, since water was used during the drilling operations these measurements were considered not reliable. Standpipe piezometers were installed in three Boreholes (MMO 17-03 to MMO 17-05). The other boreholes were backfilled as per O. Reg. 903. All piezometers will be decommissioned by Project Co. following final round of groundwater level measurements.

Two borehole logs are available from the previous investigations. Boreholes MMD-1 and MMD-3 from the 2016 report are enclosed in Appendix C.

#### 4. SUBSURFACE CONDITIONS

A general description of the stratigraphy is given in the following paragraphs. However, the factual data presented on the Record of Borehole sheets takes precedence over this general description which was prepared for interpretation of the site conditions. Subsurface conditions may vary between and beyond borehole locations.

In general, the subsurface conditions at the site generally consist of a surficial clayey silt layer underlain by a relatively thick layer of clayey silt to silty clay till. The clayey silt to silty clay till is underlain by clayey silt grading to sand and silt over shale bedrock. Occasional auger grinding, hard augering, and/or split spoon bouncing were noted during advancing the boreholes in the till deposits, likely indicating presence of cobbles and/or boulders as expected to be present in till deposits of southern Ontario.

More descriptions of the subsurface conditions at the site are presented below.

##### 4.1 Topsoil

Topsoil was encountered at the ground surface in all boreholes except Boreholes MMO 17-03 and MMO 17-04. The thickness of the topsoil ranged from 75 to 200 mm.

##### 4.2 Sand

A 0.3 m thick sand deposit was encountered underlying the topsoil layer in Borehole MMO 17-07. An SPT-N value of 5 blows per 0.3 m penetration was measured in the sand indicating a loose relative density.

##### 4.3 Surficial Clayey Silt

A surficial layer of clayey silt was encountered underlying the topsoil layer in Boreholes MMO 17-01, MMO 17-02, MMO 17-05 and MMO 17-06, underlying the sand fill in Borehole MMO 17-07, and from the ground surface in Boreholes MMO 17-03 and MMO 17-04. The clayey silt ranged from 0.6 to 1.5 m in thickness and extended to depths ranging between 0.8 and 1.8 m (Elev. 204.0 and 203.0m). The SPT-N values within the clayey silt ranged from 4 to 17 blows per 0.3 m of penetration indicating a firm to very stiff consistency.

##### 4.4 Clayey Silt to Silty Clay Till

A deposit of clayey silt to silty clay till was encountered underlying the surficial clayey silt in all boreholes. The thickness of the cohesive till ranged from at least 8.2 m to 27.8 m and extended from at least 9.8 m to 29.3 m below ground surface (below Elev. 195.1 to 175.2 m).

SPT-N values recorded within the till ranged from 8 blows per 0.3 m penetration to 100 blows per 0.175 m of penetration indicating a stiff to hard consistency.

Glacial tills inherently contain cobbles and boulders.

#### 4.5 Clayey Silt to Silt

A deposit of clayey silt to silt was encountered underlying cohesive till deposit in all boreholes which penetrated the till deposit. The thickness of the clayey silt to silt ranged from 9.4 to 12.2 m and extended from depths ranging between 38.7 and 41.5 m (Elev. 165.8 and 163.2m).

SPT-N values within the cohesive till ranged from 10 to 23 per 0.3 m penetration indicating a stiff to very stiff consistency.

#### 4.6 Silt and Sand

A silt and sand deposit was encountered underlying the clayey silt to silt deposit in the boreholes which penetrated the clayey silt to silt deposit. The thickness of the cohesionless silt and sand deposit ranged from 14.7 to 18.0 m and the deposit extended to depths ranging between 56.2 and 56.7 m (Elev. 148.5 and 147.8m).

SPT-N values within the deposit ranged from 16 blows per 0.3 m penetration to 100 blows per 0.075 m of penetration indicating a compact to very dense relative density.

#### 4.7 Shale Bedrock

Grey shale bedrock of the Georgian Bay Formation was confirmed by coring in Boreholes MMO 17-03 and MMO 17-04. The bedrock surface was encountered at depths of 56.2 m and 56.7 m below ground surface (Elev. 148.5 and 147.8 m) in MMO 17-03 and MMO 17-04, respectively. The measured Total Core Recovery (TCR) and Solid Core Recovery (SCR) values were 100% in all core runs and the Rock Quality Designation (RQD) values ranged from 67 to 92%, indicating a fair to excellent rock quality.

#### 4.8 Groundwater Levels

Water levels measured in the piezometers installed during the current investigation are summarized in Table 4.1.

**Table 4.1 – Piezometer Details and Groundwater Level Measurements**

Borehole	Measurement Date	Water Level (m)		Native Material at Screen
		Depth	Elevation	
MMO 17-03	June 29, 2017	11.1	193.6	Clayey Silt to Silty Clay Till
	July 10, 2017	11.1	193.6	
	Oct 23, 2017	11.3	193.4	
MMO 17-04	July 10, 2017	11.0	193.5	Clayey Silt to Silty Clay Till
	Oct 23, 2017	11.4	193.1	
MMO 17-05	July 10, 2017	11.9	192.7	Clayey Silt to Silty Clay Till
	Oct 23, 2017	3.8	200.8	

(S) denotes Shallow piezometer, (D) denotes Deep piezometer

The above groundwater levels represent relatively short-term readings and seasonal fluctuations of the groundwater level are to be expected. The groundwater level may be at higher elevations after the spring snowmelt or after periods of heavy rainfall. Perched water may be present at higher levels in lenses or zones of more permeable sands and silts within the till.

#### 4.9 Corrosion and Sulphate Test Results

Soil samples collected from selected boreholes were submitted for analytical testing of corrosivity parameters and sulphate content. The laboratory certificates of analyses are presented in Appendix B. The results of the analytical tests are summarized in Table 4.2.

Table 4.2 – Corrosion and Sulphate Test Results

Parameter Tested	Unit	MMO 17-03	MMO 17-05
		SS3	SS6
Moisture	%	17.7	17.2
Corrosivity Index	-	4	5.5
pH	-	8.59	8.45
Soil Redox Potential	mV	206	215
Sulphide	%	< 0.02	0.23
Chloride	µg/g	1.5	2.0
Sulphate	µg/g	53	510
Electrical Conductivity	µS/cm	125	401
Resistivity	Ohms.cm	8000	2500

## 5. GEOTECHNICAL RECOMMENDATIONS

### 5.1 Foundation Design

#### 5.1.1 Spread Footings

Based on the available borehole information, shallow spread footings founded on native soil are not considered appropriate to support the bridge abutments in view of the relatively low bearing resistance available near surface and the risk of large footing settlement. Accordingly, this option has not been developed further.

#### 5.1.2 Driven H-Piles

Steel H-piles driven into the cohesive till deposit are considered suitable to support the bridge abutments. The recommendations and discussion on design and construction of driven H-piles are presented below. Cobbles and boulders generally exist within the till deposits in the project area. Driving the piles in the till deposits may result in pile misalignment and/or structural damages to the piles.

##### 5.1.2.1 Axial Pile Resistance

The axial resistances of a steel HP310x110 pile driven into the till deposit was assessed based on the subsurface conditions obtained at the proposed foundation locations. The estimated axial geotechnical resistances are summarized in Table 5.2 below.

Table 5.2 - Geotechnical Resistances for HP310x110

Location (Reference Borehole)	Estimated Pile Tip Elevation (m)	Founding Stratum	Factored ULS (kN)	Factored SLS (kN)
North Abutment (MMO 17-03 & MMD-3)	186	Hard Clayey Silt to Silty Clay Till	1000	800
South Abutment (MMO 17-04 & MMD-1)	186	Hard Clayey Silt to Silty Clay Till	1000	800

The factored Geotechnical Resistance at ULS was assessed assuming a Consequence Factor equal to 1 (Typical), and a Resistance Factor equal to 0.4 (Typical degree of understanding of the subsurface conditions), as per CHBDC (2014). The factored Geotechnical Resistance at SLS was assessed assuming a factor of 0.8 for typical degree of understanding of the subsurface conditions.

The factored geotechnical resistance at SLS provided above corresponds to up to 25 mm of settlement.

### 5.2 Lateral Pile Resistance

The geotechnical lateral resistance acting on a HP310x110 pile in cohesive soils may be calculated using coefficient of horizontal subgrade reaction ( $k_s$ ) and ultimate lateral resistance ( $p_{ult}$ ) as follows:

$$k_s = 67 s_u / D \quad (\text{kN/m}^3)$$

$$p_{ult} = 9 s_u \quad (\text{kPa})$$

Where:  $s_u$  = undrained shear strength (kPa)

$D$  = pile width in metres (0.31 m for HP310x110)

The lateral resistance acting on a 0.31 m for HP310x110 pile in cohesionless soils may be calculated using a value for the coefficient of horizontal subgrade reaction ( $k_s$ ) and ultimate lateral resistance ( $p_{ult}$ ) as follows:

$$k_s = n_h z / D \quad (\text{kN/m}^3)$$

$$p_{ult} = 3 \gamma' z K_p \quad (\text{kPa})$$

Where:  $z$  = depth of embedment of pile (m)

$D$  = pile width in metres (0.31 m for HP310x110)

$n_h$  = coefficient related to soil relative density ( $\text{kN/m}^3$ )

$\gamma'$  = effective unit weight ( $\text{kN/m}^3$ )

$K_p$  = passive earth pressure coefficient

The above equations and parameters provided in Table 5.3 may be used to analyze the interaction between a pile and the surrounding soil. Lateral pressures obtained from analysis must not exceed the ultimate lateral resistance.

The spring constant,  $K_s$ , for analysis may be obtained by the expression,  $K_s = k_s L D$  ( $\text{kN/m}$ ), where  $k_s$  is the coefficient of horizontal subgrade reaction ( $\text{kN/m}^3$ ),  $D$  is the pile width (m) and  $L$  is the length (m) of the pile segment or element used in the analysis. The ultimate lateral resistance,  $P_{ult}$ , can be obtained from the expression,  $P_{ult} = p_{ult} L D$ . This represents the ultimate load at which the pile fails and will not support any additional load at greater displacements.

**Table 5.3 – Geotechnical Design Parameters for Lateral Pile Resistance**

Location	Soil Unit	Elevation (m)		$\gamma'$ ( $\text{kN/m}^3$ )	$n_h$ ( $\text{kN/m}^3$ )	$K_p$	$S_u$ (kPa)
		Top	Bottom				
North Abutment (MMO17-03, MMO17-06, MMO17-07)	Clayey Silt - Firm	204.5	203	18	-	-	50
	Clayey Silt Till - Stiff	203	200.5	19	-	-	90
	Clayey Silt Till - Firm	200.5	199	18.5	-	-	50
	Clayey Silt Till - Stiff	199	194.5	20	-	-	90
	Clayey Silt Till - V. Stiff	194.5	191.5	10 (*)	-	-	100
	Clayey Silt Till - Hard	191.5	190	11 (*)	-	-	200
	Clayey Silt Till - Hard	190	186	12 (*)	-	-	250
South Abutment (MMO17-04, MMO17-05, MMD-1)	Clayey Silt – Firm	204.5	203	18	-	-	50
	Cohesive Till – V. tiff	203	201.5	20	-	-	100
	Cohesive Till – Stiff	201.5	197.5	19	-	-	75
	Cohesive Till – V. Stiff	197.5	194.5	19	-	-	100
	Cohesive Till – Stiff	194.5	191	10 (*)	-	-	90
	Cohesive Till – Hard	191	188	11 (*)	-	-	200
	Cohesive Till – Hard	188	186	12 (*)	-	-	250

Note (\*): Submerged Unit Weight



The modulus of subgrade reaction and ultimate lateral resistance may have to be reduced, based on the pile spacing. The reduction factors to be used for a pile group oriented perpendicular or parallel to the direction of loading are provided in Table 5.4. Intermediate values may be obtained by linear interpolation.

**Table 5.4 - Subgrade Reaction Reduction Factors for Pile Spacing**

Condition	Pile Spacing, Centre to Centre	Reduction Factor
Pile group oriented <b>perpendicular</b> to direction of loading	4D	1.0
	1D	0.5
Pile group oriented <b>parallel</b> to direction of loading	8D	1.0
	6D	0.7
	4D	0.4
	3D	0.25

### 5.2.1 Downdrag

Downdrag forces will develop along the length of pile embedded in the cohesive till deposit at the abutment locations due to settlement induced by the approach embankment loads. For design purposes, an unfactored downdrag force of 300 kN per pile is recommended to evaluate the impact of downdrag. In accordance with Section 6.8.4 of the CHBDC, the factored downdrag load should be added to the factored permanent loads to assess the effects of downdrag. A check should be performed to confirm that the factored permanent and downdrag loads do not exceed the factored below-ground structural resistance of the pile. As per CHBDC, live loads and downdrag loads are not combined.

### 5.2.2 H-Pile Installation

Pile driving must be controlled in accordance with Standard Drawing SS103-11 (Hiley Formula) and an ultimate pile resistance (2 times the design load at ULS) should be specified by the designer.

The piles may encounter refusal on the cobbles and/or boulders that may be present in the till deposit above the design tip elevations. The pile installation equipment should be capable of penetrating through the cobbles and boulders. Oversize materials (e.g. greater than 75 mm nominal diameter) should not be used for any new fill which the piles will be driven through.

### 5.2.3 Pile Tips

To prevent structural damages to the piles when setting them in the very dense/hard till/shale bedrock or if cobbles or boulders are encountered, piles should be equipped with tip protection. All driven H-piles should be fitted with pile tip protection as per OPSS.PROV 903 and OPSD 3000.100 (Type I H-Pile Driving Shoe).

Care must be taken when driving piles to very dense/hard till with cobbles and boulders or to bedrock to avoid overdriving and damage to the piles. If pile damage or misalignment occurs, PDA testing may be required to assess the pile capacity and integrity. Consideration should be given to using Titus Steel (Standard H-point) or approved equivalent for the remaining piles at this site.

## 5.3 Frost Protection

The design depth of frost penetration at this site is 1.2 m. All pile caps and footing bases should be provided with 1.2 m of earth cover or an equivalent thickness of synthetic insulation.

## 5.4 Backfill to Abutments

Backfill to the abutment walls should be Granular A or Granular B Type II material meeting the requirements of OPSS.PROV 1010. The backfill should be in accordance with OPSS 902 and placed to the extent shown in OPSD



3101.150.

Compaction equipment to be used adjacent to retaining structures should be restricted in accordance with OPSS 501. The design of the abutment should incorporate a subdrain as shown in OPSD 3101.150.

### 5.5 Lateral Earth Pressure

Lateral earth pressures acting on the structure may be assumed to be triangular and to be governed by the characteristics of the abutment backfill. For a fully drained condition, the pressures should be computed in accordance with the CHBDC but generally are given by the expression:

$$P_h = K * (\gamma h + q)$$

where:

- $P_h$  = horizontal pressure on the wall at depth  $h$  (kPa)
- $K$  = earth pressure coefficient
- $\gamma$  = unit weight of retained soil (kN/m<sup>3</sup>)
- $H$  = depth below top of fill where pressure is computed (m)
- $q$  = value of any surcharge (kPa)

In accordance with Clause 6.9.3 of the CHBDC, a compaction surcharge should be applied in the design.

Earth pressure coefficients for backfill to the abutment walls are dependent on properties of the granular fill used as the backfill. Typical values are shown in Table 5.5.

**Table 5.5 – Coefficients of Lateral Earth Pressure**

Loading Condition	OPSS Granular A or Granular B Type II $\phi = 35^\circ, \gamma = 22.8 \text{ kN/m}^3$		OPSS Granular B Type I or Type III $\phi = 32^\circ, \gamma = 21.2 \text{ kN/m}^3$	
	Horizontal Surface Behind Wall	Sloping Backfill (2H:1V)	Horizontal Surface Behind Wall	Sloping Backfill (2H:1V)
Active (Unrestrained Wall)	0.27	0.38*	0.31	0.46*
At-rest (Restrained Wall)	0.43	-	0.47	-
Passive	3.7	-	3.3	-

\* For wing walls

### 5.6 Seismic Considerations

Based on the encountered subsurface conditions, Site Class C may be assumed to evaluate the seismic site response, as per Table 4.1, Clause 4.4.3.2 of the CHBDC 2014.

The peak ground acceleration, PGA, for a 2% in 50-year probability of exceedance at this site is 0.11 g as per the National Building Code of Canada 2015 (NBCC 2015).

In accordance with Clause 4.6.5 of the CHBDC 2014, retaining structures should be designed using active ( $K_{AE}$ ) and passive ( $K_{PE}$ ) earth pressure coefficients that incorporate the effects of earthquake loading. The coefficients of horizontal earth pressure for seismic loading presented in Table 5.6 may be used:

**Table 5.6 – Earth Pressure Coefficients for Earthquake Loading**

Loading Condition	OPSS Granular A or OPSS Granular B Type II $\phi = 35^\circ, \gamma = 22.8 \text{ kN/m}^3$	OPSS Granular B Type I or Type III $\phi = 32^\circ, \gamma = 21.2 \text{ kN/m}^3$
Active ( $K_{AE}$ )*	0.31	0.35
Passive ( $K_{PE}$ )	3.5	3.1
At-rest ( $K_{OE}$ )**	0.57	0.62

\* After Mononobe and Okabe, passive case assumes a horizontal surface in front of the wall.

\*\* After Woods

Given the low seismic ground motions and the presence of very stiff to hard clayey silt to silty clay till, the potential for liquefaction is considered low at this site.

## 5.7 Approach Embankments and Reinforced Soil System (RSS)

### 5.7.1 General

The GA drawing indicates that reinforced earth systems (RSS) for false abutments and wingwalls will be installed at both structures. The drawing indicates RSS walls up to 10.5 m high at the south abutment and up to 9.5 m high at the north abutment. It should be noted that no structural loading is applied to the RSS system in the case of false abutments. The RSS walls will be designed to “High Performance” and “High Appearance” at this site.

The existing soils at the abutments and approach embankments generally consist of 0.6 to 1.5 m of typically firm to stiff clayey silt overlying typically stiff to very stiff clayey silt to silty clay till. The construction of the structure will require the placement of approximately 9 m of fill at the north approach and 10 m of fill at the south approach. The side slopes of the approach embankments will be at an inclination of 2H:1V.

### 5.7.2 Subgrade Preparation

Topsoil and any soft surficial clayey silt/silty clay, loose fill, disturbed soils and deleterious materials within the footprint of the approach embankments should be removed and replaced with suitable granular material compacted as per OPSS.PROV 501. The exposed subgrade surface should be proof rolled and inspected to confirm that the subgrade is suitable and uniformly competent.

The work should be carried out in accordance with OPSS.PROV 902 and construction should be carried out in the dry. Once the subgrade is prepared, the construction traffic and equipment should not travel on the subgrade.

The RSS walls should be founded on a minimum 500 mm thick layer of bedding material conforming to OPSS Granular A requirements to form a uniform subgrade. Engineered fill placed under the RSS mass to achieve the design founding level should be compacted to 100% of its SPMDD at a moisture content within 2% of optimum. The engineered fill layer should extend at least 500 mm beyond the limits of the RSS mass.

### 5.7.3 Geotechnical Resistance

As per MTO RSS Design Guidelines, the minimum soil cover to the underside of the levelling pad shall be at least 800 mm, or 40% of the actual frost depth for the area, whichever is greater. The minimum soil cover to the top of the levelling pad shall be at least 500 mm.

The bases of RSS walls founded in very stiff clayey silt to silty clay till at a minimum 1.0 m depth below the existing ground surface should be designed for a Factored Geotechnical Resistance of 375 kPa and Geotechnical Resistance at SLS of 250 kPa.

The recommended geotechnical resistances are for vertical concentric loading. The effects of load inclination and eccentricity need to be considered in accordance with CHBDC.

The RSS mass must be designed against various modes of failure including sliding and overturning. Sliding resistance along the base native clayey silt till and engineered fill may be estimated using an ultimate friction coefficient of 0.35 and 0.55, respectively.

The internal stability or structural integrity of the RSS walls should be analyzed by the supplier/designer of the proprietary product selected for this site.

#### **5.7.4 Approach Embankment Stability**

Slope stability analyses were carried out to assess the stability of the RSS wall/embankment using the commercially available program Slope/W, employing the Morgenstern-Price method of analysis. The analysis was performed on a critical longitudinal section of the RSS wall assuming a reinforcing strip length of 80% of wall height.

The results of the analyses are provided in Figures E1 to E3. The computed Factor of Safety (FOS) exceed the minimum FOS of 1.3 and 1.5 for the short and long-term conditions, respectively, indicating that the RSS wall will be stable up to the design height assuming proper subgrade preparation and proper placement and compaction of fill materials.

#### **5.7.5 Approach Embankment Settlement**

The settlements of the foundation soils were estimated to range between 55 and 85 mm under the approach embankments. Embankment settlement due to fill compression is estimated to 0.5% of the fill height for granular fill or earth fill compacted to 100% of their SPMDD at a moisture content within 2% of optimum. Approximately 50% of the total fill compression (or 0.25% of the fill height) will occur during construction and the remaining 50% or approximately 20 to 25 mm at this site will occur after construction.

In accordance with MTO's Embankment Settlement Criteria for Design (March 2, 2010) for bridge approach areas, the following post-construction settlement criteria (within 20 years following paving) have been adopted for the design:

- No more than 25 mm within 20 m behind the bridge abutment;
- 25 mm to 50 mm from 20 m to 50 m from the bridge abutment;
- 50 mm to 75 mm from 50 m to 75 m from the bridge abutment; and
- 75 mm to 100 mm greater than 75 m from the bridge abutment.

Based on the results of the settlement analysis, it is recommended that a preload period of 4 months be allowed for embankment settlement to take place following construction to full height. The actual waiting period duration should be determined by the actual foundation behavior assessed from the settlement monitoring program by the foundation designer.

### **5.8 Excavation and Dewatering**

All excavations should be carried out in accordance with the requirements of the Occupational Health and Safety Act (OHSA). For the purposes of the OHSA, the cohesive till within the depth of excavation may be classed as Type 3 soil.

The excavation and backfilling for foundations should be carried out in accordance with OPSS 902.

The water level measured in standpipe piezometers installed in the cohesive till varied typically between approximately Elev. 193 and 194 m which is below the base of excavation for RSS wall construction. Given the consistency and relatively low permeability of the cohesive soils, groundwater control measures such as perimeter ditches and pumping from filtered sumps should be adequate. The possibility exists that additional pumps may

be required if localized zones of high volume of perched groundwater are encountered.

All RSS walls should be constructed in the dry.

### 5.9 Corrosion and Sulphate Attack Potential

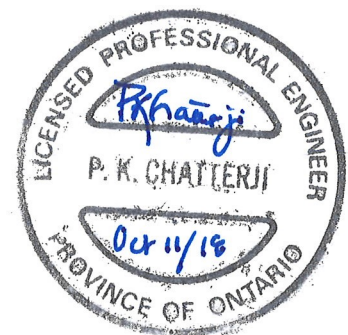
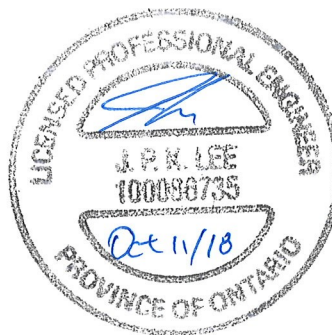
The results of the analytical testing for corrosivity and sulphate content of the soil samples indicate the following:

- The potential for sulphate attack on structural concrete from the surrounding soil is negligible based on the generally low concentration of sulphate in the samples tested.
- The potential for corrosion on metal elements of the structure is considered to be mild to moderate.
- Appropriate protection measures are recommended if metal structural elements are used.

### 5.10 Construction Concerns

Potential construction concerns include, but not necessarily limited to:

- The driven steel H-pile installation in till materials that typically contain cobbles and boulders may result in pile misalignment and/or tip damages. The piling contractors should be warned of the associated risks.
- All RSS walls should be constructed in the dry. The clayey silt subgrade should be covered/protected as soon as practical upon exposure and be protected from any disturbances that will likely weaken the material.
- Water inflow into the excavation may occur. The water inflow may be handled by pumping from filtered sumps.



## STATEMENT OF LIMITATIONS AND CONDITIONS

### 1. STANDARD OF CARE

This Report has been prepared in accordance with generally accepted engineering or environmental consulting practices in the applicable jurisdiction. No other warranty, expressed or implied, is intended or made.

### 2. COMPLETE REPORT

All documents, records, data and files, whether electronic or otherwise, generated as part of this assignment are a part of the Report, which is of a summary nature and is not intended to stand alone without reference to the instructions given to Thurber by the Client, communications between Thurber and the Client, and any other reports, proposals or documents prepared by Thurber for the Client relative to the specific site described herein, all of which together constitute the Report.

IN ORDER TO PROPERLY UNDERSTAND THE SUGGESTIONS, RECOMMENDATIONS AND OPINIONS EXPRESSED HEREIN, REFERENCE MUST BE MADE TO THE WHOLE OF THE REPORT. THURBER IS NOT RESPONSIBLE FOR USE BY ANY PARTY OF PORTIONS OF THE REPORT WITHOUT REFERENCE TO THE WHOLE REPORT.

### 3. BASIS OF REPORT

The Report has been prepared for the specific site, development, design objectives and purposes that were described to Thurber by the Client. The applicability and reliability of any of the findings, recommendations, suggestions, or opinions expressed in the Report, subject to the limitations provided herein, are only valid to the extent that the Report expressly addresses proposed development, design objectives and purposes, and then only to the extent that there has been no material alteration to or variation from any of the said descriptions provided to Thurber, unless Thurber is specifically requested by the Client to review and revise the Report in light of such alteration or variation.

### 4. USE OF THE REPORT

The information and opinions expressed in the Report, or any document forming part of the Report, are for the sole benefit of the Client. NO OTHER PARTY MAY USE OR RELY UPON THE REPORT OR ANY PORTION THEREOF WITHOUT THURBER'S WRITTEN CONSENT AND SUCH USE SHALL BE ON SUCH TERMS AND CONDITIONS AS THURBER MAY EXPRESSLY APPROVE. Ownership in and copyright for the contents of the Report belong to Thurber. Any use which a third party makes of the Report, is the sole responsibility of such third party. Thurber accepts no responsibility whatsoever for damages suffered by any third party resulting from use of the Report without Thurber's express written permission.

### 5. INTERPRETATION OF THE REPORT

- a) Nature and Exactness of Soil and Contaminant Description: Classification and identification of soils, rocks, geological units, contaminant materials and quantities have been based on investigations performed in accordance with the standards set out in Paragraph 1. Classification and identification of these factors are judgmental in nature. Comprehensive sampling and testing programs implemented with the appropriate equipment by experienced personnel may fail to locate some conditions. All investigations utilizing the standards of Paragraph 1 will involve an inherent risk that some conditions will not be detected and all documents or records summarizing such investigations will be based on assumptions of what exists between the actual points sampled. Actual conditions may vary significantly between the points investigated and the Client and all other persons making use of such documents or records with our express written consent should be aware of this risk and the Report is delivered subject to the express condition that such risk is accepted by the Client and such other persons. Some conditions are subject to change over time and those making use of the Report should be aware of this possibility and understand that the Report only presents the conditions at the sampled points at the time of sampling. If special concerns exist, or the Client has special considerations or requirements, the Client should disclose them so that additional or special investigations may be undertaken which would not otherwise be within the scope of investigations made for the purposes of the Report.
- b) Reliance on Provided Information: The evaluation and conclusions contained in the Report have been prepared on the basis of conditions in evidence at the time of site inspections and on the basis of information provided to Thurber. Thurber has relied in good faith upon representations, information and instructions provided by the Client and others concerning the site. Accordingly, Thurber does not accept responsibility for any deficiency, misstatement or inaccuracy contained in the Report as a result of misstatements, omissions, misrepresentations, or fraudulent acts of the Client or other persons providing information relied on by Thurber. Thurber is entitled to rely on such representations, information and instructions and is not required to carry out investigations to determine the truth or accuracy of such representations, information and instructions.
- c) Design Services: The Report may form part of design and construction documents for information purposes even though it may have been issued prior to final design being completed. Thurber should be retained to review final design, project plans and related documents prior to construction to confirm that they are consistent with the intent of the Report. Any differences that may exist between the Report's recommendations and the final design detailed in the contract documents should be reported to Thurber immediately so that Thurber can address potential conflicts.
- d) Construction Services: During construction Thurber should be retained to provide field reviews. Field reviews consist of performing sufficient and timely observations of encountered conditions in order to confirm and document that the site conditions do not materially differ from those interpreted conditions considered in the preparation of the report. Adequate field reviews are necessary for Thurber to provide letters of assurance, in accordance with the requirements of many regulatory authorities.

### 6. RELEASE OF POLLUTANTS OR HAZARDOUS SUBSTANCES

Geotechnical engineering and environmental consulting projects often have the potential to encounter pollutants or hazardous substances and the potential to cause the escape, release or dispersal of those substances. Thurber shall have no liability to the Client under any circumstances, for the escape, release or dispersal of pollutants or hazardous substances, unless such pollutants or hazardous substances have been specifically and accurately identified to Thurber by the Client prior to the commencement of Thurber's professional services.

### 7. INDEPENDENT JUDGEMENTS OF CLIENT

The information, interpretations and conclusions in the Report are based on Thurber's interpretation of conditions revealed through limited investigation conducted within a defined scope of services. Thurber does not accept responsibility for independent conclusions, interpretations, interpolations and/or decisions of the Client, or others who may come into possession of the Report, or any part thereof, which may be based on information contained in the Report. This restriction of liability includes but is not limited to decisions made to develop, purchase or sell land.

## Appendix A

### Record of Borehole Sheets – Current Investigation

## SYMBOLS, ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES

### 1. TEXTURAL CLASSIFICATION OF SOILS

CLASSIFICATION	PARTICLE SIZE	VISUAL IDENTIFICATION
Boulders	Greater than 200mm	same
Cobbles	75 to 200mm	same
Gravel	4.75 to 75mm	5 to 75mm
Sand	0.075 to 4.75mm	Not visible particles to 5mm
Silt	0.002 to 0.075mm	Non-plastic particles, not visible to the naked eye
Clay	Less than 0.002mm	Plastic particles, not visible to the naked eye

### 2. COARSE GRAIN SOIL DESCRIPTION (50% greater than 0.075mm)

TERMINOLOGY	PROPORTION
Trace or Occasional	Less than 10%
Some	10 to 20%
Adjective (e.g. silty or sandy)	20 to 35%
And (e.g. sand and gravel)	35 to 50%

### 3. TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

DESCRIPTIVE TERM	UNDRAINED SHEAR STRENGTH (kPa)	APPROXIMATE SPT <sup>(1)</sup> 'N' VALUE
Very Soft	12 or less	Less than 2
Soft	12 to 25	2 to 4
Firm	25 to 50	4 to 8
Stiff	50 to 100	8 to 15
Very Stiff	100 to 200	15 to 30
Hard	Greater than 200	Greater than 30

NOTE: Hierarchy of Soil Strength Prediction

- 1) Laboratory Triaxial Testing
- 2) Field Insitu Vane Testing
- 3) Laboratory Vane Testing
- 4) SPT value
- 5) Pocket Penetrometer



### 4. TERMS DESCRIBING DENSITY (COHESIONLESS SOILS ONLY)

DESCRIPTIVE TERM	SPT "N" VALUE
Very Loose	Less than 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	Greater than 50

### 5. LEGEND FOR RECORDS OF BOREHOLES

SYMBOLS AND ABBREVIATIONS FOR SAMPLE TYPE	SS Split Spoon Sample	WS Wash Sample	AS Auger (Grab) Sample
	TW Thin Wall Shelby Tube Sample	TP Thin Wall Piston Sample	
	PH Sampler Advanced by Hydraulic Pressure	PM Sampler Advanced by Manual Pressure	
	WH Sampler Advanced by Self Static Weight	RC Rock Core	SC Soil Core

$$\text{Sensitivity} = \frac{\text{Undisturbed Shear Strength}}{\text{Remoulded Shear Strength}}$$

 Water Level  
 Shear Strength Determination by Pocket Penetrometer


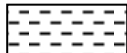



- (1) SPT 'N' Value      Standard Penetration Test 'N' Value – refers to the number of blows from a 63.5kg hammer free falling a height of 0.76m to advance a standard 50 mm outside diameter split spoon sampler for 0.3 m depth into undisturbed ground.
- (2) DCPT      Dynamic Cone Penetration Test – Continuous penetration of a 50 mm outside diameter, 60° conical steel point attached to "A" size rods driven by a 63.5 kg hammer free falling a height of 0.76 m. The resistance to cone penetration is the number of hammer blows required for each 0.3 m advance of the conical point into undisturbed ground.



# UNIFIED SOILS CLASSIFICATION

MAJOR DIVISIONS		GROUP SYMBOL	TYPICAL DESCRIPTION
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	GW	Well-graded gravels or gravel-sand mixtures, little or no fines.
		GP	Poorly-graded gravels or gravel-sand mixtures, little or no fines.
		GM	Silty gravels, gravel-sand-silt mixtures.
		GC	Clayey gravels, gravel-sand-clay mixtures.
	SAND AND SANDY SOILS	SW	Well-graded sands or gravelly sands, little or no fines.
		SP	Poorly-graded sands or gravelly sands, little or no fines.
		SM	Silty sands, sand-silt mixtures.
		SC	Clayey sands, sand-clay mixtures.
FINE GRAINED SOILS	SILTS AND CLAYS $W_L < 50\%$	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays. ( $W_L < 30\%$ ).
		CI	Inorganic clays of medium plasticity, silty clays. ( $30\% < W_L < 50\%$ ).
		OL	Organic silts and organic silty-clays of low plasticity.
	SILTS AND CLAYS $W_L > 50\%$	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
		CH	Inorganic clays of high plasticity, fat clays.
		OH	Organic clays of medium to high plasticity, organic silts.
HIGHLY ORGANIC SOILS		Pt	Peat and other highly organic soils.
CLAY SHALE			
SANDSTONE			
SILTSTONE			
CLAYSTONE			
COAL			

## EXPLANATION OF ROCK LOGGING TERMS

<u>ROCK WEATHERING CLASSIFICATION</u>		<u>SYMBOLS</u>	
<b>Fresh (FR)</b>	No visible signs of weathering.		
<b>Fresh Jointed (FJ)</b>	Weathering limited to the surface of major discontinuities.		CLAYSTONE
<b>Slightly Weathered (SW)</b>	Penetrative weathering developed on open discontinuity surfaces, but only slight weathering of rock material.		SILTSTONE
<b>Moderately Weathered (MW)</b>	Weathering extends throughout the rock mass, but the rock material is not friable.		SANDSTONE
<b>Highly Weathered (HW)</b>	Weathering extends throughout the rock mass and the rock is partly friable.		COAL
<b>Completely Weathered (CW)</b>	Rock is wholly decomposed and in a friable condition, but the rock texture and structure are preserved.		Bedrock (general)

<u>DISCONTINUITY SPACING</u>		<u>STRENGTH CLASSIFICATION</u>			
Bedding	Bedding Plane Spacing	Rock Strength	Approximate Uniaxial Compressive Strength		Field Estimation of Hardness*
			(MPa)	(psi)	
Very thickly bedded	Greater than 2m	Extremely Strong	Greater than 250	Greater than 36,000	Specimen can only be chipped with a geological hammer
Thickly bedded	0.6 to 2m				
Medium bedded	0.2 to 0.6m	Very Strong	100-250	15,000 to 36,000	Requires many blows of geological hammer to break
Thinly bedded	60mm to 0.2m				
Very thinly bedded	20 to 60mm	Strong	50-100	7,500 to 15,000	Requires more than one blow of geological hammer to break
Laminated	6 to 20mm				
Thinly Laminated	Less than 6mm	Medium Strong	25.0 to 50.0	3,500 to 7,500	Breaks under single blow of geological hammer.
		Weak	5.0 to 25.0	750 to 3,500	Can be peeled by a pocket knife with difficulty
		Very Weak	1.0 to 5.0	150 to 750	Can be peeled by a pocket knife, crumbles under firm blows of geological pick.
		Extremely Weak (Rock)	0.25 to 1.0	35 to 150	Indented by thumbnail

<u>TERMS</u>	
Total Core Recovery: (TCR)	Core recovered as a percentage of total core run length.
Solid Core Recovery: (SCR)	Percent Ratio of solid core of full cylindrical shape recovered. Expressed with respect to the total length of core run.
Rock Quality Designation: (RQD)	Total length of sound core recovered in pieces 0.1m in length or larger as a percentage of total core run length.
Uniaxial Compressive Strength (UCS)	Axial stress required to break the specimen
Fracture Index: (FI)	Frequency of natural fractures per 0.3m of core run.

# RECORD OF BOREHOLE No MMO 17-01

1 OF 2

METRIC

W.P. \_\_\_\_\_ LOCATION N 4 853 823.5 E 291 904.6 ORIGINATED BY ES  
 HWY 427 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2017.06.28 - 2017.06.28 CHECKED BY ME

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 (%)					
204.8	GROUND SURFACE													
0.0	<b>TOPSOIL:</b> (125mm)													
0.1	Clayey <b>SILT</b> , some sand, trace gravel Firm to Stiff Brown Moist		1	SS	6									
			2	SS	11									
203.2														
1.6	Clayey <b>SILT</b> to Silty <b>CLAY</b> , trace sand, trace gravel Very Stiff to Stiff Brown to Grey Moist (TILL)		3	SS	21									
			4	SS	22									
			5	SS	15									
			6	SS	13									
			7	SS	16									
			8	SS	12									
			9	SS	26									
195.0														
9.8	END OF BOREHOLE AT 9.8m.													

Continued Next Page

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to  
Sensitivity

20  
15  
10  
(%) STRAIN AT FAILURE

## 2 OF 2

METRIC

[illegible]

RECORD OF BOREHOLE No MMO 17-02 1 OF 2 METRIC

W.P. \_\_\_\_\_ LOCATION N 4 853 874.5 E 291 841.8 ORIGINATED BY TF  
 HWY 427 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2017.07.04 - 2017.07.04 CHECKED BY ME

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT  <b>γ</b>  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						
								20    40    60    80    100						
204.9	GROUND SURFACE													
0.0	TOPSOIL: (75mm)  Clayey <b>SILT</b> , trace sand, trace gravel, some organics, rootlets Firm to Stiff Brown Moist		1	SS	6									
0.1			2	SS	14									
203.5	Clayey <b>SILT</b> to Silty <b>CLAY</b> , some sand, trace gravel, oxide stains Very Stiff to Stiff Brown to Grey Moist (TILL)		3	SS	19									
1.4			4	SS	29									
			5	SS	24									
			6	SS	13									
			7	SS	14									
			8	SS	18									
			9	SS	11									
195.1														
9.8	END OF BOREHOLE AT 9.8m.													

Continued Next Page

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to  
Sensitivity

20  
15  
10  
(%) STRAIN AT FAILURE

## METRIC

[illegible]

# RECORD OF BOREHOLE No MMO 17-03

1 OF 7

METRIC

W.P. \_\_\_\_\_ LOCATION N 4 853 862.1 E 291 857.7 ORIGINATED BY KK  
 HWY 427 BOREHOLE TYPE Hollow Stem Augers/HQ Coring COMPILED BY AN  
 DATUM Geodetic DATE 2017.06.22 - 2017.06.27 CHECKED BY ME

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					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						
204.7	GROUND SURFACE							20 40 60 80 100						
0.0	Clayey <b>SILT</b> , trace sand, trace gravel Firm Brown Moist		1	SS	4		204							
			2	SS	8									
203.2							203							
1.5	Clayey <b>SILT</b> to Silty <b>CLAY</b> , some sand, trace gravel Stiff to Very Stiff Brown Moist (TILL)		3	SS	11									
			4	SS	22		202							
			5	SS	15		201							
							200							
			6	SS	8		199							
							198							
			7	SS	16		197							
							196							
			8	SS	18		195							
			9	SS	23									

Continued Next Page

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to  
Sensitivity

20  
15  
10  
(%) STRAIN AT FAILURE



# RECORD OF BOREHOLE No MMO 17-03

2 OF 7

METRIC

W.P. \_\_\_\_\_ LOCATION N 4 853 862.1 E 291 857.7 ORIGINATED BY KK  
 HWY 427 BOREHOLE TYPE Hollow Stem Augers/HQ Coring COMPILED BY AN  
 DATUM Geodetic DATE 2017.06.22 - 2017.06.27 CHECKED BY ME

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 (%)					
	Continued From Previous Page													
	Hard		10	SS	18		194							0 13 51 36
							193							
			11	SS	19		192							
							191							
			12	SS	39		190							
							189							
			13	SS	64		188							
							187							
			14	SS	76		186							
							185							
			15	SS	100/ 0.175									

Continued Next Page

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to  
Sensitivity 20  
15 10 5 (%) STRAIN AT FAILURE

## 3 OF 7

W.P.	LOCATION	N 4 853 862.1 E 291 857.7	ORIGINATED BY	KK	
HWY	427	BOREHOLE TYPE	Hollow Stem Augers/HQ Coring	COMPILED BY	AN
DATUM	Geodetic	DATE	2017.06.22 - 2017.06.27	CHECKED BY	ME

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT      NATURAL LIMIT      MOISTURE CONTENT      LIQUID LIMIT			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 (%)				
								20   40   60   80   100	20   40   60   80   100	20   40   60					
	Continued From Previous Page		16	SS	100/ 0.300		○ UNCONFINED      + FIELD VANE	● QUICK TRIAXIAL      × LAB VANE							
			17	SS	64										
			18	SS	65										
178.5															
26.2	Clayey <b>SILT</b> , trace sand, trace gravel Very Stiff Grey Moist		19	SS	33										

Continued Next Page

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity

ONTMT4S MTO-19484.GPJ 2017TEMPLATE(MTO).GDT 1/9/18

RECORD OF BOREHOLE No MMO 17-03

4 OF 7

METRIC

W.P. \_\_\_\_\_ LOCATION N 4 853 862.1 E 291 857.7 ORIGINATED BY KK  
 HWY 427 BOREHOLE TYPE Hollow Stem Augers/HQ Coring COMPILED BY AN  
 DATUM Geodetic DATE 2017.06.22 - 2017.06.27 CHECKED BY ME

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		W <sub>p</sub>	W	W <sub>L</sub>		
	Continued From Previous Page													
			20	SS	20		174							
							173							
							172							
			21	SS	16		171							
							170							
							169							
			22	SS	19		168							
							167							
							166							
			23	SS	23		165							

Continued Next Page

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity 20 15 10 5 0 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No MMO 17-03 5 OF 7 METRIC

W.P. \_\_\_\_\_ LOCATION N 4 853 862.1 E 291 857.7 ORIGINATED BY KK  
 HWY 427 BOREHOLE TYPE Hollow Stem Augers/HQ Coring COMPILED BY AN  
 DATUM Geodetic DATE 2017.06.22 - 2017.06.27 CHECKED BY ME

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						
	Continued From Previous Page							20 40 60 80 100						
163.2							164							
41.5	SILT and SAND, some clay, trace gravel Compact to Very Dense Grey Moist						163							
			24	SS	16		162							
							161							
							160							
			25	SS	30		159							0 45 45 10
							158							
							157							
			26	SS	40		156							
							155							

Continued Next Page

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity 20 15 10 5 0 (%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No MMO 17-03

6 OF 7

METRIC

W.P. \_\_\_\_\_ LOCATION N 4 853 862.1 E 291 857.7 ORIGINATED BY KK  
 HWY 427 BOREHOLE TYPE Hollow Stem Augers/HQ Coring COMPILED BY AN  
 DATUM Geodetic DATE 2017.06.22 - 2017.06.27 CHECKED BY ME

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					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						
								20 40 60 80 100						
								○ UNCONFINED    + FIELD VANE ● QUICK TRIAXIAL    × LAB VANE						
Continued From Previous Page							WATER CONTENT (%) 20 40 60							
							154							
			27	SS	104/ 0.250		153							
							152							
							151							
			28	SS	100/ 0.125		150							
							149							
148.5							148							
56.2	SHALE highly to moderately weathered, thinly bedded, weak to medium strong, with strong to very strong limestone interbeds, grey: (Georgian Bay Formation)						147							
147.2							146							
57.5							145							
	Highly fractured zone (50mm) at 57.6m and (25mm) at 57.8m		29	SS	100/ 0.050									
	Limestone interbed (75mm) at 57.9m and (50mm) at 58.1m		1	RUN										
	Horizontal fracture (50mm) at 58.1m													
	Limestone interbed (50mm) at 58.4m, (125mm) at 59.1m and (25mm) at 59.6m		2	RUN										
	Horizontal fracture (125mm) at 59.1m													

Continued Next Page

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity 20 15 10 5 0 (%) STRAIN AT FAILURE

## 7 OF 7

W.P.	LOCATION	N 4 853 862.1 E 291 857.7	ORIGINATED BY	KK
HWY 427	BOREHOLE TYPE	Hollow Stem Augers/HQ Coring	COMPILED BY	AN
DATUM Geodetic	DATE	2017.06.22 - 2017.06.27	CHECKED BY	ME

[illegible]

RECORD OF BOREHOLE No MMO 17-04 1 OF 7 METRIC

W.P. \_\_\_\_\_ LOCATION N 4 853 836.1 E 291 887.8 ORIGINATED BY KK  
 HWY 427 BOREHOLE TYPE Hollow Stem Augers/HQ Coring COMPILED BY AN  
 DATUM Geodetic DATE 2017.06.27 - 2017.06.29 CHECKED BY ME

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						
204.5	GROUND SURFACE													
0.0	Clayey <b>SILT</b> , trace sand, trace gravel Stiff Brown Moist		1	SS	6									
			2	SS	10									
203.0														
1.5	Clayey <b>SILT</b> to Silty <b>CLAY</b> , trace sand, trace gravel Stiff to Very Stiff Brown to Grey Moist (TILL)		3	SS	19									
			4	SS	19									
			5	SS	13									
			6	SS	13									
			7	SS	13									
			8	SS	19									
			9	SS	16									

Continued Next Page

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity  
 20  
 15  
 10  
 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No MMO 17-04

2 OF 7

METRIC

W.P. \_\_\_\_\_ LOCATION N 4 853 836.1 E 291 887.8 ORIGINATED BY KK  
 HWY 427 BOREHOLE TYPE Hollow Stem Augers/HQ Coring COMPILED BY AN  
 DATUM Geodetic DATE 2017.06.27 - 2017.06.29 CHECKED BY ME

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						
	Continued From Previous Page													
	Hard		10	SS	12									
			11	SS	17									
			12	SS	30									
			13	SS	35									
			14	SS	86									
			15	SS	101/ 0.275									

Continued Next Page

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to  
Sensitivity

20  
15  
10  
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No MMO 17-04 3 OF 7 METRIC

W.P. \_\_\_\_\_ LOCATION N 4 853 836.1 E 291 887.8 ORIGINATED BY KK  
 HWY 427 BOREHOLE TYPE Hollow Stem Augers/HQ Coring COMPILED BY AN  
 DATUM Geodetic DATE 2017.06.27 - 2017.06.29 CHECKED BY ME

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		W <sub>p</sub>	W	W <sub>L</sub>		
	Continued From Previous Page		16	SS	100/0.250									
			17	SS	75									0 9 64 27
			18	SS	31									
			19	SS	14									
175.2 29.3	Clayey <b>SILT</b> , trace sand, trace gravel Stiff to Very Stiff Grey Moist													

ONTMT4S MTO-19484.GPJ 2017TEMPLATE(MTO).GDT 1/9/18

Continued Next Page

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity 20 15 10 5 0 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No MMO 17-04 4 OF 7 METRIC

W.P. \_\_\_\_\_ LOCATION N 4 853 836.1 E 291 887.8 ORIGINATED BY KK  
 HWY 427 BOREHOLE TYPE Hollow Stem Augers/HQ Coring COMPILED BY AN  
 DATUM Geodetic DATE 2017.06.27 - 2017.06.29 CHECKED BY ME

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						
	Continued From Previous Page													
			20	SS	20		174							0 0 73 27
							173							
							172							
			21	SS	23		171							
							170							
							169							
			22	SS	10		168							
							167							
							166							
165.8 38.7	SILT and SAND, trace gravel Compact to Very Dense Grey Moist						165							
			23	SS	11									

Continued Next Page

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to  
Sensitivity 20  
15 10 5 0 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No MMO 17-04 5 OF 7 METRIC

W.P. \_\_\_\_\_ LOCATION N 4 853 836.1 E 291 887.8 ORIGINATED BY KK  
 HWY 427 BOREHOLE TYPE Hollow Stem Augers/HQ Coring COMPILED BY AN  
 DATUM Geodetic DATE 2017.06.27 - 2017.06.29 CHECKED BY ME

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						
	Continued From Previous Page													
			24	SS	26									
			25	SS	43									
			26	SS	39									

Continued Next Page

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to  
Sensitivity 20  
15 10 5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No MMO 17-04 6 OF 7 METRIC

W.P. \_\_\_\_\_ LOCATION N 4 853 836.1 E 291 887.8 ORIGINATED BY KK  
 HWY 427 BOREHOLE TYPE Hollow Stem Augers/HQ Coring COMPILED BY AN  
 DATUM Geodetic DATE 2017.06.27 - 2017.06.29 CHECKED BY ME

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						
	Continued From Previous Page							20 40 60 80 100						
			27	SS	104/ 0.250									

Continued Next Page

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity 20 15 10 5 0 (%) STRAIN AT FAILURE

## 7 OF 7

W.P.	LOCATION	N 4 853 836.1 E 291 887.8	ORIGINATED BY	KK	
HWY	427	BOREHOLE TYPE	Hollow Stem Augers/HQ Coring	COMPILED BY	AN
DATUM	Geodetic	DATE	2017.06.27 - 2017.06.29	CHECKED BY	ME

[illegible]

# RECORD OF BOREHOLE No MMO 17-05

1 OF 2

METRIC

W.P. \_\_\_\_\_ LOCATION N 4 853 825.4 E 291 877.5 ORIGINATED BY TF  
 HWY 427 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2017.07.04 - 2017.07.04 CHECKED BY ME

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 (%)					
204.6	GROUND SURFACE													
0.0	<b>TOPSOIL:</b> (100mm)													
0.1	Clayey <b>SILT</b> , trace sand, trace gravel Firm Brown Moist		1	SS	6									
203.8														
0.8	Clayey <b>SILT</b> to Silty <b>CLAY</b> , trace sand, trace gravel Stiff to Very Stiff Brown to Grey Moist (TILL)		2	SS	14									
			3	SS	16									
			4	SS	18									
			5	SS	17									
			6	SS	15									
			7	SS	15									
			8	SS	15									
			9	SS	13									

Continued Next Page

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to  
Sensitivity

20  
15  
10  
(%) STRAIN AT FAILURE



RECORD OF BOREHOLE No MMO 17-05 2 OF 2 METRIC

W.P. \_\_\_\_\_ LOCATION N 4 853 825.4 E 291 877.5 ORIGINATED BY TF  
 HWY 427 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2017.07.04 - 2017.07.04 CHECKED BY ME

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 20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE									
	Continued From Previous Page																
			10	SS	12		194										
							193										
191.8			11	SS	28		192										
12.8	END OF BOREHOLE AT 12.8m. BOREHOLE DRY UPON COMPLETION. Well installation consists of 25mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.  WATER LEVEL READINGS DATE DEPTH(m) ELEV.(m) 2017.07.10 11.9 192.7 2017.10.23 3.8 200.8																

ONTMT4S MTO-19484.GPJ 2017TEMPLATE(MTO).GDT 1/9/18

## METRIC

[illegible]

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity

RECORD OF BOREHOLE No MMO 17-06

2 OF 2

METRIC

W.P. \_\_\_\_\_ LOCATION N 4 853 856.8 E 291 835.0 ORIGINATED BY TF  
 HWY 427 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2107.07.04 - 2017.07.04 CHECKED BY ME

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 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE									
	Continued From Previous Page																
			10	SS	12		194										
							193										
192.0			11	SS	14												
12.8	END OF BOREHOLE AT 12.8m. BOREHOLE DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH CUTTINGS TO SURFACE.						192										

## 1 OF 2

W.P.	LOCATION	N 4 853 873.3 E 291 868.8	ORIGINATED BY	ES	
HWY	427	BOREHOLE TYPE	Solid Stem Augers/Hollow Stem Augers	COMPILED BY	AN
DATUM	Geodetic	DATE	2017.06.29 - 2017.06.29	CHECKED BY	ME

[illegible]

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity

RECORD OF BOREHOLE No MMO 17-07 2 OF 2 METRIC

W.P. \_\_\_\_\_ LOCATION N 4 853 873.3 E 291 868.8 ORIGINATED BY ES  
 HWY 427 BOREHOLE TYPE Solid Stem Augers/Hollow Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2017.06.29 - 2017.06.29 CHECKED BY ME

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									
	Continued From Previous Page																
			10	SS	17		194										
							193										
			11	SS	25												
192.0 12.8	END OF BOREHOLE AT 12.8m. BOREHOLE DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO SURFACE.						192										

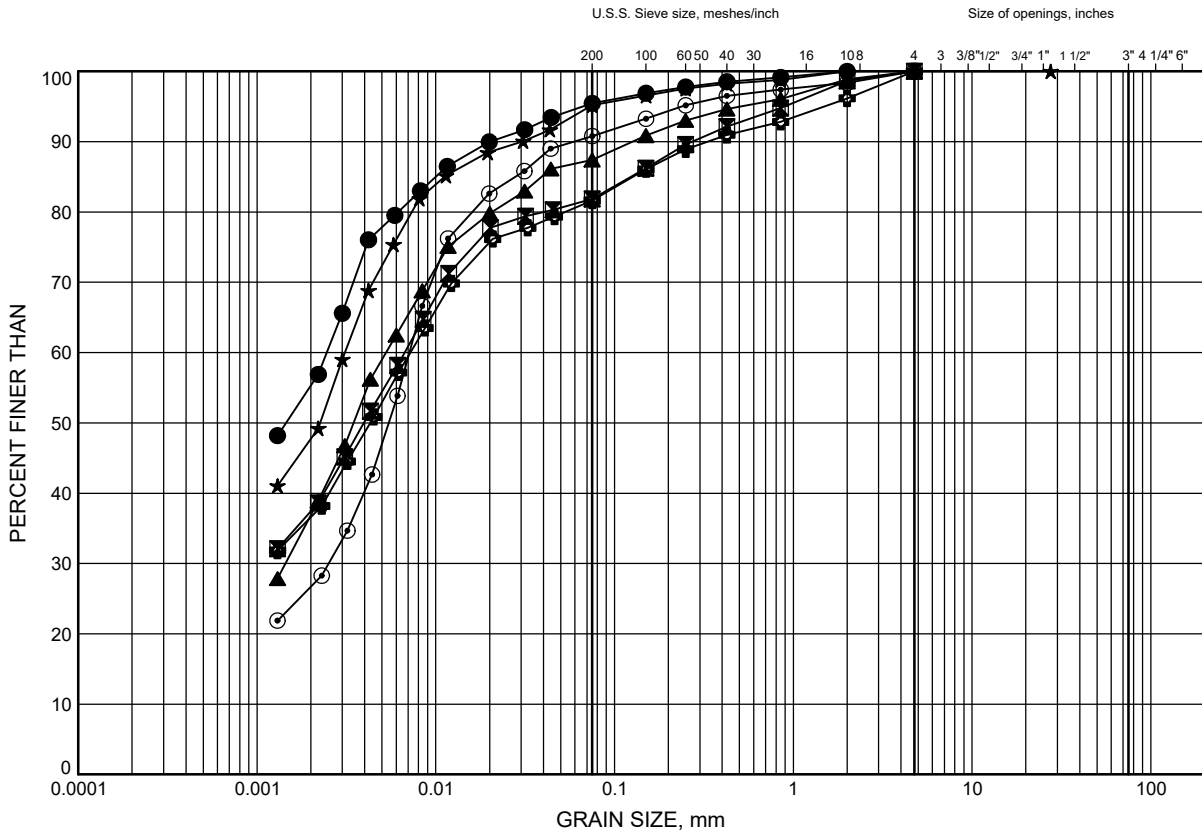
## Appendix B

### Geotechnical and Analytical Laboratory Test Results – Current Investigation

# GRAIN SIZE DISTRIBUTION

FIGURE B1

## Clayey SILT to Silty CLAY TILL



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	MMO 17-01	4.9	199.9
⊠	MMO 17-02	2.6	202.3
▲	MMO 17-03	11.0	193.7
★	MMO 17-04	4.9	199.6
⊙	MMO 17-04	21.6	182.9
⊕	MMO 17-07	6.4	198.4

Date January 2018

W.P.



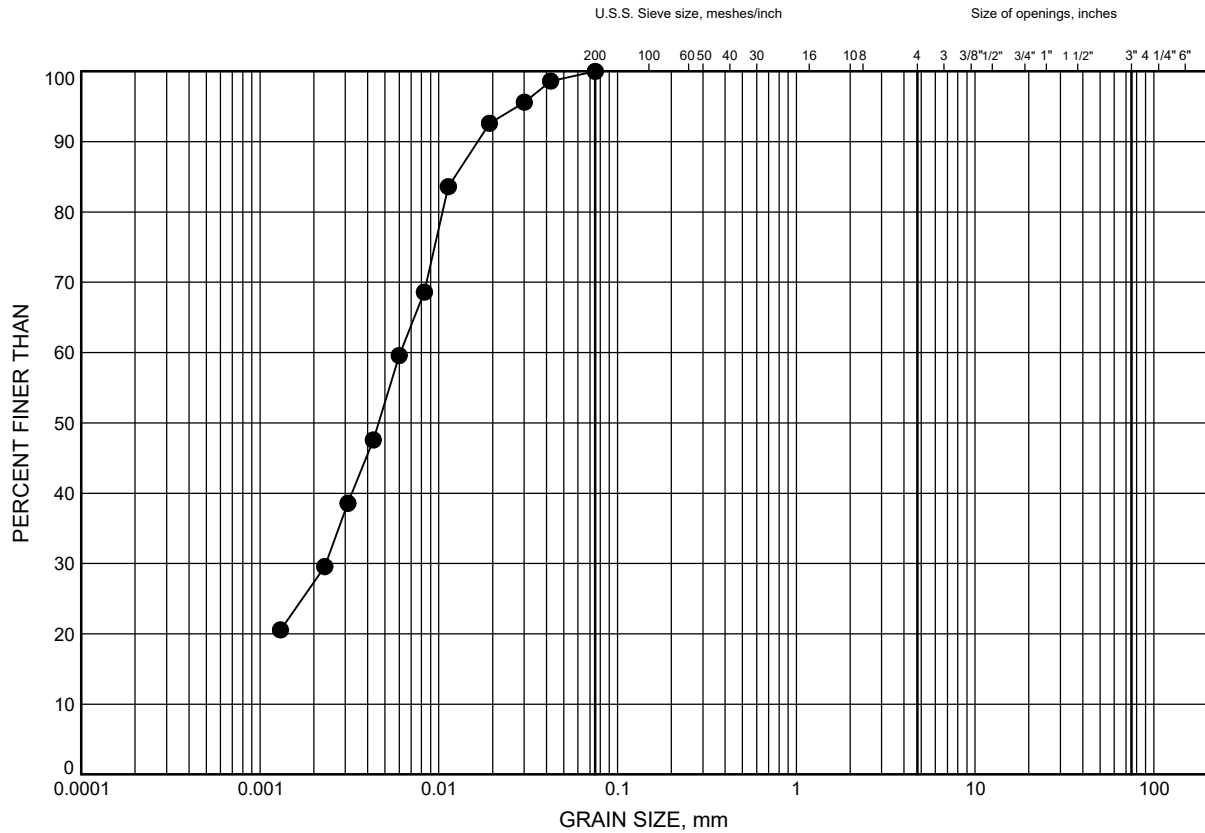
Prep'd AN

Chkd. GRL

# GRAIN SIZE DISTRIBUTION

FIGURE B2

## Clayey SILT



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	MMO 17-04	30.8	173.7

Date January 2018  
W.P. ....



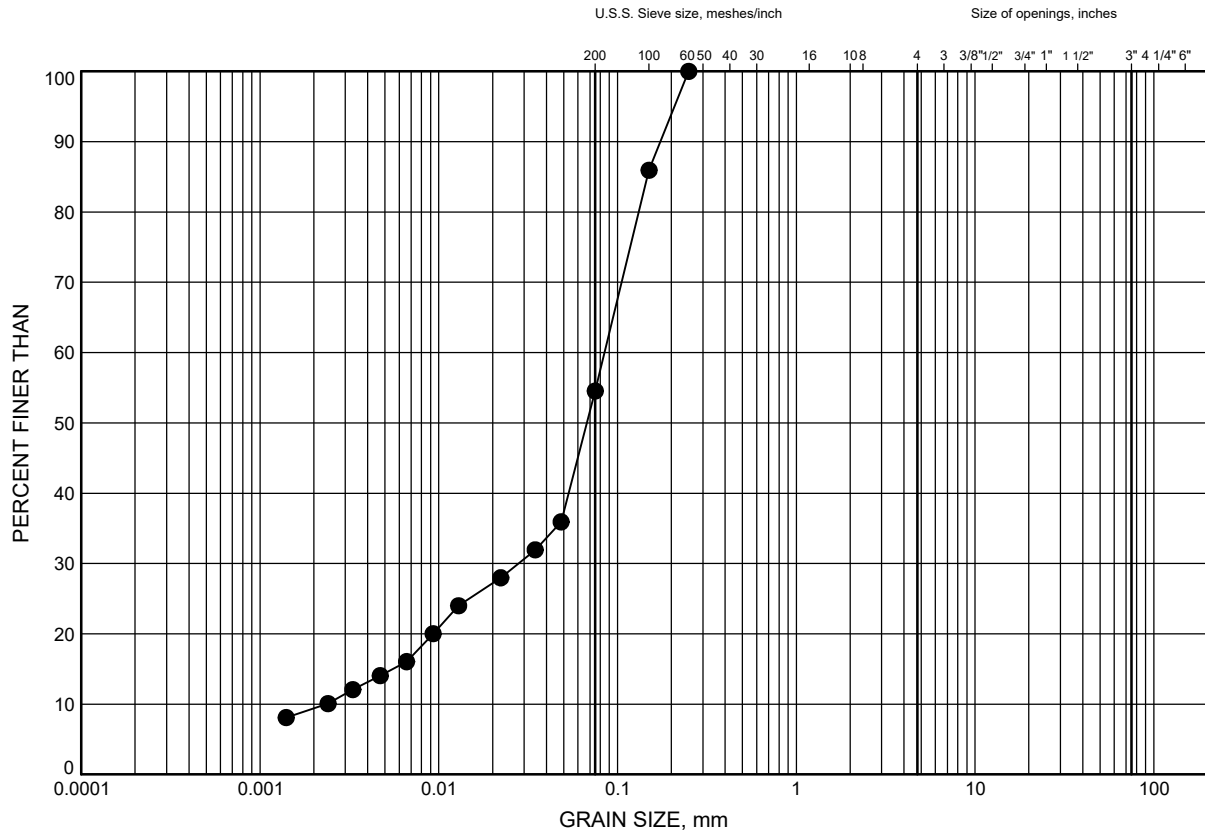
Prep'd AN  
Chkd. GRL



# GRAIN SIZE DISTRIBUTION

FIGURE B3

## SILT and SAND



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	MMO 17-03	46.0	158.7

Date January 2018  
W.P.

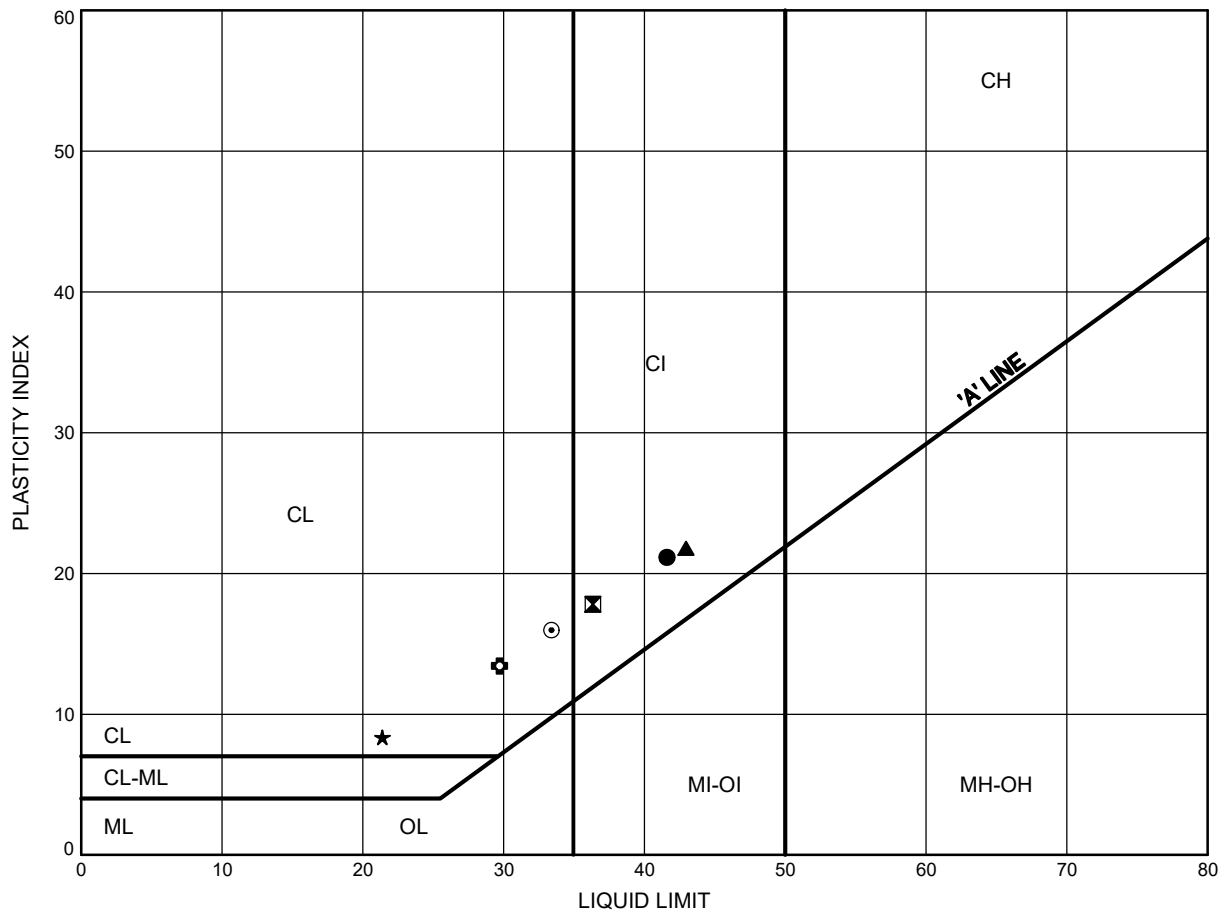


Prep'd AN  
Chkd. GRL

# ATTERBERG LIMITS TEST RESULTS

FIGURE B4

Clayey SILT to Silty CLAY TILL



## LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	MMO 17-01	4.9	199.9
⊠	MMO 17-02	2.6	202.3
▲	MMO 17-02	3.4	201.5
★	MMO 17-02	7.9	197.0
⊙	MMO 17-03	3.4	201.3
⊕	MMO 17-03	11.0	193.7

Date January 2018  
W.P. ....

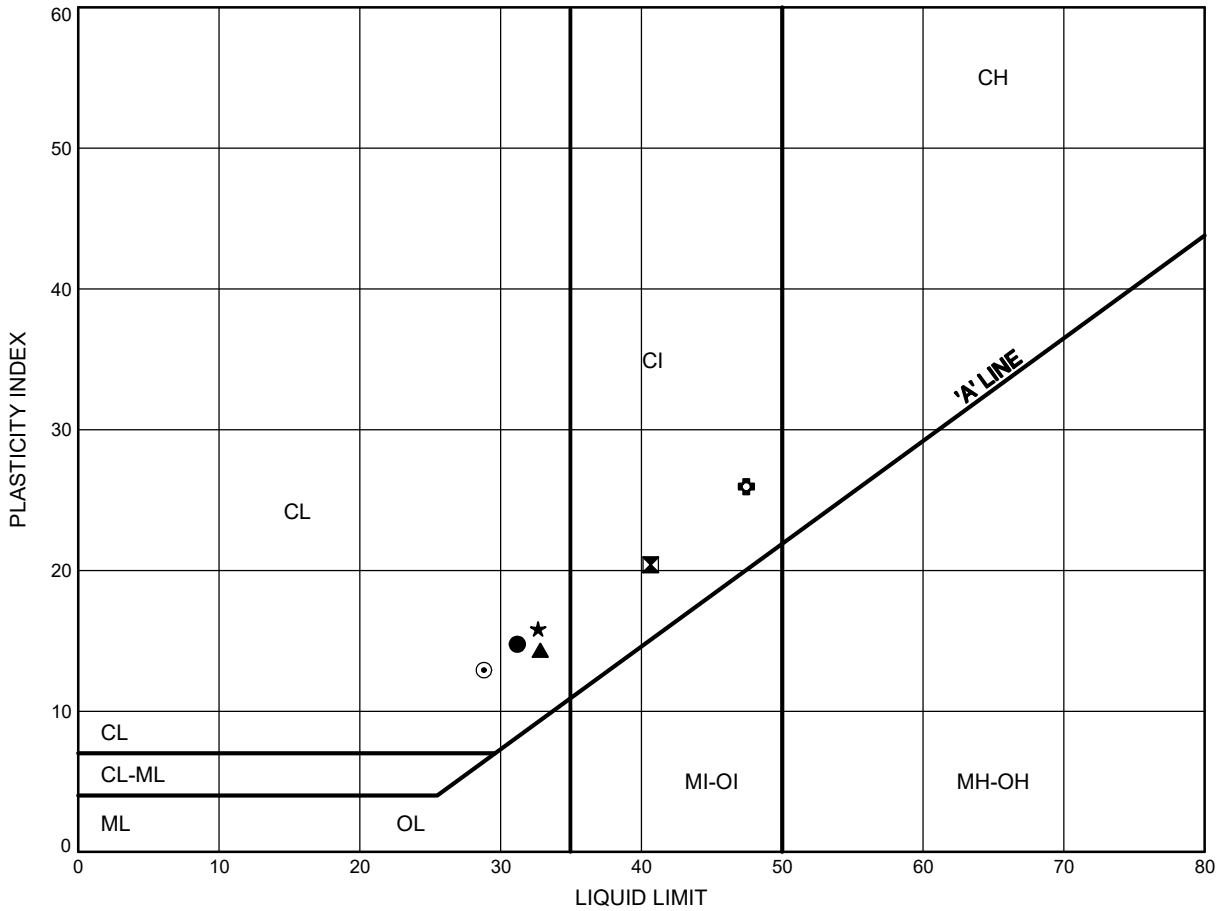


Prep'd AN  
Chkd. GRL

# ATTERBERG LIMITS TEST RESULTS

FIGURE B5

Clayey SILT to Silty CLAY TILL



## LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	MMO 17-04	2.6	201.9
⊠	MMO 17-04	4.9	199.6
▲	MMO 17-04	11.0	193.5
★	MMO 17-05	1.8	202.8
⊙	MMO 17-05	7.9	196.7
⊕	MMO 17-06	3.4	201.4

Date January 2018  
W.P. ....

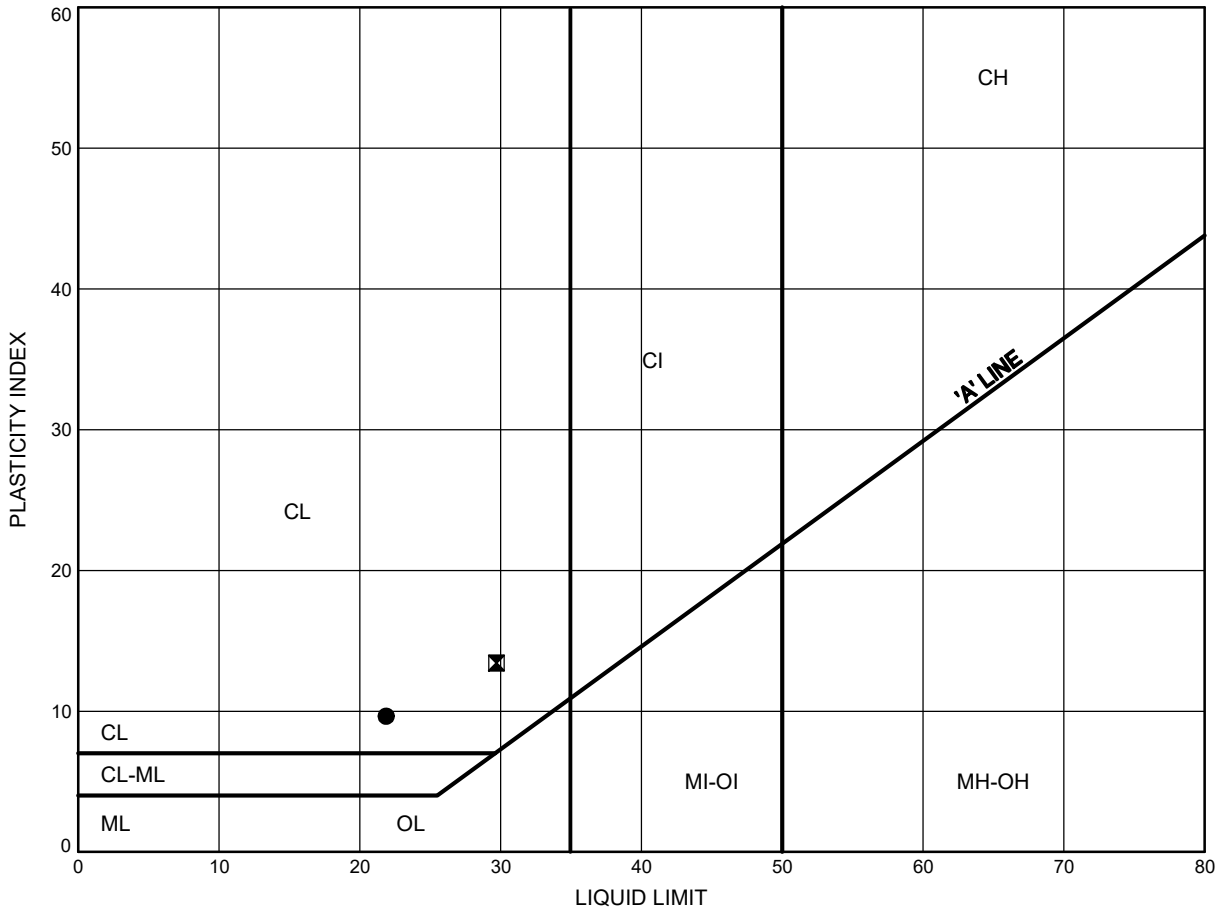


Prep'd AN  
Chkd. GRL

# ATTERBERG LIMITS TEST RESULTS

FIGURE B6

Clayey SILT to Silty CLAY TILL



## LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	MMO 17-06	7.9	196.9
⊠	MMO 17-07	6.4	198.4

Date January 2018  
W.P. ....

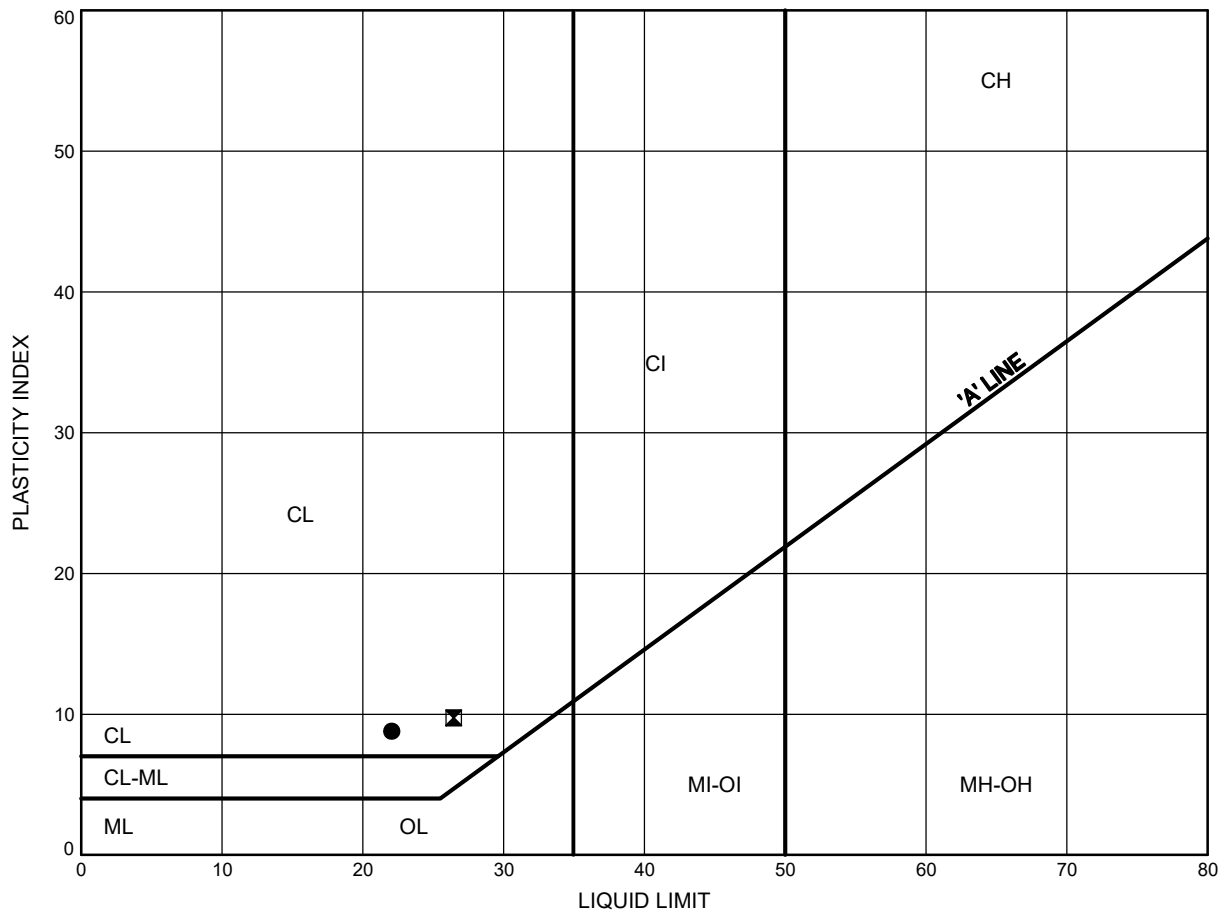


Prep'd AN  
Chkd. GRL

# ATTERBERG LIMITS TEST RESULTS

FIGURE B7

Clayey SILT



## LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	MMO 17-03	36.9	167.8
⊠	MMO 17-04	30.8	173.7

Date January 2018  
W.P. ....



Prep'd AN  
Chkd. GRL

## Certificate of Analysis

SGS Canada Inc.  
185 Concession St. Box 4300  
Lakefield, Ont., Canada, K0L 2H0



Client  
SGS LIMS Number  
Analysis Package:

Attention: Mohammad Eghtesadi  
Project#: 12307-427  
Thurber Engineering Ltd.  
CA14659-AUG17  
Corrosivity (Soil)

Sample ID	Unit	MMO 17-05, SS6(15-17)	MMO 17-03, SS6(5-7)
-----------	------	-----------------------	---------------------

Sample Date/Time		July-04-17	July-22-17
------------------	--	------------	------------

Moisture	%	17.2	17.7
pH	no unit	8.45	8.59
Corrosivity Index	none	5.5	4.0
Soil Redox Potential	mV	215	206
Sulphide	mg/L	0.23	<0.02
Chloride	mg/L	2.0	1.50
Sulphate	mg/L	510	53.0
Conductivity	uS/cm	401	125
Resistivity (calculated)	ohms.cm	2500	8000

Corrosivity Scale according to AWWA C-105.

An index greater than 10 indicates the  
soil matrix may be corrosive to cast iron alloys.

Deanna Edwards B.Sc., C.Chem  
Project Specialist  
Environment, Health and Safety

## Appendix C

### Record of Borehole Sheets – Previous Investigations

RECORD OF BOREHOLE No MMD-1      1 of 4      METRIC																	
G.W.P. _____		LOCATION      Coords: 4 853 836.0 N; 291 910.8 E				ORIGINATED BY    D.W.											
DIST    Central      HWY    427		BOREHOLE TYPE    Solid Stem Augers to 4.6m, then Mud Rotary and Tricone				COMPILED BY    N.L.											
DATUM    Geodetic		DATE      October 5 to 7, 2015				CHECKED BY    A.V.											
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						
204.9	Ground Surface																
0.0	TOPSOIL		1	SS	6												
0.3	CLAYEY SILT to SILTY CLAY, trace to some sand, trace gravel		2	SS	18												
	Firm to very stiff Brown becoming grey below a depth of 2.3m Moist		3	SS	15												
			4	SS	28												
			5	SS	20												
			6	SS	17												
			7	SS	21												
			8	SS	22												
197.8	SILT and SAND, trace clay, trace gravel		9	SS	41												
7.1	Dense Grey Moist  (TILL)		10	SS	40												
194.8	CLAYEY SILT, trace sand, trace gravel		11	SS	18												
10.1	Very stiff to hard Grey Moist  (TILL)		12	SS	23												
			13	SS	39												
189.9	Cont'd																

RECORD OF BOREHOLE No MMD-1      2 of 4      METRIC																	
G.W.P. _____		LOCATION      Coords: 4 853 836.0 N; 291 910.8 E				ORIGINATED BY    D.W.											
DIST    Central      HWY    427		BOREHOLE TYPE    Solid Stem Augers to 4.6m, then Mud Rotary and Tricone				COMPILED BY    N.L.											
DATUM    Geodetic		DATE      October 5 to 7, 2015				CHECKED BY    A.V.											
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						
189.9																	
15.0	CLAYEY SILT, trace sand, trace gravel		14	SS	39												
	Very stiff to hard Grey Moist  (TILL)																
			15	SS	58												
187.1	SANDY CLAYEY SILT, trace gravel		16	SS	75/13cm												
17.8	Hard Grey Moist  (TILL)																
			17	SS	117/28cm												
181.8	CLAYEY SILT, trace sand to sandy																
23.1	Stiff to hard Grey Moist to wet		18	SS	44												
			19	SS	27												
174.9	Cont'd																



RECORD OF BOREHOLE No MMD-1										3 of 4		METRIC		
G.W.P. _____		LOCATION _____		Coords: 4 853 836.0 N; 291 910.8 E				ORIGINATED BY D.W.						
DIST <u>Central</u> HWY <u>427</u>		BOREHOLE TYPE <u>Solid Stem Augers to 4.6m, then Mud Rotary and Tricone</u>		COMPILED BY N.L.										
DATUM <u>Geodetic</u>		DATE <u>October 5 to 7, 2015</u>		CHECKED BY A.V.										
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						
174.9														
30.0	(Cont'd) CLAYEY SILT, trace sand to sandy Stiff to hard Grey Moist to wet		20	SS	20		174							0 0 83 17
							173							
							172							
			21	SS	17		171							
							170							
							169							
			22	SS	13		168							
							167							
166.6							166							
38.3	SILT, trace clay Compact Grey Moist to wet		23*	SS	13		165							Hard drilling below a depth of 38.4m
							164							
							163							
			24	SS	18		162							1 10 82 7
							161							
159.9	Cont'd						160							







[illegible]

RECORD OF BOREHOLE No MMD-2      1 of 3      METRIC															
G.W.P. _____		LOCATION      Coords: 4 853 805.7 N; 291 861.1 E				ORIGINATED BY    D.W.									
DIST    Central      HWY    427		BOREHOLE TYPE    Solid Stem Augers to 4.6m, then Mud Rotary and Tricone				COMPILED BY    N.L.									
DATUM    Geodetic		DATE      October 7 and 8, 2015				CHECKED BY    A.V.									
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT			UNIT WEIGHT		REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	ELEVATION SCALE	SHEAR STRENGTH kPa			WATER CONTENT (%)			γ	GR SA SI CL	
204.5	Ground Surface						20 40 60 80 100	○ UNCONFINED    + FIELD VANE			w <sub>p</sub> w    w <sub>L</sub>				
0.0	TOPSOIL		1	SS	10	204	20 40 60 80 100	● QUICK TRIAXIAL    × LAB VANE			10 20 30				
204.2	SILTY CLAY, trace to some sand, trace gravel  Stiff to very stiff Brown becoming grey below a depth of 3.1m Moist		2	SS	16	203									3 17 35 45
0.3			3	SS	15	202									
			4	SS	28	201									
			5	SS	18	200									
			6	SS	17	199									
			7	SS	26	198									1 7 39 53
			8	SS	18	197									Hard drilling at a depth of 5.5m
			9	SS	10	196									
			10	SS	12	195									
			11	SS	13	194									
192.8	CLAYEY SILT, trace to with sand, trace gravel  Very stiff to hard Grey Moist  (TILL)		12	SS	22	193									4 26 52 18
11.7			13	SS	32	192									
						191									
189.5	Cont'd					190									

ON MTO\_NEW LOGO HWY 427 15TF013A-REV.GPJ ON\_MOT.GDT 14/01/2016 12:29:45 PM  
+ , X<sup>5</sup> : Numbers refer to Sensitivity 20 15 10 5 0 5 10 15 20 (%) STRAIN AT FAILURE


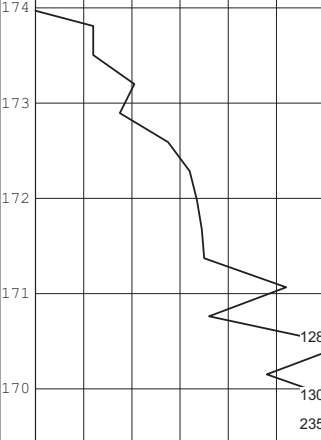
RECORD OF BOREHOLE No MMD-2      2 of 3      METRIC															
G.W.P. _____		LOCATION      Coords: 4 853 805.7 N; 291 861.1 E				ORIGINATED BY    D.W.									
DIST    Central      HWY    427		BOREHOLE TYPE    Solid Stem Augers to 4.6m, then Mud Rotary and Tricone				COMPILED BY    N.L.									
DATUM    Geodetic		DATE      October 7 and 8, 2015				CHECKED BY    A.V.									
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT			UNIT WEIGHT		REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	ELEVATION SCALE	SHEAR STRENGTH kPa			WATER CONTENT (%)			γ	GR SA SI CL	
189.5	CLAYEY SILT, trace to with sand, trace gravel  Very stiff to hard Grey Moist  (TILL)		14	SS	103	189	20 40 60 80 100	○ UNCONFINED    + FIELD VANE			w <sub>p</sub> w    w <sub>L</sub>				
15.0			15	SS	34	188									0 2 73 25
			16	SS	92	187									
			17	SS	36	186									
			18	SS	42	185									
			19	SS	26	184									
						183									Hard drilling at a depth of 21.8m
						182									
						181									
						180									0 3 73 24
178.4	CLAYEY SILT  Very stiff Grey Moist				179										
26.1					178										
					177										
174.5	Cont'd					176									

ON MTO\_NEW LOGO HWY 427 15TF013A-REV.GPJ ON\_MOT.GDT 14/01/2016 12:29:45 PM  
+ , X<sup>5</sup> : Numbers refer to Sensitivity 20 15 10 5 0 5 10 15 20 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No MMD-2										3 of 3		METRIC										
G.W.P.		LOCATION		Coords: 4 853 805.7 N; 291 861.1 E				ORIGINATED BY D.W.														
DIST Central		HWY 427		BOREHOLE TYPE Solid Stem Augers to 4.6m, then Mud Rotary and Tricone				COMPILED BY N.L.														
DATUM Geodetic		DATE		October 7 and 8, 2015				CHECKED BY A.V.														
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 (%)							
174.5																						
30.0	CLAYEY SILT (Cont'd)																					
173.6	Very stiff Grey Moist		20	SS	19																	
30.9	Switched to Dynamic Cone Penetration Test																					
167.3																						
37.2	End of Dynamic Cone Penetration Test																					
<p>Monitoring Well Legend:</p> <p> Bentonite seal</p> <p> Native</p> <p> Filter sand</p> <p> 50mm dia. screen</p> <p> Bentonite</p> <p> Water level measured in piezometer</p> <p>Notes:</p> <p>1. Groundwater level cannot be measured upon completion of drilling due to utilization of mud rotary drilling technique.</p> <p>Monitoring Well Readings:</p> <table border="1"> <thead> <tr> <th>Date</th> <th>Depth (m)</th> <th>Elev. (m)</th> </tr> </thead> <tbody> <tr> <td>16/11/15</td> <td>10.2</td> <td>194.3</td> </tr> <tr> <td>23/12/15</td> <td>9.3</td> <td>195.2</td> </tr> </tbody> </table>														Date	Depth (m)	Elev. (m)	16/11/15	10.2	194.3	23/12/15	9.3	195.2
Date	Depth (m)	Elev. (m)																				
16/11/15	10.2	194.3																				
23/12/15	9.3	195.2																				

RECORD OF BOREHOLE No MMD-3										1	of 3	METRIC			
G.W.P.		LOCATION		Coords: 4 853 879.3 N; 291 858.6 E				ORIGINATED BY			D.W.				
DIST		HWY		BOREHOLE TYPE		Solid Stem Augers to 4.6m, then Mud Rotary and Tricone				COMPILED BY		N.L.			
DATUM		Geodetic		DATE		October 8 and 9, 2015				CHECKED BY		A.V.			
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 (%)						
204.9	Ground Surface														
0.0	TOPSOIL														
204.6															
0.3	SAND, trace silt		1	SS	6										
204.1	Loose														
0.8	Brown		2	SS	17										
	Moist														
	SILTY CLAY, trace sand														
	Very stiff														
	Brown becoming grey below		3	SS	17										
	2.3m														
	Moist														
			4	SS	25										
			5	SS	16										
			6	SS	15										
			7	SS	20										
199.3															
5.6	CLAYEY SILT, some sand, trace gravel														
	Stiff to hard														
	Grey		8	SS	12										
	Moist to wet														
	(TILL)														
			9	SS	15										
			10	SS	12										
			11	SS	11										
			12	SS	11</										

[illegible]

RECORD OF BOREHOLE No MMD-3							3 of 3		METRIC						
G.W.P.	LOCATION Coords: 4 853 879.3 N; 291 858.6 E						ORIGINATED BY D.W.								
DIST Central HWY 427	BOREHOLE TYPE Solid Stem Augers to 4.6m, then Mud Rotary and Tricone						COMPILED BY N.L.								
DATUM Geodetic	DATE October 8 and 9, 2015						CHECKED BY A.V.								
SOIL PROFILE				SAMPLES											
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	* 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 (%)	
174.9								SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE						GR SA SI CL	
174.0 30.9	Switched to Dynamic Cone Penetration Test		20	SS	17		174								
169.2 35.7	End of Dynamic Cone Penetration Test						170								
Notes: 1. Groundwater level cannot be measured upon completion of drilling due to utilization of mud rotary drilling technique.															

[illegible]

RECORD OF BOREHOLE No MMD-4						2 of 4		METRIC						
G.W.P.	LOCATION			Coords: 4 853 841.2 N; 291 818.4 E			ORIGINATED BY D.W.							
DIST Central HWY 427	BOREHOLE TYPE Solid Stem Augers to 4.6m, then Mud Rotary and Tricone			COMPILED BY N.L.										
DATUM Geodetic	DATE October 13 and 14, 2015			CHECKED BY A.V.										
SOIL PROFILE			SAMPLES											
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	* GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT  SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
189.7 15.0	(Cont'd) CLAYEY SILT, some sand, trace gravel  Stiff to hard Grey Moist  (TILL)		14	SS	41		189			o				
							188			o				
			15	SS	47		187							
			16	SS	96		186			—o—				Hard drilling at a depth of 17.7m 7 14 58 21
							185							
							184							Hard drilling at a depth of 19.8m
			17	SS	75/10cm		183			o				Sampler bouncing
							182							
							181							
			18	SS	38		180			o				
							179							
178.6 26.1	SILT, trace sand, trace clay  Compact Grey Moist to wet						178							
			19	SS	20		177			non-plastic				0 7 85 8
							176							
174.7	Cont'd						175							

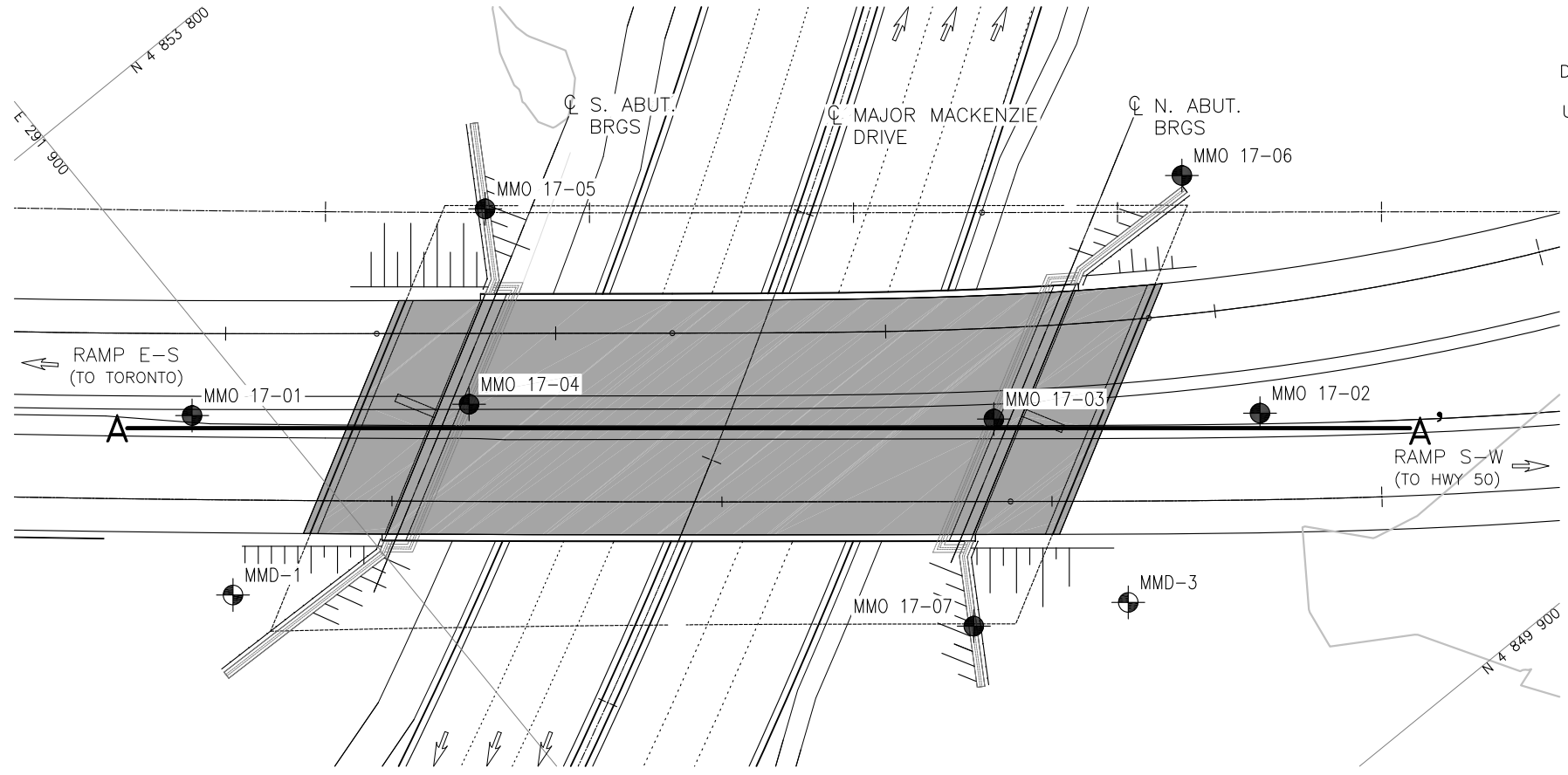
RECORD OF BOREHOLE No MMD-4      3 of 4      METRIC																			
G.W.P. _____		LOCATION      Coords: 4 853 841.2 N; 291 818.4 E										ORIGINATED BY      D.W.							
DIST      Central      HWY      427		BOREHOLE TYPE      Solid Stem Augers to 4.6m, then Mud Rotary and Tricone										COMPILED BY      N.L.							
DATUM      Geodetic		DATE      October 13 and 14, 2015										CHECKED BY      A.V.							
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS *	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED      + FIELD VANE ● QUICK TRIAXIAL      × LAB VANE				WATER CONTENT (%)				GR	SA	SI	CL
174.7 30.0	CLAYEY SILT, trace sand  Stiff to very stiff Grey Moist to wet																		
			20	SS	17		174												
							173												
							172												
			21	SS	15		171												
							170												
							169												
			22	SS	16		168												
							167												
							166												
			23	SS	13		165												
							164												
							163												
			24	SS	27		162												
							161												
							160												
159.7	Cont'd																		

RECORD OF BOREHOLE No MMD-4      4 of 4      METRIC																			
G.W.P. _____		LOCATION      Coords: 4 853 841.2 N; 291 818.4 E										ORIGINATED BY      D.W.							
DIST      Central      HWY      427		BOREHOLE TYPE      Solid Stem Augers to 4.6m, then Mud Rotary and Tricone										COMPILED BY      N.L.							
DATUM      Geodetic		DATE      October 13 and 14, 2015										CHECKED BY      A.V.							
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS *	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED      + FIELD VANE ● QUICK TRIAXIAL      × LAB VANE				WATER CONTENT (%)				GR	SA	SI	CL
45.0	(Cont'd) CLAYEY SILT, trace sand  Stiff to very stiff Grey Moist																		
			25	SS	30		159												
							158												
157.9 46.8	SAND and Gravel, trace silt  Very dense Grey Moist						157												
			26	SS	68		156												
							155												
							154												
154.2 50.5	SHALE BEDROCK  Highly weathered Grey						153												
			27	SS	75/8cm		152												
							151												
							150												
			28	SS	72/5cm		149												
							148												
147.1 57.6	End of borehole  * no recovery in split-spoon sampler  Notes:  1. Groundwater level cannot be measured upon completion of drilling due to the utilization of mud rotary drilling technique		29	SS	100/3cm														

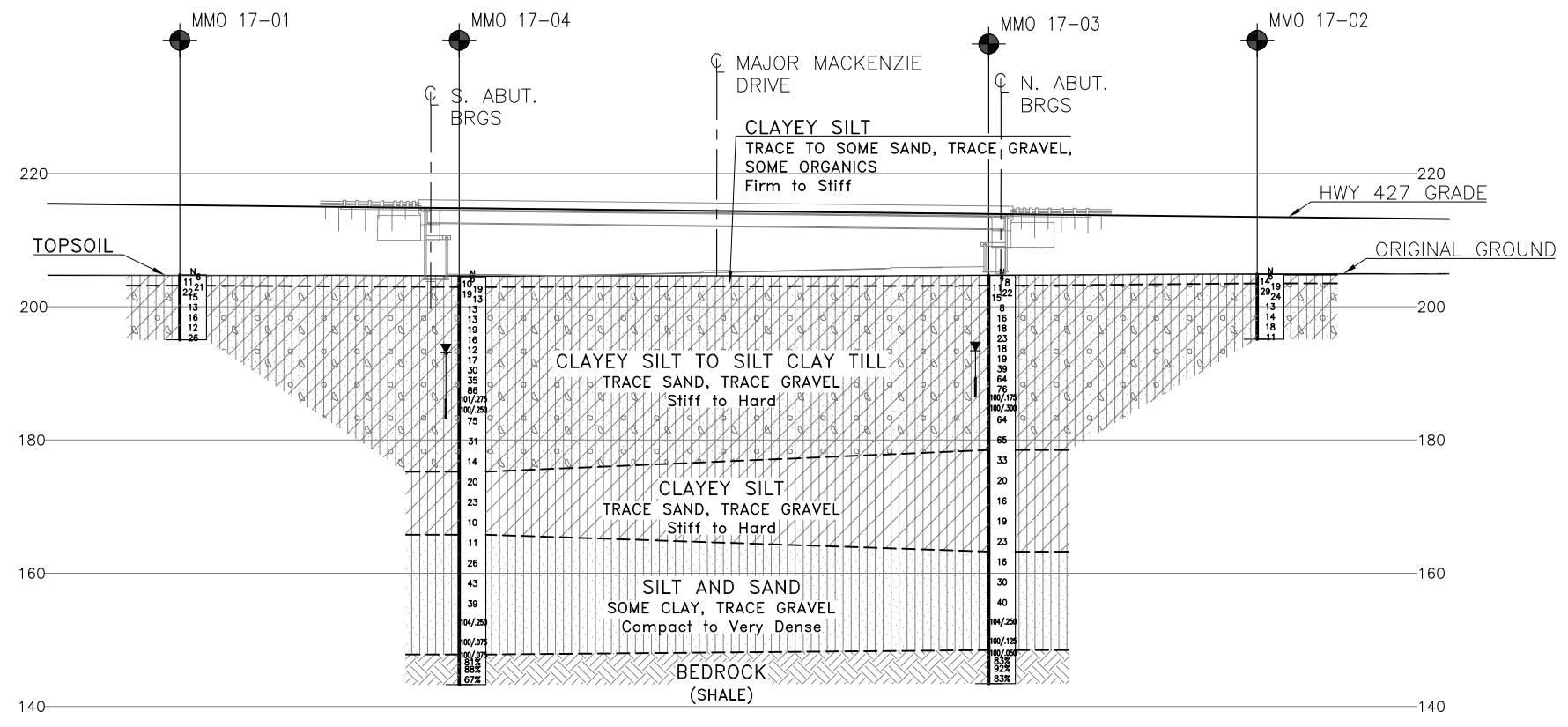
## Appendix D

### Borehole Locations and Soil Strata Drawings



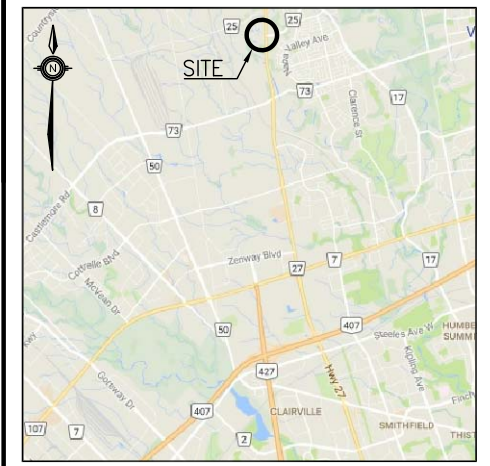


PLAN



PROFILE ALONG A-A'

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



KEYPLAN

LEGEND

	Borehole (By Thurber)
	Borehole (By Others)
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
	Water Level
	Head Artesian Water
	Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
MMD-1	204.9	4 853 836.0	291 910.8
MMD-3	204.9	4 853 879.3	291 858.6
MMO 17-01	204.8	4 853 823.5	291 904.6
MMO 17-02	204.9	4 853 874.5	291 841.8
MMO 17-03	204.7	4 853 862.1	291 857.7
MMO 17-04	204.5	4 853 836.1	291 887.8
MMO 17-05	204.6	4 853 825.4	291 877.5
MMO 17-06	204.8	4 853 856.8	291 835.0
MMO 17-07	204.8	4 853 873.3	291 868.8

-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.

GEOCRIS No.

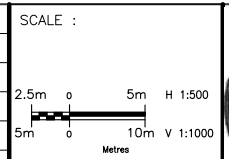
Hwy 427 Expansion  
Hwy 427 NBL and SBL at  
Major Mackenzie Drive Overpass

BOREHOLE LOCATIONS AND SOIL STRATA

PROJECT ID.	STAGE IDENTIFIER	DESIGN PACKAGE NUMBER	DISCIPLINE	STRUCTURE NUMBER	DOCUMENT TYPE	DRAWING NUMBER	REVISION NUMBER
H427-D	I	5	STR	B18	DWG	701	0

FILENAME: H:\Drafting\19000\19484\1ED19484-PLR-Hwy 427 OverMajorMackenzie.dwg  
PLOTDATE: 7/17/2019 4:09 PM

NO.	DATE	REVISIONS	BY	CHK	LEAD	PROJ. MGR.
0	19/07/18	ISSUED FOR CONSTRUCTION	AN	KS	JL	JL



DESIGNED	G. LAY	GL	19/07/18
DRAWN	A. NOOR	AN	19/07/18
CHECKED	K. SHI	KS	19/07/18
APPROVED LEAD ENGINEER	J. LEE	JL	19/07/18
APPROVED PROJ. MANAGER	J. LEE	JL	19/07/18
NAME (PRINT)	INIT.	DATE	





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



KEYPLAN

LEGEND

	Borehole (By Thurber)
	Borehole (By Others)
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
	Water Level
	Head Artesian Water
	Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
MMD-1	204.9	4 853 836.0	291 910.8
MMD-3	204.9	4 853 879.3	291 858.6
MMO 17-01	204.8	4 853 823.5	291 904.6
MMO 17-02	204.9	4 853 874.5	291 841.8
MMO 17-03	204.7	4 853 862.1	291 857.7
MMO 17-04	204.5	4 853 836.1	291 887.8
MMO 17-05	204.6	4 853 825.4	291 877.5
MMO 17-06	204.8	4 853 856.8	291 835.0
MMO 17-07	204.8	4 853 873.3	291 868.8

-NOTES-

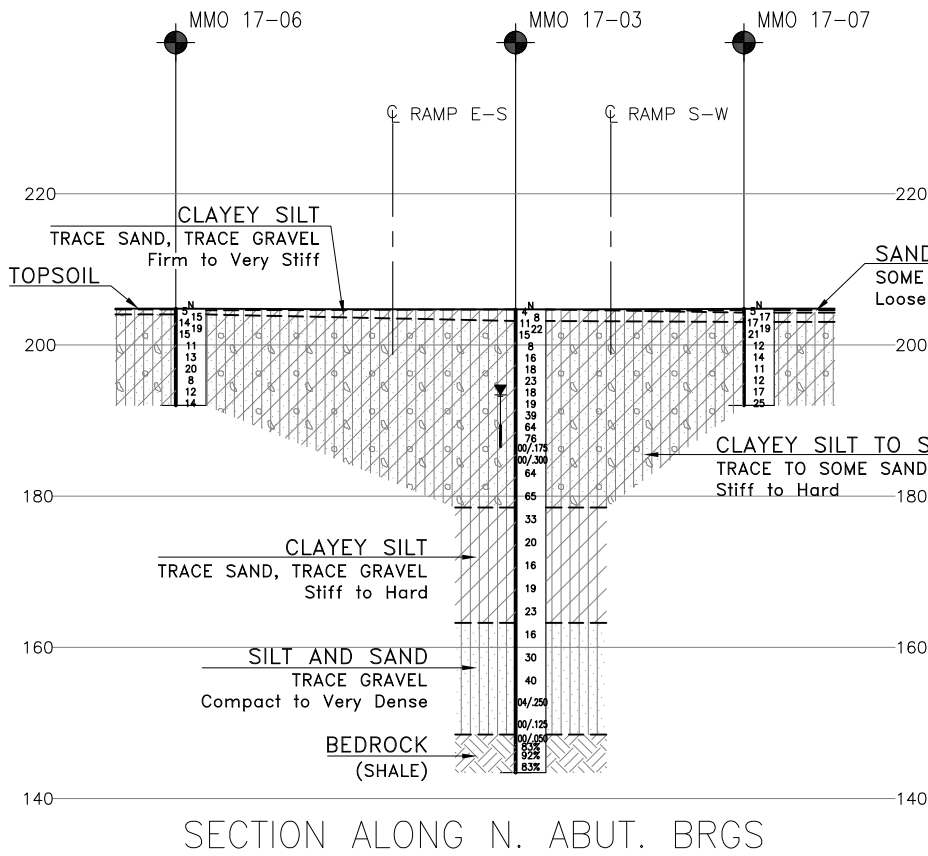
- The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
- This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

GEOCRES No.

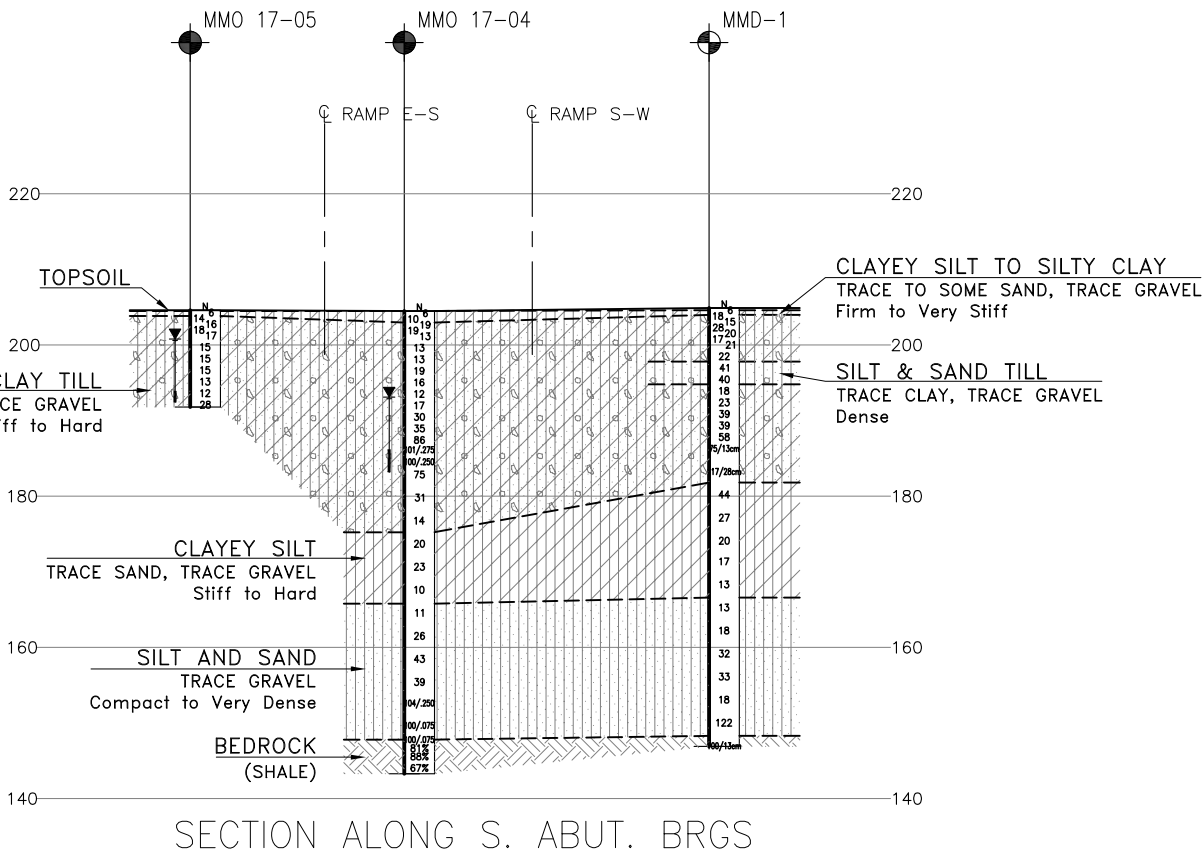
HWY 427 EXPANSION  
HWY 427 NBL AND SBL AT  
MAJOR MACKENZIE DRIVE OVERPASS

BOREHOLE LOCATIONS AND SOIL STRATA

PROJECT ID.	STAGE IDENTIFIER	DESIGN PACKAGE NUMBER	DISCIPLINE	STRUCTURE NUMBER	DOCUMENT TYPE	DRAWING NUMBER	REVISION NUMBER
H427-D	I	5	STR	B18	DWG	702	0



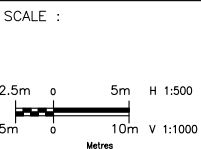
SECTION ALONG N. ABUT. BRGS



SECTION ALONG S. ABUT. BRGS

FILENAME: H:\Drafting\19000\19484\1ED19484-PLR-HWY 427 OverMajorMackenzie.dwg  
PLOT DATE: 7/17/2019 4:10 PM

NO.	DATE	REVISIONS	BY	CHK	LEAD DES.	PROJ. MGR.
0	19/07/18	ISSUED FOR CONSTRUCTION	AN	KS	JL	JL



DESIGNED	G. LAY	GL	19/07/18
DRAWN	A. NOOR	AN	19/07/18
CHECKED	K. SHI	KS	19/07/18
APPROVED LEAD ENGINEER	J. LEE	JL	19/07/18
APPROVED PROJ. MANAGER	J. LEE	JL	19/07/18
NAME (PRINT)	INIT.	DATE	



TITLE							
HWY 427 EXPANSION HWY 427 NBL AND SBL AT MAJOR MACKENZIE DRIVE OVERPASS							
BOREHOLE LOCATIONS AND SOIL STRATA							
PROJECT ID.	STAGE IDENTIFIER	DESIGN PACKAGE NUMBER	DISCIPLINE	STRUCTURE NUMBER	DOCUMENT TYPE	DRAWING NUMBER	REVISION NUMBER
H427-D	I	5	STR	B18	DWG	702	0

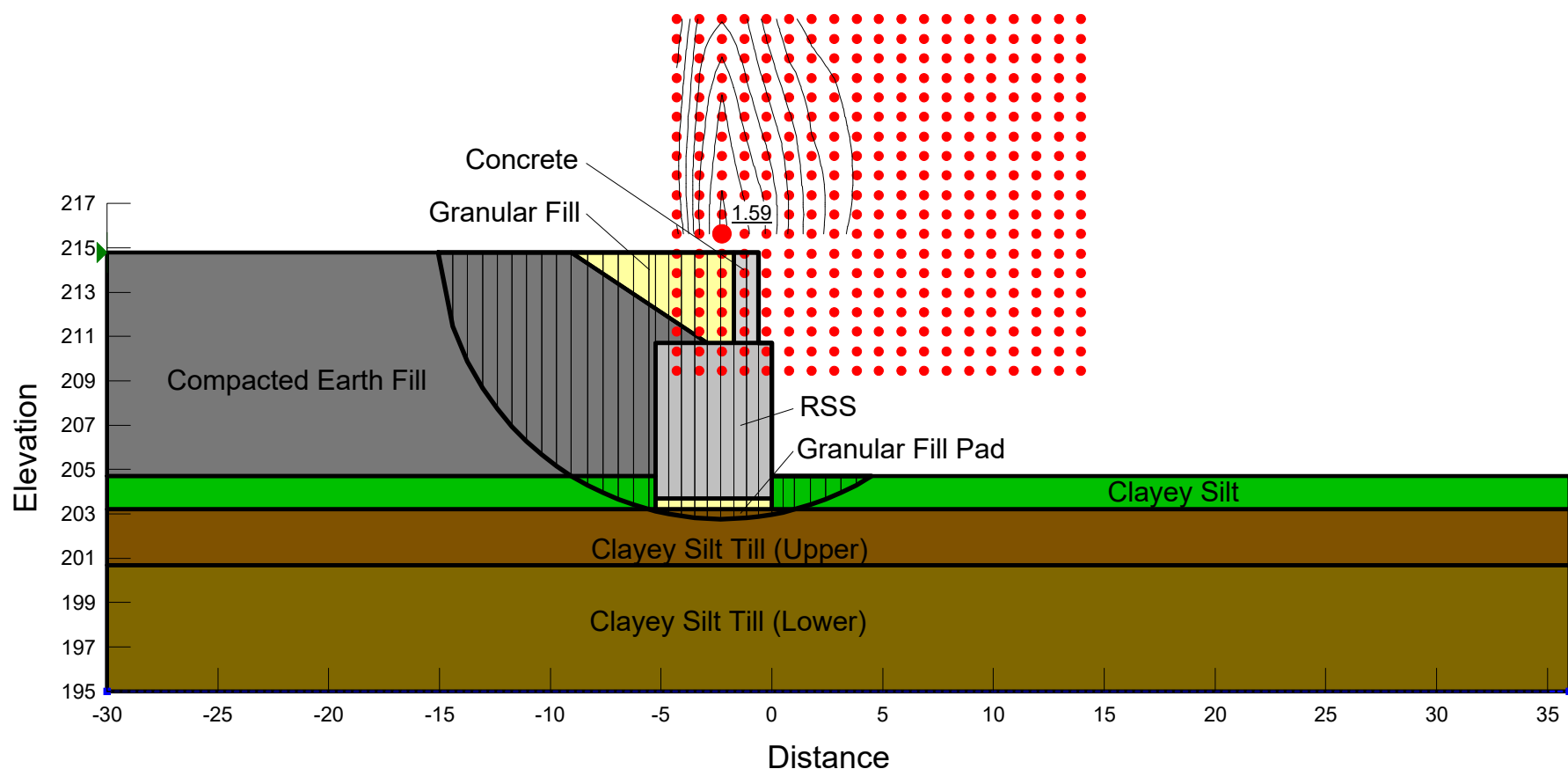
## Appendix E

### Stability Analysis Output for Approach Embankments

# **MAJOR MACKENZIE OVERPASS RSS WALL SHORT-TERM CONDITION**

File Name: MMO Critical RSS Section (Short Term)\_1mdepth.gsz  
 Last Edited By: Geoff Lay  
 Date: 4/9/2018  
 Method: Morgenstern-Price, Half Sine  
 Minimum Slip Surface Depth: 1 m  
 Seismic: 0

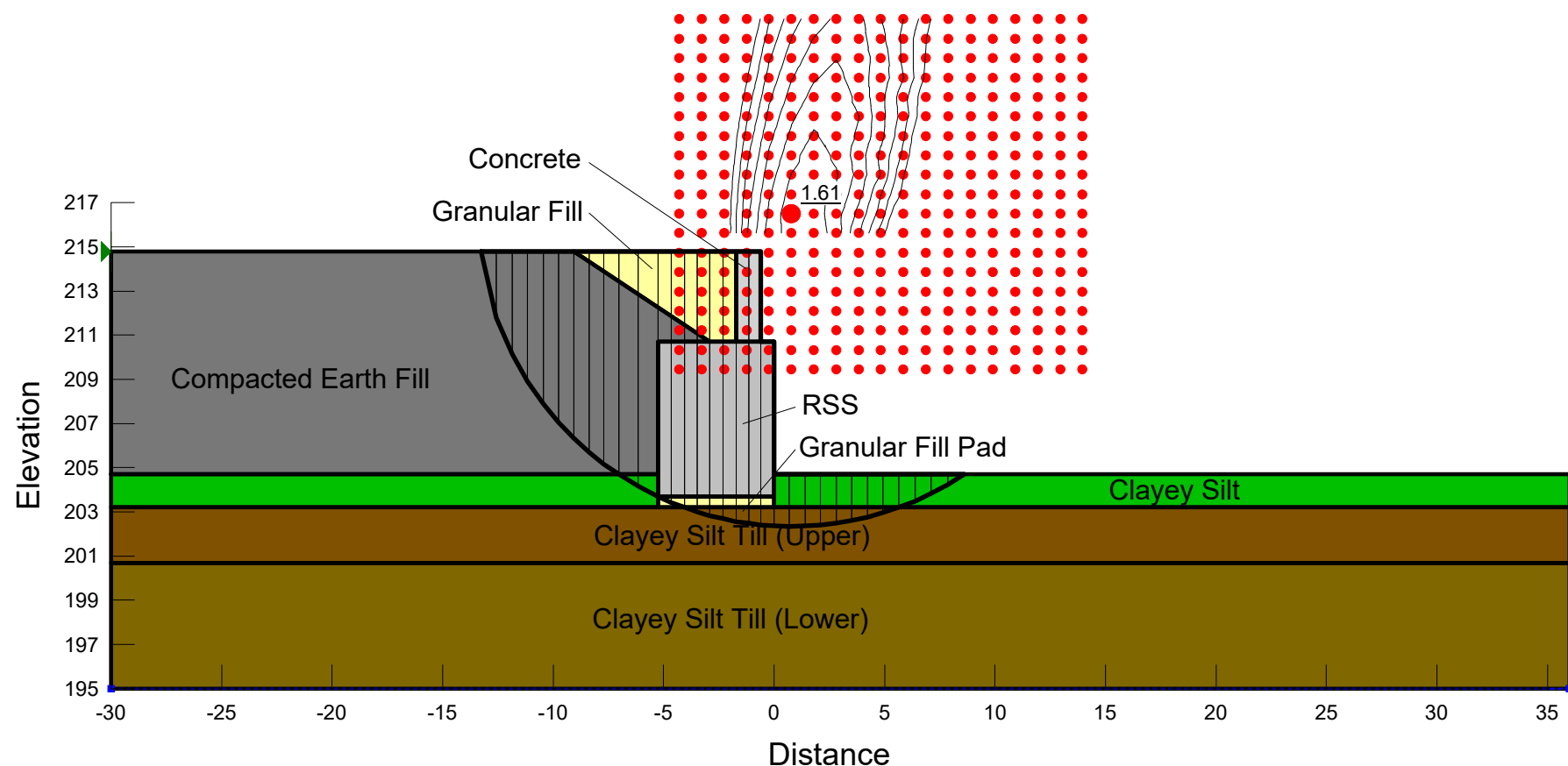
Compacted Earth Fill	20 kN/m <sup>3</sup>	0 kPa	30 °
Clayey Silt	18 kN/m <sup>3</sup>	50 kPa	0 °
Clayey Silt Till (upper)	21 kN/m <sup>3</sup>	100 kPa	0 °
Clayey Silt Till (lower)	20 kN/m <sup>3</sup>	75 kPa	0 °
Granular Fill	21 kN/m <sup>3</sup>	0 kPa	35 °
Concrete	1 kN/m <sup>3</sup>	1,000 kPa	0 °
RSS	22 kN/m <sup>3</sup>	200 kPa	34 °



# **MAJOR MACKENZIE OVERPASS RSS WALL LONG-TERM CONDITION**

File Name: MMO Critical RSS Section (Long Term)\_1mdepth.gsz  
 Last Edited By: Geoff Lay  
 Date: 4/9/2018  
 Method: Morgenstern-Price, Half Sine  
 Minimum Slip Surface Depth: 1 m  
 Seismic: 0

Compacted Earth Fill	20 kN/m <sup>3</sup>	0 kPa	30 °
Clayey Silt	18 kN/m <sup>3</sup>	5 kPa	30 °
Clayey Silt Till (upper)	21 kN/m <sup>3</sup>	0 kPa	32 °
Clayey Silt Till (lower)	20 kN/m <sup>3</sup>	0 kPa	31 °
Granular Fill	21 kN/m <sup>3</sup>	0 kPa	35 °
Concrete	1 kN/m <sup>3</sup>	1,000 kPa	0 °
RSS	22 kN/m <sup>3</sup>	200 kPa	34 °



# **MAJOR MACKENZIE OVERPASS RSS WALL SEISMIC CONDITION**

File Name: MMO Critical RSS Section (Seismic)\_1mdepth.gsz  
 Last Edited By: Geoff Lay  
 Date: 4/9/2018  
 Method: Morgenstern-Price, Half Sine  
 Minimum Slip Surface Depth: 1 m  
 Seismic: 0.055g

Compacted Earth Fill	20 kN/m <sup>3</sup>	0 kPa	30 °
Clayey Silt	18 kN/m <sup>3</sup>	50 kPa	0 °
Clayey Silt Till (upper)	21 kN/m <sup>3</sup>	100 kPa	0 °
Clayey Silt Till (lower)	20 kN/m <sup>3</sup>	75 kPa	0 °
Granular Fill	21 kN/m <sup>3</sup>	0 kPa	35 °
Concrete	1 kN/m <sup>3</sup>	1,000 kPa	0 °
RSS	22 kN/m <sup>3</sup>	200 kPa	34 °

